Technical Specifications for Wastewater Treatment System Upgrade

Mountaire Farms of Delaware, Inc.
Millsboro, Delaware

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### APPENDIX No. 1 – PUMP CURVES
SECTION 02 20 01
SITE CONDITIONS

PART 1 GENERAL

1.01 SUBSURFACE INFORMATION

A. A report of subsurface exploration at particular locations in the area of the work has been conducted. The report identifies properties of below grade conditions at the locations and at the time that the borings were conducted.

B. This report, by its nature, cannot reveal all conditions that exist on the site. Should subsurface conditions be found to vary substantially from this report, changes in the design and construction of foundations may be made.

C. Geotechnical report data are not considered all conclusive and it is the Contractor's responsibility to further investigate site conditions as he determines necessary and at his own expense.

1.02 SITE INVESTIGATION AND REPRESENTATION

A. It is the Contractor's responsibility that he completely satisfy himself as to the nature and location of the work; the general and local conditions, particularly those related to the availability of transportation, disposal, handling and storage of materials, availability of labor, water, electric power, roads, and uncertainties of weather, river/stream stages, or similar physical conditions at the site; the current and potential conditions of the ground; the type and quantity of equipment and facilities needed prior to and during the execution of the Work and all other matters and conditions which can in any way affect the work or the associated costs required by this Contract.

B. It is also the responsibility of the Contractor that he completely satisfy himself with regard to the character, quality, and quantity of surface and subsurface materials to be encountered from inspecting the site and from evaluating information provided by the Owner in the geotechnical report, as well as from information presented within these Contract Documents. Any failure by the Contractor to acquaint himself with all the available information will not relieve him from his duty to properly estimate the difficulty or cost of successfully performing the work. Neither the Owner nor the Engineer assume responsibility for any conclusion or interpretation made by the Contractor on the basis of the information made available by the Owner or the Engineer.

1.03 RESPONSIBILITY FOR UTILITY PROPERTIES AND SERVICE

A. Utilities and structures which are known to be adjacent to or in the area of the work are shown on the Drawings. The locations shown are taken from existing records, the best information available from existing plans, and survey information; however, the Contractor shall anticipate deviations and omissions in the actual locations and types and quantities of utilities and structures shown. Those shown are for the convenience of the Contractor only, and no responsibility is assumed by either the Owner or the Engineer for their accuracy or completeness.

B. The Contractor shall at all times provide unobstructed access to fire hydrants, underground conduit, manholes, and water or gas valve boxes.

C. The Contractor shall notify all utility offices that are affected by the work at least fifteen (15) days prior to starting construction operations. The Contractor shall not expose any utility without first obtaining permission from the affected agency. Once permission has been granted, locate and, if necessary, expose and provide temporary support for all existing underground utilities in advance of operations.

D. When existing utility lines or structures are located such that they physically conflict with permanent structures to be constructed under this Contract, the utility line or structure shall be permanently relocated. Such relocations shall be considered as required by this Contract.
E. The Contractor shall give immediate notice to the Engineer, the Owner and the owner of the utility (where applicable) when a physical conflict is determined to exist. Any delays resulting from the required relocations of the utilities are the responsibility of the Contractor.

F. Where existing utility lines or structures are so located as to interfere with the Contractor’s prosecution of the work, but do not physically conflict with completed manholes or other permanent structures to be constructed under this Contract, any modification, alteration, or relocation of interfering utility, either permanent or temporary, shall be accomplished at the expense of the Contractor.

G. When notified by the Contractor that an interference or conflict has been determined to exist, the Engineer will determine whether such interference shall be considered as required by construction or as incidental to construction.

1.04 INTERFERING STRUCTURES

A. The Contractor shall take all necessary precautions to prevent damage to existing structures whether on the surface, aboveground, or underground. An attempt has been made to show major structures on the Plans. While the information has been compiled from the best available sources, the completeness and accuracy of the Plans cannot be guaranteed, and it is given as a guide to avoid known possible difficulties.

B. The Contractor shall protect existing structures from damage, whether or not they lie within the right-of-way or the limits of the easements obtained by the Owner. Where existing structures must be removed to properly conduct the work, or are damaged during the work, they shall be restored at the Contractor’s own expense to at least their original condition and to the satisfaction of the Engineer.

C. The Contractor may, with the approval of the Engineer and without additional compensation, remove and replace in a condition as good as or better than original, any small interfering structures such as fences and signposts that interfere with the Contractor’s operations.

1.05 FIELD RELOCATION

A. During the progress of the work, minor relocations of the work may be necessary. Such relocations shall be made only by direction of the Engineer. If existing structures are encountered that will prevent construction as shown, notify the Engineer before continuing with the work in order that the Engineer may make such field revisions as necessary to avoid conflict with the existing structures. Failure to notify the Engineer when an existing structure is encountered and the work proceeds in spite of this interference, the Contractor shall be responsible for any damage that may occur.

1.06 DIFFERING SITE CONDITIONS

A. If the existing site conditions materially differ than what is represented on the Drawings, the contractor shall notify the Owner and Engineer immediately. If the differences will result in the contractor submitting a change order for additional Work, the contractor shall be responsible for obtaining additional topographic and/or utility surveys of the existing conditions to fully substantiate his claim for additional Work. Surveys shall be signed by a licensed land surveyor in the state where the project is located.

1.07 PAYMENT

A. The work specified in this Section shall be considered incidental and payment will be included as part of the appropriate lump sum specified in the Contract Documents.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION
SECTION 03 20 00
CONCRETE REINFORCEMENT

PART 1 GENERAL

1.01 SCOPE OF WORK
   A. Furnish all labor, materials, equipment, and incidentals for concrete reinforcement to complete the Work as indicated on the Drawings and as specified herein.
   B. The material specified herein shall comply with the American Iron and Steel provision of the Clean Water Act as it applies to the State Revolving Loan Funds and as administered by the State of Delaware. It is the Contractor's responsibility to determine if the Approved Manufacturers comply with the requirements of the provision.

1.02 RELATED SECTIONS
   A. Section 01 30 00 - Administrative Requirements.
   B. Section 01 40 00 - Quality Requirements.
   C. Section 03 30 00 - Cast-in-Place Concrete.

1.03 REFERENCES
   A. ACI 301 - Specifications for Structural Concrete for Buildings; American Concrete Institute International; 2010.
   B. ACI 318 - Building Code Requirements For Structural Concrete and Commentary; American Concrete Institute International; 2011.
   C. ACI SP-66 - ACI Detailing Manual; American Concrete Institute International; 2004.
   F. ASTM A 615/A 615M - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement; 2015.
   G. CRSI (DA4) - Manual of Standard Practice; Concrete Reinforcing Steel Institute; 2009.
   H. CRSI (P1) - Placing Reinforcing Bars; Concrete Reinforcing Steel Institute; Ninth Edition.

1.04 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   C. Review of these drawings is mandatory by the Structural Engineer of Record prior to fabrication.
   D. Manufacturer's Certificate: Certify that reinforcing steel and accessories supplied for this project meet or exceed specified requirements.

1.05 QUALITY ASSURANCE
   A. Perform work of this section in accordance with ACI 301.
   B. Provide Engineer with access to fabrication plant to facilitate inspection of reinforcement. Provide notification of commencement and duration of shop fabrication in sufficient time to allow inspection.
PART 2 PRODUCTS

2.01 REINFORCEMENT

A. Reinforcing Steel: ASTM A 615/A 615M Grade 60 (420).
   1. Plain billet-steel bars.
   2. Unfinished.

B. Welded Wire Fabric: ASTM A185
   1. Plain welded steel wire fabric.
   2. Unfinished.

C. Reinforcement Accessories:
   1. Tie Wire: Annealed, minimum 16 gage.
   2. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for adequate support of reinforcement during concrete placement.
      a. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.
      b. For exposed-to-view concrete surfaces where legs of supports are in contact with forms provide supports with legs that are plastic protected (CRSI, Class 1) or stainless steel protected (CRSI, Class 2).

2.02 FABRICATION

A. Fabricate concrete reinforcing in accordance with CRSI (DA4) - Manual of Standard Practice.

B. Welding of reinforcement is not permitted.

C. Locate reinforcing splices not indicated on drawings at point of minimum stress.
   1. Submit locations of splices to Engineer.

PART 3 EXECUTION

3.01 PLACEMENT

A. General: Comply with the Concrete Reinforcing Steel Institute’s recommended practice for “Placing Reinforcing Bars.” for details and methods of reinforcement placement and supports and as specified herein.

B. Avoid cutting or puncturing vapor retarder during reinforcement placement and concreting operations.

C. Accurately place, support and secure reinforcement against displacement. Do not deviate from required position.

D. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that remove or destroy bond with concrete.

E. Accommodate placement of formed openings.

F. Place reinforcement to obtain at least minimum coverages for concrete protection and within tolerances permitted by ACI 318 unless noted otherwise on the drawings. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.

G. Install welded wire fabric in as long lengths as practical. Lap adjoining pieces at least two full mesh lengths and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

H. Verify that anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not interfere with concrete placement.

3.02 FIELD QUALITY CONTROL

A. An independent testing agency will perform field quality control inspection and testing as indicated on the Drawings.

END OF SECTION
SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SCOPE OF WORK
A. Furnish all labor, materials, equipment and incidentals for cast-in-place concrete required to complete the Work as indicated on the Drawings and as specified herein.
B. The material specified herein shall comply with the American Iron and Steel provision of the Clean Water Act as it applies to the State Revolving Loan Funds and as administered by the State of Delaware. It is the Contractor's responsibility to determine if the Approved Manufacturers comply with the requirements of the provision.

1.02 RELATED SECTIONS
A. Section 03 20 00 - Concrete Reinforcement.

1.03 REFERENCES
A. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete; American Concrete Institute International; 1991 (Reapproved 2009).
B. ACI 301 - Specifications for Structural Concrete for Buildings; American Concrete Institute International; 2010.
C. ACI 305R - Hot Weather Concreting; American Concrete Institute International; 2010.
D. ACI 306R - Cold Weather Concreting; American Concrete Institute International; 2010.
E. ACI 308R - Guide to Curing Concrete; American Concrete Institute International; 2001. (Reapproved 2008).
F. ACI 350 - Code Requirements For Environmental Engineering Concrete Structures; American Concrete Institute International; 2006.
G. ACI 318 - Building Code Requirements for Structural Concrete and Commentary; American Concrete Institute International; 2011.
H. ASTM A 615/A 615M - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement; 2015.
T. COE CRD-C 572 - Corps of Engineers Specifications for Polyvinylchloride Waterstop; Corps of Engineers; 1974.
1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product data for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, dry-shake finish materials, and others as requested by the Architect.
D. Shop drawings and calculations for formwork, shoring and reshoring, prepared by a registered Professional Engineer, for fabrication erection of forms for specific finished concrete surfaces. Show for construction including jointing, special for joint or reveals, location and pattern of form tie placement, and other items that affect exposed concrete visually. Formwork, shoring and reshoring shop drawings, and calculations must bear the seal and signature of an engineer registered in the jurisdiction where the project is being constructed.
   1. Engineer’s review is for general architectural applications and features only. Design of formwork for structural stability and efficiency is Contractor’s responsibility.
E. Laboratory test reports for concrete materials and mix design test.
F. Minutes of pre-construction conference.
G. Manufacturer’s Installation Instructions: Indicate installation procedures and interface required with adjacent construction for concrete accessories.

1.05 QUALITY ASSURANCE
A. Perform work of this section in accordance with ACI 301 and ACI 318.
   1. Maintain one copy of each document on site.
B. Follow recommendations of ACI 305R when concreting during hot weather.
C. Follow recommendations of ACI 306R when concreting during cold weather.

PART 2 PRODUCTS
2.01 FORM MATERIALS
A. Forms for Exposed Finish Concrete: Plywood, metal, metal-framed plywood faced, or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on drawings.
B. Forms for Unexposed Finish Concrete: Plywood, lumber, metal, or other acceptable material. Provide lumber dressed on at least 2 edges and one side for tight fit.
C. Form Coatings: Provide commercial formulation form-coating compounds with a maximum VOC (Volatile Organic Compounds) of 350 mg/l that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
D. Form Ties: Factory-fabricated, adjustable-length, removable or snap-off metal form ties, designed to prevent form deflection and to prevent spalling concrete upon removal. Provide units that will leave no metal closer than 1-1/2 inches to exposed surface.
   1. Provide ties that, when removed, will leave holes not larger than 1 inch diameter in concrete surface.

2.02 REINFORCEMENT
A. Comply with requirements of Section 03 20 00.
2.03 CONCRETE MATERIALS

A. Cement: ASTM C 150, Type I - Normal Portland type.
   1. Use one brand of cement throughout project unless otherwise acceptable to Engineer.

   1. Do not use fine or coarse aggregates containing spalling-causing deleterious substances.
   2. Local aggregates not complying with ASTM C33 but that special tests or actual service have shown to produce concrete of adequate strength and durability may be used when approved by the Engineer.

C. Fly Ash: ASTM C 618, Class C or F.

D. Calcined Pozzolan: ASTM C 618, Class N.

E. Water: Clean and not detrimental to concrete.

2.04 CHEMICAL ADMIXTURES

A. General: Do not use chemicals that will result in soluble chloride ions in excess of 0.05 percent by weight of cement.

B. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. “Air-Mix” or “AEA 92”, Euclid Chemical Co.
      d. “Sika AER,” Sika Corp.
      e. Or Approved Equal.
         1) Substitutions: See Section 01 60 00 - Product Requirements.

C. Water-Reducing Admixture: ASTM C 494, Type A.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. “Eucon WR-75” or “Eucon WR-91” or “Eucon MR”, Euclid Chemical Co.
      c. “Pozzolith 200N” or “Polyheed 997”, Master Builders, Inc.
      d. Or Approved Equal.
         1) Substitutions: See Section 01 60 00 - Product Requirements.

D. High-Range Water-Reducing Admixture (Super Plasticizer): ASTM C 494, Type F or Type G. The admixture shall not contain more than 0.05 percent Chloride ions.
   1. Products: Subject to compliance with requirements, provide one of the following:
      b. “WRDA 19” or “Daracem 100”, W.R. Grace & Co.
      c. “Rheobuild 1000” or “Rheobuild 716”, Master Builders, Inc.
      d. “Sikament 300,” Sika Corp.
      e. Or Approved Equal.
         1) Substitutions: See Section 01 60 00 - Product Requirements.

E. Water Reducing, Non-Corrosive, and Non-Chloride Accelerating Admixture: ASTM C 494, Type C or Type E, and not contain more than 0.05% chloride ions.
   1. The admixture manufacturer must have long-term non-corrosive test data from an independent testing laboratory (of at least one year duration) using an acceptable accelerated corrosion test method such as electrical potential measures.
   2. Products: Subject to compliance with requirements, provide one of the following:
      d. Or Approved Equal.
1) Substitutions: See Section 01 60 00 - Product Requirements.

F. Water-Reducing, Retarding Admixture: ASTM C 494, Type D.
   1. Products: Subject to compliance with requirements, provide one of the following:
      e. Or Approved Equal.

G. Prohibited Admixtures: Calcium chloride, thiocyanates or admixtures containing more than 0.05% chloride ions are not permitted.

H. Certification: Written conformance to the requirements and the chloride ion content of the admixture will be required from the admixture manufacturer prior to the mix design review by the Engineer.

2.05 ACCESSORY MATERIALS

A. Non-Shrink Grout: ASTM C 1107; premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents. In addition, the grout manufacturer shall furnish test data from an independent laboratory indicating that the grout, when placed at a fluid consistency, shall achieve 95% bearing under a 48" x 48" base plate.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. "Euco NS", Euclid Chemical Co.
      d. Or Approved Equal.
   1) Substitutions: See Section 01 60 00 - Product Requirements.

2. Where high fluidity and/or increased placing time are required, use high flow grout. In addition, the grout manufacturer shall furnish test data from an independent laboratory indicating that the grout, when placed at a fluid consistency, shall achieve 95% bearing under and 18" x 36" base plate.
   a. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to the following:
      1) "High-Flow Grout," Euclid Chemical Co.
      2) "Masterflow 928," Master Builders, Inc.
      3) Minimum Compressive Strength at 48 Hours: 2,400 psi.
      4) Minimum Compressive Strength at 28 Days: 7,000 psi.
      5) Or Approved Equal.
      (a) Substitutions: See Section 01 60 00 - Product Requirements.

B. Waterstops: Provide centerbulb-type waterstops at construction joints and other joints as indicated. Size to suit joints.

C. Polyvinyl Chloride Waterstops: Corps of Engineers CRD-C 572.
   1. Manufacturers: Subject to compliance with requirements, provide products of one of the following:
      a. The Burke Co.
      b. Greenstreak Plastic Products Co.
      c. W. R. Meadows, Inc.
      d. Or Approved Equal.
   1) Substitutions: See Section 01 60 00 - Product Requirements.

D. Vapor Retarder: Provide vapor retarder cover over prepared base material where indicated below slabs on grade. Use only materials that are resistant to deterioration when tested in accordance with ASTM E 154, as follows:
   1. Polyethylene sheet not less than 8 mils thick.
E. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 2.

F. Moisture-Retaining Cover: One of the following, complying with ASTM C 171.
   1. Waterproof paper.
   2. Polyethylene film.
   3. Polyethylene-coated burlap.

G. Curing and Sealing Compound (VOC Compliant, 700 g/l): Liquid type membrane-forming curing compound, clear styrene acrylate type, complying with ASTM C1315, Type I, Class B, 25% solids content minimum. Moisture loss shall be no more than 0.30 Kg/m2 when applied at 300 sq. ft./gal. Manufacturer’s certification is required.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. “Super Rez Seal,” Euclid Chemical Co.
      d. Or Approved Equal.
         1) Substitutions: See Section 01 60 00 - Product Requirements.

H. Evaporation Control: Monomolecular film-forming compound applied to exposed concrete slab surfaces for temporary protection from rapid moisture loss.
   1. Products: Subject to compliance with requirements, provide one of the following:
      d. Or Approved Equal.
         1) Substitutions: See Section 01 60 00 - Product Requirements.

2.06 BONDING AND JOINTING PRODUCTS

A. Joint Filler: Nonextruding, resilient asphalt impregnated fiberboard or felt, complying with ASTM D 1751, 1/4 inch thick and 4 inches deep; tongue and groove profile.

B. Joint Filler: Compressible asphalt mastic with felt facers, complying with ASTM D 994, 1/4 inch thick and 4 inches deep.

C. Bonding Compound: Polyvinyl acetate or acrylic base.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Polyvinyl Acetate (Interior Only):
         1) “Euco Weld,” Euclid Chemical Co.
         2) “Everweld,” L&M Construction Chemicals, Inc.
         3) Or Approved Equal.
            (a) Substitutions: See Section 01 60 00 - Product Requirements.
      b. Acrylic or Styrene Butadiene:
         1) “SBR Latex,” Euclid Chemical Co.
         3) “Everbond,” L&M Construction Chemicals, Inc.
         5) Or Approved Equal.
            (a) Substitutions: See Section 01 60 00 - Product Requirements.

D. Epoxy Adhesive: ASTM C 881, two-component material suitable for use on dry or damp surfaces. Provide material “Type,” “Grade,” and “Class” to suit project requirements.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. “Euco Epoxy System #452MV or Eucopolycoyp LPC,” Euclid Chemical Co.
      c. “Sikadur 32 Hi-Mod,” Sika Corp.
      d. Or Approved Equal.
         1) Substitutions: See Section 01 60 00 - Product Requirements.
2.07 CONCRETE MIX DESIGN

A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301, Section 4.2.3. If trial batch method used, use an independent testing facility acceptable to Engineer for preparing and reporting proposed mix designs. The testing facility shall not be the same as used for field quality control testing.

B. Submit written reports to Engineer of each proposed mix for each class of concrete at least 15 days prior to start of work. Do not begin concrete production until proposed mix designs have been reviewed by Engineer.

C. The exact percentage of supplementary cementitious material used shall be based on a successful test placement on-site.
   1. Fly Ash Content: Maximum 25 percent of cementitious materials by weight.
   2. Calcined Pozzolan Content: Maximum 10 percent of cementitious materials by weight.

D. Design mixes to provide normal weight concrete with as indicated on drawings and schedules:

E. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, as accepted by Engineer. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Engineer before using in work.

F. Water-Cement Ratio: Provide concrete for following conditions with maximum water-cement (W/C) ratios as follows
   1. Subjected to freezing and thawing; W/C 0.45.
   2. Subjected to deicers/watertight; W/C 0.40.
   3. Reinforced concrete subjected to brackish water, salt spray, or deicers; W/C 0.40.
   4. Trowel finish interior floors subjected to small hard wheel traffic; W/cm 0.50.

G. Slump Limits: Proportion and design mixes to result in concrete slump at point of placement as follows:
   1. Ramps, slabs, and sloping surfaces: Not more than 3 inches.
   2. Reinforced foundation systems: Not less than 1 inch and not more than 3 inches.
   3. Concrete containing HRWR admixture (Superplasticizer): 7 to 9 inch range after addition of HRWR to verified 2-inch to 3-inch slump concrete (3” to 4” for concrete receiving a dry shake hardener).
   4. Other concrete: Not more than 4 inches.

2.08 ADMIXTURES

A. Use water-reducing admixture or high-range water-reducing admixture (Superplasticizer) in concrete as required for placement and workability.

B. Use nonchloride accelerating admixture in concrete slabs placed at ambient temperatures below 50 deg F (10 deg C).

C. Use high-range water-reducing admixture (HRWR) in pumped concrete, concrete for industrial slabs, architectural concrete, parking structure slabs, concrete required to be watertight, and concrete with water/cement ratios below 0.50.

D. Use air-entraining admixture in exterior exposed concrete unless otherwise indicated. Add air-entraining admixture at manufacturer’s prescribed rate to result in concrete at point of placement having total air content with a tolerance of plus or minus 1-1/2 percent within following limits:
   1. Concrete structures and slabs exposed to freezing and thawing, deicer chemicals, or hydraulic pressure:
      a. 5.0 percent for 1-1/2-inch max aggregate.
      b. 5.5 percent for 1-inch max aggregate.
      c. 5.5 percent for 3/4-inch max aggregate.
      d. 6.0 percent for 1/2-inch max aggregate.
   2. Other concrete (not exposed to freezing, thawing, or hydraulic pressure) or to exposed interior steel troweled finished subjected to vehicular traffic: maximum 3 percent air.
E. Use admixture for water reduction and set controls in strict compliance with manufacturer’s directions.

2.09 MIXING
A. Job-Site Mixing: Mix materials for concrete in appropriate drum-type batch machine mixer. For mixers of one cu. yd. or smaller capacity, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released. For mixers of capacity larger than one cu. yd., increase minimum 1-1/2 minutes of mixing time by 15 seconds for each cu. yd. or fraction thereof.

B. Provide batch ticket for each batch discharged and used in work, indicating project identification name and number, date, mix type, mix time, quantity, and amount of water introduced.

C. Ready-Mix Concrete: Comply with requirements of ASTM C 94, and as specified.
   1. When air temperature is between 85 deg F (30 deg C) and 90 deg F (32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes, and when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery to 60 minutes.

2.10 PRE-CONCRETE CONFERENCE
A. This conference shall be held at least 7-14 days prior to the beginning of the installation of foundations. The Contractor shall hold a meeting to review the detailed requirements for the concrete, including the concrete mix designs, placing techniques, finishing techniques, curing techniques and, the equipment required for these procedures.

B. The Contractor shall require responsible representatives of every party who is concerned with the concrete work to attend the conference, including, but not limiting to, the following:
   1. Contractor’s superintendent.
   2. Laboratory responsible for the concrete design mix.
   3. Laboratory responsible for field quality control.
   4. Concrete subcontractor.
   5. Ready-mix concrete producer(s).
   6. Admixture manufacturer.
   7. Concrete pumping contractor.
   8. Engineer
   9. Owner project manager

C. Minutes of the meeting shall be recorded, typed and printed by the Contractor and distributed by him to all parties concerned within 5 days of the meeting. One copy of the minutes shall also be transmitted to the following for information purposes:
   1. Owners representative.
   2. Resident engineer.

D. The minutes shall include a statement by the concrete contractor indicating that the proposed mix design and placing techniques can produce the concrete quality required by these specifications.

E. The Structural Engineer will be present at the conference. The Contractor shall notify the Structural Engineer at least 10 days prior to the scheduled date of the conference.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify lines, levels, and dimensions before proceeding with work of this section.

B. Coordinate the installation of joint materials and vapor retarder with placement of forms and reinforcing steel.
3.02 PREPARATION
A. Where new concrete is to be bonded to previously placed concrete, prepare existing surface by cleaning with steel brush and applying bonding agent in accordance with manufacturer's instructions.

3.03 FORMS
A. General: Design, erect, support, brace, and maintain formwork to support vertical and lateral, static and dynamic loads that might be applied until concrete structure can support such loads. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation, and position. Maintain formwork construction tolerances complying with ACI 347.

B. Construct forms to sizes, shapes, lines, and dimensions shown and to obtain accurate alignment, location, grades, level, and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages, inserts, and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide backup at joints to prevent leakage of cement paste.

C. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, recesses, and the like, for easy removal.

D. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Securely brace temporary openings and set tightly to forms to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

E. Chamfer exposed corners and edges as indicated, using wood, metal, PVC, or other rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.

F. Provisions for other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses, and chases from trades providing such items. Accurately place and securely support items built into forms.

G. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before concrete is placed. Retighten forms and bracing before concrete placement as required to prevent mortar leaks and maintain proper alignment.

H. Tolerances for formed surfaces shall conform to the following:
1. Variation from plumb:
   a. In the lines and surfaces of columns, piers, walls, and in arises:
      1) In any 10 ft. of length 1/4 in.
      2) Maximum for the entire length 1/2 in.
   b. For exposed corner columns, control-joint grooves and other conspicuous lines:
      1) In any 20 ft. length 1/4 in.
      2) Maximum for the entire length 1/2 in.

2. Variation from the level or from the grades specified in the contract documents:
   a. In slab soffits, ceilings, beam soffits and in arises, measured before removal of supporting shores:
      1) Maximum for the entire length 3/8 in.
   b. In exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines:
      1) Maximum for the entire length 1/2 in.
      2) Refer to section regarding monolithic slab finishes for F(F) and F(L) numbers.

3. Variation of the linear building lines from established position in plan and related position of columns, walls and partitions:
   a. In any bay 1/4 in.
   b. In any 20 ft. of length 3/8 in.
3.04 **VAPOR RETARDER INSTALLATION**

A. **General**: Following leveling and tamping of granular base for slabs on grade, place vapor retarder sheeting with longest dimension parallel with direction of pour.

B. **Lap joint 6 inches and seal vapor retarder joints with manufacturers’ recommended mastic and pressure-sensitive tape.**

3.05 **INSTALLING REINFORCEMENT**

A. **A. General**: Comply with requirements of Section 03 20 00 Concrete Reinforcement.

3.06 **JOINTS**

A. **Construction Joints**: Locate and install construction joints as indicated or, if not indicated, locate so as not to impair strength and appearance of the structure, as acceptable to Engineer. Submit locations of construction joints with shop drawings showing reinforcement.

B. **Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints except as otherwise indicated.**

C. **Use bonding agent on existing concrete surfaces that will be joined with fresh concrete.**

D. **Waterstops**: Provide waterstops in construction joints as indicated. Install waterstops to form continuous diaphragm in each joint. Make provisions to support and protect exposed waterstops during progress of work. Field-fabricate joints in waterstops in accordance with manufacturer’s printed instructions.

E. **Isolation Joints in Slabs-on-Ground**: Construct isolation joints in slabs-on-ground at points of contact between slabs-on-ground and vertical surfaces, such as column pedestals, foundation walls, grade beams, and elsewhere as indicated.

1. **Joint filler and sealant materials are specified in Division 7 Sections of these specifications.**
F. Contraction (Control) Joints in Slabs-on-Grade: Construct contraction joints in slabs-on-ground to form panels of patterns as shown.
   1. If joints are formed by saw cuts, saw cut joints immediately after slab finishing and as may be safely done without dislodging aggregate using a Soff-Cut machine or equal to a depth of 1.25 inches deep or as indicated on the Drawings.
   2. If joints are formed by preformed inserts, insert premolded plastic, hardboard or fiberboard strip into fresh concrete until top surface of strip is flush with slab surface. Tool slab edges round on each side of insert. After concrete has cured, remove inserts and clean groove of loose debris.
   3. Joint sealant material is specified in Division 7 Sections of these specifications.

3.07 INSTALLATION OF EMBEDDED ITEMS
A. General: Set and build into work anchorage devices and other embedded items required for other work that is attached to or supported by cast-in-place concrete. Use setting drawings, diagrams, instructions, and directions provided by suppliers of items to be attached thereto.
B. Forms for Slabs: Set edge forms, bulkheads, and intermediate screed strips for slabs to obtain required elevations and contours in finished surfaces. Provide and secure units to support screed strips using strike-off templates or compacting-type screeds.

3.08 PREPARATION OF FORMS SURFACES
A. Clean re-used forms of concrete matrix residue, repair and patch, as required, to return forms to acceptable surface condition.
B. General: Coat contact surfaces of forms with an approved, nonresidual, low-VOC, form-coating compound before reinforcement is placed.
C. Do not allow excess form-coating material to accumulate in forms or to come into contact with in-place concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer’s instructions.
D. Coat steel forms with a nonstaining, rust-preventative material. Rust-stained steel formwork is not acceptable.

3.09 PLACING CONCRETE
A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other crafts to permit installation of their work; cooperate with other trades in setting such work.
B. General: Comply with ACI 304, “Recommend Practice for Measuring, Mixing, Transporting, and Placing Concrete,” and as herein specified.
C. All water in the concrete mix shall be added at the mix plant. Water shall not be added at the jobsite.
D. Notify Engineer not less than 24 hours prior to commencement of placement operations.
E. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete that has hardened sufficiently to cause formation of seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete to avoid segregation at its final location.
F. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers not deeper than 24 inches and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while the preceding layer is still plastic to avoid cold joints.
   1. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI 309.
   2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than visible effectiveness of machine. Place vibrators to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have not begun to set. At each
insertion limit duration of vibration to time necessary to consolidate concrete and complete
embedment of reinforcement and other embedded items without causing segregation of
mix.

G. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation,
within limits of construction joints, until the placing of a panel or section is completed.
1. Consolidate concrete during placing operations so that concrete is thoroughly worked
around reinforcement and other embedded items and into corners.
2. Bring slab surfaces to correct level with straightedge and strike off. Use highway bull floats
or darbies to smooth surface, free of humps or hollows. Do not disturb slab surfaces prior
to beginning finishing operations.

H. Cold-Weather Placing: Comply with provisions of ACI 306 and as follows. Protect concrete
work from physical damage or reduced strength that could be caused by frost, freezing actions,
or low temperatures.

I. When air temperature has fallen to or is expected to fall below 40 deg F (4 deg C), uniformly
heat water and aggregates before mixing to obtain a concrete mixture temperature of not less
than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) at point of placement.
1. Do not use frozen materials or materials containing ice or snow. Do not place concrete on
frozen subgrade or on subgrade containing frozen materials.
2. Only the specified non-corrosive non-chloride accelerator shall be used.

J. Hot-Weather Placing: When hot weather conditions exist that would seriously impair quality and
strength of concrete, place concrete in compliance with ACI 305 and as herein specified.
1. Cool ingredients before nixing to maintain concrete temperature at time of placement
below 90 deg F (32 deg C). Mixing water may be chilled, or chopped ice may be used to
control temperature provided water equivalent of ice is calculated to total amount of mixing
water. Use of liquid nitrogen to cool concrete is Contractor's option.
2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel
temperature will not exceed the ambient air temperature immediately before embedment
in concrete.
3. Fog spray forms, reinforcing steel, and subgrade just before concrete is placed.
4. Use water-reducing retarding admixture when required by high-temperatures, low
humidity, or other adverse placing conditions, when acceptable to the Engineer.
5. Special hot weather concreting practices for watertight concrete in addition to other items
specified:
   a. When low humidity or windy conditions exist, construct a temporary wind barrier
      around the concrete pour.
   b. Fog spray the entire placement during and for 3 hours after, final finishing with
      approved compressed air or mist foggers. Fog the air above the slab until a sheen
      appears on the slab surface, but do not allow standing water to build up on the slab
      surface.
   c. Immediately after bull floating, apply a monomolecular film-forming compound for
      evaporation control

3.10 FINISH OF FORMED SURFACES

A. Rough Form Finish: For formed concrete surfaces not exposed to view in the finish work or
concealed by other construction. This is the concrete surface having texture imparted by form-
facings material used, with tie holes and defective areas repaired and patched, and fins and
other projections exceeding 1/4 inch in height rubbed down or chipped off.

B. Smooth Form Finish: For formed concrete surfaces exposed to view or to be covered with a
coating material applied directly to concrete, or a covering material applied directly to concrete,
such as waterproofing, dampproofing, veneer plaster, painting, or other similar system. This is
an as-cast concrete surface obtained with selected form-facing material, arranged in an orderly
and symmetrical manner with a minimum of seams. Repair and patch defective areas with fins and other projections completely removed and smoothed.

C. Related Unformed Surfaces: At top of walls, horizontal offsets, and similar uniformly surfaces occurring adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

D. Grout-Cleaned Finish: Provide grout-cleaned finish to scheduled concrete surfaces that have received smooth form finish treatment.

1. Combine one part portland cement to 1-1/2 parts fine sand by volume, and a 50:50 mixture of acrylic or styrene butadiene-based bonding admixture and water to consistency of thick paint. Blend standard portland cement and white portland cement, amounts determined by trial patches, so that final color of dry grout will match adjacent surfaces.

2. Thoroughly wet concrete surfaces, apply grout to coat surfaces, and fill small holes. Remove excess grout by scraping and rubbing with clean burlap. Keep damp by fog spray for at least 36 hours after rubbing.

3.11 MONOLITHIC SLAB FINISHES

A. Trowel Finish: Apply trowel finish to monolithic slab surfaces to be exposed to view and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint, or other thin film finish coating system.

1. After floating, begin first trowel finish operation using a power driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance, and with surface leveled to tolerances of Ff 25 - FL 20. Grind smooth surface defects that would telegraph through applied floor covering system.

2. Note Areas requiring quick-dry concrete.

B. Trowel and Fine Broom Finish: Where ceramic or quarry tile is to be installed with thin-set mortar, apply initial a single trowel finish as specified, then immediately follow with slightly scarifying surface by fine brooming. Texture shall be as approved by Engineer from sample panel.

1. Apply nonslip broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
   a. Immediately after float finishing, slightly roughen concrete surface by brooming with a fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Owner project manager before application.
   b. After curing, lightly work surface with a steel wire brush, or an abrasive stone, and water to expose nonslip aggregate.

3.12 CURING AND PROTECTION

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. In hot, dry, and windy weather, protect concrete from rapid moisture loss before and after finishing operations with an evaporation-control material. Apply in accordance with manufacturer’s instructions after screening and bull floating, but before power floating and troweling.

B. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Cure continuously for not less than 7 days.

C. Curing Methods: Perform curing of concrete by curing and sealing compound, by moist curing, by moisture-retaining cover curing, and by combinations thereof, as herein specified. Cure watertight concrete by moist curing or moisture cover curing for a minimum of 7 days.

D. Provide moisture-retaining cover curing by following methods.
   1. Keep concrete surface continuously wet by covering with water.
   2. Use continuous water-fog spray.
3. Cover concrete surface with specified absorptive cover, thoroughly saturate cover with water, and keep continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4-inch lap over adjacent absorptive covers.

E. Provide moisture-cover curing as follows:
   1. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practical width with sides and ends lapped at least 3 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

F. Provide curing and sealing compound to all exposed interior slabs, not receiving a liquid densifier, and troweled slabs receiving mastic applied adhesives or “shake on” hardeners. Exterior slabs, sidewalks, curbs, and architectural concrete, not receiving a penetrating sealer, shall be cured with the specified clear, non-yellowing curing and sealing compound. Maximum coverage shall be 400 ft²/gallon on floated or broomed surfaces for the curing/sealing compound.
   1. Apply specified curing and sealing compound to concrete slabs as soon as final finishing operations are complete (within 2 hours and after surface water sheen has disappeared). Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer’s directions. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period.

G. The curing process must begin immediately after final finishing.

H. Curing Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces, by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue with curing with methods specified above, as applicable.

I. Curing Unformed Surfaces: Cure unformed surfaces, such as slabs, floor topping, and other flat surfaces, by application of appropriate curing method.

3.13 REMOVAL OF FORMS

A. General: Formwork not supporting weight of concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 24 hours after placing provided concrete is sufficiently hard to not be damaged by form-removal operations, and provided curing and protection operations are maintained.

B. Formwork supporting weight of concrete, such as beam soffits, joists, slabs, and other structural elements, may not be removed until concrete has attained at least 75% of design minimum 28 day compressive strength but not less than the following time limits:
   1. Beams, joists and one-way slabs - 7 days.
   2. Two-way slabs - 14 days.

C. Determine potential compressive strength of in-place concrete by testing field-cured specimens representative of concrete location or members.

D. Form-facing material may be removed 4 days after placement only if shores and other vertical supports have been arranged to permit removal of form-facing material without loosening or disturbing shores and supports.

3.14 REUSE OF FORMS

A. Clean and repair surfaces of forms to be reused in work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-coating compound as specified for new formwork.

B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use “patched” forms for exposed concrete surfaces except as acceptable to Engineer.
3.15 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place. Mix, place, and cure concrete as herein other miscellaneous concrete filling shown or required to complete work.

B. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on drawings. Set anchor bolts for machines and equipment to template at correct elevations, complying with certified diagrams or templates of manufacturer furnishing machines and equipment.

C. Reinforced Masonry: Provide concrete grout for reinforced masonry lintels and bond beams where indicated on drawings and as scheduled. Maintain accurate location of reinforcing steel during concrete placement.

D. Grout base plates and foundations, as indicated, using specified non-shrink grout. Where high fluidity and/or increased placing time is required use the specified high flow grout. This grout shall be used for all base plates larger than 10 square feet.

3.16 CONCRETE SURFACE REPAIRS

A. Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removal of forms, when acceptable to Engineer.

1. Cut out honeycomb, rock pockets, and voids over 1/4 inch in any dimension, and holes left by tie rods and bolts, down to solid concrete but in no case to a depth of less than 1 inch. Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water, and brush-coat the area to be patched with specified bonding agent. Place patching mortar before bonding compound has dried.

2. For exposed-to-view surfaces, blend white portland cement and standard portland cement so that, when dry, patching mortar will match color surrounding. Provide test areas at an inconspicuous location to verify mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.

B. Repair of Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Engineer. Surface defects, include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, fins, and other projections on surface, and stains and other discoloration’s that cannot be removed by cleaning. Flush out form tie holes, fill with dry-pack mortar, or precast cement cone plugs secured in place with bonding agent.

1. Repair concealed formed surfaces, where possible, that contain defects that affect the durability of concrete. If defects cannot be repaired, remove and replace concrete.

C. Repair of Unformed Surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface plane to tolerances specified for each surface and finish. Correct low and high areas as herein specified. Test unformed surfaces sloped to drain for trueness of slope and smoothness by using a template having required slope.

1. Repair finished unformed surfaces that contain defects that affect durability of concrete. Surface defects, as such, including crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through nonreinforced sections regardless for width, spalling, popouts, honeycomb, rock pockets, and other objectionable conditions.

2. Correct high areas in unformed surfaces by grinding after concrete has cured at least 14 days.

3. Correct low areas in unformed surfaces during or immediately after completion of surface finishing operations by cutting out low areas and replacing them with underlayment compound or repair topping. Finish repaired areas to blend into adjacent concrete. Proprietary underlayment compounds may be used when acceptable to Owner project manager.

4. Repair defective areas, except random cracks and single holes not exceeding 1 inch in diameter, by cutting out and replacing with fresh concrete. Remove defective areas to
sound concrete with clean, square cuts and expose reinforcing steel with at least 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding compound. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

D. Repair isolated random cracks and single holes not over 1 inch in diameter by dry-pack method. Groove top of cracks and cut out holes to sound concrete and clean of dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding compound. Mix dry-pack, consisting of one part portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing. Place dry-pack mixture in place and finish to match adjacent concrete. Keep patched area continuously moist for not less than 72 hours.

E. Perform structural repairs with prior approval of Engineer for method and procedure, using specified epoxy adhesive and mortar.

F. Repair methods not specified above may be used, subject to acceptance of Engineer.

G. Bonding Compound Usage: The specified bonding compound shall be used in interior uses not subject to moisture. In moist conditions, a bonding grout, including the specified bonding admixture or the specified epoxy adhesive, must be used. The patching mortar or new concrete must then be placed while the bonding grout or epoxy adhesive is still tacky.

### 3.17 FIELD QUALITY CONTROL

A. An independent testing agency will perform field quality control inspection and testing as indicated on Drawings.

B. Provide free access to concrete operations at project site and cooperate with appointed firm.

C. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of concrete operations.

D. Tests of concrete and concrete materials may be performed at any time to ensure conformance with specified requirements.

E. Sampling and testing for quality control during placement of concrete may include the following, as directed by Engineer.

1. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.

2. Slump: ASTM C 143; one test at one point of discharge for each set of compressive strength test cylinders; additional tests when concrete consistency seems to have changed.

3. Air Content: ASTM C 173, volumetric method for lightweight or normal weight concrete; ASTM C 231 pressure method for normal weight concrete; one for each set of compressive strength test cylinders for each type of air-entrained concrete.

4. Water Content: The water content of freshly mixed concrete will be tested each time cylinders are made and as directed by the Architect in accordance with ASSHTO T318 Measurement of Water Content of Fresh Concrete Using the Microwave Oven.

5. Concrete Temperature: Test hourly when air temperature is 40 deg F (4 deg C) and below, when 80 deg F (27 deg C) and above, and each time a set of compression test specimens is made.

6. Compression Test Specimen: ASTM C 31. Mold and store cylinders for laboratory-cured test specimens except when field-cure test specimens are required.

7. Compressive Strength Tests: The following number of concrete test cylinders shall be cast for each class of concrete for each day’s work (pour), 75 cubic yards, or 5000 square feet or greater:

   a. For Footings and Other Structural Concrete:
      1) 2 @ 7 Days, Lab Cured
      2) 3 @ 28 Days, Lab Cured
b. For Columns and Walls:
   1) 2 @ 7 Days, Lab Cured
   2) 3 @ 7 Days, Field Cured
   3) 3 @ 28 Days, Lab Cured
   4) 3 @ 28 Days, Field Cured

8. When additional test specimens shall be performed as directed by the Engineer or Engineer of Record with two (2) specimens required for a test. To establish break data, two (2) cylinders must be broken and averaged.

9. NOTE: All field cured test cylinders shall be cast and cured in the field in the concrete placement and under environmental conditions similar as possible to the conditions to which the pour is subjected.

10. When frequency of testing will provide fewer than 5 strength tests for a given class of concrete, conduct testing from at least 5 randomly selected batches or from each batch if fewer than 5 are used.

F. Test results will be reported in writing to Engineer, Ready-Mix Producer, and Contractor within 24 hours after tests. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-day tests and 28-day tests.

3.18 DEFECTIVE CONCRETE
   A. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.
   B. Repair or replacement of defective concrete will be determined by the Engineer. The cost of additional testing shall be borne by Contractor when defective concrete is identified.
   C. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Engineer for each individual area.

3.19 SCHEDULE - CONCRETE TYPES AND FINISHES
   A. See structural drawings for minimum 28 day compressive strength.

END OF SECTION
SECTION 04 20 00
UNIT MASONRY ASSEMBLIES

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidental to complete and make ready for use all unit masonry assemblies required to complete the Work as indicated on the Drawings and as specified herein.

B. The material specified herein shall comply with the American Iron and Steel provision of the Clean Water Act as it applies to the State Revolving Loan Funds and as administered by the State of Delaware. It is the Contractor’s responsibility to determine if the Approved Manufacturers comply with the requirements of the provision.

1.02 REFERENCES

A. ACI 530/ASCE 5/TMS 402 - Building Code Requirements for Masonry Structures; American Concrete Institute International; 2011.

B. ACI 530.1/ASCE 6/TMS 602 - Specification For Masonry Structures; American Concrete Institute International; 2011.


D. ASTM A 951/A 951 M - Standard Specification for Steel Wire for Masonry Joint Reinforcement


G. ASTM C 144 - Standard Specification for Aggregate for Masonry Mortar


I. ASTM C 270 - Standard Specification for Mortar for Unit Masonry

J. ASTM C 404 - Standard Specification for Aggregates for Masonry Grout

K. ASTM C 476 - Standard Specification for Grout for Masonry

L. ASTM C 1019 - Specification for Method of Sampling and Testing Grout

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data for masonry units, fabricated wire reinforcement, and mortar.

C. Material Certificates: Include statements of material properties indicating compliance with requirements including compliance with standards and type designations within standards. Provide for each type and size of the following:

1. Masonry units:
   a. Include material test reports substantiating compliance with requirements.
   b. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.

2. Cementitious materials. Include brand, type, and name of manufacturer

3. Grout mixes. Include description of type and proportions of ingredients.

4. Reinforcing bars.

5. Joint reinforcement.

6. Anchors, ties, and metal accessories.

D. Shop Drawings: For the following:

1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.

2. Reinforcement: Reinforcing bars, bar positioners, and horizontal joint reinforcement. Detail bending and placement of unit masonry reinforcing bars and joint reinforcement.

3. Accessories: Flashings, weeps, and vents.
E. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
   1. Include test reports, per ASTM C 1019, for grout mixes required to comply with compressive strength requirement.
F. Cold-weather construction procedures evidencing compliance with requirements specified in referenced unit masonry standard.
G. Hot-weather construction procedures evidencing compliance with requirements specified in referenced unit masonry standard.

1.04 QUALITY ASSURANCE
A. Comply with provisions of ACI 530/ASCE 5/TMS 402 and ACI 530.1/ASCE 6/TMS 602, except where exceeded by requirements of the contract documents.
B. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, through one source from a single manufacturer for each product required.
C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from a single manufacturer for each cementitious component and from one source or producer for each aggregate.

1.05 DELIVERY, STORAGE, AND HANDLING
A. Deliver masonry materials to project in undamaged condition.
B. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install.
C. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
D. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
E. Store masonry reinforcing and accessories in dry locations to prevent corrosion and accumulation of dirt and oil.

1.06 PROJECT CONDITIONS
A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day’s work. Cover partially completed masonry when construction is not in progress
   1. Extend cover a minimum of 24 inches down both sides and hold cover securely in place.
B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least 3 days after building masonry walls or columns.
C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
   1. Protect base of wall from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
   2. Protect sills, ledges, and projections from mortar droppings.
   3. Protect surfaces of window and door frames, as well as similar products with painted, prefinished or integral finishes, from mortar droppings.
   4. Turn scaffold boards near the wall edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
D. Cold Weather Requirements: Comply with recommendations of IMIAWC (CW).
   1. Maintain materials and surrounding air temperature to a minimum of 40 degrees F prior to, during, and 48 hours after completion of masonry work.
2. Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions.

3. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 degrees F and above and will remain so until masonry has dried, but not less than 7 days after completing cleaning.

E. Hot Weather Requirements: Comply with IMIAWC (HW).
1. Maintain materials and surrounding air temperature to maximum 90 degrees F prior to, during, and 48 hours after completion of masonry work.

PART 2 PRODUCTS

2.01 CONCRETE MASONRY UNITS

A. General: Comply with requirements indicated below applicable to each form of concrete masonry unit required.

1. Defective Units: If referenced masonry unit standards allow a certain percentage of units to exceed tolerances and to contain chips, cracks, or other defects exceeding limits stated in the standard, such units shall not be used in the work unless approved in writing by the Engineer. Do not use units where such defects, including dimensions that vary from specified dimensions by more than stated tolerances, will be exposed in the completed Work or will impair the quality of completed masonry.

B. Standard Concrete Masonry Units: ASTM C 90

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 1900 psi.

2. Weight Classification: Weight classifications as follows, unless otherwise indicated:
   a. Below grade - Normal weight units
   b. Exterior walls - Normal weight units
   c. Interior wall - Normal weight units

3. Size: Manufactured to dimensions 3/8 inch less than nominal dimensions indicated below.
   a. 8 x 8 x 16.
   b. 12 x 8 x 16.

4. Texture/Color: Provide standard smooth texture and manufacturer's standard color unless otherwise noted.

5. Special Shapes: Provide shapes as follows
   a. Provide special shapes for half units, lintels, corners, jambs, sashes, movement joints, headers, bond beams, and other special conditions.

2.02 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150, Type I, except Type III may be used for cold-weather construction.

B. Hydrated Lime: ASTM C 207, Type S.

C. Masonry Cement: ASTM C 91

1. Available Products:
   a. Lafarge North America Inc.; Magnolia Masonry Cement or Lafarge Masonry Cement
   b. Lehigh Cement Company; Lehigh Masonry Cement.
   d. Or Approved Equal.
   1) Substitutions: See Section 01 60 00 - Product Requirements.

D. Aggregate for Mortar: ASTM C 144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand.

E. Aggregate for Grout: ASTM C 404.
F. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with concrete masonry units, containing integral water repellent by same manufacturer.
   1. Available Products:
      a. Grace Construction Products, a unit of W. R. Grace & Co. - Conn.; Dry-Block Mortar Admixture.
      b. Master Builders, Inc.; Rheomix Rheopel.
      c. Or Approved Equal.
         1) Substitutions: See Section 01 60 00 - Product Requirements.

G. Water: Clean and potable.

H. Accelerating Admixture: Nonchloride type for use in cold weather.
   1. See Section 01 60 00 - Product Requirements.

2.03 REINFORCEMENT

A. Steel Reinforcing Bars: Uncoated deformed steel bars meeting ASTM A 615, Grade 60.

B. Horizontal Joint Reinforcement, General: ASTM A 951.
   2. Wire Size for Side Rods: 9 gauge minimum.
   4. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.

C. Horizontal Joint Reinforcement for Single-Wythe Masonry: Ladur type with single pair of side rods.
   1. Reinforcement Spacing:
      a. Above finish floor: 16 inches on center
      b. Below finish floor and parapets: 8 inches on center
   2. Available Products:
      b. Or Approved Equal.
         1) Substitutions: See Section 01 60 00 - Product Requirements.

2.04 TIES/ANCHORS/BAR POSITIONERS

A. Materials: Provide ties and anchors specified in subsequent paragraphs that are made from materials that comply with subparagraphs below, unless otherwise indicated.
   2. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304.
   3. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Bar Positioners: Provide wire-type positioners for vertical and horizontal reinforcing bars.
   1. Type: Z-shape positioners fabricated with hot-dip galvanized 9 gauge carbon steel wire.
   2. Available Products:
      a. Dayton Superior Corp., Dur-O-Wal Division; D/A 810, D/A 812, or D/A 817.
      c. Hohmann & Barnard, Inc.; #RB or #RB-Twin Rebar Positioner.
      d. Or Approved Equal.
         1) Substitutions: See Section 01 60 00 - Product Requirements.

C. Control Joint Ties: At expansion and control joints, provide galvanized metal/wire joint stabilization anchors.
   3. Or Approved Equal.
      a. Substitutions: See Section 01 60 00 - Product Requirements.
2.05 MISCELLANEOUS ANCHORS

A. Anchor Bolts: Headed or L-shaped steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.

B. Post-Installed Anchors: Anchors as described below, with capability to sustain, without failure, load imposed within factors of safety indicated, as described by testing per ASTM E 488, conducted by a qualified independent testing agency.
   1. Type: Adhesive Anchors
      a. Simpson Strong-Tie; Acrylic-Tie
      b. Hilti; HIT HY 20
      c. Or Approved Equal.
         1) Substitutions: See Section 01 60 00 - Product Requirements.

2.06 MASONRY ACCESSORIES

A. Joint Filler: Closed cell foam, oversized 50 percent; self-expanding joints.

B. Preformed Control Joint Gaskets: Made from PVC, complying with ASTM D 2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

D. Grout Stop: A monofilament screen to isolate grout flow and prevent grout fall-through while maintaining a positive bond in the mortar joint.
   1. Provide a monofilament screen fabricated from ¼ inch 30 inch high-strength non-corrosive polypropylene polymers.
      a. Available Products:
         1) Dur-O-Stop by Dur-O-Wal.
         2) MGS-Mortar/Grout Screen by Hohmann & Barnard, Inc.
         3) Grout Shield by Sandell Manufacturing Company, Inc.
      b. Or Approved Equal.

E. 1. Substitutions: See Section 01 60 00 - Product Requirements.

2.07 MASONRY CLEANERS

A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces.
   1. Use product expressly approved for intended use by cleaner manufacturer and by manufacturer of masonry units being cleaned.
      a. Available Manufactures:
         1) Diedrich Technologies, Inc.
         2) EaCo Chem, Inc.
         3) ProSoCo, Inc.
         4) Or Approved Equal.
            (a) Substitutions: See Section 01 60 00 - Product Requirements.

B. Proprietary Detergent Cleaners: Manufacturer's standard strength concrete masonry cleaner designed for removing mortar/grout stains from new masonry.
   1. Use only products expressly approved by manufacturer of CMU units.
      a. Available Manufacturers:
         1) Sure-Klean 600.
         2) Vanitrol.
         3) Or Approved Equal.
            (a) Substitutions: See Section 01 60 00 - Product Requirements.
2.08 MORTAR AND GROUT MIXES

A. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated or need to provide required compressive strength of masonry.
   1. For masonry below grade or in contact with earth, use Type M.
   2. For exterior masonry above grade, use Type S.
   3. For interior masonry, use Type S.

B. Grout for Unit Masonry: Comply with ASTM C 476.
   1. Use grout of type indicated or, if not otherwise indicated, of coarse type that will comply with Table 1.15.1 in ACE 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
   2. Grout shall develop an ultimate compressive strength of 2,000 psi at 28 days.
      a. Aggregate: Conform to ASTM C 144; maximum size coarse aggregate shall be ½ inch.
      b. Slump: 8 to 11 inches as measured according to ASTM C 143/C 143 M.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field conditions are acceptable and are ready to receive masonry.
B. Verify that related items provided under other sections are properly sized and located.
C. Verify that built-in items are in proper location, and ready for roughing into masonry work.

3.02 PREPARATION

A. Direct and coordinate placement of metal anchors supplied for installation under other sections.
B. Provide temporary bracing during installation of masonry work. Maintain in place until building structure provides permanent bracing.

3.03 COURSING

A. Establish lines, levels, and coursing indicated. Protect from displacement.
B. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.
C. Concrete Masonry Units:
   1. Bond: Running.
   2. Coursing: One unit and one mortar joint to equal 8 inches.

3.04 PLACING AND BONDING

A. Lay solid masonry units in full bed of mortar, with full head joints, uniformly jointed with other work.
B. Lay hollow masonry units with face shell bedding on head and bed joints.
C. Buttering corners of joints or excessive furrowing of mortar joints is not permitted.
D. Remove excess mortar and mortar smears as work progresses.
E. Interlock intersections and external corners.
F. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.
G. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.
H. Cut mortar joints flush where wall tile is scheduled or resilient base is scheduled.
I. Isolate top joint of masonry partitions from horizontal structural framing members and slabs or decks with compressible joint filler.
J. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, and remove loose masonry units and mortar.

K. Fill cores in hollow concrete masonry units with grout 24 inches under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.

3.05 REINFORCEMENT AND ANCHORAGE - GENERAL

A. Unless otherwise indicated on drawings or specified under specific wall type, install horizontal joint reinforcement 16 inches on center, except at 8 inches on center in parapets and below finish floor.

B. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 16 inches each side of opening.

C. Place continuous joint reinforcement in first joint below top of walls.

D. Lap joint reinforcement ends minimum 6 inches.

E. Interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.

F. Provide continuity at wall intersections by using prefabricated T-shaped units.
   1. Space reinforcement not more than 8 inches on center.

G. Provide continuity at corners by using prefabricated L-shaped units.
   1. Space reinforcement not more than 8 inches on center.

H. Cells that contain vertical reinforcing are to be grouted full. Grout to have a 28 day minimum compressive strength of 2500 psi. Lap vertical reinforcing a minimum of 48 bar diameters and insure bar is centered in the cell. Fill cells in 48 inch lifts maximum. Power vibrate grout in each cell full height of each lift.

I. Verify that anchorages embedded in concrete or attached to structural steel members are properly placed.

3.06 LINTELS

A. Install reinforced unit masonry lintels over openings where lintels are not scheduled on the drawings.
   1. Openings to 42 inches: Place two, No. 4 reinforcing bars 1 inch from bottom web.
   2. Openings from 42 inches to 78 inches: Place two, No. 5 reinforcing bars 1 inch from bottom web.
   3. Do not splice reinforcing bars.
   4. Support and secure reinforcing bars from displacement. Maintain position within 1/2 inch of dimensioned position.
   5. Allow masonry lintels to attain specified strength before removing temporary supports.

B. Maintain minimum 8 inch bearing on each side of opening.

3.07 CONTROL AND EXPANSION JOINTS

A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Form control joints in concrete masonry as follows:
   1. Install preformed control-joint gaskets designed to fit standard sash block and of width requiring for installing sealant and backer rod specified in Division 7 Section "Joint Sealants," but not less than 3/8 inch.

3.08 BUILT-IN WORK

A. As work progresses, install built-in metal door frames and other items to be built into the work and furnished under other sections.

B. Install built-in items plumb, level, and true to line.
C. Bed anchors of metal door and glazed frames in adjacent mortar joints. Fill frame voids solid with grout.
   1. Fill adjacent masonry cores with grout minimum 12 inches from framed openings.
D. Do not build into masonry construction organic materials that are subject to deterioration.

3.09 TOLERANCES
A. Maximum Variation from Alignment of Columns: 1/4 inch.
B. Maximum Variation From Unit to Adjacent Unit: 1/16 inch.
C. Maximum Variation from Plane of Wall: 1/4 inch in 10 ft and 1/2 inch in 20 ft or more.
D. Maximum Variation from Plumb: 1/4 inch per story non-cumulative; 1/2 inch in two stories or more.
E. Maximum Variation from Level Coursing: 1/8 inch in 3 ft and 1/4 inch in 10 ft; 1/2 inch in 30 ft.
F. Maximum Variation of Joint Thickness: 1/8 inch in 3 ft.
G. Maximum Variation from Cross Sectional Thickness of Walls: 1/4 inch.

3.10 CUTTING AND FITTING
A. Cut and fit for chases. Coordinate with other sections of work to provide correct size, shape, and location.
B. Obtain approval prior to cutting or fitting masonry work not indicated or where appearance or strength of masonry work may be impaired.

3.11 REPAIRING, POINTING, AND CLEANING
A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointing to eliminate evidence of replacement.
B. Replace defective mortar. Match adjacent work.
C. Pointing: During the tooling of joints, enlarge voids and holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat uniform appearance. Prepare joints for sealant application, where indicated.
D. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
E. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
   1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
   2. Test cleaning methods on sample wall panel; leave one-half of panel uncleansed for comparison purposes. Obtain Engineer's approval of sample cleaning before proceeding with cleaning of masonry.
   3. Protect adjacent non-masonry surfaces from contact with acidic cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
   4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
   5. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.
   6. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

3.12 PROTECTION
A. Without damaging completed work, provide protective boards at exposed external corners which are subject to damage by construction activities.
B. Provide protection without damaging completed work.
C. At day's end, cover unfinished wall to prevent moisture infiltration. Weight cover down to prevent blow-off and maintain protection for fresh masonry work.

3.13 SCHEDULES
A. Interior Partitions: Single wythe concrete block units.

3.14 MASONRY WASTE DISPOSAL
A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.
B. Excess Masonry Waste: Remove and legally dispose of all masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, off of Owner's property.

3.15 FIELD QUALITY CONTROL
A. An independent testing agency will perform field quality control inspection and testing as indicated on the Drawings.

END OF SECTION
SECTION 05 12 00
STRUCTURAL STEEL FRAMING

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, and incidentals required and install structural steel including bearing plates, columns, beams, and miscellaneous shapes and plates required to erect the structural framing as indicated on the Drawings and as specified herein. The Contractor shall provide all anchor bolts, nuts, and washers as required to install the structural in a safe and workmanlike manner in accordance with the Drawings and specifications or as required to complete the installation.

B. The material specified herein shall comply with the American Iron and Steel provision of the Clean Water Act as it applies to the State Revolving Loan Funds and as administered by the State of Delaware. It is the Contractor's responsibility to determine if the Approved Manufacturers comply with the requirements of the provision.

1.02 REFERENCE STANDARDS

M. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2013.
W. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; American Welding Society; 2012.
X. AWS D1.1/D1.1M - Structural Welding Code - Steel; American Welding Society; 2010 w/Errata.

1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Shop Drawings:
   1. Indicate profiles, sizes, spacing, locations of structural members, openings, attachments, and fasteners.
   2. Connections not detailed.
   3. Indicate cambers and loads.
   4. Indicate welded connections with AWS A2.4 welding symbols. Indicate net weld lengths.
C. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within the previous 12 months.

1.04 QUALITY ASSURANCE
A. Fabricate structural steel members in accordance with AISC "Steel Construction Manual."
B. Fabricator: Company specializing in performing the work of this section with minimum five (5) years of documented experience.
C. Erector: Company specializing in performing the work of this section with minimum five (5) years of documented experience.

PART 2 PRODUCTS
2.01 MATERIALS
A. Steel Angles, Plates, and Channels: ASTM A36/A36M.
B. Rolled Steel Structural Shapes: ASTM A992/A992M.
C. Steel Shapes, Plates, and Bars: ASTM A 242/A 242M high-strength, corrosion-resistant structural steel.
D. Cold-Formed Structural Tubing: ASTM A500/A500M, Grade B.
E. Hot-Formed Structural Tubing: ASTM A501, seamless or welded.
H. Structural Bolts and Nuts: Carbon steel, ASTM A307, Grade A galvanized to ASTM A 153/A 153M, Class C.
I. High-Strength Structural Bolts, Nuts, and Washers: ASTM A325 or A325M, Type 1, medium carbon, galvanized, with matching compatible ASTM A563 or A563M nuts and ASTM F436 washers.
J. Headed Anchor Rods: ASTM F 1554, Grade 36, Heavy Hex.
K. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.
L. Touch-Up Primer for Galvanized Surfaces: Fabricator's standard, complying with VOC limitations of authorities having jurisdiction.

2.02 FABRICATION
A. Shop fabricate to greatest extent possible.
B. Continuously seal joined members by continuous welds. Grind exposed welds smooth.
C. Fabricate connections for bolt, nut, and washer connectors.

2.03 FINISH

A. Galvanize all structural steel members to comply with ASTM A 123/A 123M. Provide minimum 1.7 oz/sq ft galvanized coating.

2.04 SOURCE QUALITY CONTROL

A. An independent testing agency will perform shop quality control inspection and testing as indicated on Drawings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that conditions are appropriate for erection of structural steel and that the work may properly proceed.

3.02 ERECTION

A. Erect structural steel in compliance with AISC "Code of Standard Practice for Steel Buildings and Bridges".

B. Allow for erection loads, and provide sufficient temporary bracing to maintain structure in safe condition, plumb, and in true alignment until completion of erection and installation of permanent bracing.

C. Field weld components indicated on shop drawings.

D. Use carbon steel bolts only for temporary bracing during construction, unless otherwise specifically permitted on drawings. Install high-strength bolts in accordance with AISC "Specification for Structural Joints Using ASTM A325".

E. Do not field cut or alter structural members without approval of Engineer.

F. After erection, prime welds, abrasions, and surfaces not galvanized, except surfaces to be in contact with concrete.

G. Grout solidly between column plates and bearing surfaces, complying with manufacturer's instructions for nonshrink grout. Trowel grouted surfaces smooth, splaying neatly to 45 degrees.

3.03 TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch per story, non-cumulative.

B. Maximum Offset From True Alignment: 1/4 inch.

3.04 FIELD QUALITY CONTROL

A. An independent testing agency will perform field quality control inspection and testing as indicated on Drawings.

END OF SECTION
SECTION 05 21 00
STEEL JOIST FRAMING

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Open web steel joists and shear stud connectors, with bridging, attached seats and anchors.
B. Loose bearing members, such as plates or angles, and anchor bolts for site placement.
C. Supplementary framing for floor and roof openings greater than 18 inches.
D. The material specified herein shall comply with the American Iron and Steel provision of the Clean Water Act as it applies to the State Revolving Loan Funds and as administered by the State of Delaware. It is the Contractor's responsibility to determine if the Approved Manufacturers comply with the requirements of the provision.

1.02 RELATED REQUIREMENTS
A. Section 05 12 00 - Structural Steel Framing: Superstructure framing.
B. Section 05 31 00 - Steel Decking: Support framing for openings less than 18 inches in decking.

1.03 REFERENCE STANDARDS
G. SJI (SPEC) - Catalog of Standard Specifications and Load Tables for Steel Joists and Joist Girders; Steel Joist Institute; 2011.
H. SJI Technical Digest No. 9 - Handling and Erection of Steel Joists and Joist Girders; Steel Joist Institute; 2008.
J. SSPC-SP 2 - Hand Tool Cleaning; Society for Protective Coatings; 1982 (Ed. 2004).

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Shop Drawings: Indicate standard designations, joist coding, configurations, sizes, spacings, cambers, locations of joists, joist leg extensions, bridging, and connections.
C. Welders' Certificates: Submit manufacturer's certificates, certifying welders employed on the Work, verifying AWS qualification within the previous 12 months.

1.05 QUALITY ASSURANCE
A. Design connections not detailed on the drawings under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in Delaware.
B. Joists shall be designed for the uplift load indicated on the Drawings. Additional bridging / bracing required shall be indicated on the shop drawings.
C. Perform Work, including that for headers and other supplementary framing, in accordance with SJI Standard Specifications Load Tables and SJI Technical Digest No.9.
D. Manufacturer Qualifications: Company specializing in performing the work of this section with minimum five years documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Transport, handle, store, and protect products to SJI requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Steel Joists:
   1. Any member of the Steel Joist Institute.

2.02 MATERIALS
A. Open Web Joists: SJI Type K Joists:
   1. Provide bottom and top chord extensions as indicated.
   2. Finish: Galvanized.
C. Shear Stud Connectors: Made from ASTM A 108 Grade 1015 bars.
D. Structural Steel For Supplementary Framing and Joist Leg Extensions: ASTM A 36/A 36M.
E. Welding Materials: AWS D1.1; type required for materials being welded.
F. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, Type I - Inorganic, complying with VOC limitations of authorities having jurisdiction.

2.03 FABRICATION
A. Fabrication shall be done only from shop drawings that have been approved by the Engineer.

2.04 FINISH
A. Galvanize joists as specified.
B. Prepare surfaces to be finished in accordance with SSPC-SP 2.
C. Galvanizing: Provide minimum 1.7 oz/sq ft galvanized coating to ASTM A123/A123M requirements.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify existing conditions prior to beginning work.

3.02 ERECTION
A. Erect joists with correct bearing on supports.
B. Allow for erection loads. Provide sufficient temporary bracing to maintain framing safe, plumb, and in true alignment.
C. Coordinate the placement of anchors for securing loose bearing members furnished as part of the work of this section.
D. After joist alignment and installation of framing, field weld joist seats to steel bearing surfaces.
E. After joist alignment and installation of framing, field weld joist seats to bearing plates.
F. Position and field weld joist chord extensions and wall attachments as detailed.
G. Install supplementary framing for floor and roof openings greater than 18 inches.
H. Do not permit erection of decking until joists are braced bridged, and secured or until completion of erection and installation of permanent bridging and bracing.
I. Do not field cut or alter structural members without approval of joist manufacturer.
3.03 TOLERANCES
   A. Maximum Variation From Plumb: 1/4 inch.
   B. Maximum Offset From True Alignment: 1/4 inch.

3.04 FIELD QUALITY CONTROL
   A. An independent testing agency will perform field quality control inspection and testing as indicated on the drawings.

END OF SECTION
SECTION 05 31 00
STEEL DECKING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Roof deck.

B. Supplementary framing for openings up to and including 18 inches.

C. The material specified herein shall comply with the American Iron and Steel provision of the Clean Water Act as it applies to the State Revolving Loan Funds and as administered by the State of Delaware. It is the Contractor's responsibility to determine if the Approved Manufacturers comply with the requirements of the provision.

1.02 RELATED REQUIREMENTS

A. Section 05 12 00 - Structural Steel Framing: Support framing for openings larger than 18 inches.

B. Section 05 21 00 - Steel Joist Framing: Support framing for openings larger than 18 inches.

1.03 REFERENCE STANDARDS


E. AWS D1.3 - Structural Welding Code - Sheet Steel; American Welding Society; 2008.

F. SDI (DM) - Publication No.31, Design Manual for Composite Decks, Form Decks, Roof Decks; Steel Deck Institute; 2007.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittals procedures.

B. Shop Drawings: Indicate deck plan, support locations, projections, openings, reinforcement, pertinent details, and accessories.

C. Product Data: Provide deck profile characteristics, dimensions, structural properties, and finishes.

D. Certificates: Certify that products furnished meet or exceed specified requirements.

E. Submit manufacturer's installation instructions.

F. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within the previous 12 months.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing the work of this Section approved by manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Cut plastic wrap to encourage ventilation.

B. Separate sheets and store deck on dry wood sleepers; slope for positive drainage.
PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Steel Deck:
   1. Any good standing member of Steel Deck Institute.

2.02 STEEL DECK
A. Roof Deck: Non-composite type, fluted steel sheet:

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify existing conditions prior to beginning work.

3.02 INSTALLATION
A. Erect metal deck in accordance with SDI Design Manual and manufacturer's instructions. Align and level.
B. On concrete and masonry surfaces provide minimum 4 inch bearing.
C. On steel supports provide minimum 1-1/2 inch bearing.
D. Fasten deck to steel support members at ends and intermediate supports at 12 inches on center maximum, parallel with the deck flute and at each transverse flute using methods specified.
E. Weld deck in accordance with AWS D1.3.
F. At deck openings from 6 inches to 18 inches in size, provide 2 x 2 x 1/4 inch steel angle reinforcement. Place angles perpendicular to flutes; extend minimum two flutes beyond each side of opening and fusion weld to deck at each flute.
G. Immediately after welding deck and other metal components in position, coat welds, burned areas, and damaged surface coating, with touch-up primer.

3.03 FIELD QUALITY CONTROL
A. An independent testing agency will perform field quality control inspection and testing as indicated on drawings.

END OF SECTION
SECTION 06 10 00
ROUGH CARPENTRY

PART 1 - GENERAL

1.01 DESCRIPTION
A. The types of carpentry work specified in this section include, but are not limited to, the following:
   1. Wood furring
   2. Wood grounds, nailers, blocking and sleepers
   3. Miscellaneous wood framing
   4. Sheathing and substrates for applied finishes.
B. The material specified herein shall comply with the American Iron and Steel provision of the Clean Water Act as it applies to the State Revolving Loan Funds and as administered by the State of Delaware. It is the Contractor's responsibility to determine if the Approved Manufacturers comply with the requirements of the provision.

1.02 SUBMITTALS
A. Material Certificates: Where dimensional lumber is provided to comply with minimum allowable unit stresses, submit listing of species and grade selected for each use, and submit evidence of compliance with specified requirements. Compliance may be in form of a signed copy of applicable portion of lumber producer's grading rules showing design values for selected species and grade. Design values shall be as approved by the Board of Review of American Lumber Standards Committee.
B. Certification:
   1. Preservative Treatment: For each type specified, include certification by treating plant stating type of preservative solution and pressure process used, net amount of preservative retained and conformance with applicable standards.
   2. For water-borne treatment include statement that moisture content of treated materials was reduced to levels indicated prior to shipment to project site.
   3. Fire-Retardant Treatment: Submit certification by treating plant that fire-retardant treatment materials comply with governing ordinances and that treatment will not bleed through finished surfaces.

1.03 PRODUCT DELIVERY, STORAGE, AND HANDLING
A. Store materials a minimum of 6" above ground on framework or blocking and cover with protective waterproof covering providing for adequate air circulation or ventilation.
B. Do not store seasoned materials in wet or damp portions of building.
C. Protect fire-retardant materials against high humidity and moisture during storage and erection.
D. Protect sheet materials from corners breaking and damaging surfaces, while unloading.

1.04 JOB CONDITIONS
A. Coordinate location of furring, nailers, blocking, grounds and similar supports so that attached work will comply with design requirements as detailed on the drawings and specified in various sections of the specifications.

PART 2 - PRODUCTS

2.01 MATERIALS
A. Lumber, General:
   1. Grade Stamps: Factory-mark each piece of lumber with grade stamp of inspection agency evidencing compliance with grading rule requirements and identifying grading agency, grade, species, moisture content at time of surfacing, and mill.
For exposed lumber apply grade stamps to ends or back of each piece, or omit grade stamps entirely and issue certificate of grade compliance from inspection agency in lieu of grade stamp.

Nominal sizes are indicated, except as shown by detail dimensions. Provide actual sizes as required by PS 20, for moisture content specified for each use.

Provide dressed lumber, S4S, unless otherwise indicated.

Provide seasoned lumber with 19% maximum moisture content at time of dressing.

B. Miscellaneous Lumber:

1. Provide wood for support or attachment of other work including cant strips, bucks, nails, blocking, furring, grounds, stripping and similar members. Provide lumber of sizes indicated, worked into shapes shown, and as follows:
   a. Moisture Content: 19% maximum for lumber items not specified to receive wood preservative treatment.
   b. Grade: Standard Grade light framing size lumber of any species or board size lumber as required. No. 3 Common or Standard grade boards per WCLIB or WWPA rules or No. 3 boards per SPIB rules.

2. Trade-mark: Identify each plywood panel with appropriate APA trademark.

3. Concealed Performance-Rated Plywood: Where plywood panels will be used for the following concealed types of applications, provide APA Performance Rated Panels complying with requirements indicated for grade designation, span rating, exposure durability classification, edge detail (where applicable) and thickness.

3. Plywood Backing Panels: For mounting electrical or telephone equipment, provide fire-retardant treated plywood panels with grade designation, APA C-D PLUGGED INT with exterior glue, in thickness indicated, or, if not otherwise indicated, not less than 3/4".

2.02 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

1. Where rough carpentry is exposed to weather, in ground contact, or in area of high relative humidity, provide fasteners with a hot-dip zinc coating per ASTM A 153 or of AISI Type 304 stainless steel.


E. Lag Bolts: ANSI B18.2.1.

F. Bolts: Steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and where indicated, flat washers.

2.03 METAL FRAMING ANCHORS

A. General: Provide metal framing anchors of type, size, metal, and finish indicated that comply with requirements specified including the following:

1. Current Evaluation/Research Reports: Provide products for which model code evaluation/research reports exist that are acceptable to authorities having jurisdiction and that evidence compliance of metal framing anchors for application indicated with the building code in effect for this project.

2. Allowable Designs Loads: Provide products for which manufacturer publishes allowable design loads that are determined from empirical data or by rational engineering analysis and that are demonstrated by comprehensive testing performed by a qualified independent testing laboratory.
B. Galvanized Steel Sheet: Steel sheet zinc-coated by hot-dip process on continuous lines prior to fabrication to comply with ASTM A 525 for Coating Designation G60 and with ASTM A 446, Grade A (structural quality); ASTM A 526 (commercial quality); or ASTM A 527 (lock-forming quality); as standard with manufacturer for type of anchor indicated.

2.04 MISCELLANEOUS MATERIALS
A. Adhesives for Field Gluing Panels to Framing: Formulation complying with APA AFG-01 that is approved for use with type of construction panel indicated by both adhesive and panel manufacturer.
B. Water Repellent Preservative: NWWDA-tested and -accepted formulation containing 3-iodo-2-propynyl butyl carbonate (IPBC) as its active ingredient.

2.05 FABRICATION
A. Fire-Retardant Treated Products:
1. Where fire-retardant lumber or plywood is specified or otherwise indicated, provide materials which comply with AWPA C20 and C27 respectively, for pressure impregnation with fire-retardant chemicals, and which have a flame spread rating of not more than 25 when tested in accordance with UL Test 723 or ASTM E 84, and show no increase in flame spread and significant progressive combustion upon continuation of test for additional 20 minutes.
2. Where treated items are exposed to exterior or to high humidities or are to have a transparent finish in form of stain or sealer, provide materials which show no change in fire-hazard classification when subjected to standard rain test (UL 790 or ASTM B 2898).
3. Use fire-retardant treatment which will not bleed through or adversely affect type of finish indicated and which does not require brush treatment of field-made end cuts to maintain fire-hazard classification.
4. Where transparent finish is indicated use type of treatment and species which permits milling of lumber after treatment without altering indicated fire-hazard classification, as determined by fire testing.
5. Kiln-dry treated items to maximum moisture content of 19%.
6. Provide UL label on each piece of fire-retardant lumber or plywood.
B. Preservative Treated Wood Products:
1. Wood shall be treated to comply with applicable requirements of AWPA Standards C2 (lumber) and C9 (plywood) and of AWPB Standards listed below. Mark each treated item with the AWPB Quality Mark Requirements.
2. Pressure-treat above-ground items with water-borne preservatives complying with AWPB LP-2. After treatment, kiln-dry lumber and plywood to a maximum moisture content respectively, of 19% and 15%. Treat indicated items and the following:
   a. Wood cants, nailers, curbs, blocking, stripping, and similar members in connection with roofing, flashing, vapor retarders and waterproofing.
   b. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
   c. Wood framing members less than 18" above grade.
3. Pressure-treat the following with water-borne preservatives for ground contact use complying with AWPB LP-22:
   a. Wood member in contact with ground.
   b. Wood members in contact with fresh water.
4. Complete fabrication of treated items prior to treatment, when possible. If cut after treatment, coat cut surfaces with heavy brush coat of same chemical used for treatment and to comply with AWPA M4.
PART 3 - EXECUTION

3.01 GENERAL

A. Discard units of material which are unsound, warped, bowed, twisted, improperly treated, not adequately seasoned or too small to fabricate work with a minimum of joints or optimum jointing arrangement.

B. Fit carpentry work to other work. Scribe and cope for accurate fit. Set accurately to required lines with members plumb and true.

C. Shim with metal or slate for bearing on concrete and masonry substrates. Where indicated, grout with 1:3 Portland cement-sand grout for full-bearing.

D. Securely attach carpentry work to substrates by anchoring and fastening as shown and as required by recognized standards.
   1. Provide washers under bolt heads and nuts in contact with wood.
   2. Nail plywood in accordance with recommendations of the American Plywood Association.

E. Fasteners: Use common wire nails, except as otherwise shown or specified herein. Do not wax or lubricate fasteners that depend on friction for holding power. Select fasteners of size that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting of wood; predrill as required. Do not drive threaded friction type fasteners; turn into place. Tighten bolts and lag screws at installation and retighten as required for tight connections prior to closing in or at completion of work. Nailing and spiking shall be done in a thorough manner with nails of ample size, using spikes larger than 20d where practicable.

3.02 WOOD FRAMING, GENERAL

A. Anchor and nail as shown, and to comply with "Recommended Nailing Schedule" of "Manual for House Framing" and "National Design Specifications for Wood Construction" published by N.F.P.A.


3.03 WOOD GROUNDS, NAILERS, BLOCKING, AND SLEEPERS

A. Coordinate location with other work; refer to shop drawings of such work.

B. Attach to substrates securely with anchor bolts or other attachment devices as shown and as required to support applied loading. Countersink bolts and nuts flush with surfaces. Build into masonry as work progresses, cutting to fit masonry unit size involved. Anchor to formwork before concrete placement.

C. Provide grounds of dressed, key-beveled lumber not less than 1-1/2" wide and of thickness required to bring face of ground to exact thickness of finish material involved. Remove temporary grounds where no longer required. Where indicated as permanent grounds, provide treated lumber.

D. The Contractor shall accomplish blocking as required to hold the work in proper position, including wood nailers and blocking in connection with the roof construction. Blocking shall be concealed when the finished work is in place. Blocking for supporting members for hanging plumbing fixtures and "in-wall" blocking for securement of toilet accessories shall be provided.

3.04 TEMPORARY BRACING AND CENTERING

A. The Contractor shall furnish and set temporary bracing, closures, guardrails and centering as is required to complete the work of all trades. Temporary workmen protection devices shall be in complete compliance with OSHA regulations. Centering shall be maintained until the masonry is thoroughly set, then shall be removed by Contractor.
3.05 NAILING AND BOLTING

A. Bolts shall be used at locations shown on the drawings or as specified. Where bolts are used, holes shall be bored only slightly larger than the size of the bolts. Where uncoated metal bolts are exposed, the threads shall be trimmed off after the nuts are firmly tightened.

B. Galvanized bolts shall be of the proper lengths so that they will not need to be cut off for appearance where exposed. Galvanized bolts shall be used at any location subject to weathering and when used in conjunction with preservative treated wood. Nails and screws used in conjunction with preservative treated wood shall be galvanized.

3.06 ROUGH HARDWARE

A. Provide and install rough hardware and metal fasteners as shown on drawings, specified herein, or required for proper installation of carpentry and architectural woodwork. Nails, spikes, screws, bolts, and other fastenings shall be of sizes and types required to rigidly secure members in place.

END OF SECTION
SECTION 07 52 00
MODIFIED BITUMINOUS MEMBRANE ROOFING

PART 1 GENERAL
1.01 SECTION INCLUDES
A. Modified bituminous roofing membrane, conventional application.
B. Insulation, flat and tapered.
C. Base flashings.
D. Roofing cant strips.

1.02 RELATED REQUIREMENTS
A. The material specified herein shall comply with the American Iron and Steel provision of the Clean Water Act as it applies to the State Revolving Loan Funds and as administered by the State of Delaware. It is the Contractor’s responsibility to determine if the Approved Manufacturers comply with the requirements of the provision.

1.03 RELATED SECTIONS
A. Section 06 10 00 - Rough Carpentry: Wood nailers and curbs.
B. Section 07 62 00 - Sheet Metal Flashing and Trim: Counterflashings.

1.04 REFERENCE STANDARDS

1.05 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer’s catalog data for membrane and bitumen materials, base flashing materials, insulation, vapor retarder, and surfacing.
C. Shop Drawings: Indicate joint or termination detail conditions, conditions of interface with other materials, setting plan for tapered insulation, and mechanical fastener layout.
D. Manufacturer’s qualification data.
E. Installer’s qualification data.
F. Manufacturer’s Installation Instructions: Indicate special procedures.
G. Manufacturer’s Certificate: Certify that products meet or exceed specified requirements.
H. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner’s name and registered with manufacturer.

1.06 QUALITY ASSURANCE
A. Perform work in accordance with NRCA Roofing and Waterproofing Manual and manufacturer’s instructions.
B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.
C. Installer Qualifications: Company specializing in performing the work of this section with minimum 5 years’ experience and approved by manufacturer.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Deliver products in manufacturer’s original containers, dry, undamaged, with seals and labels intact.
B. Store products in weather protected environment, clear of ground and moisture; ballast materials may be stored outdoors.
C. Protect foam insulation from direct exposure to sunlight.

1.08 FIELD CONDITIONS
A. Do not apply roofing membrane when environmental conditions are outside the ranges recommended by manufacturer.
B. Do not apply roofing membrane during unsuitable weather.
C. Do not apply roofing membrane when ambient temperature is below 40 degrees F.
D. Do not apply roofing membrane to damp or frozen deck surface or when precipitation is expected or occurring.
E. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.

1.09 WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Correct defective Work within a two-year period after Date of Substantial Completion.
C. Provide five-year manufacturer's material and labor warranty to cover failure to prevent penetration of water.

PART 2 PRODUCTS
2.01 MANUFACTURERS
A. Membrane Materials:
   4. Substitutions: See Section 01 60 00 - Product Requirements.
B. Insulation:
   5. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 ROOFING - CONVENTIONAL APPLICATION
A. Modified Bituminous Roofing: Two-ply membrane, with insulation.
B. Roofing Assembly Requirements:
   1. Insulation Thermal Value (R), minimum: 20; provide insulation of thickness required.
   2. Surfacing: Mineral granules.
C. Acceptable Insulation Types - Constant Thickness Application: Any type that meets requirements and is approved by membrane manufacturer for application.
   1. Minimum 2 layers of polyisocyanurate board.
D. Acceptable Insulation Types - Tapered Application: Any type that meets requirements and is approved by membrane manufacturer for application.
   1. Tapered extruded polystyrene board.
   2. Uniform thickness polyisocyanurate board covered with tapered extruded polystyrene board.

2.03 MEMBRANE AND SHEET MATERIALS
   A. Membrane: Polymer modified asphalt, reinforced with non-woven fabric; granule surfaced; with the following characteristics:
   B. Flexible Flashing Material: Same material as membrane.

2.04 BITUMINOUS MATERIALS
   A. Bitumen: Asphalt, ASTM D312 Type IV; for adhering insulation, use Type III.
   B. Primer: ASTM D41, asphalt type.
   C. Roof Cement: ASTM D4586, Type II.

2.05 INSULATION
   A. Polyisocyanurate Board Insulation: Rigid cellular foam, complying with ASTM C1289, Type I, aluminum foil both faces; Class 1, non-reinforced foam core, and with the following characteristics:
   B. Extruded Polystyrene Board Insulation: ASTM C578, Type X; Extruded expanded polystyrene board with natural skin surfaces, with drainage channels one face; with the following characteristics:
      1. Tapered Board: Slope as indicated; minimum thickness 1/2 in; fabricate of fewest layers possible.

2.06 ACCESSORIES
   A. Insulation Joint Tape: Glass fiber reinforced type as recommended by insulation manufacturer, compatible with roofing materials; 6 inches wide; self-adhering.
   B. Insulation Fasteners: Appropriate for purpose intended and approved by roofing manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that surfaces and site conditions are ready to receive work.
   B. Verify deck is supported and secure.
   C. Verify deck is clean and smooth, flat, free of depressions, waves, or projections, properly sloped and suitable for installation of roof system.
   D. Verify deck surfaces are dry and free of snow or ice.
   E. Verify that roof openings, curbs, and penetrations through roof are solidly set, and cant strips are in place.

3.02 INSULATION INSTALLATION - CONVENTIONAL APPLICATION
   A. Ensure vapor retarder is clean and dry, continuous, and ready for application of roofing system.
   B. Attachment of Insulation:
      1. Mechanically fasten first layer of insulation to deck in accordance with roofing manufacturer's instructions and Factory Mutual requirements.
      2. Embed second layer of insulation into flood coat mopping of hot bitumen in accordance with roofing and insulation manufacturers' instructions.
   C. Place tapered insulation to the required slope pattern in accordance with manufacturer's instructions.
   D. Lay boards with edges in moderate contact without forcing. Cut insulation to fit neatly to perimeter blocking and around penetrations through roof.
E. Tape joints of insulation in accordance with roofing and insulation manufacturers' instructions.
F. Do not apply more insulation than can be covered with membrane in same day.

3.03 MEMBRANE APPLICATION
A. Apply membrane in accordance with manufacturer's instructions.
B. Apply membrane; lap and seal edges and ends permanently waterproof.
C. Apply smooth, free from air pockets, wrinkles, fish-mouths, or tears. Ensure full bond of membrane to substrate.
D. At end of day's operation, install waterproof cut-off. Remove cut-off before resuming roofing.
E. At intersections with vertical surfaces:
   1. Extend membrane over cant strips and up a minimum of 8 inches onto vertical surfaces.
   2. Apply flexible flashing over membrane.
F. Around roof penetrations, mop in and seal flanges and flashings with flexible flashing.
G. Coordinate installation of roof drains and sumps and related flashings.

3.04 FIELD QUALITY CONTROL
A. See Section 01 40 00 - Quality Requirements, for general requirements for field quality control and inspection.
B. Require site attendance of roofing and insulation material manufacturers daily during installation of the Work.

3.05 CLEANING
A. Remove bituminous markings from finished surfaces.
B. In areas where finished surfaces are soiled by bitumen or other source of soiling caused by work of this section, consult manufacturer of surfaces for cleaning advice and conform to their documented instructions.
C. Repair or replace defaced or damaged finishes caused by work of this section.

3.06 PROTECTION
A. Protect installed roofing and flashings from construction operations.
B. Where traffic must continue over finished roof membrane, protect surfaces using durable materials.

END OF SECTION
PART 1 GENERAL

1.01 SCOPE OF WORK
   A. Provide all labor, equipment, and materials to fabricate and/or install the following.
      1. Wall and parapet caps
      2. Flashing set in masonry joint
      3. Counter flashing
      4. Gutters and downspouts
   B. The material specified herein shall comply with the American Iron and Steel provision of the
      Clean Water Act as it applies to the State Revolving Loan Funds and as administered by the
      State of Delaware. It is the Contractor’s responsibility to determine if the Approved
      Manufacturers comply with the requirements of the provision.

1.02 RELATED SECTIONS
   A. Section 04 21 20 - Unit Masonry
   B. Section 07 90 00 - Sealants

1.03 FURNISHED BUT NOT INSTALLED
   A. Furnish various trades with flashing and other items of sheet metal work shown or specified to
      be built in by them.

1.04 SHOP DRAWINGS
   A. Submit complete shop drawings for sheet metal work to Architect for approval.

1.05 GUARANTEE
   A. All flashing and sheet metal work shall be included in 5 year guarantee specified under roofing.
   This applicator shall furnish guarantee in written form.

PART 2 PRODUCTS

2.01 MATERIALS
   A. Prefinished metal.
   B. Galvanized sheet metal.
      1. ASTM A-361, hot dip type, 24 gauge.
      2. Solder - ASTM B-32, 50% tin.

PART 3 EXECUTION

3.01 INSTALLATION
   A. Counter flashing shall be installed according to figure “A”, page 101, SMACNA Manual.
   B. Corners shall be shop fabricated with legs extending each way from a corner a minimum of 18”.
   C. Roof penetration flashing shall be fabricated and installed using 24 gauge galvanized steel in
   D. Flashing
      1. Lengths not to exceed 15 feet.
      2. Side laps 6 inches, end laps 10 inches.
      3. Adhere joints together with adhesive recommended by manufacturer.
      4. Apply to masonry with cold setting cement on horizontal surfaces.
   E. Gutters and downspouts to be installed per drawings.
3.02 EXPANSION AND CONTRACTION
   A. Make ample provisions for expansion and contraction of all sheet metal work. See SMACNA Manual.

3.03 WORKMANSHIP
   B. Accurately form to size, shape and dimensions with all angles and lines in true alignment.
   C. The work shall conform to "Architectural Sheet Metal Manual" as issued by the Sheet Metal and Air Conditioning Contractors' National Assoc., Inc.

END OF SECTION
SECTION 07 90 00
JOINT SEALANTS

PART 1 GENERAL
1.01 SUMMARY
A. This section includes joint sealants for the following locations:
   1. Exterior joints in vertical surfaces and non traffic horizontal surfaces as indicated below:
      a. Control and expansion joints in cast-in-place concrete.
      b. Control and expansion joints in unit masonry.
      c. Perimeter joints between materials listed above and frames of door and windows.
   2. Exterior joints in horizontal traffic surfaces as indicated below:
      a. Control, expansion, and isolation joints in cast-in-place concrete slabs.
      b. Tile control and expansion joints.
   3. Interior joints in vertical surfaces and horizontal non traffic surfaces indicated below:
      a. Control and expansion joint on exposed interior surfaces of exterior walls.
      b. Perimeter joints of exterior openings.
      c. Perimeter joints between interior wall surfaces and frames of interior doors and windows.
      d. Perimeter joints of toilet fixtures.
   4. Interior joints in horizontal traffic surfaces as indicated below:
      a. Control and expansion joints in tile flooring.

1.02 RELATED DOCUMENTS AND REQUIREMENTS
A. Drawings and general provisions of Contract, including General and Supplementary Conditions
   and Division 1 Specification Sections apply to this section.
B. The material specified herein shall comply with the American Iron and Steel provision of the
   Clean Water Act as it applies to the State Revolving Loan Funds and as administered by the
   State of Delaware. It is the Contractor's responsibility to determine if the Approved
   Manufacturers comply with the requirements of the provision.

1.03 SYSTEM PERFORMANCE REQUIREMENTS
A. Provide elastomeric joint sealants that have been produced and installed to establish and to
   maintain watertight and airtight continuous seals without causing staining or deterioration of
   joint substrates.
B. Provide joint sealants for interior applications that have been produced and installed to
   establish and maintain airtight continuous seals that are water resistant and without staining or
   deterioration of joint substrates.

1.04 SUBMITTALS
A. General: Submit the following in accordance with Condition of Contract and Division 1
   Specifications Sections.
B. Product data from manufacturers for each joint sealant product required.
   1. Certification by joint sealant manufacturer that sealants plus the primers and cleaners
      required for sealant installation comply with local regulations controlling use of volatile
      organic compounds.
C. Samples for initial selection purposes in form of manufacturer's standard bead samples,
   consisting of strips of actual products showing full range of colors available, for each product
   exposed to view.

1.05 QUALITY ASSURANCE
A. Installer Qualifications: Engage an experienced installer who has completed joint sealant
   applications similar in material, design, and extent to that indicated for Project that have
   resulted in construction with a record of successful in-service performance.
B. Single Source Responsibility for joint sealant materials: Obtain joint sealant materials from a single manufacturer for each different product required.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multicomponent materials.
B. Store and handle materials in compliance with manufacturer’s recommendations to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.07 PROJECT CONDITIONS
A. Environmental Conditions: Do not proceed with installation of joint sealants under the following conditions:
   1. When ambient and substrate temperature conditions are outside the limits permitted by joint sealant manufacturer or below 40 deg F (4.4 deg C).
B. Joint Width Conditions: Do not proceed with installation of joint sealants where joint widths are less or greater than allowed by joint sealant manufacturer for application indicated.
C. Joint Substrate Conditions: Do not proceed with installation of joint sealants until contaminants capable of interfering with their adhesion are removed from joint substrates.

PART 2 PRODUCTS

2.01 MATERIALS, GENERAL
A. Compatibility: Provide joint sealants, joint fillers, and other related materials that are compatible with one another and with joint substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
B. Color: Provide color of exposed joint sealants to comply with the following:
   1. Provide selections made by Architect from manufacturer’s full range of standard colors for products of type indicated.

2.02 ELASTOMERIC JOINT SEALANTS
A. Elastomeric Sealant Standard: Provide manufacturer’s standard chemically curing elastomeric sealants that comply with ASTM C 920.
   1. Additional Movement Capability: Where additional movement capability is specified in Elastomeric Joint Sealant Data Sheet, provide products with the capability, when tested for adhesion and cohesion under maximum cyclic movement per ASTM C 719, to withstand the specified percentage change in the joint width existing at time of installation and remain in compliance with other requirements of ASTM C 920 for use indicated.
B. Available Products: Subject to compliance with requirements, elastomeric sealants that may be incorporated in the work include, but are not limited to, the products specified in each Elastomeric Joint Sealant Date Sheet.
C. Products: Subject to compliance with requirements, provide one of the products specified in each Elastomeric Joint Sealant Date Sheet.

2.03 JOINT SEALANT BACKING
A. General: Provide sealant backings of material and type that are non-staining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
B. Plastic Foam Joint Fillers: Preformed, compressible, resilient, non-staining, non-waxing, non-extruding strips or flexible plastic foam of material indicated below and of size, shape, and density to control sealant depth and otherwise contribute to producing optimum sealant performance:
   1. Closed cell polyethylene foam, nonabsorbent to liquid water and gas, non-outgassing in unruptured state.
2.04 MISCELLANEOUS MATERIALS
   A. Primer: Material recommended by joint sealant manufacturer where required for adhesion of
      sealant to joint substrates indicated, as determined from preconstruction joint sealant-substrate
      tests and field tests.
   B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants
      and sealant backing materials, free of oily residues or other substances capable of staining or
      harming in any way joint substrates and adjacent nonporous surfaces, and formulated to
      promote optimum adhesion of sealants to joint substrates.
   C. Masking Tape: Non-staining, nonabsorbent material compatible with joint sealants and surfaces
      adjacent to joints.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Examine joints indicated to receive joint sealants, with installer present, for compliance with
      requirements for joint configuration, installation tolerances, and other conditions affecting joint
      sealant performance. Do not proceed with installation of joint sealants until unsatisfactory
      conditions have been corrected.

3.02 PREPARATION
   A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to
      comply with recommendations of joint sealant manufacturer and the following requirements:
      1. Remove all foreign material from joint substrates that could interfere with adhesion of joint
         sealant, including dust, paints, (except for permanent protective coatings tested and
         approved for sealant adhesion and compatibility by sealant manufacturer), old joint
         sealants, oil, grease, waterproofing, water repellants, water, surface dirt, and frost.
      2. Clean concrete, masonry, unglazed surfaces of ceramic tile, and similar porous joint
         substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a
         combination of these methods to produce a clean, sound substrate capable of developing
         optimum bond with joint sealants. Remove loose particles remaining from above cleaning
         operations by vacuuming or blowing out joints with oil free compressed air.
      3. Remove laitance and form release agents from concrete.
      4. Clean metal, glass, porcelain enamel, glazed surfaces of ceramic tile, and other
         nonporous surfaces with chemical cleaners or other means that do not stain, harm
         substrates, or leave residues capable of interfering with adhesion of joint sealants.
   B. Joint Priming: Prime joint substrates where indicated of where recommended by joint sealant
      manufacturer based on preconstruction joint sealant-substrate tests or prior experience. Apply
      primer to comply with joint sealant manufacturer’s recommendations. Confine primers to areas
      of joint sealants bond; do not allow spillage or migration onto adjoining surfaces.
   C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining
      surfaces that otherwise would be permanently stained or damaged by such contact or by
      cleaning methods required to remove sealant smears. Remove tape immediately after tooling
      without disturbing joint seal.

3.03 INSTALLATION OF JOINT SEALANTS
   A. General: Comply with joint sealant manufacturer’s printed installation instructions applicable to
      products and applications indicated, except where more stringent requirements apply.
   B. Sealant Installation Standard: Comply with recommendations of ASTM C 1193 for use of joint
      sealants as applicable to materials, applications, and conditions indicated.
   C. Installation of Sealant Backings: Install sealant backings to comply with the following
      requirements:
      1. Install joint fillers to provide support of sealants during application and at position required
         to produce the cross-sectional shapes and depths of installed sealants relative to joint
         widths that allow optimum sealant movement capability.
a. Do not leave gaps between ends of joint fillers.
b. Do not stretch, twist, puncture, or tear joint fillers.
c. Remove absorbent joint fillers that have become wet prior to sealant application and replace with dry material.

D. Installation of Sealants: Install sealants by proven techniques that result in sealants directly contacting and fully wetting joint substrates, completely filling recesses provided for each joint configuration, and providing uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability. Install sealants at the same time sealant backings are installed.

E. Tooling of Nonsag Sealants: Immediately after sealant application and prior to time skinning or curing begins, tool sealants to form smooth, uniform beads of configuration indicated, to eliminate air pockets, and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

1. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.

3.04 CLEANING

A. Clean off excess sealants or sealant smears adjacent to joints as work progresses by methods and with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.

3.05 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances or from damage resulting from construction operations or other causes so that they are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so that reinstallation in required areas are indistinguishable from original work.

END OF SECTION
SECTION 08 16 13
FIBERGLASS DOORS

PART 1 GENERAL

1.01 SCOPE OF WORK
A. Section Includes
   1. Fiberglass reinforced plastic (FRP) doors.
   2. Frames for fiberglass reinforced plastic doors.
   3. Hinges and other door hardware.
   5. Accessories.
B. The material specified herein shall comply with the American Iron and Steel provision of the Clean Water Act as it applies to the State Revolving Loan Funds and as administered by the State of Delaware. It is the Contractor's responsibility to determine if the Approved Manufacturers comply with the requirements of the provision.

1.02 REFERENCE STANDARDS

1.03 ADMINISTRATIVE REQUIREMENTS
A. Coordination: Obtain hardware templates from hardware manufacturer prior to starting fabrication.

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's standard details, installation instructions, and hardware and anchor recommendations.
C. Shop Drawings: Show layout and profiles; include assembly methods.
   1. Indicate product components, including hardware reinforcement locations and preparations, accessories, finish colors, patterns, and textures.
   2. Indicate wall conditions, door and frame elevations, sections, materials, gages, finishes, location of door hardware by dimension, and details of openings; use same reference numbers indicated on Drawings to identify details and openings.
D. Maintenance Data: Include instructions for repair of minor scratches and damage.
E. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer; include detailed terms of warranty.
F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.

1.05 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with not less than three years of experience.
B. Installer Qualifications: Company specializing in installing products of the type specified in this section with not less than three years of experience.
1.06 DELIVERY, STORAGE, AND HANDLING
   A. Mark doors with location of installation, door type, color, and weight.
   B. Deliver materials in manufacturer’s original, unopened, undamaged containers with identification labels intact.
   C. Store materials in original packaging, under cover, protected from exposure to harmful weather conditions and from direct contact with water.
      1. Store at temperature and humidity conditions recommended by manufacturer.
      2. Do not use non-vented plastic or canvas shelters.
      3. Immediately remove wet wrappers.
   D. Store in position recommended by manufacturer, elevated minimum 4 inches above grade, with minimum 1/4 inches space between doors.

1.07 FIELD CONDITIONS
   A. Do not install doors until structure is enclosed.
   B. Maintain temperature and humidity at manufacturer’s recommended levels during and after installation of doors.

1.08 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Provide ten (10) year manufacturer warranty covering materials and workmanship.

PART 2 PRODUCTS
2.01 MANUFACTURERS
   A. Molded Fiberglass Doors:
      3. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 DOOR AND FRAME ASSEMBLIES
   A. Door and Frame Assemblies: Factory-fabricated, prepared and machined for hardware.
      1. Door and frame pre-assembled, complete with hinges; shipped with braces, spreaders, and packaging as required to prevent damage.
      2. Mechanical Durability: Tested to ANSI A250.4 Level A (1,000,000 cycles), minimum; tested with hardware and fasteners intended for use on project.
      3. Screw-Holding Capacity: Tested to 900 psi, minimum.
      4. Surface Burning Characteristics: Flame spread index of 25 or less, smoke developed index of 450 or less, Class A; when tested in accordance with ASTM E84.
      5. Flammability: Self-extinguishing when tested in accordance with ASTM D635.
      6. Chemical Resistance: Resist degradation due to exposure to tap water, distilled water, and:
         a. Sewage and moisture-laden air in sewage treatment areas.
         b. Chlorine-treated moisture in air.
      7. Sizes: As indicated on drawings.
     10. Clearance Between Bottom of Door and Finished Floor: 3/4 inch, maximum; not less than 1/4 inch clearance to threshold.
     11. Provide frame anchors that allow for variation in rough opening size; do not field cut doors or frames to fit.

2.03 COMPONENTS
   A. Doors: Through-color gel coating on fiberglass reinforced polyester resin construction with reinforced core.
2. Door Construction: Molded in one piece including gel coating on all sides; manufacturer's standard subframe, core and faces fused during cure in mold; hardware reinforcements.
4. Waterproof Integrity: All edges, cut-outs, and hardware preparations factory fabricated of fiberglass reinforced plastic; provide cut-outs with joints sealed independently of glazing or louver inserts or trim.
5. Hardware Preparations: Factory reinforce, machine, and prepare for all hardware including field installed items; provide solid blocking for each hardware item; make field cutting, drilling or tapping unnecessary; obtain manufacturer's templates for hardware preparations.
6. Bottom Rail: Provide height necessary to allow up to 1-1/4 inches to be field cut off bottom of door without impairing door strength or durability.

B. Frames: Profiles and dimensions as indicated on drawings; same type and construction used in mechanical durability test for doors.
   1. Construction for Non-Fire-Rated Doors: Use one of the following:
      a. Molded fiberglass with gel-coating matching doors.
   2. Corner Joints: Mitered with concealed corner blocks or angles of same material as frame; fiberglass and aluminum joined with screws; steel and stainless steel spot welded; sealed watertight with silicone sealant.
   3. At hardware cut-outs provide continuous backing or mortar guards of same material as frame, sealed watertight.
   4. Frame Anchors: Stainless steel, Type 304; provide 3 anchors in each jamb for heights up to 84 inches with one additional anchor for each additional 24 inches in height.

C. Transom and Other Panels: Same construction as doors.
D. Hinge and Hardware Fasteners: Stainless steel, Type 304; wood screws.

2.04 ACCESSORIES
A. Astragals for Inactive Leaves: Pultruded fiberglass angle or tee; same color as gel coat.
B. Glazing and Louver Stops: Pultruded fiberglass unless otherwise indicated or required by fire rating; provided by door manufacturer to fit factory made openings, color and texture to match door; fasteners not penetrating waterproof integrity.
   1. Exterior Doors: Provide non-removable stops on outside and continuous compression gasket weatherseal.
   2. Glazed Openings: Provide removable stops on one side.
   3. Opening Sizes: As indicated on drawings.
C. Glazing: Laminated safety glass, 3/8 inch thick, with minimum 0.030 inch thick interlayer, clear.
D. Louvers for Non-Fire-Rated Doors: Same materials, construction, finish, and color as door; fixed vanes, 45 degree sloped vanes.
E. Hardware: As specified in Section 08 71 00.
F. Thresholds: Molded fiberglass, with skid resistant surface, full width of door opening, same color as frame.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify actual dimensions of openings by field measurements before door fabrication; show recorded measurements on shop drawings.
B. Do not begin installation until substrates have been properly prepared.
C. If substrate preparation is the responsibility of another installer, notify Engineer of unsatisfactory preparation before proceeding.
3.02 PREPARATION  
A. Remove existing doors and frames, and dispose of all removed materials in accordance with local authorities having jurisdiction.  
B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.  
C. Clean and prepare substrate in accordance with manufacturer’s directions.  
D. Protect adjacent work and finish surfaces from damage during installation.  

3.03 INSTALLATION  
A. Install in accordance with manufacturer’s instructions; do not penetrate frames with anchors.  
B. Set units plumb, level, and true-to-line, without warping or racking doors, and with specified clearances; anchor in place.  
C. Separate aluminum and other metal surfaces from sources of corrosion of electrolytic action at points of contact with other materials.  
D. Repair or replace damaged installed products.  

3.04 ADJUSTING  
A. Lubricate, test, and adjust doors to operate easily, free from warp, twist or distortion, and to fit watertight for entire perimeter.  
B. Adjust hardware for smooth and quiet operation.  
C. Adjust doors to fit snugly and close without sticking or binding.  

3.05 CLEANING  
A. Clean installed products in accordance with manufacturer’s instructions prior to owner’s acceptance.  

3.06 PROTECTION  
A. Protect installed products from damage during subsequent work.  

END OF SECTION
SECTION 08 33 23
OVERHEAD COILING DOORS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Overhead coiling doors, operating hardware, exterior, manual operation.

1.02 RELATED REQUIREMENTS
A. Section 08 71 00 - Door Hardware: Cylinder cores and keys.
B. The material specified herein shall comply with the American Iron and Steel provision of the Clean Water Act as it applies to the State Revolving Loan Funds and as administered by the State of Delaware. It is the Contractor's responsibility to determine if the Approved Manufacturers comply with the requirements of the provision.

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide general construction, component connections and details.
C. Shop Drawings: Indicate pertinent dimensioning, anchorage methods, hardware locations, and installation details.
D. Manufacturer's Instructions: Indicate installation sequence and procedures, adjustment and alignment procedures.
E. Maintenance Data: Indicate lubrication requirements and frequency and periodic adjustments required.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Overhead Coiling Doors:
   6. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 COILING DOORS
A. Exterior Coiling Doors: Aluminum slat curtain.
   1. Capable of withstanding positive and negative wind loads of 20 psf, without undue deflection or damage to components.
   2. Sandwich slat construction with insulated core of foamed in place insulation; insulation (u-) value: 0.50 BTU/hr sq ft deg F
   3. Nominal Slat Size: 3 inches wide x required length.
   4. Finish: Factory painted, color as selected.
   5. Guides: Formed track; galvanized steel.
   6. Hood Enclosure: Manufacturer's standard; aluminum.
9. Exterior lock and latch handle.

2.03 MATERIALS
A. Curtain Construction: Interlocking slats.
   1. Slat Ends: Alternate slats fitted with end locks to act as wearing surface in guides and to prevent lateral movement.
   2. Curtain Bottom: Fitted with angles to provide reinforcement and positive contact in closed position.
   3. Weatherstripping: Moisture and rot proof, resilient type, located at jamb edges, bottom of curtain, and where curtain enters hood enclosure of exterior doors.
B. Aluminum Slats: ASTM B221 (ASTM B221M), aluminum alloy Type 6063.
C. Guide Construction: Continuous, of profile to retain door in place with snap-on trim, mounting brackets of same metal.
D. Steel Guides: ASTM A36/A36M steel angles, size as indicated, hot-dip galvanized per ASTM A 123/A 123M.
E. Hood Enclosure: Internally reinforced to maintain rigidity and shape.
F. Hardware:
   1. Lock Cylinders: Specified in Section 08 71 00.
   2. Latching: Inside mounted, adjustable keeper, spring activated latch bar with feature to keep in locked or retracted position.
   3. Latch Handle: Interior handle.
G. Roller Shaft Counterbalance: Steel pipe and helical steel spring system, capable of producing torque sufficient to ensure smooth operation of curtain from any position and capable of holding position at mid-travel; with adjustable spring tension; requiring 25 lb nominal force to operate.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify that opening sizes, tolerances and conditions are acceptable.

3.02 INSTALLATION
A. Install units in accordance with manufacturer's instructions.
B. Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress.
C. Securely and rigidly brace components suspended from structure. Secure guides to structural members only.
D. Fit and align assembly including hardware; level and plumb, to provide smooth operation.

3.03 TOLERANCES
A. Maintain dimensional tolerances and alignment with adjacent work.
B. Maximum Variation From Plumb: 1/16 inch.
C. Maximum Variation From Level: 1/16 inch.
D. Longitudinal or Diagonal Warp: Plus or minus 1/8 inch per 10 ft straight edge.

3.04 ADJUSTING
A. Adjust operating assemblies for smooth and noiseless operation.

3.05 CLEANING
A. Clean installed components.
B. Remove labels and visible markings.

END OF SECTION
SECTION 08 71 00
DOOR HARDWARE

PART 1 GENERAL
1.01 SECTION INCLUDES
   A. Hardware for fiberglass doors.
   B. Thresholds.
   C. Weather-stripping, seals and door gaskets.

1.02 RELATED REQUIREMENTS
   A. Section 08 16 13 - Fiberglass Doors and Frames
   B. Section 08 33 23 - Overhead Coiling Doors: Lockable coiling doors.
   C. The material specified herein shall comply with the American Iron and Steel provision of the Clean Water Act as it applies to the State Revolving Loan Funds and as administered by the State of Delaware. It is the Contractor's responsibility to determine if the Approved Manufacturers comply with the requirements of the provision.

1.03 REFERENCE STANDARDS
   C. BHMA A156.1 - American National Standard for Butts and Hinges; Builders Hardware Manufacturers Association, Inc.; 2006 (ANSI/BHMA A156.1).
   D. BHMA A156.2 - American National Standard for Bored and Preassembled Locks & Latches; Builders Hardware Manufacturers Association; 2011 (ANSI/BHMA A156.2).
   E. BHMA A156.3 - American National Standard for Exit Devices; Builders Hardware Manufacturers Association; 2008 (ANSI/BHMA A156.3).
   F. BHMA A156.4 - American National Standard for Door Controls - Closers; Builders Hardware Manufacturers Association, Inc.; 2008 (ANSI/BHMA A156.4).
   G. BHMA A156.6 - American National Standard for Architectural Door Trim; Builders Hardware Manufacturers Association; 2010 (ANSI/BHMA A156.6).
   H. BHMA A156.7 - American National Standard for Template Hinge Dimensions; Builders Hardware Manufacturers Association; 2003 (ANSI/BHMA A156.7).
   I. BHMA A156.8 - American National Standard for Door Controls - Overhead Stops and Holders; Builders Hardware Manufacturers Association, Inc.; 2010 (ANSI/BHMA A156.8).
   J. BHMA A156.13 - American National Standard for Mortise Locks & Latches Series 1000; Builders Hardware Manufacturers Association; 2012 (ANSI/BHMA A156.13).
   K. BHMA A156.18 - American National Standard for Materials and Finishes; Builders Hardware Manufacturers Association, Inc.; 2012 (ANSI/BHMA A156.18).
   L. BHMA A156.22 - American National Standard for Door Gasketing and Edge Seal Systems, Builders Hardware Manufacturers Association; 2012 (ANSI/BHMA A156.22).
   M. DHI (LOCS) - Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames; Door and Hardware Institute; 2004.
1.04 ADMINISTRATIVE REQUIREMENTS
   A. Coordinate the manufacture, fabrication, and installation of products onto which door hardware will be installed.
   B. Furnish templates for door and frame preparation to manufacturers and fabricators of products requiring internal reinforcement for door hardware.
   C. Convey Owner's keying requirements to manufacturers.

1.05 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Manufacturer's catalog literature for each type of hardware, marked to clearly show products to be furnished for this project.
   C. Shop Drawings:
      1. Indicate locations and mounting heights of each type of hardware, schedules, catalog cuts,
   D. Hardware Schedule: Detailed listing of each item of hardware to be installed on each door. Use door numbering scheme as included in the Contract Documents. Identify electrically operated items and include power requirements.
   E. Keying Schedule: Submit for approval of Owner.
   F. Manufacturer's Installation Instructions: Indicate special procedures, perimeter conditions requiring special attention.
   G. Maintenance Data: Include data on operating hardware, lubrication requirements, and inspection procedures related to preventative maintenance.
   H. Keys: Deliver with identifying tags to Owner by security shipment direct from hardware supplier.
   I. Warranty: Submit manufacturer's warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING
   A. Package hardware items individually; label and identify each package with door opening code to match hardware schedule.

1.08 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Provide five year warranty for door closers.

PART 2 PRODUCTS
2.01 DOOR HARDWARE - GENERAL
   A. Provide all hardware specified or required to make doors fully functional, compliant with applicable codes, and secure to the extent indicated.
   B. Provide all items of a single type of the same model by the same manufacturer.
   C. Provide products that comply with the following:
      1. Applicable provisions of federal, state, and local codes.
      2. ADA Standards for Accessible Design.
      5. Products Requiring Electrical Connection: Listed and classified by UL as suitable for the purpose specified and indicated.
D. Finishes: All door hardware the same finish unless otherwise indicated.
   1. Primary Finish: Satin stainless steel (US26D).
   2. Finish Definitions: BHMA A156.18.

2.02 HINGES
A. Hinges: Provide hinges on every swinging door.
   1. Provide five-knuckle full mortise butt hinges unless otherwise indicated.
   2. Provide ball-bearing hinges at all doors having closers.
   3. Provide hinges in the quantities indicated.
   4. Provide non-removable pins on exterior outswinging doors.
B. Butt Hinges: Comply with BHMA A156.1 and A156.7; standard weight, unless otherwise indicated.
   1. Provide hinge width required to clear surrounding trim.
C. Quantity of Hinges Per Door:
   1. Doors From 60 inches High up to 90 inches High: Three hinges.
   2. Doors 90 inches High up to 120 inches High: Four hinges.

2.03 PUSH/PULLS
A. Push/Pulls: Comply with BHMA A156.6.
   1. Provide push and pull on doors not specified to have lockset, latchset, exit device, or auxiliary lock.
   2. On solid doors, provide matching push plate and pull plate on opposite faces.

2.04 LOCKS AND LATCHES
A. Locks: Provide a lock for every door, unless specifically indicated as not requiring locking.
   1. Hardware Sets indicate locking functions required for each door.
   2. If no hardware set is indicated for a swinging door provide an office lockset.
   3. Trim: Provide lever handle or pull trim on outside of all locks unless specifically stated to have no outside trim.
   4. Lock Cylinders: Provide key access on outside of all locks unless specifically stated to have no locking or no outside trim.
   5. In door sections, where a lock cylinder referenced to Section 08 71 00 is specified, furnish and install a mortise lock cylinder keyed to the building keying system.
B. Lock Cylinders: Manufacturer's standard tumbler type, six-pin standard core.
   1. Provide cams and/or tailpieces as required for locking devices required.
C. Keying: Grand master keyed.
   1. Key to existing keying system.
D. Latches: Provide a latch for every door that is not required to lock, unless specifically indicated "push/pull" or "not required to latch".

2.05 CYLINDRICAL LOCKSETS
A. Locking Functions: As defined in BHMA A156.2, and as follows:
   1. Passage: No locking, always free entry and exit.
   2. Privacy: F76, emergency tool unlocks.
   3. Office: F81, key not required to lock, remains locked upon exit.

2.06 MORTISE LOCKSETS
A. Locking Functions: As defined in BHMA A156.13, and as follows:
   1. Passage: F01.
   2. Privacy: F19, or F02 with retraction of deadbolt by use of inside lever/knob.
   3. Office: F04, key not required to lock, remains locked upon exit.
   4. Entry, Deadbolt: F20, may be locked without key, free egress.
2.07 FLUSHBOLTS
   A. Flushbolts: Lever extension bolts in leading edge of door, one bolt into floor, one bolt into top of frame.
      1. Pairs of Swing Doors: At inactive leaves, provide flush bolts of type as required to comply with code.
      2. Floor Bolts: Provide dustproof strike except at metal thresholds.
   B. Manual Flushbolts: Provide lever extensions for top bolt at over-size doors.
   D. Coordinators: Provide on doors having closers and self-latching or automatic flushbolts to ensure that leaves close in proper order.

2.08 EXIT DEVICES
   A. Provide Exit devices for doors as indicated on the Hardware Schedule and for all Electrical room doors.
   B. Locking Functions: Functions as defined in BHMA A156.3, and as follows:
      1. Entry/Exit, Always-Unlocked: Outside lever unlocked, no outside key access, no latch holdback.
      2. Entry/Exit, Free Swing: Key outside retracts latch, latch holdback (dogging) for free swing during occupied hours, not fire-rated; outside trim must be specified as lever or pull.

2.09 CLOSERS
   A. Closers: Complying with BHMA A156.4.
      1. Provide surface-mounted, door-mounted closers unless otherwise indicated.
      2. Provide a door closer on every exterior door.
      3. Provide a door closer on every fire- and smoke-rated door. Spring hinges are not an acceptable self-closing device unless specifically so indicated.
      4. On pairs of swinging doors, if an overlapping astragal is present, provide coordinator to ensure the leaves close in proper order.
      5. At outswinging exterior doors, mount closer in inside of door.

2.10 STOPS AND HOLDERS
   A. Stops: Complying with BHMA A156.8; provide a stop for every swinging door, unless otherwise indicated.
      1. Provide wall stops, unless otherwise indicated.
      2. If wall stops are not practical, due to configuration of room or furnishings, provide overhead stop.
      3. Stop is not required if positive stop feature is specified for door closer; positive stop feature of door closer is not an acceptable substitute for a stop unless specifically so stated.

2.11 GASKETING AND THRESHOLDS
   A. Gaskets: Complying with BHMA A156.22.
      1. On each door in smoke partition, provide smoke gaskets; top, sides, and meeting stile of pairs. If fire/smoke partitions are not indicated on drawings, provide smoke gaskets on each door identified as a “smoke door” and 20-minute rated fire doors.
      2. On each exterior door, provide weatherstripping gaskets, unless otherwise indicated; top, sides, and meeting stiles of pairs.
      3. Where exterior door is also required to have fire or smoke rating, provide gaskets functioning as both smoke and weather seals.
      4. On each exterior door, provide door bottom sweep, unless otherwise indicated.
      5. On each interior electrical room door, provide gaskets similar to smoke gaskets.
   B. Thresholds:
      1. At each exterior door, provide a threshold unless otherwise indicated.
C. Fasteners At Exterior Locations: Non-corroding.

2.12 PROTECTION PLATES AND ARCHITECTURAL TRIM
A. Protection Plates:
   1. Kickplate: Provide on push side of every door with closer, except storefront and all-glass doors.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that doors and frames are ready to receive work; labeled, fire-rated doors and frames are present and properly installed, and dimensions are as indicated on shop drawings.
B. Verify that electric power is available to power operated devices and of the correct characteristics.

3.02 INSTALLATION
A. Install hardware in accordance with manufacturer's instructions and applicable codes.
B. Use templates provided by hardware item manufacturer.
C. Mounting heights for hardware from finished floor to center line of hardware item:
   1. For steel doors and frames: Comply with DHI "Recommended Locations for Architectural Hardware for Steel Doors and Frames."

3.03 FIELD QUALITY CONTROL
A. Field inspection and testing will be performed under provisions of Section 01 40 00.

3.04 ADJUSTING
A. Adjust work under provisions of Section 01 70 00.
B. Adjust hardware for smooth operation.
C. Adjust gasketing for complete, continuous seal; replace if unable to make complete seal.

3.05 CLEANING
A. Clean adjacent surfaces soiled by hardware installation. Clean finished hardware per manufacturer's instructions after final adjustments has been made. Replace items that cannot be cleaned to manufacturer's level of finish quality at no additional cost.

3.06 PROTECTION
A. Protect finished Work under provisions of Section 01 70 00.
B. Do not permit adjacent work to damage hardware or finish.

3.07 HARDWARE SETS

3.08 GENERAL
A. These Hardware Sets indicate requirements for single doors of that type, with conditional requirements for pairs and other situations.
B. Pairs of Swinging Doors: Provide one of each specified item on each leaf unless specifically stated otherwise. Treat pairs as two active leaves unless otherwise indicated.

3.09 SWING DOORS -- NOT REQUIRING KEY LOCKING
A. HW-1: Push/Pull, Non-Fire-Rated:
   1. Closer.
   2. Push/Pull.
B. HW-2: Latchset, Non-Fire-Rated.
   1. Latchset, Passage.
   2. Pair: One leaf inactive, with manual flush bolts.
C. HW-5: Privacy Lockset, Non-Fire-Rated:
   1. Lockset, Privacy.
D. HW-6: Exit Device, Always-Unlocked, Normally-Closed, Fire-Rated or Non-Fire-Rated:
   1. Closer.
   2. Exit Device, Rim, Entry/Exit, Always-Unlocked.
   3. Pair: Removable Mullion, removable only by key.

3.10 SWING DOORS -- LOCKABLE, MAY BE LEFT UNLOCKED, KEY NOT REQUIRED TO LOCK

A. HW-10: Office, Non-Fire-Rated:
   1. Lockset, Office.
   2. Pair: One leaf inactive, with manual flush bolts.

B. HW-13: Public Entrance, Exit Device, Lockable, Non-Fire-Rated:
   1. Closer.
   2. Exit Device, Rim, Entry/Exit, Free Swing, lever outside trim.
   3. Pair: Surface vertical rod type devices.

END OF SECTION
SECTION 09 91 23
PAINTS AND COATINGS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidentals required to prepare surfaces and apply paints and coatings as specified within this Section, unless otherwise indicated on the Drawings.

B. The material specified herein shall comply with the American Iron and Steel provision of the Clean Water Act as it applies to the State Revolving Loan Funds and as administered by the State of Delaware. It is the Contractor’s responsibility to determine if the Approved Manufacturers comply with the requirements of the provision.

1.02 REFERENCES

C. ASTM D 4263 - Indicating Moisture in Concrete by the Plastic Sheet Method.
D. ASTM F 1869 - Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
E. AWWA C 652 - Disinfection of Water-Storage Facilities.
F. AWWA D 102 - Painting Steel Water Storage Tanks.
G. International Concrete Repair Institute (ICRI) Guideline No. 03732 - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.
H. SSPC-SP 1 - Solvent Cleaning.
I. SSPC-SP 2 - Hand Tool Cleaning.
J. SSPC-SP 3 - Power Tool Cleaning.
K. SSPC-SP 5/NACE 1 - White Metal Blast Cleaning.
L. SSPC-SP 6/NACE 3 - Commercial Blast Cleaning.
M. SSPC-SP 10/NACE 2 - Near-White Metal Blast Cleaning.
N. SSPC-SP 13/NACE 6 - Surface Preparation of Concrete.

1.03 DEFINITIONS

A. Definitions of Painting Terms: ASTM D 16, unless otherwise specified.
B. Dry Film Thickness (DFT): Thickness of a coat of paint in fully cured state measured in mils (1/1000 inch).

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.
B. Product Data: Submit manufacturer’s product data for each coating, including generic description, complete technical data, surface preparation, and application instructions.
C. Manufacturer’s Quality Assurance: Submit manufacturer’s certification that coatings comply with specified requirements and are suitable for intended application.
D. Applicator’s Quality Assurance: Submit list of a minimum of 5 completed projects of similar size and complexity to this Work. Include for each project:
   1. Project name and location.
   2. Name of owner.
   3. Name of contractor.
   4. Name of engineer.
   5. Name of coating manufacturer.
6. Approximate area of coatings applied.
7. Date of completion.

E. Warranty: Submit manufacturer’s standard warranty.

1.05 QUALITY ASSURANCE

A. Manufacturer’s Qualifications:
1. Specialize in manufacture of coatings with a minimum of 10 years successful experience.
2. Able to demonstrate successful performance on comparable projects.

B. Applicator’s Qualifications:
1. Experienced in application of specified coatings for a minimum of 5 years on projects of similar size and complexity to this Work.

1.06 DELIVERY, STORAGE, AND PROTECTION

A. Delivery: Deliver materials to site in manufacturer’s original, unopened containers and packaging, with labels clearly identifying:
1. Coating or material name.
2. Manufacturer.
3. Color name and number.
4. Batch or lot number.
5. Date of manufacture.
6. Mixing and thinning instructions.

B. Storage:
1. Store materials in a clean dry area and within temperature range in accordance with manufacturer’s instructions.
2. Keep containers sealed until ready for use.
3. Do not use materials beyond manufacturer’s shelf life limits.

C. Handling: Protect materials during handling and application to prevent damage or contamination.

1.07 ENVIRONMENTAL REQUIREMENTS

A. Weather:
1. Air and Surface Temperatures: Prepare surfaces and apply and cure coatings within air and surface temperature range in accordance with manufacturer’s instructions.
2. Surface Temperature: Minimum of 5 degrees F (3 degrees C) above dew point.
3. Relative Humidity: Prepare surfaces and apply and cure coatings within relative humidity range in accordance with manufacturer’s instructions.
4. Precipitation: Do not prepare surfaces or apply coatings in rain, snow, fog, or mist.
5. Wind: Do not spray coatings if wind velocity is above manufacturer’s limit.

B. Ventilation: Provide ventilation during coating evaporation stage in confined or enclosed areas in accordance with AWWA D 102.

C. Dust and Contaminants:
1. Schedule coating work to avoid excessive dust and airborne contaminants.
2. Protect work areas from excessive dust and airborne contaminants during coating application and curing.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Tnemec Company Incorporated
B. Benjamin Moore
C. Sherwin Williams
D. Substitutions: See Section 01600 - Product Requirements.

2.02 **COATING SYSTEMS FOR STEEL - STRUCTURAL, TANKS, PIPE, AND EQUIPMENT**

A. Exterior Exposed:
1. System Type: Epoxy/urethane.
3. Primer: Series 66 Hi-Build Epoxoline: DFT 3.0 to 5.0 mils.
5. Finish Coat: Series 73 Endura-Shield: DFT 2.0 to 5.0 mils.
6. Total DFT: 7.0 to 13.0 mils.
7. Finish Color: See Schedule of Colors. If not specified, as selected by Owner from manufacturer’s standard colors.

B. Interior Exposed:
1. System Type: Epoxy.
3. Primer: Series 66 Hi-Build Epoxoline: DFT 3.0 to 5.0 mils.
4. Finish Coat: Series 66 Hi-Build Epoxoline: DFT 4.0 to 6.0 mils.
5. Total DFT: 7.0 to 11.0 mils.
6. Finish Color: See Schedule of Colors. If not specified, as selected by Owner from manufacturer’s standard colors.

C. Immersion:
1. System Type: Coal tar epoxy.
2. Surface Preparation: SSPC-SP 10.
4. Total DFT: 14.0 to 20.0 mils.
5. Finish Color: Black.

D. Below Grade:
1. System Type: Coal tar epoxy.
2. Surface Preparation: SSPC-SP 10.
4. Total DFT: 14.0 to 20.0 mils.
5. Finish Color: Black.

E. Marginally Prepared Surfaces (Maintenance, Non-Immersion):
1. System Type: Epoxy.
2. Surface Preparation: In accordance with manufacturer’s instructions.
3. Primer: Series 135 Chembuild: DFT 4.0 to 6.0 mils.
4. Finish Coat: Series 66 Hi-Build Epoxoline: DFT 4.0 to 6.0 mils.
5. Total DFT: 8.0 to 12.0 mils.
6. Finish Color: See Schedule of Colors. If not specified, as selected by Owner from manufacturer’s standard colors.

2.03 **COATING SYSTEMS FOR FACTORY PRIMED STEEL - DOORS, FRAMES, AND MISCELLANEOUS EQUIPMENT**

A. Exterior Exposed:
1. System Type: Epoxy/urethane.
2. Surface Preparation: Clean and dry.
5. Finish Coat: Series 73 Endura-Shield: DFT 2.0 to 3.0 mils.
6. Total DFT: 4.0 to 6.0 mils.
7. Finish Color: See Schedule of Colors. If not specified, as selected by Owner from manufacturer’s standard colors.
B. Interior Exposed:
   1. System Type: Epoxy.
   2. Surface Preparation: Clean and dry.
   5. Finish Coat: Series 66 Hi-Build Epoxoline: DFT 2.0 to 3.0 mils.
   6. Total DFT: 4.0 to 6.0 mils.
   7. Finish Color: See Schedule of Colors. If not specified, as selected by Owner from manufacturer's standard colors.

2.04 COATING SYSTEMS FOR NONFERROUS METAL - PIPE AND MISCELLANEOUS FABRICATIONS

A. Exterior Exposed:
   1. System Type: Epoxy/urethane.
   2. Surface Preparation: In accordance with manufacturer's instructions.
   3. Primer: Series 66 Hi-Build Epoxoline: DFT 2.0 to 3.0 mils.
   4. Finish Coat: Series 73 Endura-Shield: DFT 2.0 to 3.0 mils.
   5. Total DFT: 4.0 to 6.0 mils.
   6. Finish Color: See Schedule of Colors. If not specified, as selected by Owner from manufacturer's standard colors.

B. Interior Exposed:
   1. System Type: Epoxy.
   2. Surface Preparation: In accordance with manufacturer's instructions.
   3. Primer: Series 66 Hi-Build Epoxoline: DFT 2.0 to 3.0 mils.
   5. Total DFT: 4.0 to 6.0 mils.
   6. Finish Color: See Schedule of Colors. If not specified, as selected by Owner from manufacturer's standard colors.

C. Immersion:
   1. System Type: Epoxy.
   2. Surface Preparation: SSPC-SP 1 followed by abrasive blast.
   3. Primer: Series 66 Hi-Build Epoxoline: DFT 3.0 to 5.0 mils.
   4. Finish Coat: Series 66 Hi-Build Epoxoline: DFT 4.0 to 6.0 mils.
   5. Total DFT: 7.0 to 11.0 mils.
   6. Finish Color: See Schedule of Colors. If not specified, as selected by Owner from manufacturer's standard colors.

2.05 COATING SYSTEMS FOR DUCTILE OR CAST IRON - PIPE, PUMPS AND VALVES

A. Exterior Exposed:
   1. System Type: Epoxy.
   2. Surface Preparation: In accordance with manufacturer's instructions.
   3. Primer: Series 66 Hi-Build Epoxoline: DFT 3.0 to 5.0 mils.
   5. Finish Coat: Series 73 Endura-Shield: DFT 2.0 to 3.0 mils.
   6. Total DFT: 9.0 to 14.0 mils.
   7. Finish Color: See Schedule of Colors. If not specified, as selected by Owner from manufacturer's standard colors.
   8. Note: Factory Coated Pumps and Valves shall not be coated by Contractor.

B. Below Ground:
   1. System Type: Coal tar epoxy.
   2. Surface Preparation: In accordance with manufacturer's instructions.
   4. Total DFT: 14.0 to 20.0 mils.
5. Finish Color: Black.
6. Note: Factory Coated items shall not be coated.

C. Interior Exposed:
1. System Type: Epoxy.
2. Surface Preparation: In accordance with manufacturer’s instructions.
3. Primer: Series 66 Hi-Build Epoxoline: DFT 3.0 to 5.0 mils.
4. Finish Coat: Series 66 Hi-Build Epoxoline: DFT 4.0 to 6.0 mils.
5. Total DFT: 7.0 to 11.0 mils.
6. Finish Color: See Schedule of Colors. If not specified, as selected by Owner from manufacturer’s standard colors.

D. Immersion:
1. System Type: Coal tar epoxy.
2. Surface Preparation: In accordance with manufacturer’s instructions.
4. Total DFT: 14.0 to 20.0 mils.
5. Finish Color: Black.

2.06 COATING SYSTEMS FOR PVC

A. Exterior Exposed:
1. System Type: Epoxy/urethane.
2. Surface Preparation: Scarify.
3. Primer: Series 66 Hi-Build Epoxoline: DFT 2.0 to 3.0 mils.
4. Finish Coat: Series 73 Endura-Shield: DFT 2.0 to 3.0 mils.
5. Total DFT: 4.0 to 6.0 mils.
6. Finish Color: See Schedule of Colors. If not specified, as selected by Owner from manufacturer’s standard colors.

B. Interior Exposed:
1. System Type: Epoxy.
2. Surface Preparation: Scarify.
3. Primer: Series 66 Hi-Build Epoxoline: DFT 2.0 to 3.0 mils.
5. Total DFT: 4.0 to 6.0 mils.
6. Finish Color: See Schedule of Colors. If not specified, as selected by Owner from manufacturer’s standard colors.

2.07 COATING SYSTEMS FOR INSULATED PIPE

A. Interior/Exterior Exposed:
1. System Type: Acrylate.
2. Surface Preparation: Clean and dry.
3. Primer: Series 6 Tneme-Cryl: DFT 2.0 to 3.0 mils.
5. Total DFT: 4.0 to 6.0 mils.
6. Finish Color: See Schedule of Colors. If not specified, as selected by Owner from manufacturer’s standard colors.

2.08 COATING SYSTEMS FOR PRECAST CONCRETE AND CONCRETE MASONRY UNITS

A. Exterior Exposed:
1. System Type: Acrylate.
3. Primer: Series 156 Enviro-Crete: DFT 4.0 to 8.0 mils.
4. Finish Coat: Series 156 Enviro-Crete: DFT 4.0 to 8.0 mils.
5. Total DFT: 8.0 to 16.0 mils.
6. Finish Color: See Schedule of Colors. If not specified, as selected by Owner from manufacturer’s standard colors.
B. Interior Exposed:
   1. System Type: Epoxy.
   3. Primer: Series 66 Hi-Build Epoxoline: DFT 4.0 to 6.0 mils.
   4. Finish Coat: Series 66 Hi-Build Epoxoline: DFT 4.0 to 6.0 mils.
   5. Total DFT: 8.0 to 12.0 mils.
   6. Finish Color: See Schedule of Colors. If not specified, as selected by Owner from manufacturer’s standard colors.

2.09 COATING SYSTEMS FOR CONCRETE FLOORS
   A. See Section 03300 - "Cast-In-Place Concrete".

2.10 COATING SYSTEMS FOR CONCRETE MASONRY UNITS
   A. Exterior
      1. Primer: Two-Component, heavy-duty cementitious acrylic block filler
         a. Cement-Plex 875 B62W200/B42V201, @ 13.0 - 25.0 mils DFT, as manufactured by The Sherwin Williams Co.
      2. Finish: One Component, Pigmented Acrylic
         a. DTM Acrylic Coating, Gloss or Semi Gloss, B66 Series, @ 2.5 - 4.0 mils DFT per coat (two coats), as manufactured by The Sherwin Williams Co.
   B. Interior
      1. Primer: Two-Component
         a. PrepRite Masonry Primer, B28W300, @ 1.0 - 1.5 mils DFT, as manufactured by The Sherwin-Williams Company
      2. Finish: One-Component, Pigmented Alkyd Coating, Gloss
         a. Industrial Enamel VOC, B54Z Series, @ 2.0 - 3.0 mils DFT per coat (two coats), as manufactured by The Sherwin-Williams Co.

2.11 ACCESSORIES
   A. Coating Application Accessories:
      1. Accessories required for application of specified coatings in accordance with manufacturer’s instructions, including thinners.
      2. Products of coating manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Examine areas and conditions under which coating systems are to be applied. Notify Engineer of areas or conditions not acceptable. Do not begin surface preparation or application until unacceptable areas or conditions have been corrected.

3.02 PROTECTION OF SURFACES NOT SCHEDULED TO BE COATED
   A. Protect surrounding areas and surfaces not scheduled to be coated from damage during surface preparation and application of coatings.
   B. Immediately remove coatings that fall on surrounding areas and surfaces not scheduled to be coated.

3.03 SURFACE PREPARATION OF STEEL
   A. Prepare steel surfaces in accordance with manufacturer’s instructions.
   B. Fabrication Defects:
      1. Correct steel and fabrication defects revealed by surface preparation.
      2. Remove weld spatter and slag.
      3. Round sharp edges and corners of welds to a smooth contour.
      4. Smooth weld undercuts and recesses.
      5. Grind down porous welds to pinhole-free metal.
      6. Remove weld flux from surface.
C. Ensure surfaces are dry.

D. Immersion or Below Grade Surfaces: Remove visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter in accordance with SSPC-SP 10/NACE 2.

E. Exterior Exposed or Interior Exposed Surfaces: Remove visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter in accordance with SSPC-SP 6/NACE 3.

F. Interior or Immersion Surfaces, Severe Exposure: Remove visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter in accordance with SSPC-SP 5/NACE 1.

G. Marginally Prepared Surfaces (Maintenance): Remove visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter in accordance with manufacturer's instructions.

H. Abrasive Blast-Cleaned Surfaces: Coat abrasive blast-cleaned surfaces with primer before visible rust forms on surface. Do not leave blast-cleaned surfaces uncoated for more than 8 hours.

I. Shop Primer: Prepare shop primer to receive field coat in accordance with manufacturer's instructions.

3.04 SURFACE PREPARATION OF NONFERROUS METAL

A. Prepare galvanized steel and nonferrous metal surfaces in accordance with manufacturer’s instructions.

B. Surface preparation recommendations will vary depending on substrate and exposure conditions.

C. Ensure surfaces are dry.

D. Immersion Service: Clean surfaces by abrasive blasting.

E. Remove Rust From Galvanized Steel:
   1. Remove white rust from galvanized steel by hand or power brushing.
   2. Remove rust from old galvanized steel in accordance with SSPC-SP 2 or SP 3.
   3. Do not damage or remove galvanizing.

F. Increase mechanical adhesion under moderate to severe conditions, such as exterior exposure or chemical environments, by abrasive blast and/or chemical cleaning.

3.05 SURFACE PREPARATION OF DUCTILE OR CAST IRON

A. Prepare ductile or cast iron surfaces in accordance with manufacturer’s instructions.

B. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.

3.06 SURFACE PREPARATION OF PVC

A. Prepare PVC surfaces in accordance with manufacturer’s instructions.

B. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.

C. Scarify PVC surfaces.

3.07 SURFACE PREPARATION OF INSULATED PIPE

A. Prepare insulated pipe surfaces in accordance with manufacturer’s instructions.

B. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.

3.08 SURFACE PREPARATION OF CONCRETE

A. Interior, Wet Substrate:
   1. Prepare concrete surfaces in accordance with manufacturer’s instructions, SSPC-SP 13/NACE 6, and ICRI 03732.
   2. Allow concrete to cure for a minimum of 28 days.
3. Test concrete for moisture in accordance with ASTM D 4263 and F 1869.
4. Abrasive blast surface to remove laitance and solid contaminants and to provide clean, sound substrate with uniform anchor profile.
5. Fill holes, pits, voids, and cracks with Tnemec 63-1500 Filler and Surfacer.
6. Ensure surfaces are clean, dry, and free of oil, grease, chalk, form release agents, and other contaminants.

B. Exterior:
1. Prepare concrete surfaces in accordance with manufacturer's instructions, SSPC-SP 13/NACE 6, and ICRI 03732.
2. Allow concrete to cure for a minimum of 7 days.
3. Test concrete for moisture in accordance with ASTM D 4263 and F 1869.
4. Level concrete protrusions and mortar spatter.
5. Ensure surfaces are clean, dry, and free of oil, grease, chalk, form release agents, and other contaminants.

C. Exterior, Previously Painted:
1. Prepare concrete surfaces in accordance with manufacturer's instructions, SSPC-SP 13/NACE 6, and ICRI 03732.
2. Test concrete for moisture in accordance with ASTM D 4263 and F 1869.
3. Remove chalk and old paint not tightly bonded to surface.
4. Patch cracks in accordance with manufacturer's instructions.
5. Level concrete protrusions and mortar spatter.
6. Determine compatibility of primer over unknown previously-applied coatings by preparing a test patch.
7. Ensure surfaces are clean, dry, and free of oil, grease, and other contaminants.

3.09 SURFACE PREPARATION OF CONCRETE FLOORS
A. Prepare concrete surfaces in accordance with manufacturer's instructions, SSPC-SP 13/NACE 6, and ICRI 03732.
B. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.
C. Allow concrete to cure for a minimum of 28 days before coating.
D. Test concrete for moisture in accordance with ASTM D 4263 and F 1869.

3.10 SURFACE PREPARATION OF POROUS CONCRETE MASONRY UNITS
A. Prepare porous concrete masonry unit surfaces in accordance with manufacturer's instructions and SSPC-SP 13/NACE 6.
B. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.
C. Allow mortar to cure for a minimum of 28 days before coating.
D. Level protrusions and mortar spatter.

3.11 APPLICATION
A. Apply coatings in accordance with manufacturer's instructions.
B. Mix and thin coatings, including multi-component materials, in accordance with manufacturer's instructions.
C. Keep containers closed when not in use to avoid contamination.
D. Do not use mixed coatings beyond pot life limits.
E. Use application equipment, tools, pressure settings, and techniques in accordance with manufacturer's instructions.
F. Uniformly apply coatings at spreading rate required to achieve specified DFT.
G. Apply coatings to be free of film characteristics or defects that would adversely affect performance or appearance of coating systems.
3.12 DISINFECTION
A. Disinfection of Water Contact Surfaces and Filling of Water Storage Tanks:
   1. Do not disinfect water contact surfaces or fill water storage tanks until application of coating systems is complete, coatings have fully cured, and field quality control inspection is complete.
   2. Allow number of days in accordance with manufacturer’s instructions and as directed by Engineer for full cure of coating systems on water contact surfaces before flushing, disinfecting, or filling with water.
   3. Disinfection: AWWA C 652 or as directed by Engineer.

3.13 REPAIR
A. Materials and Surfaces Not Scheduled To Be Coated: Repair or replace damaged materials and surfaces not scheduled to be coated.
B. Damaged Coatings: Touch-up or repair damaged coatings. Touch-up of minor damage shall be acceptable where result is not visibly different from adjacent surfaces. Recoat entire surface where touch-up result is visibly different, either in sheen, texture, or color.
C. Coating Defects: Repair in accordance with manufacturer’s instructions coatings that exhibit film characteristics or defects that would adversely affect performance or appearance of coating systems.

3.14 CLEANING
A. Remove temporary coverings and protection of surrounding areas and surfaces.

3.15 PROTECTION OF COATING SYSTEMS
A. Protect surfaces of coating systems from damage during construction.

3.16 ONE-YEAR INSPECTION
A. Owner will set date for one-year inspection of coating systems.
B. Inspection shall be attended by Owner and Contractor.
C. Repair deficiencies in coating systems as determined by Engineer in accordance with manufacturer’s instructions.

3.17 SCHEDULES
A. Schedule of Colors:
   1. Raw Water: Olive Green
   2. Anaerobic Lagoon Effluent: Olive Green
   3. Clarified Water: Aqua
   4. Potable Water: Dark Blue
   5. Backwash Waste: Light Brown
   6. Activated Sludge: Light Gray
   7. Return Sludge: Dark Brown
   8. Waste Sludge: Dark Brown
   9. Primary Coagulant: Orange
  10. Ammonia: White
  11. Carbon Source: Black
  12. Caustic: Yellow with Green Band
  13. Chlorine: Yellow
  14. Lime Slurry: Light Green
  15. Polymers: Orange with Green Band
  16. Sulfuric Acid: Yellow with Red Band
  17. Compressed Air: Dark Green
  18. Fire Protection: Red
B. Coating Systems in this section do not apply to Precast Concrete Tanks. Refer to section 03481-Precast Post Tension Concrete Tanks.

END OF SECTION
SECTION 10 53 00
PREMANUFACTURED CANOPY

PART 1: GENERAL

1.01 DESCRIPTION OF WORK
A. Work in this section includes furnishing and installation of extruded aluminum overhead hanger rod style canopies as manufactured by Mapes Industries Inc.

B. Related Items and Considerations
   1. Flashing of various designs may be required. Generic flashing supplied by Mapes. Specialty flashing to be supplied by installer.
   2. Consider water drainage away from canopy where necessary.

1.02 QUALITY ASSURANCE
A. Products meeting these specifications established standard of quality required as manufactured by Mapes Industries, Inc. Lincoln, Nebraska 1-888-273-1132.

1.03 FIELD MEASUREMENT
A. Confirm dimensions prior to preparation of shop drawings when possible.
B. If requested, supply manufacturer’s standard literature and specifications for canopies
C. Submit shop drawings showing structural component locations/positions, material dimensions and details of construction and assembly.

1.04 PERFORMANCE REQUIREMENTS
A. Canopy must conform to local building codes
B. PE Stamped calculations are not required.

1.05 DELIVER, STORAGE, HANDLING
A. Deliver and store all canopy components in protected areas.

PART 2 PRODUCTS

2.01 MANUFACTURER
A. Mapes Canopies
   1. Lincoln, Nebraska
   2. Phone: 1-888-273-1132.
   3. Fax: 1-877-455-6572.

2.02 MATERIALS
A. Decking shall consist of 3” extruded flat soffit 0.078 decking.
B. Intermediate framing members shall be extruded aluminum, alloy 6063-T6, in profile and thickness shown in current Mapes brochures.
C. Hanger rods and attachment hardware shall be a standard finish.
D. Fascia shall be standard extruded 8” J style.

2.03 FINISHES
A. Finish type shall be 2-Coat Kynar Finish.

2.04 FABRICATION
A. All Mapes Super Lumideck extruded aluminum canopies are shipped with the materials precut to size for field assembly.
B. All connections shall be mechanically assembled utilizing 3/16 fasteners with a minimum shear stress of 350 lb. Pre-welded or factory-welded connections are not acceptable.
C. Concealed drainage. Water shall drain from covered surfaces into intermediate trough and be directed to Front Scupper.
PART 3 EXECUTION

3.01 INSPECTION
   A. Confirm that surrounding area is ready for the canopy installation.
   B. Installer shall confirm dimensions and elevations to be as shown on drawings provided by Mapes Industries.
   C. Erection shall be performed by an approved installer and scheduled after all concrete, masonry and roofing in the area is completed.

3.02 INSTALLATION
   A. Installation shall be in strict accordance with manufacturer's shop drawings. Particular attention should be given to protecting the finish during handling and erection.
   B. After installation, entire system shall be left in a clean condition.

END OF SECTION
SECTION 22 01 00
GENERAL PLUMBING PROVISIONS

P1 GENERAL

1.01 WORK INCLUDED

A. The work covered by Division 22 sections consist of furnishing all equipment, material, appliances and material for the plumbing, piping, heating, air conditioning, and ventilation conditions of the contract. Include all accessories necessary to the proper operation of the systems and equipment specified.

B. General Contractor shall provide and install all concrete pads and bases required for installation of mechanical equipment. Mechanical Contractor is responsible for the exact sizes required, location of anchor bolts, etc.

C. Some equipment may be furnished by others. Mechanical Contractor is responsible to review drawings and specifications for equipment being furnished. Furnish all accessories and supplies required for complete installation on all equipment furnished by others relating to Mechanical Contractors scope of work.

D. General Contractor shall provide and install all access panels required for service of mechanical equipment, valves, and controls above hard ceilings and walls.

1.02 RELATED SECTIONS

A. The General Conditions and Division 1, General Requirements, as bound in the specifications preamble, apply to all work under Division 22. Carefully note its contents in performance of work.

B. Complete Commissioning of the Mechanical and Plumbing Systems is part of this work. There will be other more specific items required within certain sections of the specifications. The Mechanical and Plumbing Contractors are responsible for participation in this process as required by the Commissioning Authority.

C. The Architectural, Electrical, and Structural plans and Specifications, including Information to Bidders and other pertinent documents issued by the Engineer are a part of this Specifications and the accompanying mechanical plans. Comply with them in every respect. Examine all the above carefully. Failure to comply does not dismiss the Contractor of responsibility nor may it be used as a basis for additional compensation due to omission of architectural, electrical, and structural details from the mechanical drawings.

D. All electrical power wiring is specified under Division 26 of the Specifications. Mechanical Contractor shall furnish all motor starters required for the control and protection of all motors furnished for the Division 22. Furnish and install all automatic temperature and interlock wiring required for controlling mechanical equipment furnished under Division 22, in compliance with Division 26 of the Project Manual.

E. All concrete pads required for installation of mechanical equipment are specified in another section of the Specifications.

1.03 CODES, FEES, AND LATERAL COSTS

A. Comply with all applicable codes, specifications, industry standards, utility company regulations, local ordinances, and the applicable requirements of the following the latest nationally accepted codes and standards:

3. IMC - International Mechanical Code.
4. IPC - International Plumbing Code.
B. In Case of difference between Codes, Specifications, Laws, local ordinances, industry standards, utility company regulations, and Contractor Documents, the most stringent governs. Promptly notify the Engineer in writing in any such difference.

C. Drawings are accurate to the best of the Engineers knowledge. Contractor shall coordinate with all trades for complete installation of equipment, piping, and accessories. Drawings shall be followed as closely as possible in construction. Contractor shall conform to the requirements shown on all drawings. Contractor is responsible for the installation of all fittings, offsets, transitions, and accessories for complete installation of the system not shown in drawings. Contractor is required for a complete and thorough inspection of the existing conditions.

D. Contractor is responsible to remove any work installed that does not meet the requirements of the Codes, Laws, Local Ordinances, Utility Company regulations, and Industry Standards. Contractor shall reinstall all work to meet the requirements previously stated at no cost to Owner.

E. Mechanical Contractor shall furnish and provide complete installation of seismic restraints for all equipment, materials, piping, and duct systems per the latest accepted Building Code. See code for minimum design loads.

F. Contractor shall obtain all permits required and pay all fees related with work under the Contract. Contractor shall arrange for all connections from utility company and pay all charges including inspection fees and meters if required.

G. Comply with State of Arkansas adopted ADA Accessible Guidelines regarding accessible or handicapped features.

H. Submission of a proposal will be regarded as proof of the contractor is familiarized with any drawings, site of construction, and additional material given for the project. Because of the renovation factor of this project, the contractor will be required to complete an intensive and absolute inspection of the current conditions. Any claims made after the proposal for additional materials and labor will be null and void if difficulties could have been foreseen after an in-depth examination.

1.04 GUARANTEE

A. Furnish a written certificate guaranteeing all materials, equipment and labor furnished to be free of all defects for a period of one (1) year from and after the date of final acceptance of the work by the Owner and further guarantee to replace such work without charges if any defects appear within the stipulated guaranty period.
1.05 SOIL CONDITIONS
   A. The Specifications and the drawings in no way imply the conditions of the soil to be encountered. When excavating may be required in execution of the work, this Contractor agrees that he has informed himself regarding conditions affecting the work.

1.06 INSPECTION OF PREMISES
   A. Before submitting a bid, visit the site of the proposed project to determine the conditions relating to this work.

1.07 UTILITIES, LOCATIONS AND ELEVATIONS
   A. Locations and elevations of the various utilities included within the scope of this work have been obtained from substantially reliable sources and are offered as a general guide only, without guarantee as to accuracy. Verify the location and elevation of all utilities and their relation to the work before entering a contract.
   B. Identify outdoor underground lines with continuous strip of plastic utility marker tape at regular intervals (maximum of 10 feet) “Caution (utility) pipe below”. Install one foot directly above pipe before backfilling to grade.

1.08 EQUIPMENT NOT SPECIFIED UNDER DIVISION 22
   A. Equipment which requires plumbing and other mechanical connections may be specified in another division of this Specification. Under these conditions, provide necessary utilities including waste, water and natural gas.
   B. Rough-in work from approved shop drawings only.

P2 PRODUCTS
2.01 EQUIPMENT AND MATERIALS
   A. Provide new materials bearing the manufacturer’s name, trade name, and the UL label in every case where a standard has been established for the particular material. Furnish the standard product of a manufacturer regularly engaged in the production of the required type of equipment. Provide the manufacturer’s latest approved design.
   B. Deliver equipment and materials to the site and store in original containers, suitably sheltered from the elements, but readily accessible for inspection by the Engineer until installed. Store all items subject to moisture damage (such as controls) in dry, heated spaces.
   C. Provide equipment and materials of the same general type and of the same make throughout the work to provide uniform appearance, operation and maintenance.
   D. Tightly cover equipment and protect against dirt, water and chemical or mechanical injury and theft. At the completion of the work, clean fixtures, equipment and materials and polish thoroughly. Turn over to the Owner in a condition satisfactory to the Engineer. Repair damage or defects developing before acceptance of the work at no expense to the Owner.
   E. Insure that items to be furnished fit the space available. Make necessary field measurements to ascertain space requirements, including those for connections. Furnish and install such sizes and shapes of equipment that the final installation suits the true intent and meaning of the drawings and Specifications.
   F. Follow manufacturer’s directions completely in the delivery, storage, protection and installation of all equipment and materials. Promptly notify the Engineer in writing of any conflicts between any requirements of the Contract Documents and the manufacturers’ directions. Obtain the Engineer’s written instruction before proceeding with the work. Replace any work that does not comply with the manufacturers’ directions or such written instructions from the Engineer, at no cost to the Owner.
   G. Support all products by service organizations with adequate spare parts inventory and personnel located reasonably close to the site.
   H. Where multiple units of the same type or class of products are required, provide all units of the same manufacturer.
2.02 EQUIPMENT ACCESSORIES

A. Furnish and install all equipment, accessories, connections and incidental items necessary to fully complete all work, ready for use, occupancy and operation by the Owner.

B. Where equipment requiring different arrangement or connections from those shown is provided, install the equipment to operate properly with the intent of the drawings and Specifications.

C. Support, plumb, rigid and true to line, all work and equipment furnished. Study thoroughly all general, structural, electrical and mechanical drawings, shop drawings and catalog data to determine how equipment, fixtures, piping, ductwork, etc., are to be supported, mounted or suspended and provide extra steel bolts, inserts, pipe stands, brackets and accessories for proper supports whether shown on the drawings. When directed, submit drawings showing supports.

2.03 MATERIAL AND EQUIPMENT SCHEDULE

A. Submit to the Engineer as soon as practical, six (6) complete sets of the schedule of materials and equipment proposed for the installation. Include manufacturers' names, catalog data, diagrams, drawings and other descriptive data and submit under one cover with an index sheet in front.

B. In substitution of hard copy submittals, PDF submittals will be accepted under the listed conditions below. The Engineer reserves the right to wait until all submittals per contractor have been sent before reviewing:

C. All the submittals being submitted to the engineer in one PDF file or sets of PDF files per contractor.

D. In case of Submittal Exchange Website, The Engineer reserves the right to wait until all submittals per contractor have been sent before reviewing.

E. Provide written certification that shop drawings are in accordance with the specifications and are dimensionally correct the reference to available space.

F. Shop drawings for the Engineer's files are required on the following items:
   2. Filters.
   3. Exhaust Fans.
   4. Plumbing Fixtures.
   5. Insulation.
   6. Valves and other Specialties.
   7. Grilles and Registers.
  11. Piping and Duct Insulation Materials.
  12. Complete Mechanical Equipment Electrical Data and Wiring Details.

2.04 EQUIPMENT AND MATERIAL SUBSTITUTIONS

A. It is the responsibility of the Contractor to investigate any desired substitutions for specified equipment prior to submission of his bid. The Mechanical Contractor shall be responsible for any changes required in mechanical, electrical, structural or vibration isolation systems and shall bear all cost for those changes whether the substitute equipment is named by manufacturer in the specifications or is submitted to the Engineer for "or equal" consideration. All changes shall be accomplished in a manner acceptable to the Engineer at no additional cost to the Owner.

B. To obtain prior approval on equipment or material not specified in Division 15 Specifications or Equipment Schedules, Mechanical Contractor MUST submit to the Engineer any proposed equipment or material ten (10) working days prior to the bid date. If this procedure is not
followed, Mechanical Contractor understands that he will bear all additional costs associated with providing approved equipment.

C. If any substitute equipment is submitted to Engineer for approval, without said

3.01 COORDINATION OF WORK

A. Compare the mechanical drawings and Specifications with the drawings and Specifications for other trades and report any discrepancies between them to the Engineer and obtain from him written instruction for changes necessary in the mechanical work. Install the mechanical work in cooperation with other trades installing inter-related work. Before installation, make proper provisions to avoid interferences in a manner approved by the Engineer. Make all changes required in the work caused either by neglect or existing field conditions at no cost to the Owner.

B. Furnish anchor bolts, sleeves, inserts and supports required for the mechanical work. Locate anchor bolts, sleeves, inserts and supports as directed by the trade requiring them and insure that they are properly installed.

C. Slots, chases, openings and recesses in existing structure shall be cut, patched and repaired by the Contractor.

D. Adjust locations of pipes, ducts, equipment fixtures, etc., to accommodate the work and for interferences anticipated and encountered. Determine the exact route and location of each pipe and duct prior to fabrication.
   1. Provide right-of-way to lines that pitch over those that do not pitch. For example, Plumbing drains normally have right-of-way. Lines whose elevations cannot be changed have the right-of-way over lines whose elevations can be changed.
   2. Make offsets, transitions and changes in direction in pipes and ducts as required to maintain proper head room and pitch.

E. Install all mechanical work to permit removal without damage to other parts, to coils, fan shafts and wheels, filters, belt guards, sheaves and drives and all other parts requiring periodic replacement or maintenance. Arrange pipes, ducts and equipment to permit ready access to valves, cocks, traps, starters, motors, control components and to clear the openings of swinging and overhead doors and of access panels.

F. Change the cross-sectional dimensions of ductwork when required to meet job conditions, but maintain at least the same equivalent cross sectional area. Secure the approval of the Engineer prior to fabrication of ductwork requiring such changes. Sizes shown on the plans are clear dimensions; add for internal insulation if specified.

3.02 CHLORINATION OF DOMESTIC WATER LINES

A. A. After the hot and cold water systems are complete, all fixtures connected, the system flushed out completely and the shut-off valve to the water main closed, fill the system with a solution containing 50 parts per million of available chlorine. Allow the solution to stand six (6) hours before flushing and returning to service.

B. Then fill the system with a solution containing 100 parts per million of available chlorine. Allow this solution to stand two (2) hours before flushing and returning to service.

C. Notify the Owner twenty-four hours prior to test so his representative can witness test. Obtain chemical analysis of the domestic water lines after chlorination from a Certified Chemist and submit the results of these tests to the Engineer and Owner.

3.03 RECORD DRAWINGS

A. Maintain record drawings showing exact locations and sizes, as actually installed, of piping, drains, cleanouts, ductwork, controls and equipment as specified herein. Deliver to the Engineer upon completion and acceptance of the work, one (1) complete set of contract drawings marked to indicate all deviations from intended installation.
3.04 CUTTING AND PATCHING

A. The General Contractor shall be responsible for all required cutting, patching, etc., incidental to this work and shall make all required repairs thereafter to the satisfaction of the Engineer. Do not cut into any major structural element, beam or column without the written approval of the Engineer.

B. Cut, patch, repair and/or replace pavements, sidewalks, roads and curbs as required to permit the installation of the work and pay all expenses incurred for this work.

C. Openings in fire or smoke barriers for air handling ductwork or air movement shall be protected in accordance with NFPA 90A and 90B and the International Mechanical Code.

D. Pipes, conduits, cables, wires, air ducts, pneumatic tubes and ducts and similar handling service equipment that pass-through fire or smoke barriers shall be protected in accordance with NFPA 101.

E. All fire stopping assemblies must be UL approved assemblies.

3.05 EXCAVATION AND TRENCHING FOR PIPING

A. Excavate to the depths indicated on the Drawings or as required to provide adequate slope and burial depth. Excavated materials not required or suitable for backfill or fill shall be removed from the site. Do such grading as is necessary to prevent surface water from flowing into trenches or other excavations. Water accumulating therein shall be removed by pumping or by other method. Sheeting and shoring shall be installed as may be necessary for protection of the work and for safety of personnel. Excavation shall be by open cut except that short sections of a trench may be tunneled if the pipe can be safely and properly installed and backfill can be properly tamped in such tunnel sections.

B. Trench excavation: Grade bottom of trenches to provide uniform bearing and support for each section of pipe on undisturbed soil. Where rock is encountered excavate to a minimum over depth of 4" below trench depths indicated on the Drawings or specified. Over depth in rock excavation and unauthorized over depths shall be backfilled. Whenever wet or otherwise unstable soil incapable of properly supporting the pipe is encountered such soil shall be removed and the trench backfilled to proper grade as hereinafter specified.

C. Depth of cover: Trenches shall be of depth that will provide three feet minimum cover for domestic water, fire lines, sanitary and storm sewers from existing grade or from indicated finish grade, whichever is lower, unless otherwise specifically shown.

D. Protection of existing utilities: Existing utility lines to be retained that are shown on the Drawings or the locations of which are made known to the Contractor prior to excavation, as well as all utility lines uncovered during excavation operations, shall be protected from damage during excavation and backfilling, and if damaged, shall be repaired by the Contractor, at his expense.

E. Trenches shall not be backfilled until required pressure and other tests have been performed and until the utilities systems as installed conform to requirements of Drawings and Specifications.

F. Backfill trenches with excavated materials consisting of earth, sandy clay, sand, gravel, soft shale or other approved materials, free from clods of earth or stones 2-1/2" maximum dimension, deposited in 6" layers and compacted to 95% Standard Proctor Compaction Test of the maximum laboratory density determined in accordance with ASTM D698, Moisture-Density Relation of Soils. Test for maximum density will be made without expense to the Contractor. If fills fail to meet the specified densities, the Contractor shall remove and re-compact the fill until specified densities are achieved. Compaction test shall be performed for each fifty linear feet of trench.

G. Provide a 4" thick (minimum) layer of 3/4-inch No. 4 gravel aggregate bedding beneath all buried piping. Bedding shall be compacted and leveled to provide sloping required.
H. Tests for displacement of sewers: After the trench, has been back killed to 2 feet or more above the pipe, if the pipe shows poor alignment, displaced pipe, or any other defects, such defects shall be remedied by the Contractor at his expense.

3.06 EQUIPMENT START-UP AND TESTING
A. Instruct the Owner’s operating personnel during start-up and separate operating tests of each major item of equipment. During the operating tests, prove the operation of each item of equipment to the satisfaction of the Engineer. Give at least seven (7) days’ notice to the Engineer of equipment start-up and operating tests.

3.07 CATALOG DATA FOR OWNER
A. Provide, in loose-leaf binders, one (1) set of a compilation of catalog data of each manufactured item of equipment used in the mechanical work and present this compilation to the Architect for transmittal to the Owner before final payment is made. Include descriptive data and printed installation, operating and maintenance instructions for each item of equipment. Provide a complete double index as follows:
   1. Listing of products alphabetically by name.
   2. Listing the names of manufacturers whose products have been incorporated in the work alphabetically together with their addresses and the names and addresses of the local sales representatives.
   3. Complete spare parts data with current prices and supply sources.

3.08 INSTRUCTION OF OWNER’S REPRESENTATIVE
A. Instruct the representative of the Owner in the proper operation and maintenance of all elements of the mechanical system.

3.09 PROTECTIVE COATINGS
A. Paint exterior surfaces of steel piping run in or through concrete floor fill, under tile floors or underground, and aluminum surfaces in contact with masonry, with one coat of acid resisting bituminous base paint.
B. Paint all exposed galvanized ducts behind grilles flat black.

3.10 TEST AND ACCEPTANCE
A. Water Piping System: Test with water at 100 psi for one (1) hour or with available city water pressure for twenty-four (24) hours to prove tight and free from leaks.
B. Plumbing and Drainage System: Test the new system humidity and drain piping with water and prove tight. Test system with 10 feet of water for 24-hour period. If approved by the administrative authority, an air test of 5 pounds for 24 hours without introduction of additional air may be used. The air test shall be conducted with a 3-inch gauge with a maximum scale of 100 psi.

3.11 NOISE CONTROL
A. It is intended that the mechanical systems as installed under this contract be free from objectionable noise when the system is operating. Provide vibration isolation accessories and isolate equipment, pipeline, ductwork, etc., as required to insure an acceptable noise level in all the mechanical systems.

3.12 CLEANING AND ADJUSTING
A. Do not allow waste material and rubbish to accumulate in or above the premises. After completion of this work, remove rubbish, tools, scaffolding and surplus materials from and about the building and leave all work clean and ready for use. Clean all equipment, pipes, valves and fittings of grease, metal cuttings and sludge. Repair any stoppage, discoloration or other damage to parts of the building, its finish or furnishings due to failure to properly clean the mechanical systems, without additional cost to the Owner. Adjust all automatic control devices for proper operation.
3.13 ACCESS PANELS
   A. Provide access panels as required in all walls, ceilings and ductwork to service and have
      access to all valves, operating parts and duct mounted fire dampers. For all ceiling and wall
      access doors that are required in gypsum board and plaster, provide minimum 24” x 24”, unless
      due to structural restraints the access door can be reduced to a minimum of 18” x 18”, Milnor
      type appropriate for the construction involved.

3.14 TEMPORARY HEAT
   A. Permanent heating and cooling systems may be used to provide temporary heating and cooling
      to the building during construction, if the following requirements are met:
      1. A complete air filtration system with 60 percent efficiency filters is installed and properly
         maintained.
      2. No permanent diffusers are used.
      3. No plenum type return air system is employed.
      4. the HVAC duct system is adequately sealed to prevent the spread of airborne particulate
         and other contaminants.
      5. Following a 72-hour building flush-out, all duct systems are vacuumed with portable
         high-efficiency particulate arrestee (HEPA) vacuums and documented clean in
         accordance with National Air Duct Cleaners Association (NADCA) specifications.
      6. Contractor shall replace any equipment that is damaged during temporary usage with new
         equipment.
      7. All warranty periods shall not begin until Certificate of Substantial Completion is issued.
      8. Verify with engineer that the installation is ready and approved for operation.

3.15 FINALLY
   A. It is the intention that this specification shall provide a complete installation except as herein
      before specifically excepted. All accessory construction and apparatus necessary or
      advantageous in the operation and testing of the work shall be included. The omission of
      specific reference to any part of the work necessary for such complete installation shall not be
      interpreted as relieving this Contractor from furnishing and installing such parts.

END OF SECTION
SECTION 22 05 13
COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 GENERAL

1.01 GENERAL CONSTRUCTION AND REQUIREMENTS.
A. Three phase electric motors.
1. RELATED REQUIREMENTS
   a. Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.
      1) Section 26 29 13 - Enclosed Controllers.
2. REFERENCE STANDARDS
   a. NEMA MG 1 - Motors and Generators; 2017.
      1) NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

B. SUBMITTALS
   1. See Section 01 30 00 - Administrative Requirements for submittal procedures.
   2. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.
      a. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.
      b. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.
      c. Operation Data: Include instructions for safe operating procedures.
      d. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

3. QUALITY ASSURANCE
   a. Conform to NFPA 70.
      1) Provide certificate of compliance from Authority Having Jurisdiction indicating approval of high efficiency motors.
   b. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

C. DELIVERY, STORAGE, AND HANDLING
   1. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

D. WARRANTY
   1. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS
C. Regal-Beloit Corporation (Century);  : www.centuryelectricmotor.com/#sle.
D. GENERAL CONSTRUCTION AND REQUIREMENTS
   1. Electrical Service: Refer to Section 26 05 83 for required electrical characteristics.
      a. Construction:
         1) Open drip-proof type except where specifically noted otherwise.
         2) Design for continuous operation in 104 degrees F (40 degrees C) environment.
         3) Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
4) Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

5) Wiring Terminations:
   (a) Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
   (b) For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

PART 3 INSTALLATION

3.01 INSTALL IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS.
   A. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
   B. Check line voltage and phase and ensure agreement with nameplate.

END OF SECTION
SECTION 22 05 33
HEAT TRACING FOR PLUMBING PIPING

PART 1 GENERAL

1.01 REFERENCE STANDARDS
   B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.02 ADMINISTRATIVE REQUIREMENTS
   A. Coordinate the work with other trades to provide ground fault protection for electric heat tracing circuits as required by NFPA 70.
   B. Coordinate the work with other trades to provide circuit breaker ratings suitable for installed circuit lengths.

1.03 SUBMITTALS
   A. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions of equipment and controls, maintenance and repair data, and parts listings.
   B. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.04 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.
   B. Acceptable Installers: Familiar with the installation of heat-trace cabling and equipment, subject to compliance with requirements of the Contract Documents.

PART 2 PRODUCTS

2.01 CABLE OUTER JACKET MARKINGS
   A. Name of manufacturer, trademark, or other recognized symbol of identification.
   B. Catalog number, reference number, or model.
   C. Month and year of manufacture, date coding, applicable serial number, or equivalent.
   D. Agency listing or approval.

2.02 CONNECTION KITS
   A. Provide with NEMA 4X rating for prevention of corrosion and water ingress.

2.03 ACCESSORIES
   A. Provide Accessories As Indicated or As Required for Complete Installation, Including but Not Limited To:
      1. High temperature, glass filament tape for attachment of heating cable to metal piping.
      2. Aluminum self-adhesive tape for attachment of heating cable to plastic piping.
      3. Heat-conductive putty.
      4. Cable ties.
      5. Silicone end seals and splice kits.
      6. Installation clips.
      7. Warning labels for attachment to exterior of piping insulation. Refer to Section 22 05 53.

2.04 HEAT TRACE POWER SOURCES
   A. Breakers feeding heat trace cable shall be ground fault type breakers. Leakage current sensitivity shall be from 50 ma to 65 ma.
PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that piping and equipment are ready to receive work.
B. Verify field measurements are as indicated on shop drawings.
C. Verify required power is available, in proper location, and ready for use.

3.02 PREPARATION
A. Clean exposed surfaces prior to installation.
B. Prepare surfaces using approved methods as recommended by manufacturer.

3.03 INSTALLATION
A. Install in accordance with manufacturer’s written installation instructions.
B. Comply with installation requirements of IEEE 515.1 and NFPA 70, Article 427.
C. Apply heating cable linearly on pipe with fiberglass tape only after piping has successfully completed any required pressure testing.
D. Comply with applicable local building codes and requirements of authorities having jurisdiction.
E. Identification:
   1. After thermal insulation installation, apply external pipeline decals to indicate presence of the thermal insulation cladding at intervals not to exceed 20 ft (6 m) including cladding over each valve or other equipment that may require maintenance.

3.04 FIELD QUALITY CONTROL
A. Field Testing and Inspections:
   1. Inspect for sources of water entry and proper sealing.
   2. Inspect weather barrier to confirm that no sharp edges are contacting the trace heating.
   3. Insulation Resistance: Greater than 20 megohms at a test voltage of 2500 VDC for polymer insulated trace heaters.
   4. Test heating cable integrity with megohmmeter at the following intervals:
   5. Measure voltage and current at each unit.

3.05 PROTECTION
A. Protect installed products from damage until Date of Substantial Completion.

END OF SECTION
SECTION 22 05 53
MECHANICAL IDENTIFICATION

P1 GENERAL
1.01 SECTION INCLUDES
A. Nameplates.
B. Tags.
C. Stencils.
D. Pipe Markers.

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS
A. See Section 22 01 00 - General Provisions, for submittal procedures.
B. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
C. Valve Schedule: Schedule of wording, symbols, letter size, and color coding for valve identification. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shutoff and similar special uses by special "flags" in margin of schedule. In addition to mounted copies, furnish extra copies for maintenance manuals as specified in Division 1.
D. Product Data: Provide manufacturers catalog literature for each product required.
E. Manufacturer's Installation Instructions: Indicate special procedures, and installation.
F. Project Record Documents: Record actual locations of tagged valves.

P2 PRODUCTS
2.01 IDENTIFICATION APPLICATIONS
A. Furnace Units: Nameplates.
B. Condensing Units: Nameplates.
C. Control Panels: Nameplates.
D. Dampers: Ceiling tacks, where located above lay-in ceiling.
E. Ductwork: Stenciled painting.
F. Major Control Components: Nameplates.
G. Piping: Pipe markers.
H. Pumps: Nameplates.
I. Small-sized Equipment: Tags.
J. Thermostats: Nameplates.
K. Valves: Tags and ceiling tacks where located above lay-in ceiling.

2.02 NAMEPLATES
A. Manufacturers:
   1. Kolby Pipe Marker Co.
   2. Seton Identification Products.
B. Description: Laminated three-layer plastic with engraved letters.
   2. Letter Height: 1/4 inch.

2.03 TAGS
A. Manufacturers:
   1. Advanced Graphic Engraving.
   2. Brady Corporation.
   4. Seton Identification Products.
B. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2-inch diameter.
C. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2-inch diameter with smooth edges.
D. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

2.04 STENCILS
A. Manufacturers:
   1. Brady Corporation.
   2. Kolby Pipe Marker Co.
B. Stencils: With clean cut symbols and letters of following size:
   1. 3/4 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 to 2 inch Outside Diameter of Insulation or Pipe: 8-inch-long color field, 3/4-inch-high letters.
   3. 2-1/2 to 6 inch Outside Diameter of Insulation or Pipe: 12-inch-long color field, 1-1/4-inch-high letters.
   4. 8 to 10 inch Outside Diameter of Insulation or Pipe: 24-inch-long color field, 2-1/2-inch-high letters.
   5. Over 10 inch Outside Diameter of Insulation or Pipe: 32-inch-long color field, 3-1/2-inch-high letters.

2.05 PIPE MARKERS
A. Manufacturers:
   1. Brady Corporation.
   2. Kolby Pipe Marker Co.
   3. MIFAB, Inc.
   4. Seton Identification Products.
B. Comply with ASME A13.1.
C. Plastic Pipe Markers: 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.
D. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
E. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mils thick, manufactured for direct burial service.

F. Color code as follows:
   1. Potable, Cooling, Boiler, Feed, Other Water: Green with white letters.
   2. Fire Quenching Fluids: Red with white letters.
   3. Toxic and Corrosive Fluids: Orange with black letters.
   4. Flammable Fluids: Yellow with black letters.
   6. Compressed Air: Blue with white letters.

2.06 CEILING TACKS

A. Manufacturers:
   1. Craft mark.

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

C. Color code as follows:
   1. HVAC Equipment: Yellow.
   2. Fire Dampers and Smoke Dampers: Red.

P3 EXECUTION

3.01 PREPARATION

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

3.02 INSTALLATION

A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags with corrosion resistant chain.

C. Install plastic pipe markers in accordance with manufacturer's instructions.

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

E. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

F. Use tags on piping 3/4-inch diameter and smaller.
   1. Identify service, flow direction, and pressure.
   2. Install in clear view and align with axis of piping.
   3. Locate identification not to exceed 20 feet 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.

G. Identify air handling units and heat transfer equipment, devices with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.

H. Identify control panels and major control components outside panels with plastic nameplates.

I. Identify valves in main and branch piping with tags.

J. Tag automatic controls, instruments, and relays. Key to control schematic.

K. Identify piping, concealed or exposed, with plastic pipe markers. Use tags on piping 3/4-inch diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet 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.
Mountaire Farms of Delaware, Inc.
Millsboro, DE
Wastewater Treatment System Upgrade

L. Install ductwork with stenciled painting. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.

M. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION
SECTION 22 07 19
PIPING INSULATION

P1 GENERAL

1.01 SECTION INCLUDES
A. Piping insulation.
B. Jackets and accessories.

1.02 RELATED REQUIREMENTS
A. Section 22 10 05 - Plumbing Piping: Placement of hangers and hanger inserts.
B. Section 23 23 00 - Refrigerant Piping and Specialties: Placement of inserts.

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS
A. See Section 22 01 00 - General Provisions, for submittal procedures.
B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.05 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than five years of documented experience.
B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum five years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.
B. Deliver material to job site in original non-broken factory packaging, labeled with manufacturer's density and thickness.
1.07 FIELD CONDITIONS
   A. Maintain ambient conditions required by manufacturers of each product.
   B. Maintain temperature before, during, and after installation for minimum of 24 hours.
   C. Perform work at ambient and equipment temperature as recommended by the adhesive manufacturer.

P2 PRODUCTS
2.01 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION
   A. Surface Burning Characteristics: Flame spread/smoke developed index of 25/50, maximum, when tested in accordance with ASTM E 84, NFPA 255, or UL 723.

2.02 GLASS FIBER
   A. Manufacturers:
      1. Knaul Insulation.
      3. Owens Corning Corp.
      5. Substitutions: See Section 22 01 00 - General Provisions.
   B. Insulation: ASTM C 547; rigid molded, noncombustible.
      1. 'K' value: ASTM C 177, 0.24 at 75 degrees F.
      2. Maximum service temperature: 850 degrees F.
      3. Maximum moisture absorption: 0.2 percent by volume.
   C. Vapor Barrier Jacket: White Kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E 96/E 96M of 0.02 perm-inches.
   D. Tie Wire: 0.048-inch stainless steel with twisted ends on maximum 12 inch centers.
   E. Vapor Barrier Lap Adhesive:
      1. Compatible with insulation.
   F. Insulating Cement/Mastic:
      1. ASTM C 195; hydraulic setting on mineral wool.
   G. Fibrous Glass Fabric:
      1. Cloth: Untreated; 9 oz./sq. yd. weight.
      2. Blanket: 1.0 lb./cu ft. density.
      3. Weave: 5x5.
   H. Indoor Vapor Barrier Finish:
      1. Cloth: Untreated; 9 oz./sq. yd. weight.
      2. Vinyl emulsion type acrylic, compatible with insulation, white color.
   I. Insulating Cement:
      1. ASTM C 449/C 449M.

2.03 CELLULAR GLASS
   A. Manufacturers:
      1. Pittsburgh Corning Corporation.
      2. Substitutions: See Section 22 01 00 - General Provisions.
   B. Insulation: ASTM C 552.
      1. 'K' value:.33 at 75 degrees F.
      2. Service Temperature: Up to 900 degrees F.
      3. Water Vapor Permeability: 0.005 per inch.
      4. Water Absorption: 0.2 percent by volume, maximum.
2.04 JACKETS

A. PVC Plastic.
   1. Manufacturers:
      b. Substitutions: See Section 22 01 00 - General Provisions.
   2. Jacket: One piece molded type fitting covers and sheet material, off-white color.
      a. Minimum Service Temperature: 0 degrees F.
      b. Maximum Service Temperature: 150 degrees F.
      c. Moisture Vapor Permeability: 0.002 per inch, maximum, when tested in accordance with ASTM E 96/E 96M.
      d. Thickness: 15 mils.
      e. Connections: Brush on welding adhesive.
   3. Covering Adhesive Mastic:
      a. Compatible with insulation.

B. Canvas Jacket: UL listed 6 oz./sq. yd. plain weave cotton fabric treated with dilute fire retardant lagging adhesive.
   1. Lagging Adhesive:
      a. Compatible with insulation.

   1. Thickness: 0.016-inch sheet.
   2. Finish: Embossed.
   4. Fittings: 0.016-inch-thick die shaped fitting covers with factory attached protective liner.
   5. Metal Jacket Bands: 3/8-inch-wide; 0.015-inch-thick aluminum. PART 3 EXECUTION

P3 EXECUTION

3.01 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.
B. Verify that surfaces are clean and dry, with foreign material removed.
C. Repair all insulation that is damaged during construction using the same materials.

3.02 INSTALLATION

A. Install in accordance with manufacturer’s instructions.
B. Install in accordance with NAIMA National Insulation Standards.
C. Exposed Piping: Locate insulation and cover seams in least visible locations.
D. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.
E. Glass fiber insulated pipes conveying fluids below ambient temperature:
   1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
   2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
F. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
G. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.
H. Glass fiber insulated pipes conveying fluids above ambient temperature:
   1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.

I. Inserts and Shields:
   1. Application: Piping 1 inch diameter or larger.
   2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
   3. Insert location: Between support shield and piping and under the finish jacket.
   4. Insert configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
   5. Insert material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

J. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions.

K. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces: Finish with PVC jacket and fitting covers.

L. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

M. M. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

3.03 SCHEDULES

A. Plumbing Systems:
   1. Domestic Hot Water Supply:
      a. Glass Fiber Insulation:
         1) Pipe Size Range: all sizes.
         2) Thickness: 1 inch.
      b. Cellular Glass Insulation:
         1) Pipe Size Range: all sizes.
         2) Thickness: 1 inch.
   2. Domestic Cold Water Supply:
      a. Glass Fiber Insulation:
         1) Pipe Size Range: all sizes.
         2) Thickness: 1 inch.
      b. Cellular Glass Insulation:
         1) Pipe Size Range: all sizes.
         2) Thickness: 1 inch.
   3. Process Water Supply:
      a. Glass Fiber Insulation:
         1) Pipe Size Range: all sizes.
         2) Thickness: 2 inch.
      b. Cellular Glass Insulation:
         1) Pipe Size Range: all sizes.
         2) Thickness: 2 inch.

END OF SECTION
SECTION 22 10 05
PLUMBING PIPING

P1 GENERAL

1.01 SECTION INCLUDES
   A. Pipe, pipe fittings, valves, and connections for piping systems.
      1. Sanitary sewer.
      2. Domestic water.

1.02 RELATED REQUIREMENTS
   A. Section 22 01 00 - General Provisions.
   B. Section 22 05 23 - Mechanical Identification.
   C. Section 22 07 19 - Piping Insulation.

1.03 REFERENCE STANDARDS
   C. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2001 (R2005).
   E. ASME B31.9 - Building Services Piping; The American Society of Mechanical Engineers; 2008 (ANSI/ASME B31.9).
   G. ASME (BPV IX) - Boiler and Pressure Vessel Code, Section IX - Welding and Brazing Qualifications; The American Society of Mechanical Engineers; 2007.
   N. ASTM B 88M - Standard Specification for Seamless Copper Water Tube (Metric); 2005.


V. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems; American Water Works Association; 2005 (ANSI/AWWA C105/A21.5).

W. AWWA C65l - Disinfecting Water Mains; American Water Works Association; 2005 (ANSI/AWWA C651).


Z. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2008.


AB. MSS SP-I 10 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 1996.


1.04 SUBMITTALS
A. See Section 22 01 00 - General Provisions, for submittal procedures.

B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

C. Project Record Documents: Record actual locations of valves.

1.05 QUALITY ASSURANCE
A. Perform Work in accordance with State of South Carolina and city of Millsboro, Delaware, standards.

B. Maintain one copy on project site.

C. Valves: Manufacturer's name and pressure rating marked on valve body.

D. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations.

E. Welder Qualifications: Certified in accordance with ASME (BPV IX).

F. Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.

1.06 REGULATORY REQUIREMENTS
A. Perform Work in accordance with State of South Carolina and city of Florence, South Carolina plumbing code.

B. Conform to applicable code for installation of backflow prevention devices.

C. Provide certificate of compliance from authority having jurisdiction indicating approval of installation of backflow prevention devices.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.08 FIELD CONDITIONS
A. Do not install underground piping when bedding is wet or frozen.

P2 PRODUCTS

2.01 SANITARY SEWER PIPING, BURIED BEYOND 5 FEET OF BUILDING
A. PVC Pipe: ASTM D 2665 or ASTM D 3034.
   1. Fittings: PVC.

2.02 SANITARY SEWER PIPING, BURIED WITHIN 5 FEET OF BUILDING
A. PVC Pipe: ASTM D 2665 or ASTM D 3034.
   1. Fittings: PVC.

2.03 SANITARY SEWER PIPING, ABOVE GRADE
A. Cast Iron Pipe: CISPI 301, hubless, service weight.
   1. Fittings: Cast iron.

B. In Fire-rated Walls:
   1. Cast iron.
      a. Fittings: Cast iron.

C. In Plenum-rated Areas:
   1. Cast iron.
      a. Fittings: Cast iron.

2.04 WATER PIPING, BURIED BEYOND 5 FEET OF BUILDING
A. Copper Pipe: ASTM B 42, hard drawn.
   1. Fittings: ASME B 16.18, cast copper alloy or ASME B 16.22 wrought copper and bronze.

2.05 WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING
A. Copper Pipe: ASTM B 42, hard drawn.
   1. Fittings: ASME B 16.18, cast copper alloy or ASME B16.22 wrought copper and bronze.

2.06 WATER PIPING, ABOVE GRADE
A. Sch. 80 PVC Pipe: Cold Water - ASTM D 1785 PVC, Hot Water - ASTM D 1785 CPVC
   1. Fittings: PVC or CPVC

2.07 STORM WATER PIPING, BURIED BEYOND 5 FEET OF BUILDING
A. PVC Pipe: ASTM D 2665 or ASTM D 3034.
   1. Fittings: PVC.

2.08 STORM WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING
A. PVC Pipe: ASTM D 2665 or ASTM D 3034.
   1. Fittings: PVC.

2.09 STORM WATER PIPING, ABOVE GRADE
A. Cast Iron Pipe: ASTM A 74 service weight.
   1. Fittings: Cast iron.

B. Cast Iron Pipe: CISPI 301, hubless, service weight.
   1. Fittings: Cast iron.

2.10 PIPE HANGERS AND SUPPORTS

A. Plumbing Piping - Drain, Waste, and Vent:
   2. Hangers for Pipe Sizes 1/2 Inch to 1-1/2 Inches: Carbon steel, adjustable swivel, split ring.
   3. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
   4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
   5. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
   8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

B. Plumbing Piping - Water:
   1. Conform to ASME B31B. .9.
   2. Hangers that will corrode shall have corrosion resistant resin covering.
   3. Hangers for Pipe Sizes 1/2 Inch to 1-1/2 Inches: Carbon steel, adjustable swivel, split ring.
   6. Hangers for Hot Pipe Sizes 6 Inches and Over: Adjustable steel yoke, cast iron pipe roll, double hanger.
   7. Multiple or Trapeze Hangers: Steel channels with welded supports or spacers and hanger rods.
   8. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 Inches and Over: Steel channels with welded supports or spacers and hanger rods, cast iron roll.
   9. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
   11. Wall Support for Hot Pipe Sizes 6 Inches and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron pipe roll.
   13. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
   14. Floor Support for Hot Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, lockout, nipple, floor flange, and concrete pier or steel support.
   15. Floor Support for Hot Pipe Sizes 6 Inches and Over: Adjustable cast iron pipe roll and stand, steel screws, and concrete pier or steel support.
   17. All hangers, wall supports, floor supports, and vertical supports shall be resin coated to prevent deterioration.

2.11 BALL VALVES

A. Manufacturers:
   1. Tyco Flow Control.
   2. Conbraco Industries.
   3. Nibco, Inc.
   5. Crane.
   6. Substitutions: See Section 22 01 00 - General Provisions.
B. Construction, 4 Inches and Smaller: MSS SP-110, Class 150, 400 psi CWP, bronze, two piece body, chrome plated brass ball, regular port, teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, solder ends with union.

2.12 WATER PRESSURE REDUCING VALVES

A. Manufacturers:
   1. Amtrol Inc.
   2. Cla-Val Co.

B. Up to 2 Inches:
   1. MSS-80, bronze body, stainless steel and thermoplastic internal parts, fabric reinforced diaphragm, strainer, threaded single union ends.

C. Over 2 Inches:
   1. MSS SP-85, cast iron body, bronze fitted, elastomeric diaphragm and seat disc, flanged.

2.13 RELIEF VALVES

A. Pressure Relief:
   1. Manufacturers:
      a. Cla-Val Co.
      b. Henry Technologies.
      c. Watts Regulator Company.
      d. Spence Engineering Company
      e. Substitutions: See Section 15010 - General Provisions.
   2. AGA Z21.22 certified, bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, temperature relief maximum 210 degrees F, capacity ASME (BPV IV) certified and labeled.

B. Temperature and Pressure Relief:
   1. Manufacturers:
      a. Cla-Val Co.
      b. Henry Technologies.
      c. Watts Regulator Company.
      d. Spence Engineering Co.
      e. Substitutions: See Section 15010 - General Provisions.
   2. AGA Z21.22 certified, bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, temperature relief maximum 210 degrees F, capacity ASME (BPV IV) certified and labeled.

2.14 STRAINERS

A. Manufacturers:
   2. Green Country Filtration.
   3. WEAMCO.

B. Size 1-1/2 inch to 4 inch:
   1. Class 125, flanged iron body, Y pattern with 1/16 inch stainless steel perforated screen.

C. Size 5 inch and Larger:
   1. Class 125, flanged iron body, basket pattern with 1/8 inch stainless steel perforated screen.
P3  EXECUTION

3.01  EXAMINATION
   A. Verify that excavations are to required grade, dry, and not over-excavated.

3.02  PREPARATION
   A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
   B. Remove scale and dirt, on inside and outside, before assembly.
   C. Prepare piping connections to equipment with flanges or unions.

3.03  INSTALLATION
   A. Install in accordance with manufacturer’s instructions.
   B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
   C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
   D. Install piping to maintain headroom, conserve space, and not interfere with use of space.
   E. Group piping whenever practical at common elevations.
   F. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 15082.
   G. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors.
   H. Provide access where valves and fittings are not exposed.
   I. Establish elevations of buried piping outside the building to ensure not less than 3 ft of cover.
   J. Install vent piping penetrating roofed areas to maintain integrity of roof assembly.
   K. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
   L. Provide support for utility meters in accordance with requirements of utility companies.
   M. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting.
   N. Install bell and spigot pipe with bell end upstream.
   O. Install valves with stems upright or horizontal, not inverted.
   P. Pipe vents from gas pressure reducing valves to outdoors and terminate in weather proof hood.
   Q. Install water piping to ASME B31.9.
   R. PVC Pipe: Make solvent-welded joints in accordance with ASTM D 2855.
   S. Sleeve pipes passing through partitions, walls and floors.
   T. Inserts:
      1. Provide inserts for placement in concrete formwork.
      2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
      3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
      4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
   U. Pipe Hangers and Supports:
      1. Install in accordance with ASME B31.9.
      2. Support horizontal piping as scheduled.
      3. Install hangers to provide minimum 1/2-inch space between finished covering and adjacent work.
4. Place hangers within 12 inches of each horizontal elbow.
5. Use hangers with 1-1/2-inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
8. Provide copper plated hangers and supports for copper piping.
9. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
10. Provide hangers adjacent to motor driven equipment with vibration isolation; refer to Section 15072.
11. Support cast iron drainage piping at every joint.

V. Where water pressure within the building exceeds 80 psi static, install an approved water-pressure reducing valve conforming to ASSE 1003 with strainer to reduce the building pressure to 80 psi static or less.

3.04 APPLICATION
   A. Use grooved mechanical couplings and fasteners only in accessible locations.
   B. Install unions downstream of valves and at equipment or apparatus connections.
   C. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.
   D. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
   E. Install globe valves for throttling, bypass, or manual flow control services.
   F. Provide ball valves in natural gas systems for shut-off service.

3.05 TOLERANCES
   A. Drainage Piping: Maintain invert elevations within 1/4 inch vertically of location indicated on drawings. Slope to drain at minimum of 1/4 inch per foot slope for pipes 3 inch and smaller and 1/8 inch per foot slope for pipes larger than 3 inch.
   B. Contractor must maintain inverts as indicated on the drawings. The Contractor shall employ the latest precision technology available to insure the accuracy of the installation. If the Contractor is unable to maintain, the Contractor should notify the Engineer IMMEDIATELY to obtain direction.
   C. Water Piping: Slope at minimum of 1/32 inch per foot and arrange to drain at low points.

3.06 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM
   A. Disinfect water distribution system in accordance with South Carolina state and local codes.
   B. Prior to starting work, verify system is complete, flushed and clean.
   C. Ensure Ph of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
   D. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.
   E. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.
   F. Maintain disinfectant in system for 24 hours.
   G. If final disinfectant residual tests less than 25 mg/L, repeat treatment.
   H. Flush disinfectant from system until residual equal to that of incoming water or 1.0
   I. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.
3.07 SERVICE CONNECTIONS

A. Provide new sanitary sewer services. Before commencing work check invert elevations required for sewer connections, confirm inverted and ensure that these can be properly connected with slope for drainage and cover to avoid freezing.

B. Provide new water service complete with approved reduced pressure backflow presenter and water meter with by-pass valves, pressure reducing valve.
   1. Provide sleeve in wall for service main and support at wall with reinforced concrete bridge. Calk enlarged sleeve and make watertight with pliable material. Anchor service main inside to concrete wall.
   2. Provide 18 gage galvanized sheet metal sleeve around service main to 6 inch above floor and 6 feet minimum below grade. Size for minimum of 2 inches of loose batt insulation stuffing.

C. Connection of dissimilar pipe materials shall be made with the specified adapter couplings.

D. Sewers shall be encased or cradles in concrete where shown on the plans or as directed by the Engineer. Unless otherwise noted on the plans, concrete encasement shall encircle the pipe and shall be a minimum thickness of four inches.

E. Provide new gas service complete with regulators. Gas service distribution piping to have initial minimum pressure of 7 inch wg. Provide regulators on each line serving gravity type appliances, sized in accordance with equipment.

F. Contractor shall connect to existing gas service in accordance with the requirements of gas service official and all applicable municipal and state regulations. All gas piping shall conform to and be tested in accordance with the local gas company and the Standard Gas Code. Gas piping shall have cathodic protection and all piping subject to natural gas pressure over 15 ounces must be welded. Any charge made by the gas company for placing the valves, piping, and connection to service main shall be borne by this Contractor. See plans for extent of piping.

G. This Contractor shall extend the system of gas piping, to the various outlets as indicated on plans, complete with stop cocks, drip pockets, valves and other accessories that may be required to give proper and adequate service.

H. Provide gas cocks in final connection to all equipment. Unions will not be permitted, except in final connections to equipment. Proper reducing fittings shall be used. Bushings will not be accepted. Gas piping in building shall be standard weight schedule 40 black steel pipe with malleable fittings, unless Contractor wishes to weld all joints. Welded rod shall be of same material as piping. No. 22 bronze welding will be permitted.

I. All underground as service exterior to the building (5 psi or less) shall be a polyethylene plastic pipe manufactured in accordance with ASTM No. D-2517 or D-2513 and shall be indicated on the pipe. Gas piping shall be laid at least 36" below grade at all points. Provide a #12 THN copper wire in trench with pipe and leave both ends exposed for future accessibility.

J. All gas piping in ground, including service, shall be checked with a "Holiday" detector to assure that the coating is free of holes, voids, contamination, cracks, etc. This test shall be performed after the completion of joint and finish coating and touch-up. This test shall be conducted in the presence of the Owner's inspector and performed by experienced personnel.

K. For corrosion protection, all underground steel pipe and fittings must be coated and wrapped, extending 6" above ground.

L. Test all gas piping operating at 6 oz. with air pump and mercury gauge to pressure that will maintain 25 psig for 20 minutes and inspected by gas service official.

M. All gas piping operating at more than 1 psig shall be tested at 100 psig for steel and 50 psig for plastic, for a minimum of 15 minutes and inspected by gas service official.

N. The pressure regulator at the building shall be sized, and approved by gas service official.

O. All above ground piping shall be rigid steel pipe designated for natural gas use. Pipe shall be painted with a rust inhibiting primer and a final coat the color of which shall be determined by
governing regulations or as directed by the Engineer if no governing regulations exist regarding finish color.

P. All gas piping systems within a building and other above ground gas piping shall be electrically continuous and bonded to a grounded electrode as defined in NFPA 70.

Q. Medium and high pressure gas regulators installed in the medium and high pressure gas lines (2 psi or greater) shall comply with the following provisions:
1. Shall be suitable for the inlet and outlet gas pressure.
2. Shall comply with Code and gas official requirements.
3. Shall be accessible for servicing.
4. Shall be vented to outdoors when located indoors.
5. Shall be installed in the gas piping system so that it cannot be concealed by building construction.

R. Provide a listed shut off valve - immediately ahead of and behind each medium pressure regulator.

S. Underground gas piping shall be installed in a separate ditch.

3.08 SCHEDULES

A. Pipe Hanger Spacing:
1. Metal Piping:
   a. Pipe size: 1/2 inches to 1-1/4 inches:
      1) Maximum hanger spacing: 6.5 ft.
      2) Hanger rod diameter: 3/8 inches.
   b. Pipe size: 1-1/2 inches to 2 inches:
      1) Maximum hanger spacing: 10 ft.
      2) Hanger rod diameter: 3/8 inch.
   c. Pipe size: 2-1/2 inches to 3 inches:
      1) Maximum hanger spacing: 10 ft.
      2) Hanger rod diameter: 1/2 inch.
   d. Pipe size: 4 inches to 6 inches:
      1) Maximum hanger spacing: 10 ft.
      2) Hanger rod diameter: 5/8 inch.

2. Plastic Piping:
   a. All sizes:
      1) Maximum hanger spacing: 6 ft.
      2) Hanger rod diameter: 3/8 inch.

3. Roof Supports:
   a. Provide gas piping roof supports as indicated on the plans.

END OF SECTION
Mountaire Farms of Delaware, Inc.
Millsboro, DE
Wastewater Treatment System Upgrade

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SECTION 23 01 00
GENERAL HVAC PROVISIONS

PART 1 GENERAL

1.01 WORK INCLUDED

A. The work covered by Division 23 sections consist of furnishing all labor, equipment, appliances and material for the heating, air conditioning, piping and plumbing systems in strict accordance with Codes, Specifications and the applicable drawings and subject to the terms and conditions of the contract. Include all appurtenances necessary to the proper operation of the systems and equipment specified.

B. Install all concrete pads and bases required for installing mechanical equipment.
   1. Mechanical work is responsible for the exact sizes required, location of anchor bolts, etc.
      a. Some equipment may be furnished by other divisions. Mechanical work is responsible to check the drawings and specifications for equipment that will be furnished by the Owner. Furnish the duct, insulation, controls, etc., on all equipment furnished by other divisions.
         1) Construction work in Section 06 10 00 shall furnish and install all ceiling access panels required to service mechanical equipment, valves and controls above gyp board or hidden spline ceilings.

2. RELATED SECTIONS
   a. The General Conditions and Division 1, General Requirements, as bound in the specification preamble, apply to all work under Division 23. Carefully note its contents in performance of the work.
   b. The Architectural, Plumbing, Electrical, and Structural plans and Specifications, including Information to Bidders and other pertinent documents issued by the Engineer are a part of this Specifications and the accompanying mechanical plans. Comply with them in every respect. Examine all the above carefully. Failure to comply does not relieve the Contractor of responsibility nor may it be used as a basis for additional compensation due to omission of architectural, electrical and structural details from the mechanical drawings.
   c. All electrical power wiring is specified under Division 26 of the Specifications. Mechanical work shall furnish all motor starters required for the control and protection of all motors furnished for the Division 23. Provide and install all automatic temperature and interlock wiring required for controlling mechanical equipment furnished under Division 23, in compliance with Division 26 of the Project Manual.
   d. All concrete pads and bases required for installing mechanical equipment are specified in another section of the Specifications. Advise the Contractor as to the exact sizes required, location of anchor bolts, etc.
   e. Do not paint indoor equipment supplied with painted finish, such as the main mechanical equipment unless damaged during handling and installation. In such cases, use touch-up paint of the same type and color as original paint. Conform to requirements in other sections of the Specifications and match wall finish to the room in which installed.

C. CODES, FEES AND LATERAL COSTS
   1. Comply with all applicable codes, specifications, local ordinances, industry standards, utility company regulations, and the applicable requirements of the following latest nationally accepted codes and standards:
      a. Arkansas State Mechanical Code; latest accepted edition.
      e. IFC - International Fire Code; latest accepted edition.
      f. IGC - International Gas Code; latest accepted edition.
g. IMC - International Mechanical Code; latest accepted edition.
h. IPC - International Plumbing Code; latest accepted edition.
i. IECC - International Energy Conservation Code
j. AMCA - Air Moving & Conditioning Association.
k. ASA - American Standards Association.
l. ASHRAE - American Society of Heating, Refrigerating and Air Conditioning Engineers.
m. ASME - American Society of Mechanical Engineers.
o. AWWA - American Water Works Association.
q. NEMA - National Electrical Manufacturers Association.
s. SMACNA - Sheet Metal & Air Conditioning Contractors' National Association.
t. UL - Underwriters' Laboratories, Inc.
u. AGA - American Gas Association.
v. OSHA - Occupational Safety and Hazard Association.
w. AABC - Associated Air Balance Councils
x. NEBB - National Environmental Balancing Bureau
y. Comply with State of Arkansas adopted ADA Accessible Guidelines in regard to accessible or handicapped features.
z. In case of difference between building codes, Specifications, state Laws, local ordinances, industry standards and utility company regulations and the Contract
   1) Documents, the most stringent governs. Promptly notify the Engineer in writing of any such difference.
   2) Remove any work installed that does not comply with the requirements of the applicable building codes, state laws, local ordinances, industry standards, or utility company regulations, correct the deficiencies, and reinstall all work at no cost to the Owner.
   3) The mechanical drawings show the general arrangement of all piping, equipment and appurtenances. Follow as closely as actual building construction and the work of other trades will permit. Final layout will be governed by actual field conditions with all measurements verified at the site. Conform to the requirements shown on all of the drawings. General and structural drawings take precedence over mechanical drawings. Because of the small scale of the mechanical drawings, it is not possible to indicate all offsets, fittings and accessories which may be required. Investigate the existing and finish conditions affecting the work and arrange the work accordingly, providing such fittings, valves and accessories as may be required to meet such conditions.
      (a) Contractor shall verify that all equipment, ducts, pipes and all other components will fit in the space provided before fabrication or ordering.
   4) Obtain any and all required permits in connection with this work under the Contract and pay any and all fees in connection therewith. Arrange with the serving utility companies for the connections to all utilities and pay all charges for same including inspection fees and meters if required. Refundable deposits will be paid by the Owner.

2. GUARANTEE
   a. Furnish a written certificate guaranteeing all materials, equipment and labor furnished to be free of all defects for a period of one (1) year from and after the date of final acceptance of the work by the Owner and further guarantee to replace such work without charges if any defects appear within the stipulated guaranty period.

3. SOIL CONDITIONS
   a. The Specifications and the drawings in no way imply the conditions of the soil to be encountered. When excavating may be required in execution of the work, this
Contractor agrees that he has informed himself regarding conditions affecting the work.

4. INSPECTION OFF PREMISES
   a. Before submitting a bid, visit the site of the proposed job and determine the conditions relating to this work.

D. UTILITIES, LOCATIONS AND ELEVATIONS
   1. Locations and elevations of the various utilities included within the scope of this work have been obtained from substantially reliable sources and are offered as a general guide only, without guarantee as to accuracy. Verify the location and elevation of all utilities and their relation to the work before entering into a contract.
   2. Identify outdoor underground lines with continuous strip of plastic utility marker tape at regular intervals (maximum of 10 feet) "Caution (state utility) pipe below". Install one foot directly above pipe before backfilling to grade.

E. EQUIPMENT NOT SPECIFIED UNDER DIVISION 23
   1. Equipment which requires plumbing and other mechanical connections may be specified in another division of this Specification. Under these conditions, provide necessary utilities including waste, water, natural gas, duct, insulation and controls.
   2. Rough-in work from approved shop drawings only.

PART 2 PRODUCTS

2.01 EQUIPMENT AND MATERIALS
   A. Provide new materials bearing the manufacturer's name, trade name and the UL label in every case where a standard has been established for the particular material. Furnish the standard product of a manufacturer regularly engaged in the production of the required type of equipment. Provide the manufacturer's latest approved design.
   B. Deliver equipment and materials to the site and store in original containers, suitably sheltered from the elements, but readily accessible for inspection by the Engineer until installed. Store all items subject to moisture damage (such as controls) in dry, heated spaces.
   C. Provide equipment and materials of the same general type and of the same make throughout the work to provide uniform appearance, operation and maintenance.
   D. Tightly cover equipment and protect against dirt, water and chemical or mechanical injury and theft. At the completion of the work, clean fixtures, equipment and materials and polish thoroughly. Turn over to the Owner in a condition satisfactory to the Engineer. Repair damage or defects developing before acceptance of the work at no expense to the Owner.
   E. Insure that items to be furnished fit the space available. Make necessary field measurements to ascertain space requirements, including those for connections. Furnish and install such sizes and shapes of equipment that the final installation suits the true intent and meaning of the drawings and Specifications.
      1. Follow manufacturer's directions completely in the delivery, storage, protection and installation of all equipment and materials. Promptly notify the Engineer in writing of any conflicts between any requirements of the Contract Documents and the manufacturers' directions. Obtain the Engineer's written instruction before proceeding with the work. Replace any work that does not comply with the manufacturers' directions or such written instructions from the Engineer, at no cost to the Owner.
      2. Support all products by service organizations with adequate spare parts inventory and personnel located reasonably close to the site.
      3. Where multiple units of the same type or class of products are required, provide all units of the same manufacturer.
      4. EQUIPMENT ACCESSORIES
         a. Furnish and install all equipment, accessories, connections and incidental items necessary to fully complete all work, ready for use, occupancy and operation by the Owner.
b. Where equipment requiring different arrangement or connections from those shown is provided, install the equipment to operate properly and in harmony with the intent of the drawings and Specifications.

c. Support, plumb, rigid and true to line, all work and equipment furnished. Study thoroughly all general, structural, electrical, fire suppression and mechanical drawings, shop drawings and catalog data to determine how equipment, fixtures, piping, ductwork, etc., are to be supported, mounted or suspended and provide extra steel bolts, inserts, pipe stands, brackets and accessories for proper supports whether or not shown on the drawings. When directed, submit drawings showing supports.

d. If accessories are required to complete the work and meet the intent of the specification, it is the responsibility of the Contractor to provide such accessories.

5. MATERIAL AND EQUIPMENT SCHEDULE

a. Submit to the Engineer as soon as practical, six (6) complete sets of the schedule of materials and equipment proposed for the installation. Include manufacturers' names, catalog data, diagrams, drawings and other descriptive data and submit under one cover with an index sheet in front.

b. Provide written certification that shop drawings are in accordance with the specifications and are dimensionally correct with reference to available space.

c. All submittals will be reviewed a maximum of two (2) times. The cost of additional submittal reviews beyond those two specified will be charged to the Contractor.

d. Shop drawings for the Engineer's files are required on the following items:
   1) Filters.
   2) Exhaust Fans.
   3) Grilles and Registers.
   4) Air Balance Certification.
   5) Ductwork Materials Including Duct Accessories.
   6) Duct Insulation Materials.
   7) Complete Mechanical Equipment Electrical Data and Wiring Details.

6. EQUIPMENT AND MATERIAL SUBSTITUTIONS

a. It is the responsibility of the Contractor to investigate any desired substitutions for specified equipment prior to submission of his bid. The Contractor shall be responsible for any changes required in mechanical, electrical, structural or vibration isolation systems and shall bear all cost for those changes whether the substitute equipment is named by manufacturer in the specifications or is submitted to the Architect for "or equal" consideration. All changes shall be accomplished in a manner acceptable to the Architect per Section 01 33 00 at no additional cost to the Owner.

b. In order to obtain prior approval on equipment or material not specified in Division 23 Specifications or Equipment Schedules, Contractor MUST submit to the Engineer any proposed equipment or material ten (10) working days prior to the bid date.

c. If ANY substitute equipment is submitted to Engineer for approval, without said equipment having been pre-approved, the entire submittal will be rejected for resubmittal.

d. Any equipment manufacturers which are a subsidiary to the listed acceptable manufacturers are not considered equal. Therefore, it is the responsibility of the Contractor and equipment supplier to obtain prior approval as described in paragraph 2.4, this Section.

7. ELECTRICAL MOTORS

a. Provide motors of a recognized manufacturer, wound for the voltage specified, and in conformance to latest standards of the manufacturer and performance of the National Electrical Manufacturers Association and the Institute of Electrical and Electronic Engineers. Provide motors as manufactured by General Electric, Westinghouse, Century or Siemens- Allis, Baldor or approved equal.
b. Provide motors rated for continuous duty at 100% of rated capacity and temperature raise of 40 degrees Centigrade open type; 50 degrees Centigrade drip and splash proof; 55 degrees Centigrade explosion proof and totally enclosed above an ambient of 40 degrees Centigrade.

c. Unless otherwise required, provide integral horsepower, polyphase motors, Class, general purpose, squirrel cage, open type induction motors, T-frame.

d. Provide single phase fractional horsepower motors of the open capacitor type. Generally, motors under 1/2 horsepower may be split phase type unless otherwise specified. Provide motors rated 1/2 horsepower or less with integral overcurrent protection.

e. Insure the insulation resistance between stator conductor and frames of motors is not less than 1/2 megohm. Provide shop test of motors including temperature rise, insulation resistance, motor terminal voltage, normal operating line current, RPMs, breaker or switch size with fusing and overload relay sizes.

**PART 3 EXECUTION**

**3.01 COORDINATION OF WORK**

A. Compare the mechanical drawings and Specifications with the drawings and Specifications for other trades and report any discrepancies between them to the Engineer and obtain from him written instruction for changes necessary in the mechanical work. Install the mechanical work in cooperation with other trades installing inter-related work. Before installation, make proper provisions to avoid interferences in a manner approved by the Engineer. Make all changes required in the work caused either by neglect or existing field conditions at no cost to the Owner.

B. It is the responsibility of the Contractor to coordinate installation of all equipment. Equipment installed prior to proper coordination, which interferes with the harmony and intent of the specifications and drawings, will be removed and reinstalled at the cost of the responsible Contractor.

C. Furnish anchor bolts, sleeves, inserts and supports required for the mechanical work. Locate anchor bolts, sleeves, inserts and supports as directed by the trade requiring them and insure that they are properly installed.

D. Slots, chases, openings and recesses in existing structure shall be cut, patched and repaired by the Contractor.

E. Adjust locations of pipes, ducts, equipment fixtures, etc., to accommodate the work and for interferences anticipated and encountered. Determine the exact route and location of each pipe and duct prior to fabrication.

1. Provide right-of-way to lines that pitch over those that do not pitch. For example, Plumbing drains normally have right-of-way. Lines whose elevations cannot be changed have the right-of-way over lines whose elevations can be changed.

2. Make offsets, transitions and changes in direction in pipes and ducts as required to maintain proper head room and pitch.

   a. Install all mechanical work to permit removal without damage to other parts, to coils, fan shafts and wheels, filters, belt guards, sheaves and drives and all other parts requiring periodic replacement or maintenance. Arrange pipes, ducts and equipment to permit ready access to valves, cocks, traps, starters, motors, control components and to clear the openings of swinging and overhead doors and of access panels.

   1) Change the cross sectional dimensions of ductwork when required to meet job conditions, but maintain at least the same equivalent cross sectional area. Secure the approval of the Engineer prior to fabrication of ductwork requiring such changes. Sizes shown on the plans are clear dimensions; add for internal insulation if specified.
3. RECORD DRAWINGS
   a. Maintain record drawings showing exact locations and sizes, as actually installed, of piping, drains, cleanouts, ductwork, controls and equipment as specified herein. Deliver to the Owner/Architect upon completion and acceptance of the work, one (1) complete set of contract drawings marked to indicate all deviations from intended installation.
   b. Record drawings shall be provided in hard copy form, as well as, on a DVD in PDF form.

4. CUTTING AND PATCHING
   a. The construction work shall be responsible for all required cutting, patching, etc., incidental to this work and shall make all required repairs thereafter to the satisfaction of the Engineer. Do not cut into any major structural element, beam or column without the written approval of the Engineer.
   b. Openings in fire or smoke barriers for air handling ductwork or air movement shall be protected in accordance with NFPA 90A and 90B and the Mechanical Code.
   c. Pipes, conduits, cables, wires, air ducts, pneumatic tubes and ducts and similar handling service equipment that pass through fire or smoke barriers shall be protected in accordance with NFPA 101.
   d. All fire stopping assemblies must be UL approved assemblies.

5. EQUIPMENT START-UP AND TESTING
   a. Instruct the Owner's operating personnel during start-up and separate operating tests of each major item of equipment. During the operating tests, prove the operation of each item of equipment to the satisfaction of the Engineer. Give at least seven (7) days' notice to the Engineer of equipment start-up and operating tests.

6. CATALOG DATA FOR OWNER
   a. Provide, in loose-leaf binders, two (2) sets of a compilation of catalog data of each manufactured item of equipment used in the mechanical work and present this compilation to the Owner/Architect for transmittal to the Owner before final payment is made. Include descriptive data and printed installation, operating and maintenance instructions for each item of equipment. Provide a complete double index as follows:
      1) Listing of products alphabetically by name.
      2) Listing the names of manufacturers whose products have been incorporated in the work alphabetically together with their addresses and the names and addresses of the local sales representatives.
      3) Certificates of Final Inspections.
      4) Complete spare parts data with current prices and supply sources.
      5) Extended warranties.
   b. Deliver to the Owner all special tools, lubricants, extra materials and any other products necessary for the proper operation and maintenance of the mechanical and plumbing systems.
   c. Provide project record documents indicating all changes from contract documents made during construction.
   d. Submit all Certificates of Final Inspections from the Administrative Authorities.
   e. Submit TAB reports on approved forms. Final TAB report submittals shall include all required rebalances if any are required.

F. INSTRUCTION OF OWNER'S REPRESENTATIVE
   1. Instruct the representative of the Owner in the proper operation and maintenance of all elements of the mechanical system.

G. PROTECTIVE COATINGS
   1. Paint exterior surfaces of steel piping run in or through concrete floor fill, under tile floors or underground, and aluminum surfaces in contact with masonry, with one coat of acid resisting bituminous base paint.
   2. Paint all exposed galvanized ducts behind grilles flat black.
H. TEST AND ACCEPTANCE
   1. Plumbing and Drainage System: Test the new system humidity and drain piping with water and prove tight. Test system with 10 feet of water for 24-hour period. Air test is not permitted.

I. NOISE CONTROL
   1. It is intended that the mechanical systems as installed under this contract be free from objectionable noise when the system is operating. The system shall operate at noise levels below criteria recommended for the application by ASHRAE. Provide vibration

J. CLEANING AND ADJUSTING
   1. Do not allow waste material and rubbish to accumulate in or above the premises. After completion of this work, remove rubbish, tools, scaffolding and surplus materials from and about the building and leave all work clean and ready for use. Clean all equipment, pipes, valves and fittings of grease, metal cuttings and sludge. Repair any stoppage, discoloration or other damage to parts of the building, its finish or furnishings due to failure to properly clean the mechanical systems, without additional cost to the Owner. Adjust all automatic control devices for proper operation.

K. SYSTEM OPERATING TESTS
   1. After the successful completion of all equipment start-up and test requirements, perform the following tests on the complete mechanical systems:
      a. First Operating Test by Contractor: Prove the operation of the mechanical systems and of each individual item in the systems. Give at least 10-day prior notice to the Engineer of such tests. Adjust and set proper quantities to all items and equipment. Should any item of the systems fail to perform in an approved manner, repeat this test until approved by the Engineer. During this test, balance circulation of heating and cooling water to balancing cocks, valves, thermostats and similar items to ensure that the mechanical systems perform as intended.
      b. Checking by Owner and Engineer: Following the successful completion of first operating tests by the Contractor, the Owner and the Engineer have the privilege of making such tests as they may desire during a period of three weeks to ascertain in detail if any corrections are to be made to the system. At the end of the testing by the Owner and the Engineer, the Engineer may direct the Contractor in writing to make such corrections to the systems as are within the scope of the contract.
      c. Contractor's Corrections to Systems: Make all required corrections to the systems and notify the Engineer in writing that the corrections outlined have been completed. Give at least seven (7) days' notice of a final three-day operating test.
      d. Three-Day Operating Test: Perform an operating test to the satisfaction of the Engineer for a period of three (3) days. Should any element of the systems not perform properly, make all required corrections and repeat the test until successfully performed.
      e. Submit the Form of Record proposed by the Contractor for the recording of all measurements to the Engineer for approval at least two weeks before the approved form will be required by the Contractor.
      f. Measurements: Make the following measurements at two-hour intervals (5 measurements per 8-hour day) during the three-day operating test.
      g. Electrical: Running amperes and voltage of each motor 3/4 horsepower or larger.
      h. Air temperatures in each heated or air conditioned space and outdoor temperatures.
         1) Instruments: Provide all instruments, materials and labor to perform the tests and to obtain and record the measurements specified herein, including the furnishing of all required record forms as approved by the Engineer. Submit for the Engineer's approval, complete shop drawings or catalog data for all
2) Report: Submit four (4) copies of a written report of the three-day operating test on the approved Form of Record to the Engineer for approval and subsequent transmittal to the Owner.

2. MOTOR CONTROL
   a. General: Provide each motor 1/8 horsepower or larger with a suitable controller and devices that will perform the functions as specified for the respective motors, together with manual reset thermal overload, protection in each undergrounded conductor. Provide the controller either integral with circuit protective device or mounted in separate enclosure. Starters shall be Allen-Bradley, G.E., Westinghouse, Square D or approved equal.
   b. Control: Automatic control devices such as thermostats, float or pressure switches may control the starting and stopping of motor directly, provided the device used is designated for that purpose and has an adequate horsepower rating. When automatic control device does not have such a rating, use a magnetic starter with the automatic control device actuating the pilot control circuit. When combination manual and automatic control is specified and the control device operates the motor directly, provide a manual motor starter and selector switch. When combination manual and automatic control is specified and the automatic control device actuates the pilot control circuit, a magnetic control device actuates the pilot control provided. Provide all magnetic starters with push buttons or selector switches in the covers. Provide connections to the selector switch such that only the normal automatic regulating control devices will be bypassed when the switch is in the manual position. Connect all safety control devices, such as low or high pressure cutouts, high temperature cutouts and motor overload protective devices in the motor control circuit in both the manual and automatic positions of the selector switch control circuit. Make connections to any selector switch or to more than one (1) automatic regulatory control device in accordance with wiring diagrams recommended by the manufacturer and approved by the Engineer. Where required for manual control, provide push-button stations consisting of two (2) momentary contact operators, 600 volts, 10 amperes installed and wired for three wire control to provide under-voltage relays, auxiliary contacts or other devices required for a complete system.
   c. Location: Where the controller is located within sight of the motor driven equipment (fifty feet or less), the controller and circuit protective device shall be capable of being locked in the open position. Where the controller is located out of sight of the motor driven equipment (more than fifty feet) provide a non-fused safety disconnect, suitable for the service, and which opens all ungrounded conductors simultaneously, at or on the motor driven equipment.
   d. Enclosure: Enclosure to be general purpose, NEMA Type 1 unless noted otherwise (NEMA Type 1 gasketed). The circuit breaker shall be operable by hand from outside the enclosure and shall be so interlocked with the door or doors that it must be returned to the "OFF" position before the door can be opened.
   e. Push-buttons: Provide maintained contact, standard duty type in a general purpose, NEMA Type 1 enclosure for surface mounting rated for 10 amperes continuous at 600 volts or less.

L. ACCESS PANELS
   1. Provide access panels as required in all walls, ceilings and ductwork to service and have access to all valves, operating parts and duct mounted fire dampers. For all ceiling and wall access doors that are required in gypsum board and plaster, provide minimum 24" x 24", unless due to structural restraints the access door can be reduced to a minimum of 18" x 18", Milcor type appropriate for the construction involved.
M. TEMPORARY HEATING AND COOLING

1. Permanent heating and cooling systems may be used to provide temporary heating and cooling to the building during construction, if the following requirements are met:
   a. Provide filters in equipment filter racks.
   b. Provide filter material at entrance to all return air ducts or over permanent return air grilles. All return air ductwork is to be protected from construction dust and debris. If return air duct work is not protected prior to equipment startup for temporary use, the Contractor will pay to have the entire ductwork system of the affected equipment thoroughly cleaned prior to Owner occupancy.
   c. Contractor shall provide and pay for operation, maintenance, regular replacement of filters and worn or consumed parts.
   d. shall replace any equipment that is damaged during temporary usage with new equipment.
   e. All warranty periods shall not begin until Certificate of Substantial Completion is issued.
   f. Verify with engineer that the installation is ready and approved for operation.
   g. Just prior to turning the building or portions of the building over to the Owner, Contractor will replace all filters on equipment used for temporary ventilation, heater cooling during construction.

2. FINALLY
   a. It is the intention that this specification shall provide a complete installation except as herein before specifically excepted. All accessory construction and apparatus necessary or advantageous in the operation and testing of the work shall be included. The omission of specific reference to any part of the work necessary for such complete installation shall not be interpreted as relieving this Contractor from furnishing and installing such parts.

END OF SECTION
SECTION 23 31 00
HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Metal ductwork.
B. Duct cleaning.

1.02 REFERENCE STANDARDS
B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.
C. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2015.
E. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005.

1.03 SUBMITTALS
A. Product Data: Provide data for duct materials.

PART 2 PRODUCTS

2.01 DUCT ASSEMBLIES
A. Regulatory Requirements: Construct ductwork to NFPA 90A standards.
B. Ducts: Galvanized steel, unless otherwise indicated.
C. Low Pressure Supply (System with Cooling Coils): 1/2 inch w.g. (125 Pa) pressure class, 304 Stainless Steel.
   1. This will be used as shown on the drawings.

2.02 MATERIALS
A. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G60/Z180 coating.
B. Stainless Steel for Ducts: ASTM A666, Type 304.
C. Hanger Rod: ASTM A36/A36M; steel, 303 Stainless Steel; threaded both ends, threaded one end, or continuously threaded.

2.03 DUCTWORK FABRICATION
A. Fabricate and support in accordance with SMACNA (DCS) and as indicated.
B. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
C. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
D. Fabricate continuously welded round and oval duct fittings in accordance with SMACNA (DCS).

2.04 MANUFACTURED DUCTWORK AND FITTINGS
A. Double Wall Insulated Flat Oval Ducts: Machine made from round spiral lockseam duct.
   1. Manufacture in accordance with SMACNA (DCS).
   2. Fittings: Manufacture with solid inner wall.
   3. Insulation:
      a. Thickness: 1 inch (25 mm) fiberglass.
PART 3 EXECUTION

3.01 INSTALLATION

A. Install, support, and seal ducts in accordance with SMACNA (DCS).
B. Install in accordance with manufacturer's instructions.
C. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.
D. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

3.02 CLEANING

A. 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.

END OF SECTION
SECTION 23 34 23
HVAC POWER VENTILATORS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Roof exhausters.
B. Wall exhausters.

1.02 REFERENCE STANDARDS
A. AMCA 204 - Balance Quality and Vibration Levels for Fans; 2005.
B. UL 705 - Power Ventilators; Current Edition, Including All Revisions.

1.03 SUBMITTALS
A. Product Data: Provide data on fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels at rated capacity, and electrical characteristics and connection requirements.
B. Manufacturer's Instructions: Indicate installation instructions.
C. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Greenheck;
B. Loren Cook Company;
C. Twin City Fan & Blower.

2.02 ROOF EXHAUSTERS
A. Fan Unit: V-belt or direct driven as indicated, with spun aluminum housing; resilient mounted motor; 1/2 inch (13 mm) mesh, 0.62 inch (1.6 mm) thick aluminum wire birdscreen; square base to suit roof curb with continuous curb gaskets.
B. Roof Curb: 8 inch (200 mm) high self-flashing of galvanized steel with continuously welded seams, built-in cant strips.
C. Backdraft Damper: Gravity actuated, aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked.
D. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

2.03 WALL EXHAUSTERS
A. Fan Unit: V-belt or direct driven with spun aluminum housing; resiliently mounted motor; 1/2 inch (13 mm) mesh, 0.062 inch (1.6 mm) thick aluminum wire bird screen.
B. Backdraft Damper: Gravity actuated, aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked.
C. Sheaves: For V-belt drives, provide cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.
D. Centrifugal Fan Unit: V-belt or direct driven with galvanized steel housing lined with acoustic material.
2.04 UPBLAST ROOF EXHAUSTERS

A. Shafts and Bearings:
   1. Fan Shaft:
      a. Ground and polished steel with anti-corrosive coating.
      b. First critical speed at least 25 percent over maximum cataloged operating speed.
   2. Bearings:
      a. Permanently sealed or pillow block type.
      b. Minimum L10 life in excess of 100,000 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed.
      c. 100 percent factory tested.

B. Drive Assembly:
   1. Belts, pulleys, and keys oversized for a minimum of 150 percent of driven horsepower.
   2. Belts: Static free and oil resistant.
   3. Fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.
   4. Motor pulley adjustable for final system balancing.
   5. Readily accessible for maintenance.

C. Drain Trough: Allows for single-point drainage of water, grease, and other residues.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Secure roof exhausters with cadmium plated steel lag screws to roof curb.
C. Extend ducts to roof exhausters into roof curb. Counterflash duct to roof opening.

END OF SECTION
SECTION 23 37 00
AIR OUTLETS AND INLETS

PART 1 GENERAL
1.01 SECTION INCLUDES
   A. Registers/grilles.
   B. Louvers.

1.02 REFERENCE STANDARDS

1.03 QUALITY ASSURANCE
   A. Test and rate air outlet and inlet performance in accordance with ASHRAE Std 70.
   B. Test and rate louver performance in accordance with AMCA 500-L.

PART 2 PRODUCTS
2.01 MANUFACTURERS
   A. Greenheck.
   B. Titus.
   C. Krueger

2.02 CEILING EXHAUST AND RETURN REGISTERS/GRILLES
   A. Color: To be selected by Engineer from manufacturer's standard range.

2.03 LOUVERS
   A. Type: 6 inch (150 mm) deep with blades on 45 degree slope with center baffle and return bend, heavy channel frame, 1/2 inch (13 mm) square mesh screen over exhaust and 1/2 inch (13 mm) square mesh screen over intake.
   B. Fabrication: 12 gage, 0.1046 inch (2.66 mm) thick extruded aluminum, welded assembly, with factory Epoxy finish.
   C. Color: To be selected by Engineer from manufacturer's standard range.

PART 3 EXECUTION
3.01 INSTALLATION
   A. Install in accordance with manufacturer's instructions.
   B. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.

END OF SECTION
SECTION 23 81 06
PACKAGED ROOFTOP AIR-CONDITIONERS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Packaged rooftop unit.
B. Unit controls.
C. Roof mounting curb and base.

1.02 REFERENCE STANDARDS
B. Packaged air-cooled condenser units shall be certified in accordance with ANSI/AHRI Standard 340/360 performance rating of commercial and industrial unitary air-conditioning and heat pump equipment.
C. Unit shall be certified in accordance with UL Standard 1995 Safety Standard for Heating and Cooling Equipment.
D. Unit and refrigeration system shall comply with ASHRAE 15, Safety Standard for Mechanical Refrigeration.
E. Unit Energy Efficiency Ratio (EER) shall be equal to or greater that prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.
F. Unit shall be safety certified by ETL listed. Unit nameplate shall include the ETL Label.
G. Unit shall be approved for use in and outside High Velocity Hurricane Zones (HVHZ) by the Florida Building Code (FL# 15031), when using the required steel rooftop curb and attachment methods. Maximum allowable lateral wind pressure is +100psf/-100psf. Maximum allowable uplift is +50psf/-50psf. Positive and negative required design pressures calculated for use with this system shall be determined by others on a job specific basis, in accordance with the governing code. Site specific pressures shall be less than or equal to the listed positive or negative allowable lateral wind design pressure and allowable uplift values for the product.

1.03 SUBMITTALS
A. Product Data: Literature shall be provided that indicates dimensions, operating and shipping weights, capacities, ratings, fan performance, filter information, factory supplied accessories, electrical characteristics and connection requirements. Installation, Operation, and Maintenance manual with startup requirements shall be provided.
B. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.
C. Shop Drawings: Unit drawings shall be provided that indicate assembly, unit dimensions, construction details, clearances and connection details. Computer generated fan curves for each fan shall be submitted with specific design operation point noted. Wiring diagram shall be provided with details for both power and control systems and differentiate between factory installed and field installed wiring.

1.04 WARRANTY
A. Provide a five-year warranty to include coverage for refrigeration compressors.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. AAON.
B. Trane.
C. York.
2.02 PACKAGED ROOFTOP UNITS

A. General Description
1. Packaged rooftop unit shall include compressors, evaporator coils, filters, supply fans, dampers, air-cooled condenser coils, condenser fans, reheat coil, gas heaters, and unit controls.
2. Unit shall be factory assembled and tested including leak testing of the DX coils, pressure testing of the refrigeration circuit, and run testing of the completed unit. Run test report shall be supplied with the unit in the service compartment’s literature pocket.
3. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
4. Unit components shall be labeled, including refrigeration system components and electrical and controls components.
5. Estimated sound power levels (dB) shall be shown on the unit ratings sheet.
6. Installation, Operation, and Maintenance manual shall be supplied within the unit.
7. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment’s hinged access door.
8. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment’s hinged access door.

B. Construction
a. All cabinet walls, access doors, and roof shall be fabricated of double wall, impact resistant, rigid polyurethane foam panels.
b. Unit insulation shall have a minimum thermal resistance R-value of 13. Foam insulation shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D1929-11 for a minimum flash ignition temperature of 610°F.
c. Unit construction shall be double wall with G90 galvanized steel on both sides and a thermal break. Double wall construction with a thermal break prevents moisture accumulation on the insulation, provides a cleanable interior, prevents heat transfer through the panel, and prevents exterior condensation on the panel.
d. Unit shall be designed to reduce air leakage and infiltration through the cabinet. Cabinet leakage shall not exceed 1% of total airflow when tested at 3 times the minimum external static pressure provided in AHRI Standard 340/360. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, at a maximum 8 inches of positive or negative static pressure, to reduce air leakage. Deflection shall be measured at the midpoint of the panel height and width. Continuous sealing shall be included between panels and between access doors and openings to reduce air leakage. Piping and electrical conduit through cabinet panels shall include sealing to reduce air leakage.
e. Roof of the air tunnel shall be sloped to provide complete drainage. Cabinet shall have rain break overhangs above access doors.
f. Access to filters, dampers, cooling coils, reheat coil, heaters, compressors, and electrical and controls components shall be through hinged access doors with quarter turn, zinc cast, lockable handles. Full-length stainless-steel piano hinges shall be included on the doors.
g. Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
h. Units with cooling coils shall include double sloped 304 stainless steel drain pans.
i. Unit shall be provided with base discharge and return air openings. All openings through the base pan of the unit shall have upturned flanges of at least 1/2 inch in height around the opening.
j. Unit shall include lifting lugs on the top of the unit.
k. Interior ceiling, floor, service doors, fan inlet cone, damper rack, and filter rack in the air stream are spray coated with a two-part polyurethane, heat baked coating. The coils, coil casings, condensate drain pans, damper blades and gears, fan wheel, fan
motor, energy recovery wheel casing, and compressor cabinet are not coated. Option is intended for use in coastal saltwater conditions under the stress of heat, salt, sand and wind and is applicable to all corrosive environments where a polyurethane coating is acceptable. Coating withstands at least 2,500 hours when tested under ASTM B 117-95 requirements.

i. Unit shall include factory installed, painted galvanized steel condenser coil guards on the face of the condenser coil.

10. Electrical
   a. Unit shall have a 5kAIC SCCR.
   b. Unit shall be provided with factory installed and factory wired, non-fused disconnect switch.
   c. Unit shall be provided with phase and brown out protection which shuts down all motors in the unit if the electrical phases are more than 10% out of balance on voltage, the voltage is more than 10% under design voltage or on phase reversal.

11. Supply Fans
   a. Unit shall include direct drive, unhoused, backward curved, plenum supply fans.
   b. Blowers and motors shall be dynamically balance and mounted on rubber isolators.
   c. Motors shall be premium efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.
   d. Variable frequency drives shall be factory wired and mounted in the unit. Fan motors shall be premium efficiency.

12. Cooling Coils
   a. Evaporator Coils
      1) Coils shall be designed for use with R-410A refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and galvanized steel end casings. Fin design shall be sine wave rippled.
      2) Coils shall be standard capacity.
      3) Coils shall be hydrogen or helium leak tested.
      4) Coils shall be furnished with factory installed expansion valves.
      5) Coils shall have a flexible, epoxy polymer e-coat uniformly applied to all coil surface areas without material bridging between fins. Humidity and water immersion resistance shall be up to a minimum 1,000 and 250 hours respectively (ASTM D2247-92 and ASTM D870-92). Corrosion durability shall be confirmed through testing, with coating capable of withstanding at least 6,000 hours of salt spray per ASTM B117-90. Coated coils shall receive a spray-applied, UV-resistant polyurethane topcoat to prevent UV degradation of the e-coat. Coating shall carry a 5-year warranty, from the date of original equipment shipment from the factory. The first 12 months from the date of equipment startup, or 18 months from the date of original equipment shipment from the factory, whichever is less, shall be covered under the standard AAON limited parts warranty. The remaining period of the warranty shall be covered by Luvata Electrofin. The Luvata Electrofin written instructions for installation, operation, coil cleaning, maintenance, and recording keeping must be followed. Refer to the Luvata Electrofin Terms and Conditions of Sale.

13. Refrigeration System
   a. Unit shall be factory charged with R-410A refrigerant.
   b. Compressors shall be scroll type with thermal overload protection and carry a 5-year non-prorated warranty, from the date of original equipment shipment from the factory.
   c. Compressors shall be mounted in an isolated service compartment which can be accessed without affecting unit operation. Lockable hinged compressor access doors shall be fabricated of double wall, rigid polyurethane foam injected panels to prevent the transmission of noise outside the cabinet.
d. Compressors shall be isolated from the base pan with the compressor manufacturer’s recommended rubber vibration isolators, to reduce any transmission of noise from the compressors into the building area.

e. Each refrigeration circuit shall be equipped with expansion valve type refrigerant flow control.

f. Each refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low-pressure sides and a factory installed replaceable core liquid line filter driers.

g. Unit shall include a variable capacity scroll compressor on the refrigeration circuit which shall be capable of modulation from 10-100% of its capacity.

h. Refrigeration circuit shall be provided with hot gas reheat coil, modulating valves, electronic controller, supply air temperature sensor and a control signal terminal which allow the unit to have a dehumidification mode of operation, which includes supply air temperature control to prevent supply air temperature swings and overcooling of the space.

i. Reheat coil shall have a flexible, epoxy polymer e-coat uniformly applied to all coil surface areas without material bridging between fins. Humidity and water immersion resistance shall be up to a minimum 1,000 and 250 hours respectively (ASTM D2247-92 and ASTM D870-92). Corrosion durability shall be confirmed through testing, with coating capable of withstanding at least 6,000 hours of salt spray per ASTM B117-90. Coated coils shall receive a spray-applied, UV-resistant polyurethane topcoat to prevent UV degradation of the e-coat. Coating shall carry a 5-year warranty, from the date of original equipment shipment from the factory. The first 12 months from the date of equipment startup, or 18 months from the date of original equipment shipment from the factory, whichever is less, shall be covered under the standard AAON limited parts warranty. The remaining period of the warranty shall be covered by Luvata Electrofin. The Luvata Electrofin written instructions for installation, operation, coil cleaning, maintenance, and recording keeping must be followed. Refer to the Luvata Electrofin Terms and Conditions of Sale.

14. Condensers
a. Air-Cooled Condenser
   1) Condenser fans shall be a vertical discharge, axial flow, direct drive fans.
   2) Coils shall be designed for use with R-410A refrigerant. Coils shall be multi-pass and fabricated from aluminum microchannel tubes.
   3) Coils shall be designed for a minimum of 10°F of refrigerant sub-cooling.
   4) Coils shall be hydrogen or helium leak tested.
   5) Condenser fans shall be VFD driven variable speed for condenser head pressure control. Factory provided and factory programmed VFDs shall continuously modulate the fan air flow to maintain head pressure at acceptable levels. Cooling operation shall be allowed down to 35°F with adjustable compressor lockout.
   6) Coils shall have a flexible, epoxy polymer e-coat uniformly applied to all coil surface areas without material bridging between fins. Humidity and water immersion resistance shall be up to a minimum 1,000 and 250 hours respectively (ASTM D2247-92 and ASTM D870-92). Corrosion durability shall be confirmed through testing, with coating capable of withstanding at least 6,000 hours of salt spray per ASTM B117-90. Coated coils shall receive a spray-applied, UV-resistant polyurethane topcoat to prevent UV degradation of the e-coat. Coating shall carry a 5-year warranty, from the date of original equipment shipment from the factory. The first 12 months from the date of equipment startup, or 18 months from the date of original equipment shipment from the factory, whichever is less, shall be covered under the standard AAON limited parts warranty. The remaining period of the warranty shall be covered by Luvata Electrofin.
Electrofin. The Luvata Electrofin written instructions for installation, operation, coil cleaning, maintenance, and recording keeping must be followed. Refer to the Luvata Electrofin Terms and Conditions of Sale.

15. Electric Heating
   a. Refer to schedule for Electric Heating requirements.

16. Filters
   a. Unit shall include 4-inch-thick, pleated panel filters with an ASHRAE MERV rating of 8, upstream of the cooling coil.
   b. Unit shall include 1-inch aluminum mesh pre-filters upstream of the outside air opening.
   c. Unit shall include a clogged filter switch.

17. Outside Air/Economizer
   a. Unit shall include 0-100% economizer consisting of a motor operated outside air damper and return air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven and designed to have no more than 20 cfm of leakage per sq ft. at 4 in. w.g. air pressure differential across the damper. Low leakage dampers shall be Class 2 AMCA certified, in accordance with AMCA Standard 511. Damper assembly shall be controlled by spring return enthalpy activated fully modulating actuator. Unit shall include outside air opening bird screen, outside air hood, and barometric relief dampers.

18. Controls
   a. Factory Installed and Factory Provided Controller
      1) Unit controller shall be capable of controlling all features and options of the unit. Controller shall be factory installed in the unit controls compartment and factory tested. Controller shall be capable of standalone operation with unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling available without dependence on a building management system.
      2) Controller shall have an onboard clock and calendar functions that allow for occupancy scheduling.
      3) Controller shall include non-volatile memory to retain all programmed values without the use of a battery, in the event of a power failure.
      4) Single Zone VAV Controller
         (a) Unit shall utilize a variable capacity compressor system and a variable speed fan system to modulate the cooling and airflow as required in meeting the space temperature needs and to save unit operating energy. Unit fan speed shall modulate based on space temperature, not supply air pressure.
         (b) With modulating hot gas reheat, unit shall modulate cooling and hot gas reheat as efficiently as possible, to meet space humidity loads and prevent supply air temperature swings and overcooling of the space.
         (c) Unit shall be provided with supply air temperature control. Mixing boxes and bypass ducts shall not be required for operation as a single zone VAV system.
      5) Unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling shall be accomplished with connection to interface module with LCD screen and input keypad, interface module with touch screen, or with connection to PC with free configuration software. Controller shall be capable of connection with other factory installed and factory provided unit controllers with individual unit configuration, setpoint adjustment, sensor status viewing, and occupancy scheduling available from a single unit. Connection between unit controllers shall be with a modular cable. Controller shall be capable of communicating and integrating with a LonWorks or BACnet network. [Orion Controls System]
19. Accessories
   a. Unit shall be provided with a smoke detector sensing the return and supply air of the unit, wired to shut off the unit’s control circuit.
   b. 2.03 Curbs

20. Curbs shall to be fully gasketed between the curb top and unit bottom with the curb providing full perimeter support, cross structure support and air seal for the unit. Curb gasket shall be furnished within the control compartment of the rooftop unit to be mounted on the curb immediately before mounting of the rooftop unit.

PART 3 EXECUTION

3.01 INSTALLATION

   A. Install in accordance with manufacturer’s instructions.
   B. Provide shut-off valves in condenser water inlet and outlet piping.
   C. Pipe condensate from drain pan to condensate drainage system.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Air-source heat pumps.
B. Air cooled condensing units.
C. Indoor ductless fan & coil units.
D. Outdoor units and controls.

1.02 REFERENCE STANDARDS
B. AHRI 520 - Performance Rating of Positive Displacement Condensing Units; 2004.

1.03 SUBMITTALS
A. Product Data: Provide rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.
B. Shop Drawings: Indicate assembly, required clearances, and location and size of field connections.
C. Project Record Documents: Record actual locations of components and connections.
D. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.
E. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.04 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.05 WARRANTY
A. Provide three year manufacturer's warranty for solid state ignition modules.
B. Provide five year manufacturer's warranty for heat exchangers.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Mitsubishi (Ductless Split System)
B. Substitutions: See Section 01 60 00 - Product Requirements.
2.02 SYSTEM DESIGN

A. Split-System Heating and Cooling Units: Self-contained, packaged, matched factory-engineered and assembled, pre-wired indoor and outdoor units; UL listed.
   1. Heating and Cooling: Air-source electric heat pump located in outdoor unit with evaporator; auxiliary electric heat.
   2. Cooling: Outdoor electric condensing unit with evaporator coil in central ducted indoor unit.
   3. Provide refrigerant lines internal to units and between indoor and outdoor units, factory cleaned, dried, pressurized and sealed, with insulated suction line.

B. Performance Requirements: See Drawings for additional requirements.
   1. Efficiency:
      a. Seasonal Energy Efficiency Ratio: 15, minimum.

2.03 INDOOR UNITS FOR DUCTLESS SYSTEMS

A. Indoor Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, evaporator coil, and controls; wired for single power connection with control transformer.
   1. Location: High-wall.

B. Evaporator Coils: Copper tube aluminum fin assembly, galvanized or polymer drain pan sloped in all directions to drain, drain connection, refrigerant piping connections, restricted distributor or thermostatic expansion valve.
   1. Construction and Ratings: In accordance with AHRI 210/240 and UL 207.

C. Remote Actuators:

2.04 OUTDOOR UNITS

A. Outdoor Units: Self-contained, packaged, pre-wired unit consisting of cabinet, with compressor and condenser.
   1. Construction and Ratings: In accordance with AHRI 210/240 with testing in accordance with ASHRAE Std 23.1 and UL 207.

B. Air Cooled Condenser: Aluminum fin and copper tube coil, AHRI 520 with direct drive axial propeller fan resiliently mounted, galvanized fan guard.

C. Accessories: Filter drier, high pressure switch (manual reset), low pressure switch (automatic reset), service valves and gage ports, thermometer well (in liquid line).
   1. Provide thermostatic expansion valves.

D. Operating Controls:
   1. Control by room thermostat to maintain room temperature setting.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that substrates are ready for installation of units and openings are as indicated on shop drawings.

B. Verify that proper power supply is available and in correct location.

C. Verify that proper fuel supply is available for connection.

3.02 INSTALLATION

A. Install in accordance with NFPA 90A and NFPA 90B.

B. Install refrigeration systems in accordance with ASHRAE Std 15.

END OF SECTION
SECTION 23 82 00
CONVECTION HEATING AND COOLING UNITS

PART 1 GENERAL
1.01 SECTION INCLUDES
A. Electric unit heaters.

1.02 SUBMITTALS
A. Product Data: Provide typical catalog of information including arrangements.
B. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.
C. Warranty: Submit manufacturer's warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

PART 2 PRODUCTS
2.01 ELECTRIC UNIT HEATERS
A. Manufacturers:
   1. Reznor
   2. Chromalox
B. Provide products listed, classified, and labeled by Underwriters Laboratories Inc. (UL), Intertek (ETL), or testing firm acceptable to Authority Having Jurisdiction as suitable for the purpose indicated.
C. Assembly: Suitable for mounting from ceiling or structure above with built-in controls, thermal safety cut-out, and electric terminal box.
D. Controls:
   1. 24-volt relay.
   2. Built-in thermostat.

PART 3 EXECUTION
3.01 INSTALLATION
A. Install in accordance with manufacturer's recommendations.
B. Unit Heaters:
   1. Hang from building structure, with pipe hangers anchored to building, not from piping or electrical conduit.

END OF SECTION
SECTION 25 00 10
PROGRAMMABLE LOGIC CONTROLLERS

PART 1 GENERAL

1.01 SCOPE OF WORK
A. Contractor shall provide programmable logic controllers (PLC) that will provide for control of process equipment, process oriented machinery, and process systems.

1.02 QUALITY ASSURANCE
A. PLC shall be manufactured by Allen Bradley.

1.03 REFERENCES
A. MIL STD 461B CS02: RFI/EMI Susceptibility.
C. ANSI C37.90a: Surge Withstand.
D. IEEE 472.
E. NFPA 70 (NEC).
F. UL508.
G. IEC 801-3: RFI Immunity.
H. IEC 801-5: Ground Continuity.
I. IEC 801-2: Electrostatic Discharge
J. IEC 61000-4-3: Electromagnetic Field.
K. IEC 61000-4-4: Fast transients.
L. IEC 61131-3: Programming Languages.

1.04 DEFINITIONS
A. AI: Analog Input
B. AO: Analog Output
C. Fixed: A PLC style consisting of a fixed number of I/O, a processor, and a power supply all in one enclosure. Some fixed PLCs have limited expansion ability.
D. CPU: Central Processing Unit
E. DI: Digital Input
F. Distributed I/O: Hardware that has been specially designed to function as Remote I/O.
G. DO: Digital Output
H. HMI: Human-Machine Interface
I. I/O Input and/or Output
J. Modular: A PLC style consisting of cards that are assembled to comprise a complete unit. All I/O, CPU, and Power Supply are dedicated cards. Typically, these cards are inserted into a chassis.
K. Master/Slave: Communication between devices in which one device, the master, controls all communications. The other devices, the slaves, respond only when queried by the master. Typically used in a Remote I/O application.
L. Peer to Peer: Communication between two or more devices, typically PLC's, in which each device can control the communication exchange.
M. PID: Control action, proportional plus integral plus derivative.
N. PLC: Programmable Logic Controller
O. Remote I/O: Remote I/O is any and all I/O that is located remotely from the processor. Remote I/O can be over a variety of communication protocols and can use standard rack based I/O, or special Remote I/O hardware referred to as Distributed I/O.

P. SCADA: Supervisory Control and Data Acquisition

1.05 SUBMITTALS

A. Product Data: For each type of PLC include dimensions, mounting arrangements, and weights. Also include, manufacturer's technical data on features, performance, electrical ratings, characteristics, terminal connections, and finishes.

B. Operation and Maintenance Data: Provide for each PLC component literature detailing routine maintenance requirements (if any).

C. Any requirements in this specification that cannot be met, shall be so noted on the submittal information.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer shall maintain, within 200 miles of Project site, a facility, system integrator, or panel shop capable of providing training, parts, and coordination of emergency maintenance and repairs.

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

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

C. Source Limitations:

1. Provide all PLCs from a single manufacturer. If the PLC manufacturer has authorized third party vendors to provide modules that are compatible with their platforms, then products manufactured by these authorized third party vendors will be acceptable.

2. To insure reliability and compatibility with all aspects of the control system, all PLC equipment shall be from the same vendor as the SCADA software, Operator Interface Terminals, and Power Distribution Equipment.

D. 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.

E. Comply with NFPA 70.

F. Product Selection for Restricted Space: Drawings indicate maximum dimensions for PLCs, minimum clearances between PLCs, and adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances, or with PLC vendors required distances if they are greater than the distances indicated.

1.07 DELIVERY, STORAGE, AND PROTECTION

A. Deliver PLC components in packaging designed to prevent damage from static electricity, and physical damage.

B. Store PLCs according to manufacturers' requirements. As a minimum, store indoors in clean, dry space with uniform temperature to prevent condensation. Protect PLCs from exposure to dirt, fumes, water, corrosive substances, and physical damage. Also, protect the PLC from all forms of electrical and magnetic energy that could reasonably cause damage.
1.08 PROJECT CONDITIONS
A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions, unless otherwise indicated:
   1. Ambient Temperature: 0 to 55 deg C.
   2. Humidity: Less than 95 percent (noncondensing).
   3. Altitude: Not exceeding 6500 feet (3000 m).

1.09 PRODUCT PROTECTION
A. Control panel designer shall provide independent line fuses or circuit breakers, per the manufacturer's recommendation, for each power Supply, Input Module, Output Module, and other modules with separately derived power requirements.
B. Control panel designer shall insure that communication signals, 4-20mA signals, embedded HART signals, are properly conditioned for the PLC and protected from all sources of radiated energy or harmonics.

1.10 SPARE I/O
A. Each PLC will be sized to handle the required I/O plus a percentage of spares. When calculating spare I/O count, all fractional I/O points will be rounded up to the next whole I/O point. The resultant I/O count will be rounded up to next whole I/O card. When configuring spare I/O counts, use the following criteria:
   1. Analog Inputs (AI): Required for the PLC plus 20%.
   2. Analog Outputs (AO): Required for the PLC plus 20%.
   3. Digital Inputs (DI): Required for the PLC plus 20%.
   4. Digital Outputs (DO): Required for the PLC plus 20%.

1.11 SPARE PARTS
A. Furnish spare parts as described below for each type of PLC. Material shall be packaged for long term storage and identified with labels describing contents. Coordinate with each PLC-based control panel vendor to optimize the amount of spares that are provided.
   1. I/O Cards: Provide as a minimum a spare of each type of card identified. Provide an additional spare for every ten cards of a specific type installed.
   2. Processors: Provide as a minimum a spare for each type of CPU identified.
   3. PLC oriented Power Supplies: Provide as a minimum a spare of each type of power supply identified. Provide an additional spare for every ten power supplies of a specific type installed.
   4. Memory Cards: Provide as a minimum a spare of each type of card identified. Provide an additional spare for every ten cards of a specific type installed
   5. Specialty Modules: Provide as a minimum a spare of each type of module identified. Provide an additional spare for every ten modules of a specific type installed
   6. “Fixed” PLCs: Provide as a minimum a spare of each type of PLC identified. Provide an additional spare for every ten PLCs of a specific type installed.

PART 2 PRODUCTS
2.01 MANUFACTURERS
A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
B. Qualified Manufacturers:
   1. Only manufacturers that have been selling PLCs for a minimum of 5 years will be considered acceptable.
   2. Retain above for nonproprietary or below for semi proprietary specification. Refer to Division 1 Section "Product Requirements."
C. The following manufacturers are approved for this project:
   1. Rockwell Automation
2.02 PROGRAMMABLE LOGIC CONTROLLERS

A. GENERAL:

1. The PLC shall collect data, perform process control functions, communicate with other PLCs, and distribute process information along the local area network.

2. The PLC shall be able to have its program downloaded from a remote workstation over the local area network, and be locally programmed from a portable laptop computer.

3. The executive firmware of all intelligent modules shall be stored in Flash memory and shall be able to be updated in the field using standard programming tools. Executive firmware files shall be readily available via a public web site.

4. The PLC shall have provisions for communicating unsolicited messages (report by exception) to an operator interface to reduce network traffic.

5. The PLC shall be field expandable to allow for the expansion of the system by the simple addition and configuration of hardware.

6. Each component shall include a clearly visible faceplate with appropriate data such as the manufacturer's model number and a brief description of the component's function.

7. All cables and connectors shall be as specified by the manufacturer. Cables shall be assembled and installed per the manufacturer's recommendations.

8. Each discrete point shall have a light emitting diode on the face of the module to indicate point status. Green shall indicate that the point is logic level “1”, also referred to as “on” or “high”.

9. The PLC shall utilize Ethernet protocols that meet the following:
   a. Protocols that are assigned to port 502 of the TCP/IP stack by the IANA (Internet Assigned Numbers Authority).
   b. Devices must utilize embedded web pages, or a physical means such as DIP switches, to be recognized and properly addressed on the network. Ethernet protocols that require network management software, or utilize configuration files that must be downloaded to Ethernet devices, for proper network addressing, and recognition are not acceptable.
   c. Will not rely on third party vendors to meet the above criteria.

B. PLC PROGRAMMING REQUIREMENTS:

1. All specified PLC platforms will be programmed using the same programming software package. PLCs that use multiple software programming packages under similar trade names will not be accepted. The programming software will have the following:
   a. Use of all textural and graphic languages specified in IEC 61131-3.
   b. An additional language dedicated to organization of the PLCs programs and function blocks. This language shall be in Sequential Function Chart (SFC) format.
   c. Addressing shall be as follows.
      1) Digital and Analog I/O will be mapped to fixed addresses.
      2) Processor status will be mapped to fixed addresses.
      3) Internal words and other internal data can either be unmapped, or mapped to fixed addresses. If unmapped, the programming software will determine the location.
      4) Internal words, I/O and other non-processor status data will be able to be addressed by an alpha numeric pneumonic. This name will be used in unmapped variables, and in lieu of the address for mapped variables.
   d. Ability to store and retrieve instruction comments, program comments, rung comments, and other comments and notes in the PLC processor.
   e. Ability to convert from one supported PLC platform to another supported platform. Conversion shall be accomplished by exporting the program code, and importing to a new program with the desired PLC platform and configuration.
   f. The PLC programming software shall have the following tools for monitoring and troubleshooting the PLC program.
      1) Power flow animation for graphical languages.
2) A breakpoint capability to automatically halt the program just before a certain sequence is initiated.
3) Ability to advance the program step by step to insure proper operation.
4) Ability to create watch points for desired variables. These watch points will display the real time value of the variable.
5) Monitoring of step activity times within the SFC language.
6) The use of color to indicate execution progress.
7) The ability to create HMI like screens for enhanced troubleshooting and program monitoring.
8) Ability to create a table that will track a chosen variety of variables.

The PLC programming software shall allow creation of standard programming blocks. The blocks will be as follows:

1) The programmer will see each instance of a given block. To reduce PLC memory size, and increase processing speed, the programming software will use one instance for each type of DFB. The PLC will automatically manage calls and execution to insure proper code execution.
2) The programming blocks will contain programming sections. Each programmer added section can be designated as any of the four IEC languages.
3) The programming block will be able to be inserted into all four of the IEC languages in the main program. This ability will not be dependent on the languages used inside the block.
4) An internal database using unmapped variables. The variables associated with this block will be separate from the PLC database to prevent mapping conflicts.
5) Each block will appear to be a single instruction in the programming environment. The designer of the block will be able to designate pin assignments and names. These pins will be used to connect to the PLC database.

2. The Systems Integrator and/or PLC Programmer shall provide at a minimum 40 man hours to meet with the Engineer and Operators on-site to review the necessary control function, theory of operation, and sequence of operation for the system. These 40 man hours shall be provided within 60 days after the Notice to Proceed.

C. PLC ENVIRONMENTAL REQUIREMENTS:
1. The PLCs must meet or exceed the following environmental requirements:
   a. Minimum temperature range:
      1) Operating: 0-55 degrees C (+32 to +131 degrees F)
      2) Storage: -25 to +70 degrees C (-13 to +158 degrees F)
   b. Relative humidity: 30 to 95% non-condensing.
   c. Altitude:
      1) Operation 0-6,500 feet minimum
      2) Storage 0-9,800 feet minimum
   d. Degree of protection: NEMA 1 (IP20)
   e. Vibration resistance in accordance with at least one of the following:
      1) Installed rating:
         (a) DIN rail mounted PLC: 10-57 Hz, amplitude 0.075 mm, acceleration 25-100 Hz, and
         (b) Panel or plate mounted PLC: 2-25 Hz, amplitude 1.6mm, acceleration 25-200 Hz.
      2) In compliance with IEC 60068 and IEC 61131.
   f. Shock resistance: 147m/s^2 for 11ms.

D. PLC:
1. Description: A PLC designed for up to 1024 points of I/O. This PLC shall offer enhanced processing and communication options and shall be a chassis mounted modular system. The PLC shall be programmed using IEC 61131-3 compliant programming software.
2. Processor Features:
   a. Upon power loss, the PLC shall ensure memory is transferred to flash memory before PLC ram powers down. PLCs with a battery backup will not be accepted.
   b. The PLC shall have on board status lights to indicate the following various functions:
      1) Green RUN lamp that will illuminate while the program is executing
      2) Red ERR lamp that will illuminate when a fault occurs in the processor
      3) Red I/O Lamp that will illuminate upon an I/O failure or configuration fault.
      4) Yellow SER COM lamp will illuminate when activity is present on the serial port

3. General I/O Cards: The PLC shall have a series of general I/O cards. They will be as follows:
   a. Analog Inputs: All Analog input cards will offer isolation between channels.
      1) Four (4) channel +/- 10V, 0-20mA, B,E Thermocouple, Pt 100, Pt 1000, Ni 1000, 2 or 4-wire temperature probes input card.
      2) Four (4) channel RTD and Thermocouple card.
      3) Eight (8) channel RTD and Thermocouple card.
   b. Analog Outputs: All analog output cards will offer isolation between channels,
      1) Two (2) channel +/- 10V, 0-20mA output card
   c. Discrete Inputs:
      1) Sixteen (16) channel sink 24VDC input cards
      2) Sixteen (16) channel source 24VDC input cards
      3) Sixteen (16) channel 120VAC input card
      4) Thirty two (32) channel sink 24VDC input card
      5) Sixty four (64) channel sink 24VDC input card
   d. Discrete Outputs:
      1) Sixteen (16) channel 24VDC (0.5A/channel) protected transistor source output card
      2) Sixteen (16) channel 24VDC (0.5A/channel) protected transistor sink output card
      3) Thirty-two (32) channel 24VDC (0.5A/channel) protected transistor source output card
      4) Sixty-Four (64) channel 24VDC (0.5A/channel) protected transistor sink output card
      5) Eight (8) channel 24VDC 24VDC/240VAC isolated relay output card
      6) Sixteen (16) channel 24VDC/240VAC relay output card
      7) Sixteen (16) channel 48-240VAC (1A/channel) protected triac output card.

4. Specialized I/O Cards: The PLC shall have a series of application specific I/O cards. These will be as follows:
   a. High speed counter card: Eight (8) channels at 10 KHz, 16 bits. Two (2) inputs at 24VDC per channel. The card shall also be capable of handling four (4) incremental encoders in 32 bit.
   b. High performance high speed counter card: 2 channels at 60 KHz at 32 bits. Six (6) inputs at 24VDC and Two (2) reflex outputs per channel.

5. Communication Capabilities: The PLC shall have a support 10/100Mb Modbus TCP Ethernet, ASi V2 Master, Modbus, ASCII, CAN open, and Unitelway without the need for third party modules.
   a. Ethernet capabilities: When Ethernet communication is utilized, the PLC shall support the following capabilities:
      1) 10/100MB Ethernet with connection via RJ45 connectors.
      2) A memory card slot for storage of memory.
      3) Built-in web server supplied with pre-developed and installed system diagnostics screens viewable from any commercial web-browser, and the capability of adding custom developed screens.
      4) Support for bus, star, ring and tree topographies.
      5) Support for CSMA/CD methodology to access the network and prevent collisions.
6) Modbus TCP messaging
7) Use of ARP and RARP protocols to insure IP and MAC address correspondence.
8) Ability to be configured as a BootP client or DHCP server.
9) Ability to be configured as Faulty Device Replacement (FDR) server.
   (a) When configured, a replaced FDR compatible device will ask the FDR server for parameters. When this request is received, the PLC will transfer the desired IP address and all configuration parameters to the replaced device.
10) Support of SNMP
11) Global Data support for up to 64 station in each group.
12) I/O scanning that allows automatic read and write of remote I/O without programming over Modbus TCP protocol.

6. Power Supplies: The PLC shall have chassis mounted power supplies to power the chassis backplane, and provide power for the processor and applicable modules. The power supplies shall be available in both 24 VDC and 115 VAC models. The available power ratings will be from 16 to 36W.

7. Chassis: The PLC shall have chassis to mount processors, power supplies, and other applicable cards. The chassis shall come in 4, 6, 8, and 12 position configurations. The chassis will be designed to mount individual enclosed cards. The chassis shall not have top, bottom, or side walls. The cards will be secured to the chassis via a screw connection.

8. Other:
   a. Programming cable: The PLC shall utilize a USB to Mini B cable for programming. This cable shall be compatible with those designed for downloading digital cameras to USB compatible PC. Accordingly, this cable shall be available through most traditional retail stores serving the consumer electronics market.
   b. Alarming: The PLC shall have a configurable alarming capability. Each alarm point can be configured to display an alphanumeric message in the alarm buffer. The alarm buffer can be displayed via a web page, or on an operator interface screen.
   c. Connector cables:
      1) Unterminated connector cables shall be available for interfacing to the discrete and analog cards. These cables shall have one end terminated to HE10 terminal block modules. The other end shall be unterminated to allow custom interface to panel devices. The cable shall be available in 3, 5, and 10 meter lengths.
      2) Terminated connector cables shall be available for interfacing to the discrete and analog cards. These cables shall have one end terminated to interface to terminal block, or FCN socket, cards. The other end shall be terminated to interface with HE10 terminal block modules. These shall be available in lengths of 0.5, 1, 3, 5, and 10 meters.

PART 3 EXECUTION
3.01 EXAMINATION
   A. Examine areas, surfaces, and substrates to receive PLCs for compliance with requirements, installation tolerances, and other conditions affecting performance.
   B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION
   A. Anchor PLCs within enclosures as recommended by the PLC manufacturer.
   B. Provide spacing around PLC as required by the PLC manufacturer to insure adequate cooling. Insure that the air surrounding and penetrating the PLC has been ambiently conditioned to maintain the required temperature and humidity range of the PLC.
C. Wires entering and exiting PLC components shall be sized to comply with the PLC manufacturers requirements. Doors on all components shall be able to be fully closed when all the wires are installed.

D. Ventilation slots shall not be blocked, or obstructed by any means.

E. For chassis mounted PLCs, no wiring, wire ducts, or other devices shall obstruct the removal of cards from the rack.

F. PLC lights, keys, communication ports, and memory card slots shall be accessible at all times. Lights shall be visible at all times when enclosure door is opened.

3.03 IDENTIFICATION

A. Identify PLC components, and wiring according to all applicable codes, standards and contract document sections.

B. Each I/O point shall be identified on the door of PLC I/O cards or on the surface of each “Fixed” or “Fixed” style PLC.

3.04 FIELD QUALITY CONTROL

A. Field Service: The PLC based control panel supplier shall provide a qualified service representative to perform the following:
   1. Inspect PLCs, wiring, components, connections, and equipment installation. Test and adjust supplied programmable controllers, components, and equipment.
   2. Assist in field testing of equipment including pre-testing and adjusting of controllers and its associated application program if necessary.

3.05 DEMONSTRATION

A. Control panel supplier shall provide a qualified service representative to train Owner’s maintenance personnel to adjust, operate, and maintain PLCs. Manufacturer’s standard training will be sufficient unless specified elsewhere.

END OF SECTION
SECTION 25 00 20
HUMAN MACHINE INTERFACE

PART 1 - GENERAL

1.01 SCOPE OF WORK
   A. Contractor shall provide Human Machine Interface Terminals and associated configuration software for control and visualization of process equipment, process oriented machinery, and process systems.

1.02 REFERENCES
   A. NFPA 70 (NEC)
   B. UL508
   C. EN61131-2
   D. IEC 61000-6-2
   E. FCC (Class A)
   F. UL 1604
   G. CSA C22-2 #14
   H. ANSI/NEMA ICS 6
   I. API RP550
   J. ISA S5.4
   K. IAS S20
   L. ISA S50.1
   M. ISA S51.1

1.03 DEFINITIONS
   A. AI: Analog Input
   B. AO: Analog Output
   C. Control Panel Designer: A firm or individual that is responsible for designing the layout of control panels. This entity will choose the devices to be included in the panel, and will decide on the actual layout.
   D. CPU: Central Processing Unit
   E. DI: Digital Input
   F. DO: Digital Output
   G. HMI: Human-Machine Interface
   H. I/O: Input and/or Output
   I. Node: A network connection point. Examples include a PLC, PC, Operator Interface Terminal, Switch, Server, etc.
   J. OIT: Operator Interface Terminal: A terminal usually embedded in a control panel that allows the operator to view and modify control system parameters. Operator Interface Terminals are not capable of running commercially available software.
   K. Operator Station: A terminal that runs a commercially available operating system such as Windows or Linux. An Operator Station will usually execute the SCADA software. Operator Stations are usually desktop mounted personal computers. However, they may be computers that are designed to be embedded in the doors of control panels and motor control centers (MCC)
   L. PID: Control action, proportional plus integral plus derivative.
   M. PLC: Programmable Logic Controller.
N. SCADA: Supervisory Control and Data Acquisition. A SCADA System is a computer (typically a personnel computer), or a group of computers and servers running a software dedicated for SCADA purposes. This SCADA software can exchange over industrial networks, with PLC's, VFD's, and other industrial devices. Typically, the SCADA software will allow for trending, graphic display, alarm tracking, and reporting of data.

O. SCADA System Supplier: A company that takes a commercially available SCADA software package, and then develops a project-specific application. This company will typically supply hardware to run the SCADA software and project-specific application.

1.04 SUBMITTALS

A. For each type of Operator Interface Terminal include dimensions, mounting arrangements, and weights. Also include, manufacturer's technical data on features, performance, electrical ratings, characteristics, terminal connections, and finishes.

B. Each Operator Interface Terminal type shall have a separate check sheet. This check sheet shall be an acknowledgement of all criteria in this specification. The check sheet will consist of three columns. The leftmost column will indicate the referenced section of the specification. The middle column will indicate whether the indicated specification criteria are met, not met, or has a variance. The rightmost column will be used to describe reasons for variances or for not meeting the specified criteria. Each row on the check sheet will be for a dedicated specification section or sub-section. Each organization delineation will have its own dedicated row. For instance, you cannot accept section 1.5B and its corresponding subparagraphs in a single row. You must accept 1.5B in a row, and 1.5B1 in another row.

C. Operator Interface Terminal supplier shall be responsible for providing accurate and complete submittals in a timely fashion so as to not cause delay to the project schedule.

D. Once submitted, Operator Interface Terminal suppliers shall not proceed with their associated work until the reception of submittals marked as “Approved” or “Approved as noted”.

E. Operation and Maintenance Data: Provide for each Operator Interface Terminal component literature detailing routine maintenance requirements (if any).

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer shall have, within 200 miles of Project site, a facility, system integrator, or panel shop capable of providing training, parts, and coordination of emergency maintenance and repairs.

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

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

C. Source Limitations:

1. All Operator Interface Terminals shall be from a single manufacturer.
2. Operator Interface Terminals shall be from the same manufacturer of the PLC equipment.

D. 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.

E. Comply with NFPA 70.

F. Product Selection for Restricted Space: Drawings indicate maximum dimensions for Operator Interface Terminals, minimum clearances between Operator Interface Terminals, and adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances, or with Operator Interface Terminal vendors required distances if they are greater than the distances indicated.
1.06 DELIVERY, STORAGE, AND HANDLING
   A. Deliver Operator Interface Terminals in packaging designed to prevent damage from static electricity, and physical damage.
   B. Store Operator Interface Terminals according to manufacturers' requirements. As a minimum, store indoors in clean, dry space with uniform temperature to prevent condensation. Protect Operator Interface Terminals from exposure to dirt, fumes, water, corrosive substances, and physical damage. Also, protect the Operator Interface Terminals from all forms of electrical and magnetic energy that could reasonably cause damage.

1.07 PROJECT CONDITIONS
   A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions, unless otherwise indicated:
      1. Ambient Temperature: 0 to 50 deg C.
      2. Humidity: Less than 85 percent (non-condensing).

1.08 PRODUCT PROTECTION
   A. Control panel designer shall insure that communication signals are properly conditioned for the Operator Interface Terminal and protected from all sources of radiated energy or harmonics.
   B. The Operator Interface Terminal shall be powered from the associated control panel and protected by dedicated fuses or a breaker in the control panel

PART 2 - PRODUCTS
2.01 MANUFACTURERS
   A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      1. Qualified Manufacturers:
         a. Only manufacturers that have been selling Operator Interface Terminals for a minimum of 5 years will be considered acceptable.
         b. Allen Bradley is an acceptable supplier.

2.02 GENERAL:
   A. One operator interface terminal shall be supplied at each PLC location.
   B. All of the Operator Interface Terminals shall comply with the following general requirements as a minimum.
      1. Certifications: The Operator Interface Terminal will have certifications by CE, CSA, UL Class 1 Division 2 T4A or T5 (UL and CSA), and C-Tick
      2. Power Supply: The Operator Interface terminal will have a nominal voltage of 24VDC with a range of 19.2-28.8Volts DC. The power supply will have a voltage cut of $\leq 10$ milliseconds maximum and an Inrush current of $\leq 50A$ Maximum. Connection of power will be via a 3 terminal screw terminal block. This block will be pitched at least 5mm, and will have a tightening torque of 0.5Nm.
      3. Real-time Clock: All Operator Interface Terminals shall have a built-in real-time clock.
      4. LED Diagnostics: A single LED visible from the front panel, without the need to open the control panel door, will be used to indicate status of the terminal. The LED will be green during normal operation, orange if the back-lighting is faulty, and red under various fault conditions. Units using multiple LEDs, or LED's visible from the back of the unit will not be acceptable.
      5. To protect the owner's ability to competitively bid future projects, the Ethernet network shall utilize open protocols that are in the public domain. This protocol shall be the Modbus TCP/IP Network. Equipment to convert a non-public domain Ethernet protocol to a public domain protocol shall not be accepted.
2.03 ENVIRONMENTAL REQUIREMENTS:
A. All of the Operator Interface Terminals shall be capable of withstanding the following criteria as a minimum.
   1. Temperature: The Operator Interface Terminal shall be rated to operate in a range of 0-50º C. (32-122 º F.). The unit shall be able to withstand a range of -20-60º C. (-4-140 º F.) while in storage.
   2. Relative Humidity: The Operator Interface Terminal shall be capable of handling a minimum of non-condensation humidity of 0-85%.
   3. Altitude: The Operator Interface Terminal shall be designed to operate between 0-6500 feet above sea level minimum without derating.
   4. Degree of Protection: The Operator Interface Terminal shall have a front panel rating of IP 65 and conform to IEC 60529. This rating shall be a NEMA 4X rating suitable for indoor use only. The back panel rating shall be IP 20 and conform to IEC60529.
   5. Shock Resistance: The Operator Interface Terminal shall conform to IEC 60068-2-27; Semi-sinusoidal Pulse for 11ms, and 15gn on 3 axes.
   6. Vibration: The operator Interface Terminal shall conform to IEC 60068-2-6. The Terminal shall be capable of 5-9Hz at 3.5 mm, and 9-150Hz at 1g.
   7. Electrostatic Discharge: The Operator Interface Terminal shall conform to IEC61000-4-2, level 3.
   8. Electromagnetic Interference: The Operator Interface Terminal shall conform to IEC 61000-4-3, 10 V/m.
   9. Electrical Interference: The Operator Interface Terminal shall conform to IEC 61000-4-4, level 3.

2.04 OPERATOR INTERFACE TERMINAL
A. Description: Terminals shall be color, touch screen and sized as shown on the drawings.
B. Operator interface terminals shall be Rockwell PanelView 5510 utilizing the provided Studio development software..
C. RAM: The Operator Terminal shall be supplied with lithium batteries to back up 512Kb SRAM.
D. Communication Ports: The Operator Interface Terminals shall have the following:
   1. For screen sizes of 5 inches or greater viewable area, an RJ-45 port, and an integral 9-way male SUB-D connector, dedicated to serial communications shall be provided. The 9-way SUB-D connector shall support RS232/RS485 Communications. The RJ-45 port shall support RS485 communications. Additionally, a standard type A host USB connector shall be provided for application downloading. Operator Interface Terminals relying on the same port for communications and downloading shall not be acceptable.
   2. The terminal will be supplied with an integral RJ-45 port dedicated to Ethernet TCP/IP communications.

PART 3 - EXECUTION
3.01 EXAMINATION
A. Examine areas, surfaces, and substrates to receive Operator Interface Terminals for compliance with requirements, installation tolerances and other conditions affecting performance.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLICATIONS
A. Select Operator Interface Terminals based upon I/O, memory, communication, expansion, and other criteria. If multiple Operator Interface Terminal-based control panels will be supplied from different vendors, coordinate with other vendors to insure that Operator Interface Terminals are of identical brand and are equipped to utilize identical communication networks.
3.03 INSTALLATION
   A. Anchor Operator Interface Terminals within enclosures as recommended by the Operator
      Interface Terminal manufacturer.
   B. Provide spacing around Operator Interface Terminals as required by the Operator Interface
      Terminals manufacturer to insure adequate cooling. Insure that the air surrounding and
      penetrating the rear and sides of the Operator Interface Terminal has been ambiently
      conditioned to maintain the required temperature and humidity range of the Operator Interface
      Terminal.
   C. Wires entering and exiting Operator Interface Terminals shall be sized to comply with the
      manufacturers requirements.
   D. During installation, upper ventilation slots shall be covered to prevent accidental debris entry.
      However, during normal operation ventilation slots shall not be blocked, or obstructed by any
      means.

3.04 IDENTIFICATION
   A. Identify Operator Interface Terminal components, and wiring according to all applicable codes,
      standards and contract document sections.

3.05 FIELD QUALITY CONTROL
   A. Field Service: The Operator Interface Terminal-based control panel supplier shall provide a
      qualified service representative to perform the following:
      1. Inspect Operator Interface Terminal, wiring, components, connections, and equipment
         installation. Test and adjust supplied Operator Interface Terminals, components, and
         equipment.
      2. Report results in writing.

3.06 DEMONSTRATION
   A. Control panel supplier shall provide a qualified service representative to train Owner’s
      maintenance personnel to adjust, operate, and maintain Operator Interface Terminals. Manufacturer's
      standard training will be sufficient unless specified elsewhere.

END OF SECTION
SECTION 25 00 30
SCADA HARDWARE AND SOFTWARE

PART 1 - GENERAL

1.01 SCOPE OF WORK
A. Contractor shall provide SCADA Hardware and Software for control of process equipment, process oriented machinery, and process systems.

B. The SCADA system supplier, as defined below shall be responsible for the following:
   1. Supply of the plant network and main SCADA servers and/or Operator Stations.
   2. Supply of all control panels that are not specifically associated with a machine or process system specified elsewhere.
   3. Coordination with all panel suppliers to insure proper data transfer between the SCADA operator stations and control panels.
   4. The integrator shall be an Allen Bradley/Rockwell Automation Solutions Provider.
   5. The integrator must have a full time control panel assembly shop in-house that is UL-508A and UL-698A certified.

1.02 RELATED SECTIONS
A. Section 26 29 30 - Programmable Logic Controllers
B. Section 26 29 40 - Human Machine Interface
C. Section 46 09 03 - Process Control System

1.03 REFERENCES
A. NFPA 70 (NEC)
B. UL508
C. EN61131-2
D. IEC 61000-6-2
E. FCC (Class A)
F. UL 1604
G. CSA C22-2 #14
H. ANSI/NEMA ICS 6
I. API RP550
J. ISA S5.4
K. ISA S20
L. ISA S50.1
M. ISA S51.1

1.04 DEFINITIONS
A. AI: Analog Input
B. AO: Analog Output
C. Control Panel Designer: A firm or individual that is responsible for designing the layout of control panels. This person will choose the devices to be included in the panel, and will decide on the actual layout.
D. CPU: Central Processing Unit
E. DI: Digital Input
F. DO: Digital Output
G. HMI: Human-Machine Interface
H. I/O Input and/or Output
I. Node: A network connection point. Examples include a PLC, PC, Operator Interface Terminal, Switch, Server, etc.

J. Open Protocol: A network protocol whose configuration code is available with or without a fee or license.

K. Operator Interface Terminal: A terminal usually embedded in a control panel that allows the operator to view and modify control system parameters. Operator Interface Terminals are not capable of running commercially available software.

L. Operator Station: A terminal that runs a commercially available operating system such as Windows. An Operator Station will usually execute the SCADA software. Operator Stations are usually desktop mounted personal computers. However, they may be computers that are designed to be embedded in the doors of control panels and

M. PID: Control action, proportional plus integral plus derivative.

N. PLC: Programmable Logic Controller

O. Public Domain: A network protocol whose configuration code is available without the need to pay a fee or buy a license.

P. SCADA: Supervisory Control and Data Acquisition. A SCADA System is a computer (typically a personnel computer), or a group of computers and servers running a software dedicated for SCADA purposes. This SCADA software can exchange over industrial networks, with PLC's, VFD's, and other industrial devices. Typically, the SCADA software will allow for trending, graphic display, alarm tracking, and reporting of data.

Q. SCADA System Provider: A company that takes a commercially available SCADA software package, and then develops a project specific application. This company will typically supply hardware for the SCADA software and application to operate on.

R. SDT: Site Demonstration Test

1.05 SUBMITTALS

A. Product Data:
   1. The SCADA system provider shall be responsible for the accuracy and completeness of all aspects of the SCADA submittal. This includes SCADA software detailed herein, and applicable hardware. If the SCADA system provider is providing Operator Interface Terminals, then the relevant Operator Interface Terminal Submittals must be completed in addition to the four types listed below:
      a. Design submittal:
      b. System Documentation Submittals
      c. Testing Submittals
      d. Training Submittals:

B. SCADA system provider shall be responsible for providing accurate and complete submittals in a timely fashion so as to not cause delay to the project schedule.

C. Once submitted, SCADA suppliers shall not proceed with their associated work until the receipt of submittals marked as “Approved”, or "Approved as noted".

D. Operation and Maintenance Data: Provide documentation detailing routine maintenance requirements (if any) for all SCADA Server hardware and Operator Display Station hardware that is provided.

E. All submitted information shall be in English.

F. SCADA System Submittals:
   1. Design Submittals:
      a. Hardware Product Information Submittal:
         1) Hardware product information shall include, but not be limited to: catalog cut sheets, data sheets, performance surveys, test reports, equipment lists, material list, diagrams, pictures, and descriptive material. The product information shall
cover all items including mechanical devices, mounting components, wiring, terminal strips, connectors, accessories, and spare parts. The submittal information shall show the standard and optional product features, as well as all performance data and specifications.

2) Prior to commencement of manufacture (or shipment for stock items), the SCADA System Provider shall submit for review product information for all equipment and material specified in this Section, or required to support equipment or systems specified in this RFP.

b. Power Distribution Submittal:
   1) SCADA System Provider shall prepare a summary of all SCADA hardware power requirements and provide load calculations that will be used for planning power distribution across existing UPS systems. SCADA System Provider shall provide a submittal for approval 60 days prior to Comprehensive System Test.

c. Software Product Information Submittal (SPID):
   1) The software documentation shall provide a comprehensive description of all software, necessary for the operation and maintenance of the system. A software document shall be furnished for each software or program in the System. Warranty information shall be supplied for each software or program in the System. Software License information shall be submitted for each software or program in the system, indicating the number of licenses provided for each type of program or software.

2) The SCADA System Provider shall submit software documentation for review within 21 calendar days of Contract award. Software procurement shall not begin until submittal review is successful.

d. Connection Diagrams:
   1) Connection diagrams shall show the placement, labeling and wiring of components within panels, cabinets, and consoles. Wire lists and wireless diagrams shall not be accepted. Components shall be shown arranged in the physical layout (not necessarily to scale), as it would appear to a person servicing the equipment. Wiring designations, and routing designations, will follow the projects drawings standards.

2) The SCADA System Provider shall submit connection diagrams for all new panels, cabinets, and consoles. The SCADA System Provider shall also prepare and submit connection diagrams for existing panels, cabinets and consoles, which are modified or refurbished. Connection diagrams shall be Successfully Reviewed prior to the start of panel assembly. Loop diagrams may not be substituted for connection diagrams.

e. Interconnection Diagrams:
   1) Interconnection diagrams shall show the external wiring between terminals of associated equipment, control panels, motor control centers, terminal boxes, field switches, and any other device, panel, or enclosure. Interconnection diagrams shall clearly depict all cable tags. Cable tagging shall conform to project standards.

2) The SCADA System Provider shall prepare and submit interconnection diagrams for all major system components. Interconnection diagrams shall be Successfully Reviewed prior to the start of fabrication.

f. Panel Fabrication and Layout Drawings (PLFD):
   1) As a minimum, PLFD shall include front, back, and section views; the locations of all mounted components; drawing scale; nameplate engraving schedule; and structural materials and supports. A bill of material shall also be provided on the drawing, or as a separate document. All drawings shall be scaled. Overall dimensions and minimum clearances shall be shown. Sufficient detail shall be included to demonstrate material choices, outward appearance, construction methods, and seismic force resistance.
2) Complete shop drawings shall be submitted for all panels, cabinets, and consoles which are fabricated, or modified, for this project. Reviewers shall have the right to make modifications to the interior and exterior layouts of panels as part of the shop drawing review. No additional compensation will be provided to the SCADA System Provider for changes. The SCADA System Provider shall budget for one redesign of the panel layout to incorporate the reviewers’ changes. Fabrication or modification shall not be started until PFLD submittals have been Successfully Reviewed.

2. Functional design documentation submittal:
   a. Functional Network Design Document: The SCADA System Provider shall provide a functional network design document shall contain the following:
      1) A complete network system diagram showing the interconnections between hardware subsystems. This shall include fiber optic cabling, network switches, routers, fiber patch panels and other network components.
      2) Complete description of switch setup and programming to accomplish Ethernet configuration shown on the drawings.
      3) Complete list of all major system components. This includes existing panels and panels not supplied by the SCADA system supplier.
      4) Assignment of each component a unique device identifier.
      5) Labeling of all components on all block diagrams.
      6) Provide locations for all major system components
   b. Functional SCADA Architecture Design Document: The SCADA System provider shall provide a Functional SCADA Architecture design document shall contain the following:
      1) A complete system diagram showing the major components and interconnections of the Proposed SCADA system. This shall include all servers, all Workstations, Remote Terminal Units, and PLC's, at a minimum.
      2) Any required transceivers, media converters or other interconnecting equipment shall be included on the diagram.
      3) Complete description of IP addressing scheme for the proposed system
      4) Complete list of all major system components
      5) Assign each component a unique device identifier
      6) Label components on all block diagrams
      7) Provide locations for all major system components.
      8) An interface design for all areas where the facilities existing hardware interfaces with the new network
      1) The FSDD shall show the top-level design of the SCADA System Provider's proposed software in a concise manner. The complete description of support, interface, diagnostic, and general I/O software shall also be included. An inventory of major software packages, including third party, provided shall be included. A separate summary shall be provided for each major system component. The FSDD shall illustrate the flow of data from one process to another (i.e. the flow of data from field data acquisition to polling by the SCADA system to alarming to historical logging). The FSDD shall include a description of the historical data collection subsystem, including table usage and data storage rates. The document shall include, but not be limited to:
      2) Polling Process, including anticipated scan rates
      3) Data consolidation techniques for use in RTU
      4) Peer to Peer data flow
      5) Hard Drive Storage space required for each software component
      6) Memory requirements (RAM) for each software component.
      7) Within 21 days from notice to proceed, the SCADA System Provider shall submit for review the FSDD submittals.
d. Installation Drawings:

1) Installation drawings shall show installation arrangements for all provided equipment, mounting and anchoring details, conduit entries into cabinets, and SCADA electrical power supply distribution conduit and wiring. Data sheets and/or catalog cuts for mounting devices, anchors, wire, and other incidental installation materials shall be included.

2) Within 21 days prior to the start of System Testing, the SCADA System Provider shall submit installation drawings. System Testing shall not begin until the system installation drawing submittal has been Successfully Reviewed.

3. System Documentation Submittal:

a. Operation and Maintenance (O&M) Manuals:

1) SCADA System Provider shall supply O&M manuals for all equipment and software provided. The manuals shall be developed for electronic technician audience. The manuals shall detail preventive and restorative procedures required to keep the equipment in good operating condition. A manual, or manuals, shall be furnished for all deliverable hardware, including OEM equipment. Manuals for OEM equipment shall contain original printed materials, not copies, and may be in the manufacturer's original format. The O&M manuals shall contain the following:

b. Instruction Manual:

1) The manual shall contain a detailed analysis of each major component so that maintenance personnel can effectively service, troubleshoot, and repair the equipment. Each manual shall include a Table of Contents, and shall be divided into the following sections:

(a) Introduction: The purpose of the manual, special tools and equipment, and safety precautions.

(b) General Information and Specifications: A general description of each equipment item, and its specifications.

(c) Listings: Include contact information for each product provider, recommended maintenance provider, and local source for replacement parts.

(d) Theory of Operation: Explain the relationship of all equipment to each other, and its purpose in the overall SCADA network.

(e) Software: Listing and explanatory text for any software or firmware.

(f) Operation Procedures: The locations and functional descriptions of all controller indicators, or displays.

(g) Troubleshooting: A tabular list of all symptoms, probable causes of malfunction or improper operation, and probable remedies to each specific malfunction, down to the smallest board replaceable components.

c. Preventive Maintenance Instructions:

1) These instructions shall include all applicable visual examinations, hardware testing, and diagnostic hardware/software routines. Instructions on how to load and use any test and diagnostic programs and any special or standard test equipment shall be an integral part of these procedures.

d. Corrective Maintenance Specific Instructions:

1) These guides shall include adequate details for quickly and efficiently locating the cause of an equipment malfunction and shall state the probable source(s) of trouble, the symptoms, probable cause, and instructions forremedying the malfunction. These guides shall explain how to use on-line test and diagnostic programs for all devices and any special test equipment, if applicable. The corrective maintenance specific instructions shall include:

(a) Explanations for the repair, adjustment, or replacement of all equipment items.
(b) Schematic diagrams of electrical, mechanical, and parts location, illustrations, photographs, and sectional details as necessary to facilitate repair or replacement.

(c) Mechanical items requiring field repair, shall have the following:
   (1) Information on tolerances, clearances, wear limits, and maximum bolt-down torques
   (2) Information on the loading and use of special off-line diagnostic programs, tools, and test equipment
   (3) Cautions or warnings, which must be observed to protect personnel and equipment.
   (4) A list of test equipment and special tools required.
   (5) A list of recommended spare parts necessary to maintain and repair SCADA components. The list shall identify the specific part or model number, description, manufacturer's name and address, commercial equivalents, and recommended quantity to be stored. The spare parts list shall indicate which components (by model and serial number) have been provided with the delivered system as part of the spares inventory.

e. Drawings:
   1) O&M Manual drawings (with the exception of those provided by third-party manufacturers) shall not be larger than 11 inches by 17 inches. Drawings shall be legible when reproduced using conventional office copying machines. Originals shall be provided for all third-party O&M Manual materials. Preprinted O&M Manual drawings, which do not meet the above criteria, or which must be modified to show the actual as-built design, shall be redrawn as new specially-prepared shop drawings. Equipment manufacturer's drawings need not be duplicated or removed from the manuals.

f. Binders and Electronic Copies:
   1) Each O&M Manual shall be bound in 8 1/2” x 11 inch 3-ring side binders with commercial quality hardback, cleanable plastic covers. Final versions of the O&M Manual shall also be provided on CD-ROM. The manuals shall be subdivided with permanent page dividers with tab titling clearly printed under reinforced laminated plastic tabs. Each volume shall have a Table of Contents, with each product or system description identified.

g. System Operator's Manuals:
   1) The System Operator's Manuals shall describe the configuration and all functions for the systems and equipment provided. Functional descriptions shall include algorithms necessary to fully understand the functions. The manuals shall be organized for quick access to each detailed description of the operator's procedure. The manuals shall be limited only to description of procedures for functions that are performed by the operator. The System Operator's Manuals shall serve as a complete instruction to the system and equipment and shall describe in detail the operator interfaces and operator procedures. In addition to the Operator interaction sequences, the following shall be provided, as a minimum:
      (a) Summary description of all major functions
      (b) Presentation of data on displays.
      (c) Description of how the system and equipment react to situations such as heavy alarming, loss of communication links, heavy operator interaction, and loss of power and restoration of power.
      (d) Description of the hardware configuration and device switching capabilities.
      (e) Description of every message and alarm that the system is capable of outputting, an explanation of what the message indicates, and what action the system operator should take.
h. System Administrator Guide:
   1) The System Administrator Guide shall be a user's manual for all the
      corresponding systems programs. It shall include information on system
      generation from file backups, starting and bootstrapping the system, editing and
      expansion techniques (including display/report compiler, database, and
      applications edit), batch mode operation of software utilities, and troubleshooting
      to be used in conjunction with the system dumps, error and abort messages.
      User instructions for each of the peripherals and for all Software Engineer
      procedures shall be in the guide.

i. Software support materials:
   1) Program Media:
      (a) The SCADA System Provider shall furnish complete sets of program media
          documentation. These documents shall include source of all programs
          written by the SCADA System Provider specifically for the proposed
          system. This includes, RTU and PLC programs, HMI scripting, OIT
          applications, and objects of all programs necessary for the operation and
          maintenance of the systems programs. If any changes are made to
          programs during system test and acceptance, the SCADA System Provider
          shall provide, within 5 days, corrected copies of source, object, and system
          media.
      (b) Program Listings:
          (1) Each program listing shall include revision information. Each time a
              change is made in the listing, its revision level shall be documented by
              the party making the change. Program listings will include all in-
              program comments and documentation, and must be clearly
              understandable by programmers familiar with the language used.
              Undocumented code is not acceptable.
      (c) Programmer Manuals:
          (1) The purpose of these manuals will be to enable systems and
              applications programmers, to maintain, modify, and expand the
              capacity and functionality of the system. These manuals shall
              comprise the standard manuals furnished by the computer system
              manufacturer covering the Operating System, Utilities, and
              Diagnostics, and High Level Language(s) supplied, together with
              SCADA System Provider furnished manuals that are specific to the
              system. The manuals shall include descriptions of the procedures to
              be used for:
              (2) Computer system startup, restart, manual failover, and operation.
              (3) Modifying and expanding the system databases and testing revised
                  versions.
              (4) Defining, linking to the database, and testing revised and new
                  displays, logs, reports, data acquisition, process control, and data
                  processing procedures including the addition of communication links,
                  CFEs, RTUs, PLC’s, and input/output points.
              (5) System operational troubleshooting including descriptions of the
                  system error messages and the interpretation of crash dumps.
              (6) Instructions for configuring and rebuilding servers and workstations as
                  if starting a new system, as well as rebuilding from backups (this will
                  apply to peripherals applicable to the system as a whole, including
                  network items).
              (7) Provide effective procedures/techniques for creating, expanding, and
                  editing SCADA and PLC applications. Include useful backup
                  procedures required for system recovery.
(d) System Configuration Inventory List:
   (1) An inventory list shall be furnished for all contract material, software,
documentation, spare parts, and test equipment. Hardware
identification of each unique module by serial number and each
software unique module shall be included on the list. The inventory list
shall include, but not be limited to, the following information:
   (2) Manufacturer's name, part number, and serial number
   (3) Quantity of units supplied with the deliverable System/subsystem
   (4) Software modules supplied
   (5) Operating system software provided for all CPUs/microprocessors
   (6) Operating systems enhancements provided
   (7) System documentation supplied
   (8) Applicable cabinet, rack number or slot, and cables.
   (9) The inventory list, which shall be prepared and updated by the SCADA
System Provider, shall be subdivided by hardware, software, test
equipment, spares, documentation, and training courses. Each of
these major divisions shall be further subdivided to the individual
deliverable item level. Each item must be defined in sufficient detail to
permit identification in shipping documents and inventory checks. The
organization of the inventory list shall include provision for annotating
each item with forecast and actual dates for:
   (10) Review (Documentation)
   (11) Shipping and Delivery (All items Except Documentation)
   (12) System Testing (Hardware and Software)
   (13) Site Demonstration Tests (Hardware and Software)
   (14) Final Acceptance (Spares, Documentation, etc.)
   (15) Delivery (Training Courses).
   (16) A preliminary version of the System Configuration Inventory List that
demonstrates the form and content to be provided shall be submitted
for review within 10 days of Notice to Proceed. A completed System
Configuration Inventory List shall be submitted no later than 10 days
prior to the scheduled start of System Testing. The SDT shall not be
initiated until the System Configuration Inventory List submittal has
been Successfully Reviewed. A System Configuration Inventory List
updated to reflect any additions or changes during system installation
shall be included as part of the Record Documents.

(e) Record Documents:
   (1) The SCADA System Provider, within 10 days after successful
completion of Site Demonstration Test (SDT), shall submit a
preliminary version of the Record Documents. Final Record
Documents shall be submitted prior to the conclusion of the Site
Availability Demonstration (SAD). The SAD shall not be considered
complete until the final Record Documents submittal has been
Successfully Reviewed.

j. Submission Procedure:
   1) Within 5 days prior to the start of System Testing, the SCADA System Provider
shall submit preliminary copies of the O&M Manuals, System Operator's
Manuals, and System Administrator Manuals. These preliminary copies shall
contain sufficient detail to review the basic outline and scope of the manuals. At
least 5 days prior to the start of the first operator training session, the SCADA
System Provider shall submit draft copies of the O&M Manuals, System
Operator's Manuals, and System Administrator Manuals. These draft copies
shall generally be complete (at least 90%) and shall be clearly marked to
indicate where all missing or incomplete information will be included. Final
versions of the O&M Manuals, System Operator's Manuals, and System Administrator Manuals shall be submitted prior to the beginning of the Site Availability Demonstration (SAD). The SAD shall not be initiated until the final submittal has been Successfully Reviewed. Five (5) printed copies of the Final O&M Manuals, System Operator's Manuals, and System Administrator Manuals, and associated drawings, shall be provided. In addition, an electronic format copy of the manuals shall be provided on CD-ROM compatible with CD-ROM drives supplied with system. Electronic documents shall be provided in both the native application used for creating the documents (MS Word, AutoCAD, etc.) and the Adobe PDF format.

4. Testing Documentation Submittals
   a. System Test Plan: The SCADA System Provider shall prepare and submit for review a System Test Plan within 21 days after Notice to Proceed.
   b. Test Procedures: The SCADA System Provider shall prepare and submit for review a Test Procedures within 21 days after Notice to Proceed.
   c. Test Reports: The SCADA System Provider shall prepare and submit for review a Test Report within 21 days after Notice to Proceed.

5. Training Documentation Submittals:
   a. Training Plan: The SCADA System Provider shall prepare and submit for review a Training Plan within 21 days after Notice to Proceed.
   b. Course Outlines: The SCADA System Provider shall prepare and submit for review a Course Outlines within 21 days after Notice to Proceed.
   c. Training Manuals: The SCADA System Provider shall prepare and submit for review a Training Manuals within 21 days after Notice to Proceed.

1.06 QUALITY ASSURANCE
   A. Manufacturer Qualifications: A qualified manufacturer shall have, within 200 miles of Project site, a facility, system integrator, or panel shop capable of providing training, parts, and coordination of emergency maintenance and repairs. The Control System Integrator shall be a CSIA certified system supplier. (ADDENDUM #2)

   B. Source Limitations:
      1. All SCADA Software shall be from a single manufacturer.
      2. To insure reliability and optimized connectivity, the SCADA software shall be from the same vendor as the PLC equipment.

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

   D. Comply with NFPA 70.

   E. SCADA system shall use an Ethernet network as the preferred peer-to-peer network. To protect the owner's ability to competitively bid future projects, the Ethernet network shall utilize open protocols that are in the public domain. This protocol shall be the Modbus TCP/IP Network. Equipment to convert a non-public domain Ethernet protocol to a public domain protocol shall not be accepted.

   F. SCADA System Availability Requirements:
      1. A fundamental objective of the SCADA System Supplier's proposed system design shall be to ensure that no single equipment failure or temporary error condition can disable the system operation or generate any spurious control commands to the system equipment.
      2. Single Point of Failure:
         a. The SCADA equipment configuration shall prevent any single hardware or software failure from causing loss of any system function or from causing overall system malfunction. Single hardware failures may cause loss of specific communication channels temporarily until failed equipment is replaced.
3. SCADA Operational Checks: The SCADA System Supplier's proposed system shall continually check the operation of all devices in the system and report any problem to the user. Upon detecting a malfunction, the failed operation shall be attempted a number of times (programmable) in order to determine whether the malfunction is temporary or permanent. Permanent malfunctions shall be alarmed and logged. Temporary malfunctions shall not be alarmed but shall be logged for maintenance purposes. Failed devices shall be automatically replaced by spare or backup devices if such devices are available.

4. System Availability: During the System Availability Demonstration, the SCADA system shall achieve an average availability rate for all functions of at least 99.95 percent. This is equivalent to a total downtime of approximately 4 hours per year for the System.

1.07 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Section 01600 - Product Requirements.

B. Deliver Operator Stations and SCADA software in packaging designed to prevent damage from static electricity, and physical damage.

C. Store Operator Stations and SCADA software according to manufacturers' requirements. As a minimum, store indoors in clean, dry space with uniform temperature to prevent condensation. Protect Operator Stations and SCADA software from exposure to dirt, fumes, water, corrosive substances, and physical damage. Also, protect the Operator Stations and SCADA software from all forms of electrical and magnetic energy that could reasonably cause damage.

1.08 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions, unless otherwise indicated:
   1. Ambient Temperature: 0 to 40 deg C.
   2. Humidity: Less than 90 percent (noncondensing).

1.09 SPARE PARTS

A. Furnish spare parts and consumables as described below. Material shall be packaged for long term storage and identified with labels describing contents. Coordinate with each all control panel vendor to optimize the amount of spares provided.

1. Provide Five (5) spare fuses for each type of computer power supply, monitor, UPS and other devices provided with embedded replaceable fuses.

1.10 WARRANTY:

A. System Warranty Overview:

1. The system warranty shall consist of a full scope, in-place warranty, consistent with the provisions of the Terms and Conditions of the specifications and the Agreement. The warranty duration shall be 12 months beyond Final Acceptance. All software and hardware components that are part of the completed system shall be covered by the warranty. The SCADA System Provider shall coordinate any warranties provided by third party suppliers. In addition, the SCADA System Provider shall provide warranty services for the existing instrumentation shown on the drawings. This warranty service shall begin with an initial cleaning and calibration of the existing instrumentation in accordance with the equipment manufacturer's recommendations.

1.11 MAINTENANCE:

A. Preventive Maintenance:

1. The SCADA System Provider's price shall include the services of factory-trained service technicians continuing for 12-months beyond Final Acceptance. All equipment shall be systematically serviced according to equipment manufacturers' service recommendations or six months, whichever is less. All preventive maintenance activities shall be documented with service reports which shall identify the equipment being serviced, state the condition of the equipment, describe all work performed, list materials used, and
include the name of the technician performing the work and his signature. A copy of all service reports shall be delivered to the facility on the day that the work is performed. All preventive maintenance procedures shall minimize disruption of the live system operation. No preventive maintenance procedure shall be allowed to jeopardize the facilities ability to monitor and control system operation. At the Facilities option, their maintenance personnel may participate in any preventive maintenance procedures.

B. Corrective Maintenance:
1. The SCADA System Provider shall provide the services of factory-trained service technicians for the purpose of performing corrective maintenance on all system hardware and software. The period of coverage for each piece of equipment shall begin upon initial equipment purchase or manufacture and shall continue for 12-month after final acceptance or until expiration of the manufacturer's warranty, whichever period is longer. The SCADA System Provider shall provide a 24-hour, 7-day/week-service hotline for telephone notification of system malfunctions. Within 6 hours from notification by the facility the SCADA System Provider shall have a qualified service representative establish telephone contact with the facility to discuss corrective measures. If it is not possible to correct the defective operation over the telephone, the SCADA System Provider shall have a qualified service representative at the facility within 24 hours from initial notification. Prior to beginning any procedure, the SCADA System Provider shall review the recommended action plan with the facility in order to inform of any impact on the operation of the facility. Once the defect has been corrected, the facility shall be notified indicating the source of the defect and specific action taken. Any spares from the onsite supply of spares used by the SCADA System Provider in correcting the system malfunction shall be replaced within 7 days. If 24-hour response time is not provided, or other corrective maintenance requirements are not met by the SCADA System Provider, the facility shall have the right to obtain corrective maintenance from other sources and charge the SCADA System Provider reasonable time and material costs of the alternative services.

C. Software Update Services:
1. Starting with installation of the SCADA system and continuing until 12-months after Final Acceptance, the SCADA System Provider, upon authorization from Engineer, shall provide, install, test, and commission updates to the SCADA system software and computer provided software within 14 days from when such updates are announced and released by the manufacturer. All updates shall be provided which are necessary to maintain the SCADA system in compliance with the Contract Documents, as well as any incremental releases. Should an update be announced and released by the manufacturer prior to the end of the 12 month period beyond final acceptance, the SCADA System Provider shall be required to install that update if authorized by Engineer.

D. Costs:
1. The cost for one year of the preventive and corrective software maintenance services and software update service described above shall be included in the Contract price.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include:

B. Qualified Manufacturers:
1. Only manufacturers that have been selling SCADA software for a minimum of 10 years will be considered acceptable.

2.02 COMPUTERS AND PERIPHERAL EQUIPMENT:
A. REQUIREMENTS:
1. The requirements defined in this subsection apply to the computer-based components of the SCADA System Provider's proposed system. All workstations shall be from a single
manufacturer and be from the same "family" or product line. All computer equipment shall be from the equipment manufacturer's standard offering and shall not be specifically built nor require major modifications in order to meet the requirements set forth in this Specification.

2. Computer related components shall be covered by the computer manufacturer's 3 year Next Business day on-site service warranty that includes parts and labor.

B. MINIMUM HARDWARE REQUIREMENTS:
1. Workstations will be Dell Precision or an equivalent with equal or higher quality. Unless specified below, the minimum workstation hardware requirement will be as follows:
   a. Workstation and monitors as shown on the drawings.
   b. DVD with read/write capabilities.
   c. Graphics card suitable to handle the graphics of the SCADA application
   d. External keyboard
   e. Microsoft Mouse
   f. Sound Card
   g. Speakers

C. OPERATOR AND NETWORK MANAGER WORKSTATIONS:
1. The following paragraphs discuss the specific Operator and Network Management Workstations requirements for this project. This specification applies to Operator and Network Manager Workstations and Field Workstations which are thick clients.
   a. General Requirements: Operator or Network Manager Workstation is a position from which an operator or network manager can monitor and control the entire process and view all real-time data and all historical data via displays on a Computer Display Screen including all network activities. The workstations shall be equipped with Ethernet network interface cards to allow communications to the Local Area Network (LAN).
   b. Minimum Hardware Requirements: The Operator and Network Manager Workstations shall consist of the previously specified minimum hardware configuration, with the following additional requirements:
      1) Dual monitors, sized as indicated above, required for one of the workstations. Include a graphics card that makes the dual monitors work together for these stations.
   c. SCADA Software Requirements:
      1) The Operator and Network Manager Workstations shall have the SCADA Software loaded as specified in Section 2.3

D. SCADA SYSTEM SERVER:
1. The following paragraphs discuss the specific requirements for the SCADA System Servers:
   a. General Requirements: Primarily this server shall interface to the networked CFEs, locally connected PLCs, and/or remotely connected PLCs via local area network connection. This SCADA System Server shall store, distribute and gather data. The SCADA System Server shall be configured in a redundant server system configuration.
   b. Hardware Requirements: As detailed above.
   c. SCADA Software Requirements:
      1) The Operator and Network Manager Workstations shall have the SCADA Software loaded as specified in Section 2.3
   d. Servers shall not be required to have video capabilities.

E. PRINTERS:
1. The following paragraphs discuss the specific Printer requirements for this project. The quantities of printers shall be reflected on the drawings.
2. Graphics and Report Printer: The Graphics Printer shall be a Dell Color Laser Printer. The printer shall include paper trays for 8 ½ x 11 printing.
3. **Alarm Printer**: The Alarm/Event Printer shall be a 24-pin dot matrix printer with maximum graphic resolution of 360X360 and capable of printing in at least seven (7) colors. The printer shall utilize an external print server to interface with the SCADA network.

**F. SWITCHES:**
1. Managed Switches:
   a. 24 VDC SELV.
   b. Multimode or Single mode optical fiber
   c. 0-60 degree C. operating temperature or greater
   d. Switches shall be configured for project conditions. Switch cascading is not allowed.

**G. UNINTERRUPTIBLE POWER SUPPLIES:**
1. Uninterruptible Power Supplies (UPS) will be provided for the workstations, servers, and major switches in the project. As a general rule, provide a dedicated UPS for each workstation and server. Sharing of UPS's is allowed as long as a single point of UPS failure cannot disable the system. The UPS system shall be able to run on Utility or generator power without any disruption in service. The UPS shall also be able to absorb the transients generated by ATS changeover.

**H. MISCELLANEOUS REQUIREMENTS:**
1. All material shall be new, unused and actively marketed for new applications when shipped for configuration. All acquired hardware and software shall be registered to “THE OWNER”, as user, and “Owner's Company's Name”, as the organization.

**2.03 SCADA SOFTWARE**

**A. GENERAL**
1. **Description**: The SCADA software package shall support dual core and multi-processor CPU's. The SCADA software shall be part of a complete SCADA system. This system shall include personal computer(s) and industry standard networking hardware.

2. **Core SCADA functionality**: All core SCADA functionality offered, such as communications drivers, graphics capabilities, reporting, historical storage, trend and alarm displays and the development environment are offered as a single integrated software package or suite of packages. The software must be designed with the ability to make changes to the graphics while the system is running. Shutting down the system for graphic changes is not acceptable.

3. **Core SCADA Functionality**: The specified SCADA functionality shall have communications drivers, graphics capabilities, reporting, historical storage, trend and alarm displays and the development environment offered as a single integrated software package or suite of packages. The software must be designed with the ability to make changes to the graphics while the system is running. Shutting down the system to make graphics changes is not acceptable. Additionally, software will be supplied to augment, or replace functionality of the software package:

4. **Operating Systems**: As a minimum, the SCADA software shall run development and runtime implementations on the following Microsoft operating systems.
   a. Windows Pro 10

5. **Windows Services**: It shall be possible to run the SCADA software as a service under Windows.

6. **Application size**: The SCADA software and engineering configuration shall initially be priced based on the following criteria:
   a. SCADA servers: 1 Configured fully redundant which will also function as operator stations.
   b. SCADA operator stations: In addition to the operator stations that double as servers, the project will require 1 owner provided operator station.
   c. Casual view users. Casual view users are operators that will require only infrequent viewing privileges from local or remote networked desktop computers. This project requires a total of 5 users, or which a maximum of 5 simultaneous casual view users will be allowed at any time.
d. Configured Graphics pages: The project shall be designed for 30 graphics pages

e. Alarms: The project shall be designed for 300 alarms.

f. Trends: The project shall be designed for 1,500 trends.

7. Report software shall be provided and shall be SyTech XL Reporter Professional Addition. One license shall be provided with HDA and DB connectors for each HMI workstation.

8. The integrator shall purchase any and all software packages (PLC Programming, HMI, OIT, Network Management, Report Generation, etc.) required for the system and shall be in the name of the authorized end user. All software shall be delivered to the Owner.

B. CONNECTIVITY:

1. Description: The SCADA software shall employ I/O Servers to manage the reading and writing of data from PLC's, RTU's, and DCS's. The I/O Servers shall provide the data on request to any client on the Network.

2. General I/O Server capabilities: The I/O servers shall have the following:
   a. PCs running I/O servers shall have the same graphical display capabilities of any other display station on the network.
   b. The I/O Servers shall maintain a cache of data for a configurable time, such that requests from multiple display station clients do not generate unnecessary requests to the field controllers and will read from the I/O Server cache and not directly poll the field devices.
   c. The SCADA software shall support Primary and Standby I/O Servers to provide automatic redundancy in the event of a Primary I/O Server failure without any user intervention or special scripting required. This switch over from a Primary to a Standby I/O Server shall be accomplished in under 1 second when a communication failure is detected. The system shall support automatic switching of I/O communications at least 5 standby I/O servers for a single field controller if installed at a later date.

3. As a minimum the software shall be provided with the following connectivity options to 3rd party programs or databases:
   a. OPC Client
   b. OPC Server
   c. ODBC Client
   d. ODBC Server
   e. DDE Client
   f. DDE Server
   g. Open API

   1) Open API shall allow third party applications written in C, C++, C#, VBA, Pascal or Fortran access to tag, alarm and trend data. This API shall support the standard SCADA security model provided and should allow both read and write access to the SCADA data.

4. Custom Driver Generation:
   a. The SCADA software vendor shall have a package available that allows the generation of user-written device drivers. The package shall include source code for various types of working drivers that are similar to the requirements of the user (e.g. Serial Driver, TCP/IP Driver, report by exception, proprietary board etc).

C. COMMUNICATIONS

1. Description: The SCADA software shall be capable of communicating to PLCs connected to the network, remote PLCs, I/O servers, and other devices on the network.

2. General communication capabilities. The SCADA software shall have the following communications capabilities:
   a. Support of redundant communication paths to field controllers, and provision for automatic changeover to the standby path in the event of a communications failure.
   b. Support of communication to redundant field controllers. If a primary processor fails, the software shall automatically detect the failure and switch to communicating to the
standby processor. This shall require no user intervention, special scripting or use of redundant tags within the software.

c. Built in diagnostic alarms shall be provided with the system that will automatically notify the operator of the failure of any communications path.

3. Communication re-establishment:
   a. Despite the failure, upon re-establishment of communications all historical alarm, event and trend data archived by the remote field device (RTU) shall be automatically backfilled into the native SCADA alarm and trend history files. The data shall be fully viewable via the standard SCADA alarm and trend viewers.

D. SECURITY

1. Description: Security features shall be fully integrated to allow only users with appropriate security levels access to individual parts of the system.

2. Security Capabilities: The SCADA software shall have the following:
   a. Encrypted passwords that are checked on the server side.
   b. Passwords hidden in both the configuration and runtime environments to ensure that other personnel cannot access another account.
   c. Monitoring and logging of each control action of each user. This shall include all operator control actions, including system log in and log out. The sequence of actions shall be viewable within the SCADA package and also stored in an external open file format (e.g. txt, csv, dbf, sql) for later analysis.
   d. Automatically log out a user after an adjustable time period. Logging out a user will only cause the system shall revert to a view only security status. Logging out will not shutdown the system.
   e. A minimum of 8 privilege levels for each user. The software shall ensure that a user has access to all tasks for his privilege level. If the user does not have the correct privilege for a task a message will indicate insufficient privilege.
   f. Assign each graphic object to a plant area, define the privilege level, define whether operator input is enabled or disabled, and if the object will be visible or not based on the operator’s current privilege levels within the plant area.
   g. A mechanism to restrict access to different areas of the plant for each individual user or group of users. There shall be a minimum of 255 different plant areas.

E. GRAPHICAL DISPLAYS

1. Description: Graphical displays are windows that are used to represent part or all of a process in a graphical manner.

2. General Graphical Display Capabilities: The SCADA software shall have the following graphical display features:
   a. Unlimited number of graphical displays:
   b. Capable of a minimum of 2000 analog variables, with real time updates of less than 500ms (for all data to appear or change on the page)
   c. Capable of automatically re-sizing to match the screen resolution of the computer on the network, irrespective of the resolution the pages were developed in or configured for, and irrespective of whether vector or bitmap graphics are used on the page, without shutting down the SCADA software, without recompiling, and without having multiple copies of graphic pages for different resolutions.
   d. Support a screen resolution of up to 4000 x 4000 pixels.
   e. Capable of pop-up windows for trends, loops, device status, and device control by clicking on hot spots or objects on the main graphics page. 100 simultaneously opened popup display windows shall be supported by the graphics display system.
   f. Inclusion of page name, current time and date together with details of the last 3 alarms that have occurred on all graphical displays.
   g. Ability to allow the user to navigate around the graphics system utilizing a variety of navigation methods.
   h. Ability to have Hot Key links to specific graphics pages from the keyboard.
i. Windows style navigation menus allowing access to any configured page in the system from any other page.

j. Configured with “hot spots”, where as a user can click on the area and drill down into a detailed view (if available) of the plant area.

k. Ability to display communication loss for a particular I/O point wherever that data is displayed in the software.

3. Dynamic Objects: Dynamic objects are symbols that visually change when a property, tag or expression changes. Dynamic objects shall be as described below:
   a. Support the following graphical dynamic objects as a minimum:
      1) freehand lines
      2) straight lines
      3) poly-lines
      4) rectangles (including the latest curved corner style)
      5) ellipses
      6) pie slices
      7) text
      8) buttons (of the latest WinXP style)
      9) 3D Pipes
      10) Bitmaps
   b. Dynamic objects shall have a series of properties that can be used independently or concurrently. Each dynamic object shall have the following properties:
      1) Horizontal, Vertical and Rotational movement
      2) Up, Down, Left or Right Level Fill
      3) Gradient Level Fill
      4) On-Off, Multi-State, Integer, Threshold or Gradient Color Change
      5) Horizontal and Vertical Size
      6) Visibility
      7) Keyboard Input
      8) Touch (Mouse Up, Down, While Down) input
      9) Horizontal and Vertical or Rotational Slider
      10) Ability to disable the object based on security levels.
      11) Popup information in a “tool tip” form by rolling the mouse over the object

4. ActiveX: The SCADA software will be an ActiveX container and allow for insertion of ActiveX objects into standard graphics pages. The SCADA software shall interact with ActiveX objects in the following ways:
   a. Dynamically change properties of an ActiveX object via a Tag from an I/O Device
   b. Dynamically change properties from SCADA software high level language.
   c. ActiveX object to trigger actions in the SCADA software based on events in the ActiveX Object.
   d. ActiveX property values can be read by the SCADA software.

F. ALARMS

1. Description: Alarms are meant to alert an operator of an abnormal condition. They are logged, and often times require operator intervention.

2. General Alarm functionality: The alarm functionality shall have the following:
   a. No software limit to the number of alarms supported
   b. A minimum or 100 million alarm summary events shall be stored in the native trend archive to recall through standard trend display screens.
   c. Acknowledgement on one operator station shall be globally acknowledged and as such shown as Acknowledged on all operator stations. This shall be configured as one common database, with no other programming necessary to enable global acknowledgment of alarms from any PC on the network.
3. Alarm Types: The SCADA software shall monitor analog and discrete variables and calculated conditions, and determine if the variable is in an alarm condition. The SCADA software shall perform the following:
   a. All analog alarm conditions shall have adjustable dead bands and delay timers to minimize nuisance alarms. All analog alarm properties shall be adjustable without the need to shut the system down. For each Analog Tag, an alarm for each of the following conditions shall be assignable:
      1) LOW-LOW,
      2) LOW,
      3) HI,
      4) HI-HI
      5) Deviation LO
      6) Deviation HI
      7) Rate of Change
   b. Discrete alarms shall have an assignable alarm for each of the following:
      1) Variable ON
      2) Variable OFF
   c. Multi-Digital Alarms based on a combination of discrete tags. Any combination of states of the discrete tags may be configured to be an alarm. Furthermore, alarming will occur whenever a new alarm state is encountered.
   d. All alarm processing shall have the facility for time stamping and can track time to a precision of 1 millisecond.

4. Alarm Display: Alarm display shall have the following:
   a. Depending on user's log-in privileges, it shall be possible to display or acknowledge any alarm and/or the most recent alarm on any page.
   b. Alarm shall be configurable in multiple levels. The color of the text of the alarm message shall indicate priority. Text color shall be configurable by engineers.
   c. Sound indication for each alarm category shall be configurable. This must be possible at each node via internal or external speaker. The sound indication shall support the playing of any standard .WAV file.
   d. Provided with a standard alarm user modifiable display page. The alarm page shall allow for scrolling of alarms, and acknowledgment of individual alarms or all alarms on the page.
   e. Possibility to display the following information for each alarm as it appears on an alarm display page:
      1) Alarm Tag Name
      2) Alarm Description
      3) Value of the Variable
      4) Trip point
      5) Alarm Status - Disabled, Acknowledged, Unacknowledged
      6) Alarm Category or Priority
      7) Alarm Priority
      8) Time & Date
      9) Privilege
      10) Category
      11) Operator Comments
      12) Value of any Tag or result of any calculation.
   f. Ability to display each alarm state in a different color (including flashing colors).
   g. Support for both proportional and fixed fonts with all alarm fields displayed in properly aligned columns.
   h. Based on user's privileges, it shall be possible to disable alarms on individual basis, by page or by alarm category or all alarms. A disabled alarm page shall indicate to every user what alarms have been disabled.
Based on user's privileges, it shall be possible for user comments to be attached to any alarm. These comments shall either be displayed with the alarm or by clicking on the alarm.

Possibility to automatically display any graphic display when an alarm occurs or to dynamically change the appearance of any graphical object based on whether an alarm is On, Off, Acknowledged, Communications Error or Disabled.

A mechanism for operators to dynamically define filtering of alarms by alarm name, tag name, date /time range, state or type

5. Alarm Logging: The following alarm functionality shall be provided:
   a. The alarms shall be able to be logged to any designated network or local printer, disk file or database with alarm text, time and date labels. Alarms shall be printed or filed in a user-configurable format. The software shall be able to redirect printing to another printer while the system is on-line.
   b. It shall be possible to define a different method of logging alarms for each alarm category. It shall be possible to define if alarms are to be logged when the alarm transitions to ON, to OFF or on Acknowledgement.
   c. Alarms that are logged to disk shall be viewable while the system is online or offline without interrupting data collection. The software shall not limit the number of alarms logged to disk. The alarm logging shall be capable of logging an instantaneous burst of at least 4000 alarms without losing a single alarm.

6. Alarm Redundancy: All alarm calculations and management shall be performed in the Primary Server. The software shall automatically ensure that if the Primary Server fails, all alarm functions shall continue to operate normally in the standby server. The software shall automatically generate a diagnostic alarm to indicate that the Primary or Standby Server has failed. Adding, deleting or modifying alarms shall not require any changes to the software that handles the redundancy. On restoration of a failed Server, the historical alarm history must synchronize between the Primary and Standby servers so that there are no miss matches in historical alarm history.

G. TRENDS
1. Description: Trends are a collection of data points over time. When viewed over time, the trends will indicate general progression of the data.
2. General Trend Functionality: The software shall have the following functionality.
   a. The number of trends collected shall not be limited by the software.
   b. The software shall be capable of logging historical trend information at configurable sample periods from 1 Millisecond to 24 Hours.
   c. Trend data shall be stored in a circular file system with the number of files, the size of each file, the sample period, file location, privilege and area being user definable individually for each trend. File names and paths shall support file names up to 255 characters in length.
   d. Every tag defined in the system configuration shall be trended. Each trend shall contain a minimum of seven years historical data at a 10 second sample rate. The trends shall be maintained online for operator call back without the need to backup or restore history files.
3. Trend Display: The software shall have the following in its native functionality:
   a. Each operator and login shall be able to see their own fully customized trend pages. These pages must be customizable on line by each user in a drop and drag manor. Any setting available to be made in a configuration environment shall be available to the user to modify the trend graphs in run time. These include the color, scaling, pen selection as examples.
   b. Line graphs with time on a linear, continuous horizontal or vertical axis and the trended variable on the vertical or horizontal axis. Resolution of each graph shall be to within 0.1% of full scale.
   c. Where more than one variable is displayed on the same graph, the pen color of each variable and associated information shall be displayed in a different color.
d. Each trend graph shall be capable of displaying a minimum of 32 trend pens with adjustable time base to one second samples and shall be capable of viewing the entire archived trend history.

e. Historical system alarms shall be able to be overlaid on the trend pages showing the alarms state transitions.

f. A standard graphics page shall support a minimum of 100 individual trend windows embedded within the display so that an overview of multiple site levels can easily be produced.

g. Possibility to trend multiple pens or multiple plots of the same pen over various time spans for comparison purposes (i.e. previous day to today's results).

h. Each pen shall display individual ranges and engineering units. Each pen shall be scalable for display purposes independent to each other pen displayed on a page.

i. Include the capability to pan backward and forward within a selected time range to read the exact value of any displayed variable, by selecting a point on the graph or chart. The system shall display historical information as far back in time as desired, with all information being displayed within 1 second.

j. The trend display shall be dynamic, scrolling through time, with the capability to 'replay' or scroll through historical time as well as current time. There shall also be the capability to stop the automatic scrolling of the trend for detailed analysis of a point in history. Pens on the same pane shall be able to be separated both in the time axis and the range axis.

k. The trend display shall have a minimum of 2 slide wire that can be moved over the page. The slide wire will provide indication of the date, time, and value at the intersection of the slide wire and the trend point.

l. The software shall provide "zoom" and "pan" facilities for both the trended variable range and the time axis range. The "zoom" facility shall allow an operator to compress or expand the axis range whilst the "pan" facility shall allow an operator to shift the origin of the axis. The software shall allow a user to define any zoom area by dragging a mouse across the trend.

m. The software shall make available trending data from the historical database for export to disk files or external databases. It shall be possible to define the section of the trend to be exported by clicking and dragging the mouse across the trend. Data shall be exported to csv, dbf or txt formatted files. It shall also be possible to export any portion of the historical trend database via ODBC, DDE, dbf, CSV and TXT formats.

n. The software shall provide the capability of printing out either instantaneous or historical based trends on the designated trend printer. The software shall have the capability to perform a trend print (not a screen print). The trend print function shall print to the printer using objects, not bitmaps. The trend printout shall include the engineering units and ranges for each trend, a trend grid and the time base for each trend. Each trend shall be identified by a different line style (i.e. dotted, dashed, solid etc) on monochrome printers, and a different color for color printers.

4. Trend Redundancy: Trend collection and management shall be performed utilizing primary and standby servers; both shall contain all the historical trend information. If the primary server fails then the standby server shall ensure all trend functions continue to operate. Upon restoration of the primary, the standby shall automatically update the primary server such that there are no gaps in the historical trend data. No operator involvement shall be required. Failure of the primary and standby servers shall be monitored such that a failure at any time will produce a diagnostic alarm.

H. DEVELOPMENT ENVIRONMENT

1. Description: The development environment is the area that allows generation of graphic screens, alarms screens, tag database, trend screens etc.

2. General Development Environment Functionality: The SCADA software shall include a development environment with the following:

a. An integrated development package utilizing menu driven, fill in the forms style configuration to develop the runtime system.
b. All development functions shall be available at every node on the system, and allow multiple users at separate nodes to simultaneously modify the same master database. A minimum of 5 simultaneous developers shall be supported.
c. Comprehensive on-line help shall be available for all development functions, the on-line help shall contain all information provided in the hard copy manuals.
d. A utility to back-up or restore an entire database including all graphic displays, configuration data and source code, as well as online configuration (such as menu navigation, trend groups and alarm groups), via a simple point and click method. The backup/restore utility shall prompt the user prior to over writing any existing files. The utility shall employ automatic file compression/decompression.
e. Ability to import field controller tag definitions shall be included as a standard feature. Automatic updating upon a change of a definition in the I/O device tag names, addresses, ranges etc will automatically be imported into the SCADA software database. In addition it shall be possible to manually initiate the import of tag definitions at any time. The Tag import function shall be user configurable such that a user can specifically define which definition fields must not be overwritten or define how the import will operate. The import function shall support generic OPC data sources and CSV file imports in conjunction to native field controller programming software database imports.

I. GRAPHIC BUILDER
1. Description:  The graphic builder allows for development of graphic screens.
2. General Graphic Builder functionality:  The graphics builder shall be interactive and menu-driven, requiring no programming. It shall consist of the following:
   a. Directly import graphics and text in the following file formats:
      1) Autocad DXF
      2) Windows BMP
      3) Windows Meta File WMF
      4) GIF
      5) TIF
      6) PCX
      7) TXT
      8) DIB
      9) RLE.
   b. The graphics builder shall be capable of creating screens composed of both static and dynamic objects. To create these objects, the software shall provide sample screens and a set of standard shapes in a library. The developer shall be able to include these symbols by reference, or create new symbols/objects.
   c. The following Tools:
      1) Grid and guidelines (which can be displayed on screen) together with snap to grid and snap to guidelines to assist in aligning objects precisely.
      2) Horizontal and vertical alignment together with even spacing.
      3) Send to front/back. Bring Forwards one layer, Send backwards one layer.
      4) Bitmap editing including pixel drawing, image resizing, image cropping.
      5) Color swap from one color to another for a group of selected objects including colors within a bitmap. Color swap shall also include swapping a range of colors such as all reds to all greens so that shaded objects can be color changed without redrawing or re-rendering.
      6) Editing of nodes on polylines that provides the addition or removal of nodes plus movement of nodes.
   d. Unlimited “undo” and “redo” feature.
3. ActiveX:  The graphics builder shall be an ActiveX container. ActiveX objects shall be inserted and edited in a visually interactive manner. It shall be possible to connect ActiveX
properties to tags, allowing read/write between properties and tags without the need for script or code. ActiveX objects must have the same security as native graphics objects and ActiveX objects shall be visible or hidden based on the users' privilege level.

J. CUSTOM SCRIPTING LANGUAGE
1. Description: The scripting language shall be used to develop custom routines, and algorithms not supplied as part of the standard package.
2. Standard Functionality: Scripting shall not be needed to develop any custom code to achieve standard functionality including redundancy failover, recovery and backfilling of historical data.
3. General Custom Scripting Functionality: The SCADA software's scripting functionality shall include the following.
   a. An integrated high level language specifically designed for SCADA applications that shall be inherently multi-tasking and multi-threading.
   b. Fully integrated and multi-threaded Visual Basic (VB) scripting.
   c. Access to all field tags, alarms, graphics displays, database and ASCII files. The languages shall include functions with clear and precise syntax. The languages shall support user written functions and function libraries supported by the computer's operating system. The language shall have the capability to export or import data from other applications.
   d. Creation of calculated (inferred) variables based upon formulae including constants, measured variables and other calculated variables. All facilities available for logging, reporting, trending, monitoring, controlling, alarming and displaying measured variables shall also be available for calculated variables.
   e. Support of mathematical and Boolean operators including:
      1) Addition
      2) Subtraction
      3) Division
      4) Multiplication
      5) AND
      6) OR
      7) XOR
      8) NOT
      9) Greater Than
     10) Less Than
     11) Equal
     12) Parenthesis.
   f. Support for the following mathematical functions:
      1) Absolute
      2) ArcCos
      3) ArcSin
      4) ArcTan
      5) Cos
      6) DegToRad
      7) Exponent
      8) Factorial
      9) HighByte
     10) HighWord
     11) Ln
     12) Log
     13) LowByte
     14) LowWord
     15) Max
     16) Min
17) Pi,  
18) RadToDeg  
19) Random  
20) Round  
21) Sign  
22) Sin  
23) Sqrt  
24) Tan.

g. Prevention of any functions from interfering with proper SCADA functionality.  
h. Permit users to create their own functions and integrate them in the language; functions shall be reusable without the need to copy and paste. It shall be possible to call the same function multiple times from different locations, with different parameters simultaneously.  
i. Provisions to run functions automatically on start up, on page entry, on page exit, while a page is open, on button down, while button down, embedded in reports, alarm on, alarm off, on any keystroke, any keyboard entry on any mouse button click, etc.  
j. Ability to test and debug the languages on line. The debug tool shall display the source code as it executes with a pointer identifying the current line of code being executed, the value of local and global variables and any output as the user single steps through the code. Facility to set break points, single step, step over sub functions, step out of sub functions and continue execution shall be included.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas, surfaces, and substrates to receive SCADA System and associated control panels for compliance with requirements, installation tolerances and other conditions affecting performance.  
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLICATIONS

A. Select SCADA Software based on application type, tag count, type of node. It is recommended that a manufacturer's representative be consulted during the selection.

3.03 INSTALLATION

A. Anchor servers, control panels, and other devices over 36 inches high and at least 19 inches across.  
B. Ventilation slots shall not be blocked, or obstructed by any means.  
C. SCADA Computers shall be installed in an environment as indicated by the computer supplier. Insure that the computers are protected from exposure to high levels of dirt and dust. Also  
D. SCADA System Supplier shall insure that all cables are neatly routed and bundled.

3.04 IDENTIFICATION

A. Identify components, and wiring according to all applicable codes, standards and contract document sections.

3.05 FIELD QUALITY CONTROL

A. Field Service:  
1. The SCADA system supplier shall provide a qualified service representative to perform the following:  
a. Inspect wiring, components, connections, and equipment installation.  
b. Assist in field testing of equipment  
c. Install and test SCADA software as detailed below  
d. Install and test SCADA application as detailed below  
e. Report results in writing. As detailed below.
B. Installation and Start-Up:
   1. The SCADA System Provider shall develop a specific plan for the startup of the new SCADA system and for cutover of control to the new system. No startup or cutover activities shall be performed until the plan has been successfully approved by the Engineer. The sections below give some guidelines and suggestions for cutover.

C. Factory Acceptance Test (FAT):
   1. Factory testing will be observed and certified by a registered Professional Engineer.
   2. Description:
      a. Thorough testing and verification for all deliverable equipment, software, and associated documentation shall be performed on all SCADA System Provider proposed system components. The tests shall be performed to verify that the equipment is manufactured and assembled correctly, is operating as designed, and complies with the contractual requirements. The tests shall be performed to verify that the software and hardware will meet the functional and performance requirements of this document. The equipment shall be interconnected and subjected to comprehensive system testing that simulates field conditions and operations. The Factory Acceptance Test (FAT) shall include the test and verification activities specified in this section. The FAT will be attended by the Engineer. The FAT will be conducted by the SCADA System Provider.
   3. System Configuration Verification:
      a. Prior to beginning the Factory Acceptance Testing, the system/subsystem/elements shall be subjected to deliverable configuration and serialization verification. A copy of the System Inventory List annotated to reflect this verification shall be included with the Factory Acceptance Test Report. No equipment replacement or substitutions shall be permitted without rigorous quality control accounting and retesting of affected equipment.
   4. Equipment Test and Verification:
      a. Hardware Tests:
         1) The Factory Acceptance Test shall include individual end-item verification and integrated tests of all hardware. These tests shall include visual inspection verification, running standard hardware diagnostic programs, and running all special diagnostic programs used by the SCADA System Provider to demonstrate that the hardware integration task has been completed. Performance testing of all Individual Servers and Workstations, including demonstration of CPU, Memory and Storage functions shall be conducted. All hardware enclosures shall be inspected. As a minimum, the following shall be inspected and verified:
            (a) Cabinet enclosures
            (b) Frame structure
            (c) Paint work and finish
            (d) Dimensions
      b. Inspections:
         1) As a minimum the following inspections shall be performed:
            (a) CFE and Console Panels physical layout
            (b) Power supply mounting
            (c) Power cable routing
            (d) Data cable routing
            (e) Wiring runs across hinges properly installed
            (f) Fans and blowers are unobstructed
            (g) Power conditioning correctly installed.
   5. System Functional Test
      a. Test Functionalities:
1) The functional test shall exercise and demonstrate the successful operation of every specified system function and shall include, but not be limited to, the following:
   (a) Rigorous exercising of all devices both individually and collectively.
   (b) Verification of proper scanning and data acquisition of all status and data points.
   (c) Verification of proper Control Strategy up/down loading to the PLCs/RTUs.
   (d) Demonstration of analog input, pulse input, and analog output accuracy.
   (e) Testing of all user interface functions.
   (f) Verification of all control operations to ensure that they result in the correct sequence of operation at all the PLCs/RTUs using the test PLC/RTU.
   (g) Simulation of communication error conditions and demonstration of error detection and handling.
   (h) All specified display types, reports, and operator/user procedures must be shown to be implemented and verified for accuracy.
   (i) Create and process device failure conditions including PLC failure, Operator Workstation failure, peripheral failures, etc. Special attention shall be given to creating failures in the middle of operator sequences and control actions such as:
      (j) Communication failure after a command is issued but before the result is recorded in the database.
      (k) Computer failure after a command is issued but before the result is recorded in the database.
      (l) Failure of a major communications component.
      (m) Incorrect operator entry in the middle of a multi-step action.
      (n) Operator Workstation failure in the middle of a control action.
      (o) Demonstration of all redundant functions and components.
      (p) Demonstration of all required alarm processing functionality, including audible annunciation.
      (q) Demonstration of all required historical capture, storage, and retrieval functions.
      (r) Demonstration of all required data logging functions.
      (s) Demonstration of all required IT interface functions.
      (t) Demonstration of all required device control functions.
      (u) Demonstration of all required database management functionality.
      (v) Demonstration of all required software support utilities.
      (w) Demonstration of all system diagnostics, both on-line and off-line.
      (x) Demonstration of correct operation of calculated quantities including totalized values.
      (y) Demonstrate the proper operation of all changes to the system negotiated and approved during the implementation period.

b. Configuration Testing:
   1) The Factory Acceptance Test for the support software shall include the following, as a minimum:
      (a) Demonstration of restoration of system using backup media.
      (b) Demonstration of system editing capabilities including the addition and deletion or modification of points in an RTU, displays, report formats, control strategies, and the modification of the database and all database parameters.
      (c) Demonstration of the editing of system parameters including timers, intervals, etc.
      (d) Demonstration of utility software facilities, including assembling, compiling, appending, and executing new programs.
(e) On-line program debug facilities shall also be demonstrated, including downloading of a program from the central system to a remote PLC/RTU.
(f) The FAT shall demonstrate compliance to each section in this specification.

c. System Performance Testing:
1) The System Performance verification shall demonstrate that the system meets the performance requirements specified in this specification.

6. System Testing:
a. The SCADA System Provider shall stage the entire system in an integrated Factory Acceptance Test. The following system components shall be used for FAT. All components shall be interconnected using the LAN equipment:
   1) All Workstations provided by this Contract
   2) All Printers provided by this Contract
   3) All communication equipment and PLC/RTUs provided by this Contract, with final configuration loaded. These PLC/RTU programs shall include all Communication Strategies for the individual communication channels.
   4) Complete SCADA Server provided by this Contract
   5) Web Server provided by this Contract
   6) Historian Server provided by this Contract
   7) PLC/RTU test set provided by the Integrator

7. Simulation Software:
a. The SCADA System Provider shall utilize software that simulates system loading conditions equivalent to the Steady State and Heavy load conditions defined in this specification.

8. 72 Hour Continuous Test:
a. After the successful completion of the functional testing specified above, a 72-hour continuous test of the system shall be initiated. The test shall be deemed successful if no system function is lost, no hardware or software failure occurs, and no module automatic failover occurs (unless instigated by testing efforts). Hardware failure is defined for this test as the loss of a major piece of hardware, such as a peripheral, monitor, processor, I/O board, etc. Software failures will include, but not be limited to, server or workstation “lockups” or failure to respond to operator input. During this test, the system shall be exercised with simulated inputs, events, and conditions in a manner similar to an operational environment. No software “patches” or changes will be allowed to bypass failed modules during this test. Any software and/or hardware correction made to the system shall result in the mandatory rerun of the entire 72-hour test. During the 72-hour period, at least 24 hours of unstructured testing shall be included, in which the Engineer or the end user’s representatives shall be allowed to operate the system without the SCADA System Provider’s supervision (SCADA System Provider may observe).

9. I/O Point Checkout:
a. The SCADA System Provider shall perform a checkout of selected I/O points as the SCADA system is installed. The SCADA System Provider will provide testing support at the Control Center. As each PLC/RTU is switched to the new SCADA system, the integrator will test a representative sample of the I/O present on the PLC/RTU. Up to 25% of the I/O on each PLC/RTU shall be tested to confirm the database setup and HMI graphic connection. The SCADA System Provider shall verify the tested points at the HMI database level and on the configured SCADA system screens. The testing shall be witnessed by the Engineer or end user’s Representative. The quantity of points selected for testing shall be controlled by the engineer, and shall be sufficient to confirm proper database configuration. Should improper database configuration be found during the testing process, additional testing shall be conducted at no additional costs to the project. Test signals shall be injected to verify the operation of the selected Analog Input (AI), and Discrete Input (DI) point. The signal injection point shall be at the field instrument for each Analog Input or Discrete Input. Each Analog Output (AO) and Discrete Output (DO) shall be also tested for proper operation, to
the Final Control Element. End-to-end testing shall use the process graphic displays to verify proper operation of the I/O points all the way to the Operator Workstation control console. I/O point checks will also verify the proper configuration of the Historical Data Storage and Alarm/Event Subsystems on the SCADA HMI Software. I/O point checks shall utilize final communications system and SCADA network. The SCADA software must be fully operational in order to conduct this test. The Contractor shall develop a complete I/O Point Checkout Test Procedure. The test procedure shall identify the method to be used by the Contractor for verifying the I/O signals in each database location. The Contractor shall develop a point checkout form for each I/O point. The point checkout form shall include the point ID, description, all checks performed for the point, date and time of the check, and a signoff block for both the Contractor's representative and the Engineers' representative. For each item checked, the form shall include both the expected value/result and the actual value/result witnessed.

1) For each analog input point tested, the following values shall be checked:
   (a) Value at 0% of full scale (ramped in both directions)
   (b) Value at 100% of full scale (ramped in both directions)
   (c) For each analog input tested and its associated alarms, verify that the testing signals are stored in the Historical Database, if the signal is designed for historical data collection, that each alarm is displayed on the alarm displays on the SCADA Software and that each alarm is shown on the hard-copy alarm log.
   (d) For each analog output point tested, the following values shall be checked:
      (1) Milliamp reading at 0% of full scale (ramped in both directions)
      (2) Milliamp reading at 100% of full scale (ramped in both directions).
   (e) For each analog output tested, verify that the change in each output is stored in the Replicated Database, Event Historian and that each event is shown on the hard-copy event log.
   (f) For each discrete input point tested, the following items shall be checked:
      (1) For status points, proper indication
      (2) For alarm points, proper alarm notification.
   (g) For each discrete input tested, verify that the testing signals are stored in the alarm/event historian, that each alarm is displayed on the alarm displays and each event on the event displays, and that each alarm/event is shown on the hard-copy alarm or event log.
   (h) For each discrete output point tested, the following items shall be checked:
      (1) Proper operation
      (2) Actuation time-out alarm (if value is entered in database).
   (i) For each discrete output, verify that the change in each output is stored in the Event Historian and that each event is shown on the hard-copy event log. The completed I/O Checkout forms for all points shall be included as part of the I/O Checkout Test Report to be prepared and submitted at the conclusion of all I/O checkout activities.

D. Site Acceptance Test (SAT):
   1. A Site Demonstration Test of the functions, software, and performance shall be conducted after all system elements have been installed and the I/O Point Checkout has been completed. The system site demonstration tests shall be performed to verify complete operation of the system, requiring a repeat of much of the comprehensive system tests but with the equipment installed at the permanent sites, and shall include additional tests required to verify field installed equipment, which was not available during the FAT. The SCADA System Provider shall:
      a. Verify all the facility installations.
b. Demonstrate each functional requirement identified by the specification. This demonstration shall repeat the tests used during FAT, but using real rather than simulated conditions.

c. Demonstrate all equipment control functions, including the operation of automatic control strategies. Actuation of field devices shall be closely coordinated with facility operations.

d. Verify system performance parameters and system responses under field operational conditions.

e. Verify accuracy of documentation, especially operator's manuals, software documentation, and general system operating instructions.

2. The SCADA System Provider shall provide the appropriate technical representatives for the execution of the Site Demonstration Test. The SCADA System Provider's test support personnel shall be qualified to resolve and correct problems encountered with the system during the tests. In addition to test support personnel, the SCADA System Provider shall provide all test instruments and equipment necessary to troubleshoot any of the SCADA System Provider's proposed system problems encountered. The Engineer reserves the right to increase the requirements for test support personnel if support by the SCADA System Provider is inadequate.

E. Demonstration

1. SCADA System Provider shall provide a qualified service representative to train Owner's maintenance personnel to adjust, operate, and maintain SCADA system as detailed below.

2. Site Availability Demonstration (SAD):

a. Test Requirements:
   1) At the completion of Site Acceptance Test, the Integrator will conduct a Site Availability Demonstration (SAD) test utilizing all equipment, software, and services provided under this Contract in the normal day-to-day operation of the water treatment plant. During the test the system shall meet the availability criteria defined below and shall meet the performance requirements stated in the specification. SCADA System Provider personnel may participate in any and all parts of this demonstration as observers at the discretion of SCADA System Provider.

b. Scope of Test:
   1) All equipment and software delivered with the system shall be subject to the availability measurements.

c. Test Equipment:
   1) The Site Availability Demonstration shall be performed under field operating conditions. All functional and performance requirements specified in this document shall be met during the SAD.

d. Length of Test:
   1) The system shall be subjected to Site Availability Demonstration evaluation for a period of not less than 60 days (1440 hours). If at the end of the 60 days, the system availability is determined to be less than that required, the test shall continue on a day-by-day basis, dropping off the oldest day's test results. This sliding window concept shall continue until the system passes the test or until 120 days' time has passed, at which time the facility shall have the right to pursue other avenues as specified under the contract.

e. Preventive Maintenance:
   1) During the Site Availability Demonstration period, the SCADA System Provider shall perform preventive maintenance of the type and the frequency of service defined in the SCADA System Provider-provided maintenance manuals. The SCADA System Provider shall supply a recommended maintenance plan prior to start of the test.
f. Test Prerequisites:
   1) Prerequisites to starting the SAD are successful completion of the Comprehensive System Test and the Site Demonstration Test and resolution of all outstanding Discrepancy Reports. In addition, the following documentation shall be on hand at the facility:
   2) Final copies of O&M manuals
   3) Final copies of System Operator's manuals
   4) Final copies of System Administrator manuals
   5) Final Record Documents (prior to conclusion of SAD).

g. Availability Definitions:
   1) Availability Formula:
      (a) The system availability shall be determined using the following formula:
      (1) Availability=Uptime/(Downtime+Uptime)
      (2) Where the detailed definition of terms is as described below:
      (3) Uptime means the total clock time from start to end of testing minus downtime and minus any suspension time that may be mutually agreed upon, as the testing is ongoing.
      (4) Downtime accrues in three ways as defined below:
      (5) Downtime accrues when one or more system functional capability required by the Specification cannot be performed due to failure of equipment or software provided and/or installed by SCADA System Provider. For failures that occur outside of 8:00 AM to 4:30 PM Monday through Friday, a four-hour travel time allowance will be made before downtime begins to accrue. It is the SCADA System Provider's responsibility to arrange suitable communications to enable the facility to promptly notify SCADA System Provider of failures.
      (6) Downtime accrues if the same piece (or redundant pair) of equipment fails more than twice in the same 168 hour period or more than three times during the entire test. In other words, repeated failover to backup equipment will not be allowed even though each individual failover action is successful and no functionality is lost.
      (7) Downtime accrues if backup equipment remains unavailable for more than a twelve-hour grace period, allotted for repair, after the initial failure. Accrual begins after the grace period allotted for repair.
      (b) System Availability Exclusions:
      (1) The following assumptions apply in the determination of system availability:
      (2) All end user provided facilities and auxiliary support equipment are assumed to be 100% available. Any periods of failure of such equipment will be treated, therefore, as Uptime.
      (3) Any downtime caused by actions of engineers or facilities personnel will not be counted.
      (4) Outage of the system caused by malfunction of equipment not supplied by the SCADA System Provider will not be considered as downtime, unless malfunction of equipment was caused by a malfunction of the SCADA System.
      (5) System downtime will not accrue for outages caused by failure of the facilities supplied power.
      (c) Test Suspensions:
      (1) The availability test may be placed in suspension on mutual agreement between engineer and SCADA System Provider for such reasons as:
      (2) Performing preventive maintenance on an item that is not redundant.
(3) SCADA System Provider requires time to analyze a repetitive failure situation.

(d) Record Keeping:
(1) Records of system maintenance and equipment/software failure with the times of occurrence will be maintained continuously by SCADA System Provider personnel.

(e) Corrective Action:
(1) All failures shall be analyzed to the extent necessary to provide a viable explanation. Recurrent failures may require the use of sophisticated hardware failure analysis techniques or software simulation. All such analysis shall be performed by the SCADA System Provider. Where such analysis indicates that a design modification is in order, such correction shall be completed by the SCADA System Provider and incorporated in all systems provided under the terms of the Contract by either retrofit or replacement. The availability demonstration shall be deemed successfully completed if the calculated availability for the system is equal to or greater than the specified availability requirement at the end of a 60-day period. If the calculated availability achieved during the demonstration period is less than that specified, corrective action shall be implemented, and the demonstration shall be continued until the required availability is met for 60 consecutive days (1440 hours).

(f) Site Availability Demonstration Considerations:
(1) The SCADA System Provider shall submit to the facility and engineer a recommended preventive maintenance schedule prior to the test run. The downtime resulting from an intermittent failure that causes a system trip but does not preclude an immediate restart, will be limited to the time that it takes to restart the system. However, repetitive occurrences of intermittent faults in either the on-line or the backup equipment shall constitute system failure until the flaw is corrected. Failure of backup hardware, if supplied, will not be considered downtime provided that this failure does not adversely affect the operation of the system. Uptime, under this condition, will continue while the backup hardware is being repaired. Alterations to the hardware/software shall not be permitted without the engineers and facilities approval. Replacement of failed boards is acceptable.

(g) Progress Reports:
(1) The SCADA System Provider will maintain the official record of operating time, recorded incidents and disposition, maintenance action, and calculated availability. At the completion of system availability demonstration, the SCADA System Provider shall prepare a separately bound test report for Engineer to evaluate and approve.

(h) Letter of System Acceptance:
(1) Upon review and approval of test report, the Engineer shall provide a letter of System Acceptance, which will be signed by all parties and serve as designation of the beginning of the warranty period.

F. Cutover Sequence:
1. Installation, field testing and cut-over shall consist of a sequence of activities and tests conducted as the SCADA components are installed and integrated at the job site.

G. Training:
1. Training Overview:
   a. A comprehensive training program shall be provided by the SCADA System Provider covering the operation and maintenance of all elements of the SCADA System.
Provider's proposed system. Several specific requirements for the training program are listed below:

1) Training classes shall be tailored to the specific needs of the class participants.
2) For training classes conducted on-site, spare PLCs / RTUs, spare workstations, and the development workstations and Server may be temporarily installed in a training area to be designated by the Facility.
3) All training classes shall be completed prior to the start of the Site Acceptance Test.
4) All instructors shall be highly qualified for technical training with demonstrated expertise in not only SCADA system functionality but also professional training techniques. During training, instructors should have no other duties that would interrupt training. Training shall not be combined with other activities such as system configuration or startup.
5) Complete, professional, training materials shall be provided for all training classes including course outline and schedule, training manuals (in addition to system documentation), and review/testing materials.
6) Training courses shall be a combination of classroom and hands-on training. To the extent possible, hands-on training shall utilize components from the SCADA System Provider's proposed system.

2. Training Plan
   a. The training plan shall include complete descriptions of all training classes, a preliminary training schedule, a list of all proposed instructors along with resumes, examples of proposed training manuals, and a description of any special training tools available (simulators, self-paced modules, personal computer-based training, etc.). The Engineer and Facilities staff will review the training plan for assurance that the training planned by the SCADA System Provider will meet the training needs.

3. System Specific Training
   a. Training Manuals:
      1) Comprehensive training manuals shall be professionally written to present the course material in a format that is easy to comprehend. The manuals shall serve as teaching aids during presentation of the training classes and shall additionally serve as reference material after the training has been completed. Portions of system documentation may be incorporated into training manuals provided that the overall manual achieves an instructional format. If the SCADA System Provider proposes to use standard training manuals, these manuals shall be appended to reflect system characteristics specific to the projects SCADA System.
   b. Required Training Courses:
      1) Training courses shall be tailored to meet the specific needs of facility personnel. Class sizes shall be restricted to the number of students that can easily be accommodated. Classes that involve extensive hands-on activities (such as operator training, maintenance training, and software engineering) shall be limited to five students per class. Supervisor and overview courses may include up to ten participants. Sufficient sessions of each course shall be presented to satisfy class size restrictions and conflicts in facility personnel scheduling. If the SCADA System Provider's standard training curriculum includes applicable courses in addition to those discussed below, the SCADA System Provider shall also provide these courses. Following is a description of the categories of training to be provided.
      2) Operator Training:
         (a) Training courses shall be presented that instruct the system operators in the efficient operation of all aspects of the SCADA. The course material shall include the general operation of the SCADA system, and the operation of the specific system features incorporated in the SCADA system. In
particular, the operator training shall include instruction on the use of all operational functionality.

(b) Software Maintenance Training:

(1) Training courses shall be presented that will enable facilities staff to develop and maintain all aspects of the system software. Separate sessions shall be presented that deal with the following topics:

(2) Process database development and modification
(3) Historical database development and modification
(4) Process display development and modification
(5) Supervisory Control strategy development and modification
(6) Report development and modification
(7) General software maintenance, including system backup, restoration and archiving.
(8) Calculation additions, alarm and event logging additions, Graphic display, report and trend additions
(9) Network training for adding additional equipment (printers, workstations, etc) or additional PLCs / RTUs and I/O from the SCADA Network
(10) Adding, editing, transporting and testing of data sent to historical database system
(11) Any Third party tools for accessing data from any database.
(12) These courses shall address the procedures for the standard SCADA system software, plus material explaining the specific conventions and procedures used by the SCADA System Provider in developing the SCADA applications. The courses shall provide instruction in techniques for developing and maintaining current, comprehensive documentation for all applications.

END OF SECTION
SECTION 26 05 02
ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.01 SCOPE OF WORK
A. Furnish all labor, material, equipment, fees, services and permits to install the complete electrical system as shown on the Drawings and Specifications. Upon completion of construction, the system shall be in perfect working condition.

1.02 GENERAL INFORMATION
A. All electrical equipment shall be installed in a practical manner to function properly, to be easily maintainable, and to fit building construction requirements. All Drawings are diagrammatic and the Contractor shall use judgement to interpret these Drawings accordingly. Items not shown or specified which are required to produce a complete, operative and finished system shall be provided by the Contractor at no additional cost.
B. Contractor shall be responsible for coordinating the work with the local electric utility. As requested by the electric utility, the contractor shall provide construction documents and projected loads.

1.03 GENERAL CONDITIONS AND APPLICABLE SECTIONS
A. All conditions and other pertinent Sections of these Specifications shall be reviewed by the Contractor. All parts of these Specifications (including sections covering other trades) concerning the electrical installation shall be complied with every respect. It shall be the responsibility of the Electrical Contractor to be familiar with the complete set of Drawings and Specifications.

1.04 REGULATORY REQUIREMENTS
A. The installation of all work is to be done in strict accordance with all applicable local ordinances and state statutes. In case of conflict, the code having immediate jurisdiction is to govern. The methods to be used in the installation of the equipment and materials must meet or exceed these requirements. Statements in the Specifications or on the Drawings are not to be construed to permit deviation from the requirements of the governing codes and standards. Where the application of a standard or code appears to be in conflict with the requirements of the Contract Documents, the Engineer will determine which will govern.
B. Codes: Requirements of the following codes shall be minimum standard except where the Drawings and Specifications dictate a more stringent requirement. Where differences exist between these codes, the most stringent shall apply.
   1. The National Electric Code (NEC), latest edition, as amended or supplemented by the authority having local jurisdiction over this project.
   3. Occupational Safety and Health Administration (OSHA), as contained in the Code of Federal Regulations, Title 29, Part 1910, Subpart S.
C. When the minimum requirements of the Drawings and Specifications exceed code requirements, the Drawings and Specifications shall be used to determine the minimum requirements.

1.05 PERMITS
A. All permits that are legally required to execute this contract shall be obtained and paid for by the Contractor.

1.06 MISCELLANEOUS COSTS
A. All fees or charges on this project by outside agencies such as: the local utility company, other contractors, consultants, etc., shall be the responsibility of the Contractor.
1.07 DESCRIPTION OF WORK

A. The work covered by this Specification shall include all labor, equipment, fees, services and permits required to install the complete electrical system as shown on the Drawings and detailed herein. The work shall include, but shall not be limited to, the following:
1. Installation of the facility lighting and electrical service including main service, conductors, conduit, panelboards, and other electrical equipment as shown on the Drawings. The facility's electrical service shall be as shown on the drawings.
2. Motor control centers.
3. Medium voltage (24.9 KV) equipment.
4. Padmount transformers.
5. Medium voltage metal clad switchgear.
6. Grounding systems.
7. PLC based controllers with HMIs.
8. Fiber optic cabling.
9. Scada system.

1.08 DRAWINGS

A. The Drawings are an integral part of the Drawings and Specifications and everything indicated on the Drawings or in the Specifications shall be part of the Contract. In addition, all labor and materials required to provide a complete and workable installation for all the various electrical systems, shall be included in the Contractor's bid, even though each item involved is not necessarily mentioned or shown. In this situation, all materials shall be an equivalent quality as the material shown or specified for each system.

B. If any errors, omissions or obscurities are encountered in the Drawings or Specifications, the Contractor shall promptly notify the Engineer and request directions.

1.09 SUBSTITUTION OF EQUIPMENT

A. Substitutions - See Section 01600 - Product Requirements.

B. Certain manufacturer's trade names are designated herein for the purpose of setting standards of quality, design, dimensions, and to provide a standardization of spare parts.

1.10 SYSTEM TEST

A. An operating test shall be conducted after the installation is complete, and at such time as the Engineer may direct. A demonstration showing that the equipment will operate in accordance with these Specifications is required. The test will be performed in the presence of the Engineer or his designated representative. This test shall also include testing of any ground fault devices in accordance with manufacturer's recommendations. All instruments and personnel required to perform this test shall be furnished by the Contractor, and the power will be furnished by the Owner.

1.11 SUBMITTALS

A. Within ten (10) days of award of contract, the successful bidder shall present to the Owner a list of equipment, manufacturers and Subcontractors he/she proposes to use on this project.

B. The Contractor shall provide six (6) copies of manufacturer's brochures detailing ratings, dimensions, power requirements, etc., of the proposed equipment. This shall be provided within thirty (30) days of award of contract and shall be bound into one complete set. The brochures shall be indexed and tabulated, with all equipment identified as designated on the Drawings and with all pertinent data clearly indicated.

C. The cover sheet of each separate brochure shall be stamped showing job title, Contractor's name, and date. Each page containing pertinent data shall be so stamped, with the supporting information on equipment underlined or otherwise noted. The name and number of each piece of equipment shall also be noted. A separate sheet shall be submitted for each piece of equipment. Unless a different submittal format has been previously approved by the Owner, all
D. Descriptive data shall be included showing dimensions, voltage rating, current rating, weight, capacity, delivery time, and other pertinent data. Data shall be submitted in a timely manner so that no delay is caused. The Owner reserves the right to go directly to the manufacturer to obtain any details he considers necessary, if the Contractor fails to comply. Any cost incurred because of this failure, shall be borne by the Contractor.

E. If the equipment presented has different characteristics than specified, or operating characteristics are affected because of equipment substitution, computations shall be presented to clearly show the effect and the proposed solution. The Contractor bears the burden of proof of equality of equipment. Equipment not meeting specification requirements shall not be approved and disapproval will not be cause for the Contractor to change his/her bid. Materials not approved shall be revised and resubmitted within ten (10) days.

F. Submittal approval does not void the requirements of conformance with Drawings and Specifications. All submittals shall be thoroughly checked by the Contractor for proper dimensions, voltage, quantities, etc.

G. Before ordering the following equipment, the Contractor shall make submittals:
   1. Lighting and distribution panelboards
   2. Lighting fixtures and mounting brackets
   3. Wiring devices
   4. Conduit and conduit fittings
   5. Wire
   6. Safety switches and fuses
   7. Misc. starters and control stations
   8. Switchboards
   9. Variable Frequency Drives
  10. Programmable Logic Controllers
  11. HMI
  12. Motor Control Centers
  13. PLC based control systems and integration
  14. Scada system

1.12 WET AND CORROSIVE LOCATIONS
   A. In exterior areas and interior "wet and corrosive areas" all equipment shall be equipped with weatherproof stainless steel enclosures.
   B. In wet and corrosive locations, all rods and miscellaneous material shall be either aluminum or stainless steel. No galvanized or painted metal shall be allowed in these locations.

1.13 GUARANTEE
   A. A written certificate shall be furnished guaranteeing all materials, equipment and labor furnished to be free of all defects for a period of one (1) year after the date of final acceptance of the work by the Owner. If any defects appear within this stipulated time, such repair/replacement shall be completed without charge.

PART 2 PRODUCTS
2.01 GENERAL REQUIREMENTS
   A. All materials and equipment shall conform to standards set by National Electric Code (NEC), Underwriter's Laboratories, state and local agencies. Materials shall be new and of equal or greater quality than those specified.
   B. All miscellaneous hardware and materials used for mounting and installation of the electric system shall be aluminum, stainless steel or pvc coated.
PART 3 EXECUTION

3.01 GENERAL INFORMATION
A. Cooperation with all other individuals involved on this project is required to insure that the work will properly fit the building and other Contractors' requirements are met.
B. Circuit sizes and electrical requirements of equipment specified under other sections of these specifications shall be verified by the Contractor to ensure that their requirements are consistent with the Drawings. If a discrepancy exists, it shall be brought to the Engineer's attention before proceeding with the work.
C. Coordinate all electrical work with architectural and other trades, to insure proper execution of work and general progress for the entire project.

3.02 DRAWINGS
A. The general arrangement of conduits and wiring in the conduits are shown on the electrical Drawings in a manner as to be a guide to the Contractor. Certain special equipment requirements and larger conduits are detailed. Dimensions on the Drawings are to be utilized to determine the rough-in locations. Exact locations shall be determined by the Contractor in the field giving consideration to piping and equipment location requirements of other contractors. The Contractor shall make his/her own field measurements and assumes full responsibility of same.

3.03 MINOR LOCATION CHANGES
A. Minor location changes of switches, receptacles, and miscellaneous outlets shall be permitted to be made by the Engineer, or Owner prior to roughing in, where construction conflicts or operation advantage warrant the change. These minor changes shall be made at no cost by the Contractor.

3.04 LOCATIONS
A. The locations of equipment furnished under other sections of the specifications shall be located by referring to other Contractor's shop drawings prior to locating. The outlines of equipment shown on the Mechanical and Electrical Drawings are intended only as a guide to indicate relative locations of the electrical work. Refer to Architectural and Structural Drawings for construction details. If conflicts prevent installation of electrical work at the locations indicated, deviations shall be made subject to acceptance by the Engineer, and without compensation.

3.05 GROUPING OF CIRCUITS
A. Shown diagrammatically on the Drawings are circuit grouping, cable or conduit runs, and home runs. The number of conductors are shown to clarify the operation of each system. Proper conductors and conduits shall be installed by the Contractor to produce an operative system as detailed by the Drawings and Specifications.

3.06 HOME RUNS
A. All home runs shall be circuited as shown on the Drawings unless approval is obtained from the Engineer. The alternative presented must show exact conduit routing, junction box location and total circuit wattage. If the change is accepted by the Engineer, the Contractor shall note all appropriate information on the record drawing. No two ungrounded conductors shall be connected to the same ungrounded phase in the panel. No sharing of neutrals is allowed.

3.07 CONDUIT
A. All conduits installed shall be neat, parallel to building lines, and properly anchored. All conduit sleeves and fittings shall be furnished and installed by the Contractor.

3.08 EQUIPMENT BY OTHERS - INSTALLED AND WIRED BY ELECTRICAL CONTRACTOR
A. The wiring for all electrical equipment including motors and other electrically operated equipment specified in other sections of the Specifications shall be furnished and installed by the Contractor unless otherwise noted. All circuits shall be completed and left in satisfactory working condition except where noted on the Drawings or in other Sections. The suitability of
equipment supplied by other trades shall be checked by the Contractor by consulting wiring diagrams. The Electrical Subcontractor shall supply and install all cords and plugs necessary for equipment connections.

B. The Contractor shall furnish all labor and materials for rough-in and final connections to electrical equipment including disconnect switches, wiring, conduit, outlets and plates and other material not specified in the other equipment sections under the individual item, but necessary for a complete and working system. Any of the above items specified under other equipment sections shall be furnished loose to the Electrical Subcontractor for installation.

C. No additional compensation shall be considered for failure to properly interpret responsibility of other trades.

D. The Contractor shall locate all equipment by consulting shop drawings and coordinating locations with other trades, Owner and General Contractor.

3.09 CONTROL WIRING

A. The Electrical Subcontractor shall furnish and install all control wiring as required on this project. This shall include, but not be limited to control wiring as shown on the drawings and shall also include control wiring for equipment being supplied by others on this project.

3.10 CUTTING AND PATCHING

A. Workmen skilled in the particular trade involved shall make all patches of other work, where required. The right is reserved to have the Contractor whose work is involved to make the repair, and backcharge the Contractor responsible for the damage.

3.11 EQUIPMENT NAMEPLATES

A. Permanent nameplates shall be furnished and installed by the Contractor for each electrical device other than lighting outlets, wall switches and convenience receptacles. In addition, each component unit mounted on a panel or cabinet shall have a permanent nameplate. The name or legend as approved by the Engineer shall be engraved on the nameplate. In addition, the fuse, breaker or main lug only size shall be engraved on the nameplate. It shall be permanently attached with machine screws or sheet metal screws, and shall in general be no smaller than 3/4" x 2". Nameplates may be white core laminated bakelit or plastic; however, all nameplates shall be of the same type with same type engraving.

3.12 INSTALLATION

A. All penetrations by electrical raceways or equipment through walls or floors shall be sealed with fire retardant silicone foam equal to CTC PR 855 as supplied by Chase Technology Corporation, or with 3M Fire Barrier CP 25 Caulk and Fire Barrier Putty 303 as manufactured by the Electro-Products Division of the 3M Company or with Firestop Caulk as manufactured by Nelson Electric, a unit of General Signal.

B. Installer shall have the technical qualifications, experience, trained personnel and facilities to accomplish the installation in accordance with manufacturer’s instructions and the best practices of the trade.

3.13 TEMPORARY CONSTRUCTION FACILITIES

A. Furnish and install temporary power and lighting, as the needs require, for construction and safety purposes. It shall be the responsibility of the Contractor to obtain and pay for any utility charges associated with “construction power”.

3.14 DAMAGED AND DEFECTIVE WORK

A. Remove and replace damaged and defective work or materials, as directed by the Engineer, with no extra compensation. All repairs to the work shall be made with new materials or a complete new piece of equipment shall be provided, as directed by the Engineer.

3.15 OPERATING MANUALS

A. Provide the Engineer with four copies of hard bound manuals for the project, ten days prior to final acceptance of completion of the project. Manuals shall include copies of all corrected and
approved shop drawings, schedules, catalog data, illustrations, performance curves, rating
data, wiring diagrams, control diagrams, manufacturer's recommendations, operating
instructions, maintenance instructions, spare parts lists, and other pertinent information for the
specified equipment and systems. Manuals shall include a type written schedule of each motor,
giving nameplate data, switch and fuse/breaker size and voltage, and phase(s) at motor
terminals.

3.16 RECORD DRAWINGS

A. The Electrical Contractor shall be responsible for maintaining record drawings showing all
deviations from the electrical plans. This record set shall not be used for construction, and shall
be dedicated solely to maintaining an accurate record of the electrical construction. Upon
completion of the work, these Record Drawings shall be turned over to the Owner.

3.17 CLEANING

A. The Contractor shall help keep the Project neat and daily remove debris caused by his/her
work.

END OF SECTION
SECTION 26 05 03
ELECTRICAL MATERIALS AND METHODS

PART 1 MATERIALS AND WORKMANSHIP

1.01 MATERIALS
A. All materials supplied must meet all provisions of the Drawings and Specifications and shall be new.
B. The Engineer must approve any material not represented with a catalog number or quality standard.
C. All material shall be shipped to the job site in the original container which shall be properly marked with the size, type and dates of inspection and shipment.
D. All materials shall be the latest design of that manufacturer.

1.02 WORKMANSHIP
A. Workmen skilled in electrical work shall be utilized on this project. Careless or improper workmanship shall be reworked/repainted at no cost to the Owner. The Engineer shall make all determinations on quality of workmanship.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 INSTALLATION
A. For all wiring installations specified herein, or noted on the Drawings, all wiring shall be installed in raceways. The Contractor shall avail himself of the detailed drawing sheets for information relating to slab thickness, reinforcing, column sites, finish lines, chases, ceiling construction and finishes, and shall be guided accordingly in the installation of his work.

END OF SECTION
SECTION 26 05 05
SELECTIVE DEMOLITION FOR ELECTRICAL

PART 1 GENERAL
1.01 SECTION INCLUDES
A. Electrical demolition.

PART 3 EXECUTION
2.01 EXAMINATION
A. Verify that abandoned wiring and equipment serve only abandoned facilities.
B. Beginning of demolition means installer accepts existing conditions.

2.02 PREPARATION
A. Disconnect electrical systems in walls, floors, and ceilings to be removed.
B. All outages shall be closely coordinated with the Owner. Outages shall not interfere with the Owner's normal operation and shall be scheduled for Owner's non-production hours.
C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
D. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.

2.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK
A. Remove, relocate, and extend existing installations to accommodate new construction.
B. Remove abandoned wiring to source of supply. This shall include both conduit/wiring abandoned on this project and any existing abandoned conduit/wiring discovered during the course of this project.
C. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
D. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.
E. Remove any abandoned control panels.
F. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
G. Repair adjacent construction and finishes damaged during demolition and extension work.
H. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.

2.04 CLEANING AND REPAIR
A. Clean and repair existing materials and equipment that remain or that are to be reused.
B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

END OF SECTION
SECTION 26 05 19
POWER WIRES AND CONNECTORS

PART 1 GENERAL

1.01 DESCRIPTION OF WORK
   A. Electrical power wire and cable systems shall include all wire, cable, connectors and other
      accessories required to provide the complete power system indicated on the Drawings and
      Schedules.

1.02 QUALITY ASSURANCE
   A. Wire, cable and connectors shall comply with all applicable standards.

PART 2 PRODUCTS

2.01 CONDUCTORS
   A. All wire and cable shall meet the requirements of the latest edition of the National Electric Code
      (NEC) and shall be soft drawn copper unless otherwise noted. Wire and cable shall be new and
      permanently marked with size, grade of insulation, voltage and manufacturer's name on outer
      covering at regular intervals.
   
   B. Each conductor and the neutral conductor shall be factory color coded with a separate color for
      each. The color code indicated below shall be used consistently throughout the electrical
      system installation, unless otherwise specified:
      1. Phase  480 V  240 V  208 V
         2. A  Brown  Black  Black
         3. B  Orange  Orange  Red
         4. C  Yellow  Blue  Blue
         5. Neutral  Gray w/ White Tape  White  White
         6. Ground  Green  Green  Green
   
   C. Type THWN or THHN wire shall be installed in raceways above grade in permanent dry
      locations.
   
   D. Type THW or THWN wire shall be used in raceways exposed to moisture, in concrete slabs on
      fill or below grade.

2.02 MEDIUM VOLTAGE CONDUCTORS
   A. Medium voltage conductors shall be as specified on the drawings.
      1. Terminations, elbow connectors and other hardware shall be suitable for the installation
         and rated for the system voltage,

2.03 CONNECTORS
   A. Connectors on circuits with copper conductors shall be power cable compression type, hex
      screw, or bolt clamp type. Connectors shall be highly conductive and corrosion resistant
      material.
   
   B. Connectors for cable sizes 250 kcmil and larger shall have not less than two clamping elements
      or compression indents.
   
   C. Splices and joints shall be insulated with material approved for the particular use, location,
      voltage and temperature.

PART 3 EXECUTION

3.01 INSTALLATION
   A. All cable shall be continuous from origin to panel or equipment termination without running
      splice unless otherwise specified.
   
   B. No more than three circuits shall be contained in each home run for branch circuits, unless
      otherwise noted on the Drawings.
C. Wraparound labels with numbering designations shall mark control wiring in each box and at each termination. It shall correspond with a detailed wiring diagram. All control wiring shall be stranded.

D. The Contractor shall use due care to prevent damage to the conductor and insulation during installation. Conductors shall not be installed in conduit or raceways until the raceway system is complete.

E. The Contractor is required to conduct insulation tests with a 500 volt DC megger after installation is complete. This test will be performed in the presence of the Owner, and the Contractor shall furnish all equipment and personnel necessary to conduct the test.

END OF SECTION
SECTION 26 05 26
GROUNDING AND BONDING

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Grounding electrodes.
   B. Grounding conductors.
   C. Equipment grounding conductors.
   D. Bonding.

1.02 REFERENCES
   A. ANSI/NFPA 70 - National Electrical Code
   B. IEEE Std 80-1986
   C. IEEE Std 837-1989

1.03 SYSTEM DESCRIPTION
   A. Furnish all labor, materials, services, and equipment required in conjunction with a grounding system as indicated in the Contract Documents.

1.04 QUALITY ASSURANCE
   A. Installer Qualifications.
      1. An electrician experienced in the type of work to be performed shall be designated as Field Supervisor and shall be present at the site during all working hours.
   B. Regulatory Requirements.
      1. Applicable provisions of NFPA 70.
      2. Provisions specified in this Section.
      3. Manufacturing workmanship and materials shall comply with applicable provisions of NEMA, ANSI, ICEA and UL Standards.
      4. Electrical equipment shall be UL listed and comply with UL standards in all cases where UL has published lists and standards applicable to the type of equipment required to be provided.

PART 2 PRODUCTS

2.01 GROUND RODS
   A. UL listed copper bonded steel, 5/8 inch diameter by 10 feet long.
   B. Acceptable Manufacturers:
      1. Blackburn, St. Louis, MO
      2. Carolina Galvanizing, Aberdeen, NC
      3. Knight Metalcraft, Portland, TN

2.02 GROUNDING ELECTRODE CABLE
   A. Bare stranded soft temper copper, ASTM B3. Cable to be sized per National Electric Code requirements.

2.03 GROUNDING CONDUCTORS
   A. Size equipment ground conductors as indicated on Drawings. If the size is not indicated, size in accordance with NFPA 70, NEC TABLE 250-94 and 250-95.
   B. THW insulated copper: ASTM B3
   C. Conductors #10 AWG and smaller: Solid
   D. Conductors #8 AWG and larger: Concentric stranded
   E. Color code: Equipment grounds shall have green colored insulation or a green tape band at the end of the conductors.
2.04 GROUND CONNECTIONS

A. All conductor to conductor, conductor to ground rod and conductor to structure connections of #6 AWG and larger sized conductors shall be permanent CADWELD exothermic welded connections. Ground conductors spliced with a CADWELD exothermic welded connection shall be considered as a continuous conductor. All grounding connections to equipment shall use bolted lugs. When the conductor is #6 or larger, the lug shall be joined to the conductor by CADWELD exothermic process.

B. All connections of #8 AWG and smaller and all connections to conduit, equipment or other items where the ground conductor must be removable shall be made using mechanical connections.

C. All mechanical ground connectors shall be UL listed and shall be certified to have been tested to and passing IEEE Std 837-1989 for both above grade and below grade installations. If not certified to IEEE Std 837-1989, the conductor shall be sized using the fusing formula in IEEE Std 80-1986.

D. Acceptable Manufacturers:
   1. AMP Inc., Harrisburg, PA
   2. Burndy Corp., Norwalk, CT
   3. ERICO Products, Inc., Cleveland, OH
   4. T & B Corp., Bridgewater, NJ

PART 3 EXECUTION

3.01 GENERAL

A. Provide positive grounding of AC system neutrals, electrical equipment and enclosures and conductor enclosure systems (conduit, wireways, etc.) at main disconnect device. Provide an effective, permanent and continuous grounding path for circuits, equipment and conductor enclosures. The grounding path must have the capacity to conduct safely fault current likely to be imposed on it, and which shall have sufficiently low impedance to limit voltage to ground and to facilitate operation of circuit protective devices in the circuit. Clean all contact surfaces to which ground connections are to be made. Remove nonconductive coatings such as paint, lacquer and oil film from threads and other contact surfaces to assure electrical connection and continuity. Make connections to insure a permanent and effective electrical connection. Make connections to equipment and equipment enclosures with terminal lugs welded to the conductor with the CADWELD Process.

3.02 GROUNDING ELECTRODE SYSTEM

A. Main Grounding Electrodes.
   1. The grounding electrode system shall be as noted below and shown on the Drawings. All electrodes from all sub-systems shall be bonded together. Separate and isolated electrodes shall not be utilized anywhere!
      a. Natural Electrodes.
         1) A metal underground water pipe in direct contact with the earth for 10 feet (3 meters) or more. The electrical path shall not contain any insulated joints.
         2) The metal frame of a building or structure which is intentionally connected to the earth through one or more ground connections of sufficiently low impedance and having sufficient current-carrying capacity to conduct any possible voltage that may occur.

B. Man Made Electrodes
   1. All Man Made Electrodes shall be free of paint, varnish or any other non-conductive coatings. When more than one electrode is used, each electrode shall be at least 10 feet(1.8 meters) from any electrode of another sub-system. Further, all sub-system electrodes shall be bonded together.
      a. Rod Electrodes.
1) Rod electrodes of iron or steel shall have their outer surface coated to inhibit corrosion and shall be at least 5/8 inch (15.9 mm) in diameter. The rod electrodes shall not be less than 8 feet long.

2. The electrode shall be installed in a vertical position and at least 8 feet (2.4 m) of length is in contact with the soil. When rock bottom is encountered preventing vertical installation to 8 feet (2.4 m), the rod may be driven at an angle not exceeding 45 degrees from the vertical. The top of the rod shall be at or below grade.

C. Gas Piping:
1. Metal gas piping system shall not be used as a grounding electrode.

D. Bonding:
1. Bond building structural steel, metallic water piping, fire protection piping, chilled water piping and heating piping to the main grounding electrodes. All electrodes shall be bonded together. Use pipe clamps to connect to pipes. Use stranded bare copper for the bonding conductor.

3.03 EQUIPMENT AND ENCLOSURE GROUNDING SYSTEM

A. Make mechanical connections and couplings on metal conduit systems and to enclosures wrench tight. On metallic conduits for circuits rated 100 amperes and higher, install grounding bushings at switchboards, panelboards and pull boxes and connect to panel or switchboard grounding lug or the next grounding bushing in the pull box. Use continuous copper conductor sized in accordance with NEC Table 250-95. Install green insulated equipment ground wire sized in accordance with NEC Table 250-95 or as indicated. On circuits over 250 volts to ground, install grounding bushings where the metal conduits enter enclosures through concentric, eccentric or oversize knockouts in accordance with NEC Article 250-76. Connect bonding jumper sized in accordance with NEC Table 250-95 to enclosure ground point and adjacent grounding bushings.

3.04 TESTING

A. The Contractor shall perform a test of the grounding network after it has been installed and before any equipment has been placed in operation. The resistance between absolute earth and the grounding electrode system shall not exceed 25.0 ohms. The Electrical Subcontractor shall be responsible for installing two additional 10 foot driven ground rods within 50 feet of the transformer pad if the test results exceed 25.0 ohms. This shall include the necessary grounding electrode conductor.

END OF SECTION
SECTION 26 05 34
RACEWAYS, CONDUITS, AND TRENCHES

PART I GENERAL

1.01 DESCRIPTION OF WORK

A. An electrical conduit system shall be furnished and installed in accordance with the Drawings and the following Specifications. Conduit shall include all fittings and supports.

1.02 QUALITY ASSURANCE

A. Electrical conduit and associated materials shall conform with the requirements of all applicable standards.

PART 2 PRODUCTS

2.01 CONDUIT

A. PVC coated galvanized rigid steel conduit may be used for underground or in poured concrete and shall be used in all electrically hazardous locations.

B. Three-fourths (3/4") inch shall be the minimum size conduit allowed.

C. Rigid nonmetallic conduit may be used for service entrance, feeders, and branch circuits with the following specific requirements:
   1. Conduit will be Schedule 40 PVC
   2. The conduit shall be embedded in the soil below the aggregate and shall be at least 12 inches below floor surface.
   3. PVC conduits shall not be used in suspended floor slabs.
   4. All conduit bends subject to physical damage and turning up through the floor shall be PVC coated galvanized rigid steel.
   5. A grounding conductor shall be provided in each conduit.

D. Aluminum rigid conduit shall be utilized in all exterior above-grade locations and in all wet and corrosive interior locations.

E. In wet and corrosive locations, all sealights shall be Carflex manufactured by Carlon, and all fittings shall be by Carlon and shall be liquid tight, non-metallic.

F. EMT may be used in office areas, toilets and laboratories, unless otherwise specified. Fittings shall be compression type, set-screw fittings are not acceptable.

G. A grounding conductor shall be installed in each conduit. Conduit shall not be used as a grounding conductor.

H. An individual neutral conductor will be run with each 120 volt or 277 volt, single phase, single pole circuit

2.02 CONDUIT FITTINGS

A. Conduit, elbows and couplings shall be as manufactured by the Youngstown Sheet and Tube Company or approved equal.

PART 3 EXECUTION

3.01 INSTALLATION

A. Conduit systems shall be continuous from outlet to outlet, from outlets to cabinets and pull or junction boxes. They shall be rigid steel, electrical metallic tubing (EMT), rigid nonmetallic polyvinyl (PVC), or polyvinyl chloride coated rigid electrical conduit as specified herein or as indicated on the Drawings. Lock nuts and bushings shall secure the system in such a way as to be electrically continuous throughout. Conduit ends shall be capped to prevent entrance of foreign materials during construction.

B. Conduits shall be run parallel to building lines and long sweep bends shall be utilized.
C. If No. 4 or larger conductors enter a cabinet, pullbox, junction box or auxiliary gutter, the conductors shall be protected by a bushing. Also, on all conduits one and one-fourth inches (1 1/4") and larger, insulated bushings shall be utilized.

D. Ropes shall be installed in all empty or spare conduits to facilitate the pulling of future conductors.

E. The Contractor shall provide sleeves and inserts, correctly located in the structure, as required for his/her work.
   1. Inserts shall be steel and of proper size for loads encountered.
   2. Sleeves shall be provided for all conduit passing through concrete or masonry walls, partitions, concrete slabs or beams. Install during construction to avoid later cutting. Sleeves placed horizontally in walls or in any position in beams shall be standard weight ASTM A-5E steel pipe or length equal to thickness of wall or beam. Those placed vertically in non-waterproof floors shall be 20 gauge galvanized sheet steel of length equal to thickness of slab, flared and nailed to the form, or fastened to reinforcing fabric and filled with sand during pouring to prevent deformation. Sleeves in floors with waterproof membrane shall be provided with flanges or flashing rings and shall be clamped or flashed into the membrane. All sleeves shall be of sufficient diameter to clear conduit by 1/4" all around except sleeves on lines subject to movement by expansion shall clear the conduit by at least 1" all around.
   3. Sleeves around conduit through exterior walls shall be caulked watertight with oakum and plastic cement.

F. Equipment shall be installed in accordance with manufacturer's recommendations to conform with the details and applications indicated.
   1. Provide necessary support for all equipment and appurtenances as required. This includes, but is not limited to, frames or supports for items such as transformers, fans, electrical panels and other similar items requiring supports. Floor mounted equipment shall be set on a 4" high concrete housekeeping pad.
   2. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment.

3.02 TRENCHING

A. Whenever possible, all exterior low voltage conduit and wiring systems shall be installed with a minimum of 30" of cover, unless shown otherwise. Banks of trenches shall be kept as vertical as practicable, and where required, shall be properly sheeted and braced. Rock shall be excavated to a minimum depth of 4" below trench depth specified. Over-depth shall be backfilled with loose moist sand and thoroughly tamped. Any water accumulated in the trench shall be removed by pumping before backfilling commences.

B. Trenches for medium voltage conduit (24.9 KV) shall be installed with a minimum of 48" of cover. Refer to drawings for concrete encasement and other requirements. Banks of trenches shall be kept as vertical as practicable, and where required, shall be properly sheeted and braced. Rock shall be excavated to a minimum depth of 4" below trench depth specified. Over-depth shall be backfilled with loose moist sand and thoroughly tamped. Any water accumulated in the trench shall be removed by pumping before backfilling commences.

C. Trenches shall be backfilled with excavated materials approved for backfilling or other materials free from large clods of earth or stone, deposited in thoroughly and carefully compacted 6" layers, until the conductor/conduit has a cover of not less than 18". The remainder of the material shall be backfilled into the trench, moistened, and tamped in 12" layers.

D. Existing utility lines to be retained, whether known or uncovered during excavation operations, shall be protected from damage during operations, shall be protected from damage during excavation and backfilling and, if damaged, shall be restored to original condition.

END OF SECTION
SECTION 26 12 00
PAD MOUNTED TRANSFORMERS

PART 1 GENERAL

1.01 DESCRIPTION OF WORK
A. The Contractor shall furnish and install the pad mounted transformer(s) as specified herein and as shown on the contract drawings.

1.02 REFERENCES
A. The pad mounted transformer(s) and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of NEMA and ANSI.

1.03 QUALITY ASSURANCE
A. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
B. Transformers shall be provided by:
   1. ABB
   2. Square D (Transformer must be built by ABB)
   3. Cooper

PART 2 PRODUCTS

2.01 RATINGS
A. The ratings of the transformer shall be as follows or as shown on the drawings:
   1. kVA Rating - As Shown on the Drawings/ OA
   2. HV - 24.9 kV Delta
   3. HV BIL - 95 kV
   4. HV Taps + 2.2 1/2% full capacity
   5. LV - As Shown on the Drawings - Grounded Wye
   6. LV BIL - 30 kV

2.02 CONSTRUCTION
A. The unit shall be mineral oil filled and shall be in accordance with the latest edition of the NEC. The transformer shall carry its continuous rating with average winding or temperature rise by resistance that shall not exceed 65 degree C rise, based on an average ambient of 300C over 24 hours with a maximum of 400C. (the transformer shall carry its continuous rating with average winding temperature rise by resistance that shall not exceed 550C, based on average ambient of 300C over 24 hours with a maximum of 400C. The insulation system shall allow an additional 12% kVA output at 650C average winding temperature rise by resistance, on a continuous basis, without any decrease in normal transformer life.
B. The transformer shall be designed to meet the sound level standards for liquid transformers as defined in NEMA and ANSI.
C. All high-voltage windings shall have insuldur paper or equal insulation between layers of the windings. All windings shall be copper.
D. The main transformer tank and attached components shall be designed to withstand pressures 25% greater than the required operating design value without permanent deformation. Construction shall consist of carbon steel plate reinforced with external sidewall braces. All seams and joints shall be continuously welded. Each radiator assembly shall be individually welded and receive a quality control pressurized check for leaks. The entire tank assembly shall receive a similar leak test before tanking. A final six-hour leak test shall be performed.
E. The transformer(s) shall be compartmental type, self-cooled, and tamper resistant for mounting on a pad. The unit shall restrict the entry of water (other than flood water) into the compartments so as not to impair its operation. There shall be no exposed screws, bolts, or other fastening devices which are externally removable. The transformer(s) shall consist of a transformer tank and full-height, bolt-on high- and low-voltage cable terminating compartments located side-by-side separated by a rigid metal barrier. Each compartment shall have separate doors, designed to provide access to the high-voltage compartment only after the low-voltage has been opened. There shall be at least one additional fastening device accessible only after the low-voltage door has been opened, which must be removed to open the high-voltage door. Doors shall be mounted flush with the cabinet frame. The low-voltage door shall have a handle-operated, three-point latching mechanism designed to be secured with a single padlock. A hex-head bolt shall be incorporated into the low voltage door latching mechanism. Both high- and low-voltage doors shall be incorporated into the low voltage door latching mechanism. Both high- and low-voltage doors shall be equipped with liftoff type stainless steel hinges and door stops to secure them in the open position.

F. Compartments, doors and covers shall be removable to facilitate cable pulling and installation. The high-voltage door shall be on the left with the low-voltage door on the right. Compartments shall be designed for cable entry from below and shall be sized to the minimum dimensions of ANSI C57.12.26.

G. Transformer(s) shall be supplied with a welded or bolted main tank cover and be of a sealed-tank construction designed to withstand a pressure of 7 psig without permanent distortion. The tank cover shall be domed to shed water and be supplied with a tamper-resistant access handhole sized to allow access to internal bushing and switch connections. The transformer shall remain effectively sealed for a top-oil temperature of -50C to 1050C. When necessary to meet the temperature rise rating specified above, flat cooling panels of the common header type shall be provided.

H. The transformer manufacturer shall certify that the transformer is Non-PCB containing no detectable PCBs. Do not provide nonflammable transformer liquids including askarel and insulating liquids containing tetrachloroethylene, perchloroethylene, chlorine compounds, or halogenated compounds.

I. When high-voltage taps are specified above, full-capacity taps shall be provided with a tap changing mechanism designed for deenergized operation. The tapchanger operator shall be located within one of the compartments.

J. The coil windings shall be of the two winding type, designed to reduce losses and manufactured with the conductor material as specified above. The windings shall incorporate a secondary sheet conductor to maximize short-circuit strength. All insulating materials shall be rated 650C rise, 800C hot-spot operation.

K. The core material shall be high-grade, grain oriented, non-aging silicon core steel with high magnetic permeability, low hysteresis and eddy current losses. Magnetic flux densities are to be kept well below saturation to allow for a minimum of 10 percent overvoltage excitation. The cores shall be properly annealed to reduce stresses induced during the manufacturing processes and reduce core losses.

L. The core frame shall be designed to provide maximum support of the core and coil assembly. The core frame shall be welded or bolted to ensure maximum short-circuit strength. The core and coil assembly shall be designed and manufactured to meet the short-circuit requirements of ANSI C57.12.90. The core and coil assembly shall be baked in an oven prior to tanking to "set" the epoxy coating on the Kraft paper and remove moisture from the insulation prior to vacuum filling.

M. Transformer shall be vacuum-filled with the appropriate fluid as indicated above. The process shall be of sufficient vacuum and duration to insure that the core and coil assembly are free of moisture prior to filling the tank.
2.03 FINISH
A. Each transformer shall be painted utilizing an initial phosphatizing cleaning treatment, followed by manufacturer's standard paint process baked on to a total of three (3) to five (5) mils average thickness. Outdoor liquid transformer units shall include suitable outdoor paint finish. Units shall be painted Pad-mount Green, Munsell No. 7GY3.29/1.5.

2.04 ACCESSORIES
A. Transformer features and accessories shall include: Dial-type thermometer, Liquid level gauge, Pressure-vacuum gauge, One (1) inch drain valve with sample valve, Pressure relief valve, Non-PCB label, One (1) inch upper fill/fill press connection, and additional accessories as shown on drawings.
B. Transformers shall be dead front construction.
C. Each transformer shall be equipped with 9 KV lightning arresters mounted on the bushings of the transformer.
D. Each transformer shall be equipped with 4” IR windows in both the medium voltage and low voltage doors. IR windows shall have a clear view of the terminations within each compartment.
E. Transformers shall be equipped with 200 amp bushings.

2.05 PRIMARY FUSING
A. Provide bayonet draw-out overload sensing fuse in series with an under oil current limiting fuse.

2.06 FACTORY TESTING
A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards.
B. Resistance measurements of all windings on the rated voltage connection of each unit and at the tap extremes of one unit only of a given rating on this project.
1. Ratio tests on the rated voltage connection and on all tap connections.
2. Polarity and phase-relation tests on the rated voltage connections.
3. No-load loss at rated voltage on the rated voltage connection.
4. Exciting current at rated voltage on the rated voltage connection.
5. Impedance and load loss at rated current on the rated voltage connection of each unit and on the tap extremes of one unit only of a given rating on this project.
7. Induced potential tests.

PART 3 EXECUTION

3.01 GENERAL

3.02 TRANSFORMERS SHALL BE GROUNDED AS SHOWN ON THE DRAWINGS.

END OF SECTION
SECTION 26 13 21
AIR INTERRUPTER SWITCHES

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Medium-voltage air interrupter switches.
   B. Medium-voltage fuses.

1.02 REFERENCE STANDARDS
   A. IEEE 48 - IEEE Standard Test Procedures and Requirements for Alternating-Current Cable Terminations 2.5 kV through 765 kV; 1996 (R2009).
   C. IEEE C37.20.3 - IEEE Standard for Metal-Enclosed Interrupter Switchgear (1 kV-38 kV); 2013.
   D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.03 SUBMITTALS
   A. Shop Drawings: Indicate outline dimensions, enclosure construction, shipping splits, lifting and supporting points, electrical single line diagram, and equipment electrical ratings.
   B. Product Data: Provide data for components and accessories.

1.04 QUALITY ASSURANCE
   A. Products: Listed, classified, and labeled as suitable for the purpose intended.

1.05 DELIVERY, STORAGE, AND HANDLING
   A. Protect interrupter switches from weather and moisture by covering with heavy plastic or canvas and by maintaining heating within enclosure in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Square D.
   B. S&C

2.02 AIR INTERRUPTER SWITCHES
   A. Description: IEEE C37.20.3, switchgear assembly of individual air interrupter switches in free-standing cubicles, securely bolted together to form an integrated structure, suitable for installation where accessible by general public.
      1. System Voltage: 24.9 kV, three phase, 60 Hz.
      2. Maximum Design Voltage: 25.8 kV.
      3. Basic Impulse Level: 95 kV.
   B. Enclosure: Weatherproof.
      1. Include continuous ground bus through switchgear assembly, securely connected to frame of each cubicle.
      2. Main Bus: Copper.
      3. Finish: Manufacturer's standard baked enamel paint 2 mils (0.5 mm) thick.

2.03 COMPONENTS
   A. Interrupter Switch: Fused two position load interrupter switch.

2.04 ACCESSORIES
   A. Surge Arrestors: Station class; rated for the medium voltage system on this project, mount in the incoming line compartment.
B. Space Heaters: For 120 external source, sized by switchgear manufacturer.
   1. Contractor shall provide a 120v, 20 amp, 1 pole circuit from the nearest acceptable source approved by the Owner.
C. Operating Handle: Permanently mounted, lockable in both positions, interlocked to prevent opening fuse compartment door with switch in CLOSED position.

2.05 MEDIUM-VOLTAGE FUSES
   A. Manufacturers:
      1. Bussman.
   B. Description: Enclosed current limiting, non-expulsion type suitable for use indoors in enclosure.
   C. Fuse Rating: E rated fuse, size as indicated.
   D. Voltage: 24.9 kV.

2.06 SOURCE QUALITY CONTROL
   A. Provide factory inspection and testing in accordance with IEEE C37.20.3.

PART 3 EXECUTION
3.01 INSTALLATION
   A. Install in accordance with manufacturer's instructions.
   B. Install on concrete pad as indicated on Drawings.

END OF SECTION
PART 1 GENERAL

1.01 RELATED REQUIREMENTS
   A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

1.02 REFERENCE STANDARDS
   B. IEEE C57.94 - IEEE Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type General Purpose Distribution and Power Transformers; 1982 (R2006).
   C. IEEE C57.96 - Guide for Loading Dry-Type Distribution and Power Transformers; 2013.
   D. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
   E. NECA 409 - Standard for Installing and Maintaining Dry-Type Transformers; 2009.
   F. NEMA ST 20 - Dry-Type Transformers for General Applications; 2014.
   G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
   J. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
   L. UL 1561 - Standard for Dry-Type General Purpose and Power Transformers; Current Edition, Including All Revisions.

1.03 SUBMITTALS
   A. Product Data: Include voltage, kVA, impedance, tap configurations, insulation system class and rated temperature rise, efficiency, sound level, enclosure ratings, outline and support point dimensions, weight, required clearances, service condition requirements, and installed features.

1.04 QUALITY ASSURANCE
   A. Conform to requirements of NFPA 70.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.

B. Eaton
2.02 TRANSFORMERS - GENERAL REQUIREMENTS

A. Description: Factory-assembled, dry type transformers for 60 Hz operation designed and manufactured in accordance with NEMA ST 20 and listed, classified, and labeled as suitable for the purpose intended.

B. Unless noted otherwise, transformer ratings indicated are for continuous loading according to IEEE C57.96 under the following service conditions:
1. Altitude: Less than 3,300 feet (1,000 m).
2. Ambient Temperature:
   a. Greater than 10 kVA: Not exceeding 104 degrees F (40 degrees C).
   b. Less than 10 kVA: Not exceeding 77 degrees F (25 degrees C).

C. Core: High grade, non-aging silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Keep magnetic flux densities substantially below saturation point, even at 10 percent primary overvoltage. Tightly clamp core laminations to prevent plate movement and maintain consistent pressure throughout core length.

D. Impregnate core and coil assembly with non-hydroscopic thermo-setting varnish to effectively seal out moisture and other contaminants.

E. Basic Impulse Level: 10 kV.

F. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

G. Isolate core and coil from enclosure using vibration-absorbing mounts.

H. Nameplate: Include transformer connection data, ratings, wiring diagrams, and overload capacity based on rated winding temperature rise.

2.03 GENERAL PURPOSE TRANSFORMERS

A. Description: Self-cooled, two winding transformers listed and labeled as complying with UL 506 or UL 1561; ratings as indicated on the drawings.

B. Insulation System and Allowable Average Winding Temperature Rise:
1. Less than 15 kVA: Class 180 degrees C insulation system with 115 degrees C average winding temperature rise.
2. 15 kVA and Larger: Class 220 degrees C insulation system with 150 degrees C average winding temperature rise.

C. Coil Conductors: Continuous aluminum windings with terminations brazed or welded.

D. Winding Taps:
1. 15 kVA through 300 kVA: Two 2.5 percent full capacity primary taps above and four 2.5 percent full capacity primary taps below rated voltage.

E. Energy Efficiency: Comply with 10 CFR 431, Subpart K.
1. Test efficiency according to NEMA TP 2.
2. Label transformer according to NEMA TP 3.

F. Sound Levels: Standard sound levels complying with NEMA ST 20.

G. Transformer Enclosure: Comply with NEMA ST 20.
1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
   a. Indoor clean, dry locations: Type 2.
2. Construction: Steel.
   a. 15 kVA and Larger: Ventilated.
3. Finish: Manufacturer's standard grey, suitable for outdoor installations.
4. Provide lifting eyes or brackets.
PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that field measurements are as indicated.
   B. Perform pre-installation tests and inspections on transformers per manufacturer's instructions
      and as specified in NECA 409. Correct deficiencies prior to installation.
   C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION
   A. Perform work in accordance with NECA 1 (general workmanship).
   B. Install products in accordance with manufacturer's instructions.
   C. Install transformers in accordance with NECA 409 and IEEE C57.94.
   D. Arrange equipment to provide minimum clearances as specified on transformer nameplate and
      in accordance with manufacturer's instructions and NFPA 70.
   E. Provide grounding and bonding in accordance with Section 26 05 26.
   F. Remove shipping braces and adjust bolts that attach the core and coil mounting bracket to the
      enclosure according to manufacturer's recommendations in order to reduce audible noise
      transmission.
   G. Where not factory-installed, install lugs sized as required for termination of conductors as
      indicated.

3.03 ADJUSTING
   A. Measure primary and secondary voltages and make appropriate tap adjustments.
   B. Adjust tightness of mechanical and electrical connections to manufacturer's recommended
      torque settings.

3.04 CLEANING
   A. Clean dirt and debris from transformer components according to manufacturer's instructions.
   B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION
SECTION 26 24 13
SWITCHBOARDS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Low-voltage (600 V and less) switchboards and associated accessories for service and distribution applications.
B. Overcurrent protective devices for switchboards.

1.02 RELATED REQUIREMENTS
A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
B. Section 26 05 29 - Hangers and Supports for Electrical Systems.

1.03 REFERENCE STANDARDS
B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
E. NEMA PB 2 - Deadfront Distribution Switchboards; 2011.
F. NEMA PB 2.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less; 2013.
H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
J. UL 891 - Switchboards; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS
A. Coordination:
   1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
   2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
   4. Coordinate with manufacturer to provide shipping splits suitable for the dimensional constraints of the installation.
   5. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Service Entrance Switchboards:
   1. Coordinate with Utility Company to provide switchboards with suitable provisions for electrical service and utility metering, where applicable.
   2. Coordinate with Owner to arrange for Utility Company required access to equipment for installation and maintenance.
   3. Obtain Utility Company approval of switchboard prior to fabrication.
   4. Arrange for inspections necessary to obtain Utility Company approval of installation.
1.05 SUBMITTALS
   A. Product Data: Provide manufacturer's standard catalog pages and data sheets for switchboards, enclosures, overcurrent protective devices, and other installed components and accessories.
   B. Shop Drawings: Indicate dimensions, voltage, bus ampcapities, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

1.06 QUALITY ASSURANCE
   A. Conform to requirements of NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING
   A. Receive, inspect, handle, and store switchboards in accordance with manufacturer's instructions, NECA 400, and NEMA PB 2.1.
   B. Store in a clean, dry space having a uniform temperature to prevent condensation (including outdoor switchboards, which are not weatherproof until completely and properly installed). Where necessary, provide temporary enclosure space heaters or temporary power for permanent factory-installed space heaters.
   C. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
   D. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

PART 2 PRODUCTS
2.01 MANUFACTURERS
   A. Switchboards - Basis of Design: Square D.
   B. Switchboards - Other Acceptable Manufacturers:
      1. Eaton Corporation
   C. Source Limitations: Furnish switchboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.02 SWITCHBOARDS
   A. Provide switchboards consisting of all required components, control power transformers, instrumentation and control wiring, accessories, etc. as necessary for a complete operating system.
   B. Provide products listed, classified, and labeled as suitable for the purpose intended.
   C. Description: Dead-front switchboard assemblies complying with NEMA PB 2, and listed and labeled as complying with UL 891; ratings, configurations and features as indicated on the drawings.
   D. The switchboards shall be free standing floor mounted enclosures as shown on the Drawings. The switchboards are not to be part of the Motor Control Centers.
   E. Service Entrance Switchboards:
      1. Listed and labeled as suitable for use as service equipment according to UL 869A.
      2. For solidly-grounded wye systems, provide factory-installed main bonding jumper between neutral and ground busses, and removable neutral disconnecting link for testing purposes.
   F. Service Conditions:
      1. Provide switchboards and associated components suitable for operation under the following service conditions without derating:
         a. Altitude: Less than 6,600 feet (2,000 m).
      2. Provide switchboards and associated components suitable for operation at indicated ratings under the service conditions at the installed location.
G. Short Circuit Current Rating:
   1. Provide switchboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.

H. Main Devices: Configure for top or bottom incoming feed as indicated or as required for the installation. Provide separate pull section and/or top-mounted pullbox as indicated or as required to facilitate installation of incoming feed.

I. Bussing: Sized in accordance with UL 891 temperature rise requirements.
   1. Through bus (horizontal cross bus) to be fully rated through full length of switchboard (non-tapered). Tapered bus is not permitted.
   2. Provide solidly bonded equipment ground bus through full length of switchboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
   3. Phase and Neutral Bus Material: Copper.

J. Conductor Terminations: Suitable for use with the conductors to be installed.
   1. Line Conductor Terminations:
      a. Main and Neutral Lug Material: Copper, suitable for terminating copper conductors only.
      b. Main and Neutral Lug Type: Mechanical.
   2. Load Conductor Terminations:
      a. Lug Material: Copper, suitable for terminating copper conductors only.

K. Enclosures:
   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor Clean, Dry Locations: Type 1 or Type 2 (drip-proof).
   2. Finish: Manufacturer's standard unless otherwise indicated.

L. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.

M. Arc Flash Energy-Reducing Maintenance Switching: For circuit breakers rated 1200 A or higher, provide a local accessory switch with status indicator light that permits selection of a maintenance mode with alternate electronic trip unit settings for reduced fault clearing time.

N. Owner Metering:
   1. Provide microprocessor-based digital electrical metering system including all instrument transformers, wiring, and connections necessary for measurements specified.
   2. Measured Parameters:
      a. Voltage (Volts AC): Line-to-line, line-to-neutral for each phase.
      b. Current (Amps): For each phase and neutral.
      c. Frequency (Hz).
      d. Real power (kW): For each phase, 3-phase total.
      e. Reactive power (kVAR): For each phase, 3-phase total.
      f. Apparent power (kVA): For each phase, 3-phase total.
      g. Power factor.
   3. Meter Accuracy: Plus/minus 1.0 percent.

O. Instrument Transformers:
   2. Select suitable ratio, burden, and accuracy as required for connected devices.
2.03 OVERCURRENT PROTECTIVE DEVICES
   A. Circuit Breakers:
      1. Interrupting Capacity:
         a. Provide circuit breakers with interrupting capacity as required to provide the short
circuit current rating indicated, but not less than specified minimum requirements.
         b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than
the short circuit current rating indicated.

2.04 SOURCE QUALITY CONTROL
   A. Factory test switchboards according to NEMA PB 2, including the following production (routine)
tests on each switchboard assembly or component:
      1. Dielectric tests.
      2. Mechanical operation tests.
      3. Grounding of instrument transformer cases test.
      4. Electrical operation and control wiring tests, including polarity and sequence tests.
      5. Ground-fault sensing equipment test.

PART 3 EXECUTION
3.01 EXAMINATION
   A. Verify that field measurements are as indicated.
   B. Verify that the ratings and configurations of the switchboards and associated components are
consistent with the indicated requirements.
   C. Verify that mounting surfaces are ready to receive switchboards.
   D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION
   A. Install products in accordance with manufacturer’s instructions.
   B. Install switchboards in accordance with NECA 1 (general workmanship), NECA 400, and NEMA
PB 2.1.
   C. Arrange equipment to provide required clearances and maintenance access, including
accommodations for any drawout devices.
   D. Where switchboard is indicated to be mounted with inaccessible side against wall, provide
minimum clearance of 1/2 inch (10 mm) between switchboard and wall.
   E. Provide required support and attachment components in accordance with Section 26 05 29.
   F. Install switchboards plumb and level.
   G. Provide grounding and bonding in accordance with Section 26 05 26.
   H. Install all field-installed devices, components, and accessories.
   I. Where accessories are not self-powered, provide control power source as indicated or as
required to complete installation.
   J. Set field-adjustable ground fault protection pickup and time delay settings as indicated.

3.03 FIELD QUALITY CONTROL
   A. Before energizing switchboard, perform insulation resistance testing in accordance with NECA
400 and NEMA PB 2.1.
   B. Inspect and test in accordance with NETA ATS, except Section 4.
   C. Perform inspections and tests listed in NETA ATS, Section 7.1.
   D. Ground Fault Protection Systems: Test in accordance with manufacturer’s instructions as
required by NFPA 70.
      1. Perform inspections and tests listed in NETA ATS, Section 7.14. The insulation-resistance
test on control wiring listed as optional is not required.
E. Meters: Perform inspections and tests listed in NETA ATS, Section 7.11.2.
F. Instrument Transformers: Perform inspections and tests listed in NETA ATS, Section 7.10.
G. Correct deficiencies and replace damaged or defective switchboards or associated components.

3.04 ADJUSTING
   A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
   B. Adjust alignment of switchboard covers and doors.

3.05 CLEANING
   A. Clean dirt and debris from switchboard enclosures and components according to manufacturer's instructions.
   B. Repair scratched or marred surfaces to match original factory finish.

3.06 CLOSEOUT ACTIVITIES
   A. Training: Train Owner's personnel on operation, adjustment, and maintenance of switchboard and associated devices.
      1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.

3.07 PROTECTION
   A. Protect installed switchboards from subsequent construction operations.
SECTION 26 24 16
PANELBOARDS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Lighting and appliance panelboards.
B. Overcurrent protective devices for panelboards.

1.02 REFERENCE STANDARDS
A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; Federal Specification; Revision E, 2013.
B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
C. NECA 407 - Standard for Installing and Maintaining Panelboards; 2009.
D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
E. NEMA PB 1 - Panelboards; 2011.
F. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less; 2013.
G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
J. UL 67 - Panelboards; Current Edition, Including All Revisions.
M. UL 1053 - Ground-Fault Sensing and Relaying Equipment; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS
A. Coordination:
1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.
4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
5. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.04 SUBMITTALS
A. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.
B. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
   1. Include dimensioned plan and elevation views of panelboards and adjacent equipment with all required clearances indicated.

1.05 QUALITY ASSURANCE
   A. Conform to requirements of NFPA 70.

1.06 DELIVERY, STORAGE, AND HANDLING
   A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.
   B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
   C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

1.07 FIELD CONDITIONS
   A. Maintain ambient temperature within the following limits during and after installation of panelboards:
      1. Panelboards Containing Circuit Breakers: Between 23 degrees F (-5 degrees C) and 104 degrees F (40 degrees C).

PART 2 PRODUCTS
2.01 MANUFACTURERS
   A. Square D.
   B. Eaton

2.02 PANELBOARDS - GENERAL REQUIREMENTS
   A. Provide products listed, classified, and labeled as suitable for the purpose intended.
   B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
      1. Altitude: Less than 6,600 feet (2,000 m).
      2. Ambient Temperature:
         a. Panelboards Containing Circuit Breakers: Between 23 degrees F (-5 degrees C) and 104 degrees F (40 degrees C).
   C. Short Circuit Current Rating:
      1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
   D. Panelboards Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.
   E. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.
   F. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.
   G. Bussing: Sized in accordance with UL 67 temperature rise requirements.
      1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
      2. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
   H. Conductor Terminations: Suitable for use with the conductors to be installed.
I. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.

1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
   a. Indoor Clean, Dry Locations: Type 1.
   b. Outdoor Locations: Type 4X, stainless steel.
   c. Indoor "Wet and Corrosive Areas" - Nema 4x, stainless steel.

2. Fronts:
   a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
   b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.

3. Lockable Doors: All locks keyed alike unless otherwise indicated.

J. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

K. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.

L. Load centers are not acceptable.

2.03 LIGHTING AND APPLIANCE PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Conductor Terminations:
   1. Main and Neutral Lug Material: Copper, suitable for terminating copper conductors only.
   2. Main and Neutral Lug Type: Mechanical.

C. Bussing:
   2. Phase and Neutral Bus Material: Copper.

D. Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.

E. Enclosures:
   1. Provide surface-mounted or flush-mounted enclosures as indicated.
   2. Provide clear plastic circuit directory holder mounted on inside of door.

2.04 OVERCURRENT PROTECTIVE DEVICES

A. Molded Case Circuit Breakers:
   1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
   2. Interrupting Capacity:
      a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating as shown on the drawings.
      b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
   3. Conductor Terminations:
      a. Lug Material: Copper, suitable for terminating copper conductors only.
   4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
   5. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.

2.05 SOURCE QUALITY CONTROL

A. Factory test panelboards according to NEMA PB 1.
PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that field measurements are as indicated.
   B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.
   C. Verify that mounting surfaces are ready to receive panelboards.
   D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION
   A. Perform work in accordance with NECA 1 (general workmanship).
   B. Install products in accordance with manufacturer's instructions.
   C. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.
   D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
   E. Provide required supports in accordance with Section 26 05 29.
   F. Install panelboards plumb.
   G. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.
   H. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches (2000 mm) above the floor or working platform.
   I. Provide minimum of six spare 1 inch (27 mm) trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling and below floor.
   J. Provide grounding and bonding in accordance with Section 26 05 26.
   K. Install all field-installed branch devices, components, and accessories.
   L. Set field-adjustable ground fault protection pickup and time delay settings as indicated.
   M. Provide filler plates to cover unused spaces in panelboards.

3.03 ADJUSTING
   A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
   B. Adjust alignment of panelboard fronts.

3.04 CLEANING
   A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.
   B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION
SECTION 26 24 20
MOTOR-CONTROL CENTERS

PART 1 GENERAL

1.01 THIS SECTION INCLUDES THE REQUIREMENTS FOR 600V-CLASS LOW VOLTAGE MOTOR
CONTROL CENTERS (MCCS) FOR USE ON ALTERNATING CURRENT POWER SYSTEMS.

1.02 REFERENCES

A. The MCC shall meet or exceed the requirements within the following standards for MCCs.
   1. NEMA ICS 18 - Industrial Control and Systems: Motor Control Centers
   2. UL 845 - UL Standard for Safety for Motor Control Centers
   3. NOTE: UL 845 is a harmonized standard consisting of:
      a. Underwriters Laboratories Inc. (UL) UL 845
      b. Association of Standardization and Certification (ANCE) NMX-J-353-ANCE-2006
      c. NFPA 70 - National Electrical Code

1.03 DESIGN REQUIREMENTS

A. Provide MCC based upon applicable NEMA and UL standards and in accordance with the
detailed contract specifications and drawings.

B. The manufacturer of the MCC shall also be the manufacturer of the across-the-line motor
starters, across-the-line contactors, solid-state reduced voltage starters, and variable frequency
drives. The use of third-party supply and assembly for these components in the motor control
center is not acceptable and will be rejected.

1.04 PRE-MANUFACTURE SUBMITTALS

A. Manufacturer Drawings.
   1. MCC elevations showing dimensional information including details such as, but not limited
to, the following:
      a. MCC height (less any removable lifting angles or eyes)
      b. MCC width
      c. MCC depth
      d. Location of shipping splits
      e. Structure descriptions showing the following:
         1) Bus ratings
         2) Enclosure ratings
         3) Short-circuit withstand ratings
         4) Other information as required for approval
      f. Conduit locations
      g. Required bus splices
      h. Unit descriptions including information such as, starter sizes, circuit breaker frame
         sizes, circuit-breaker continuous ampere ratings, and pilot devices
      i. Nameplate information
      j. Schematic wiring diagrams
      k. Manufacturer drawings shall be provided in DWG format
      l. Manufacturer drawings do not need to be stamped if a drawing schedule is provided
         that lists the drawing numbers, revision levels, and status of drawings (such as,
         Preliminary, Approval, and Final)

   2. Product Data.
      a. Data sheets and publications on all major components including, but not limited to,
         the following:
         1) Motor starters
         2) Overload relays
         3) Circuit breaker and fuse information including time current characteristics
         4) Control power transformers
5) Pilot devices
6) Relays

   a. All clarifications and exceptions must be clearly identified

4. Installation Instructions.
   a. Provide a copy of the manufacturer’s installation instructions that includes the following:
      1) Receiving, handling, and storage instructions
      2) General description for reading nameplate data, serial numbers, UL markings, and short circuit ratings
      3) Installation procedures including splicing procedures
      4) Conduit and cable installation
      5) Installing and removing plug-in units
      6) Operation of operator handles and unit interlocks
      7) Checklist before energizing
      8) Procedure for energizing equipment
      9) Maintenance procedures

1.05 QUALITY ASSURANCE
   A. The manufacturer shall have ISO 9001 registered facilities for the design, manufacture, and testing of MCCs.
   B. MCC sections and individual MCC units shall be designed and manufactured in accordance with UL 845 requirements.

1.06 REGULATORY REQUIREMENTS
   A. Contractor shall ensure that the installation conforms to the requirements of the latest edition of the NFPA 70 ‘National Electrical Code’ and/or other applicable installation standards.

1.07 DELIVERY, STORAGE, AND HANDLING
   A. Shipping splits shall be noted on the MCC manufacturer drawings.
   B. MCCs are to be shipped with external lifting angles at the top and running continuously for each shipping split. Lifting eyelets are not acceptable.

1.08 ENVIRONMENTAL REQUIREMENTS
   A. The MCC enclosure rating shall be appropriate for the environment where the MCC is to be located.

1.09 WARRANTY
   A. The manufacturer shall provide their standard parts warranty for 18 months from the date of shipment or 12 months from the date of being energized, whichever occurs first.
   B. The manufacturer shall confirm this warranty as part of the submittal.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. MCCs shall be Allen-Bradley® CENTERLINE® 2100 motor control centers.
   B. Square D is an acceptable supplier of the motor control centers.
      1. The motor control centers shall be capable of communicating the Allen Bradley PLCs and Scada System.

2.02 RATINGS
   A. The MCC shall be rated for the system voltage as indicated on the contract drawings.
   B. The MCC horizontal and vertical power bus bracing shall be rated to meet or exceed the available fault current as shown on the contract drawings, but shall not be less than 42,000 A rms symmetrical.
C. All MCC units shall have a full rated short-circuit rating that meets or exceeds the available fault current as shown on the contract drawings.
   1. All circuit breakers used in the motor control center shall have full-rated short-circuit interrupting ratings based on the applied MCC voltage.

2.03 ENCLOSURE
A. The MCC enclosure shall be NEMA Type 1 unless otherwise shown on the drawings.
B. Each section shall be equipped with two full-metal side sheets to isolate each vertical section and to help reduce the likelihood of fault propagation between sections.
C. All interior and exterior surfaces shall be painted ANSI 49 medium-light gray. The vertical wireways and unit back plates shall be painted high-visibility gloss white.
D. All unpainted parts shall be plated for corrosion resistance.
E. Removable closing plates on each end of the MCC shall cover all horizontal bus and horizontal wireway openings.

2.04 STRUCTURE
A. The MCC shall be of dead front construction and shall consist of one or more vertical sections bolted together to form a rigid, free-standing assembly. The systems shall be designed to allow for the addition of future sections at either end and to permit the interchanging of units.
B. Vertical sections shall be rigid, free-standing structures.
   1. Vertical sections shall have internal mounting angles running continuously within the shipping block
   2. An external mounting channel that is required to maintain structure integrity is not acceptable
   3. Vertical sections shall be 90 in. high, 20 in. deep and 20 in. Wide, except where larger dimensions are required
   4. Vertical sections shall be provided with a removable steel lifting angle on all shipping blocks. The angle shall run the length of the shipping block
   5. Lifting eyes are not acceptable
   6. Horizontal wireways.
      a. Horizontal wireways shall be located at the top and bottom of the MCC
      b. Horizontal wireways shall be 6 in. in height and extend the full depth of the vertical section to allow maximum flexibility in locating conduit for MCC feeds and loads
         1) Pull-boxes to extend the height of the top horizontal wireway by 12 in. shall be provided, if specified on the contract drawings
      c. Horizontal wireways shall be continuous across the length of the MCC, except where access needs to be denied due to electrical isolation requirements
      d. The horizontal wireways shall be isolated from the power bus
      e. The horizontal wireways shall have removable covers held in place by captive screws
   7. Provide a full height vertical wireway, independent of the plug-in units, in each standard vertical section.
      a. The vertical wireway shall be isolated from the vertical and horizontal buses
      b. The vertical wireway shall be covered with a hinged and secured door
      c. Wireway tie bars shall be provided
      d. Isolation between the wireway and units shall be provided

2.05 BUS BARS
A. Horizontal Power Bus.
   1. The horizontal bus shall be rated as shown on the drawings
   2. The horizontal bus material shall be copper with tin plating
   3. The horizontal bus shall be supported, braced and isolated from the vertical bus with a high strength, non-conductive, non-tracking, glass polyester material
   4. For standard sections the horizontal bus shall be continuous within each shipping block and shall be braced within each section
5. Horizontal bus splices shall have at least two bolts on each side

   a. The vertical power bus shall have an effective rating of 600 A. If a center horizontal bus construction is utilized, then the rating shall be 300 A above and below the horizontal bus for an effective rating of 600 A. If a top or bottom mounted horizontal bus is utilized, then the full bus must be rated for 600 A
   b. The vertical bus material shall be copper with tin plating
   c. The vertical bus shall attach to the horizontal bus with at least two bolts
   d. The vertical bus shall be continuously braced by a high strength, non-conductive, non-tracking, glass-filled polyester material and isolated from the unit spaces by a non-conductive, polycarbonate molded cover
   e. The vertical bus shall be isolated from the horizontal power bus except where necessary to connect the vertical power bus to the horizontal power bus
   f. Automatic shutters shall cover plug-in stab openings when units are removed

   a. Provide a ground bus system consisting of a horizontal ground bus connected to vertical ground buses mounted in each section
   b. Provide a tin-plated copper (0.25 x 1 in. or 0.25 x 2 in.) horizontal ground bus mounted in the bottom of the MCC unless otherwise specified in the drawings
   c. Provide a pressure-type mechanical lug mounted on the ground bus in the incoming line section
   d. Provide a unit ground stab on all unit inserts. The ground stab shall establish unit insert grounding to the vertical ground bus before the plug-in power stabs engage the power bus. The grounding shall be maintained until after the plug-in power stabs are disengaged

B. Ground Bus:
   1. Provide a copper vertical-unit load ground bus in each section that can accommodate plug-in units
   2. Provide a unit load connector on all units that require load wire connections. The load connector shall provide a termination point for the load ground conductor at the unit

2.06 ETHERNET/IP COMMUNICATION

A. The MCC shall have Ethernet wiring incorporated into its design.
   1. The MCC shall have Ethernet cabling incorporated throughout the vertical section
   2. Each motor starter, AC drive and soft starter unit in the MCC shall be supplied with a means to communicate via EtherNet/IP network
   3. Ethernet Cabling.
      a. Ethernet Cable Ratings
         1) The Ethernet cable shall be 600V UL PLTC rated
         2) The use of a 300V rated cable is not acceptable
      b. Layout
         1) Cable shall connect each section to one another in the top or bottom wireways
         2) Ethernet cable through the MCC section shall be routed from the top or bottom wireways. To prevent accidental mechanical damage during MCC installation, the cable shall be located behind barriers to isolate the cable from the unit space and wireways
         3) Eight Ethernet ports shall be provided in the rear of each vertical wireway of standard sections to simplify installation, relocation, and addition of plug-in units
         4) The EtherNet/IP device within each unit shall be factory connected to an Ethernet port in the vertical wireway by using a 600V-rated Ethernet cable
      c. Power Supplies
         1) The power supply shall provide 24V DC for the devices that require it
         2) The MCC manufacturer shall check the user’s design to ensure that adequate power supplies have been specified to conform with network requirements
3) Power supply output shall be rated 8 A, 24V DC
4) The power supply shall be Allen-Bradley Bulletin 1606-XLSDNET8 or approved equal
5) The power supply unit shall be provided with a buffer module to provide a minimum of 500 ms ride-through at full load
6) The buffer module shall be Allen-Bradley Bulletin 1606-XLBUFFER or approved equal

4. EtherNet/IP Interface for Motor Starter Units.
   a. Motor starter units shall have an electronic overload relay that incorporates the following features:
      1) Built-in EtherNet/IP communication
      2) LEDs for status indication
      3) Test/Reset button
      4) Selectable trip of NEMA Class 5 to 30. Unless indicated, the trip class shall be set for NEMA Class 20 operation
      5) Four inputs and two outputs. Refer to the contract drawings for connection requirements
      6) Protective functions
         (a) Functions shall provide a programmable trip level, warning level, time delay, and inhibit window
         (b) Protective functions shall include Thermal overload, Phase loss, Stall, Jam, Underload, Current imbalance, Remote trip, and PTC thermistor input
         (c) Ground fault protection [is] [is not] required
            (1) If ground fault protection is required, the protection range shall be 1 A to
            (2) 5 A for NEMA Size 3 and smaller starters, and 20 mA to 5 A for NEMA Size 4 and larger starters
      7) Current monitoring functions shall include phase current, average current, full load current, current imbalance percent, percent thermal capacity utilized, and ground fault current (if required)
      8) Voltage, energy, and frequency measuring capabilities shall be included
      9) Diagnostic information shall include device status, warning status, time to reset, trip status, time to overload trip, and history of last five trips
     10) Preventive maintenance information shall include Allowable starts per hour, required Time between starts, Starts counter, Starts available, Time until next start, total operating hours, and elapsed operating time
     11) Overload relay shall include an on-board logic processor to allow basic logic to be performed within the overload relay based on network data and the status of the inputs to the overload relay
     12) The overload relay shall support the following CIP messaging types: Polled I/O messaging, Change-of-state/cyclic messaging, Explicit messaging, Group 4 offline node recovery messaging, and Unconnected Message Manager (UCMM)
     13) The overload relay shall provide the following functions to minimize network configuration time: Full parameter object support, Configuration consistency value, and Add-on Profile

5. EtherNet/IP Interface for Variable Frequency AC Drives and Solid-State Reduced Voltage Motor Controllers.
   a. The EtherNet/IP communication interface shall be supplied to allow for communication between the solid-state component and the Ethernet network

6. EtherNet/IP Interface for Other Units.
   a. Provide a EtherNet/IP interface for other units as indicated on the contract drawings
   b. Refer to the contract drawing wiring diagrams for points to be monitored
   a. The MCC manufacturer shall load the IP Address into each unit
   b. The IP Address shall be as indicated on the contract drawings or as provided by the contractor
   c. The MCC manufacturer shall test the MCC to ensure that each unit communicates properly prior to shipment
   d. Each unit shall have a label showing the IP Address for the devices within it
   e. The MCC manufacturer shall provide a disk containing applicable electronic data sheet (EDS) files for the EtherNet/IP devices

2.07 DEVICENET COMMUNICATION

A. The MCC shall have DeviceNet wiring incorporated into its design.
   1. The MCC shall have DeviceNet cabling incorporated throughout the vertical section
   2. Each motor starter, AC drive, and soft starter unit in the MCC shall be supplied with a means to communicate via the DeviceNet network
   3. DeviceNet Cabling.
      a. DeviceNet Cable Ratings
         1) The DeviceNet cable shall be in compliance with Article 300.3(C)(1) of the National Electrical Code, 2005
         2) The insulating rating shall be equal to at least the maximum circuit voltage applied to any conductor within the enclosure or raceway
         3) No special separation, barriers, or internal conduit shall be required for the DeviceNet conductors
         4) The trunk line cable shall be flat cable rated 8 A, 600V, Class 1
         5) The drop cable used to connect a unit to a DeviceNet port in the vertical wireway shall be round cable rated 8 A, 600V, Class 1
         6) The use of a Class II network is not acceptable
      b. Layout
         1) A DeviceNet trunk line shall be routed through the MCC lineup. To prevent accidental mechanical damage during MCC installation, the trunk line shall be located behind barriers to isolate the trunk line from the unit space and wireways
         2) Six DeviceNet ports shall be provided in the rear of each vertical wireway of standard sections to simplify installation, relocation, and addition of plug-in units
         3) Dual port connectors shall be provided when more than six DeviceNet unit connections are required in an MCC section
         4) The DeviceNet device within each unit shall be factory connected to a DeviceNet port
      c. Power Supplies
         1) All power supplies shall be ODVA approved for the DeviceNet network
         2) The power supply shall provide 24V DC for the DeviceNet system and shall be rated no less than 8 A
         3) The power supply for the MCC DeviceNet system shall be supplied as a separate plug-in unit
         4) The MCC manufacturer shall check the user’s design to ensure that adequate power supplies have been specified to conform with DeviceNet requirements
         5) The power supply output shall be rated 8 A, 24V DC
         6) The power supply shall be Allen-Bradley catalog number 1606-XLSDNET8 or approved equal
         7) The power supply unit shall be provided with a buffer module to provide a minimum of 500 ms ride-through at full load
         8) The buffer module shall be Allen-Bradley catalog number 1606-XLBUFFER or approved equal
4. DeviceNet Interface for Motor Starter Units.
   a. Motor starter units shall have an electronic overload relay that incorporates the following features:
      1) Built-in DeviceNet communication
      2) LEDs for status indication
      3) Test/Reset button
      4) Selectable trip of NEMA Class 5 to 30. Unless indicated, the trip class shall be set for NEMA Class 20 operation
      5) Four inputs and two outputs. Refer to the contract drawings for connection requirements
   b. The overload relay shall be Allen-Bradley 193-EC2/592-EC2, 193-EC3/592-EC3, or 193-EC5/592-EC5 ‘E3 Plus’ models or approved equal

5. DeviceNet Interface for Variable Frequency AC Drives and Solid-state Reduced Voltage Motor Controllers.
   a. The DeviceNet communication interface shall be supplied to allow for communication between the solid-state component and the DeviceNet system

6. DeviceNet Interface for Other Units.
   a. Provide a DeviceNet interface for other units as indicated on the contract drawings
   b. The DeviceNet interface shall have four inputs and two outputs
   c. Refer to the contract drawing wiring diagrams for points to be monitored
   d. The DeviceNet interface shall include an on-board logic processor to allow basic logic to be performed within the interface based on network data and the status of the inputs to the overload relay
   e. The DeviceNet interface shall be Allen-Bradley Bulletin 100-DNY ‘DeviceNet Starter Auxiliary (DSA) Module’ or approved equal
   a. The MCC manufacturer shall load the DeviceNet MAC ID number (node address) into each unit.
   b. The DeviceNet MAC ID number shall be as indicated on the contract drawings or as provided by the contractor.
   c. The DeviceNet network shall be designed and programmed for use at 250 kB or 500 kB.
   d. The MCC manufacturer shall test the MCC to ensure that each unit communicates properly prior to shipment.
   e. Each DeviceNet device shall have a label showing the unit location, node address, and communication rate.
   f. The MCC manufacturer shall provide a disk containing applicable electronic data sheet (EDS) files for the DeviceNet devices.

2.08 UNIT INFORMATION
   A. NEMA Size 5 FVNR starters and below shall be provided as plug-in units.
   B. Plug-in units.
      1. Plug-in units shall consist of a unit assembly, unit support pan, and unit door assembly.
      2. Units shall be supplied with removable doors. The unit doors shall be fastened to the structure so that the doors can be closed when the unit is removed.
      3. A unit support pan shall be provided for support and guiding units. Unit support pans shall remain in the structure when units are removed to provide isolation between units.
      4. A service position shall be provided for plug-in units that allows for the unit to be supported, but disengaged from the bus. The unit shall be capable of being padlocked in the service position. This position is to be used to isolate a unit from the bus to allow service to be performed on the connected load equipment.
   C. Power Stabs.
      a. Unit stabs for engaging the power bus shall be tin-plated copper and provided with stainless back-up springs to provide and maintain a high pressure 4-point connection to the vertical bus.
      b. Wiring from the unit disconnecting means to the plug-in stabs shall not be exposed on the rear of the unit. A separate isolated pathway shall be provided for each phase to minimize the possibility of unit fault conditions reaching the power bus system.
      c. The power cable termination at the plug-in stab shall be a maintenance-free crimp type connection.
   D. Withdrawable Power Stabs.
      a. Plug-in units shall have the capacity of withdrawing the power stabs, allowing the primary voltage to be disconnected with the unit door closed.
      b. The withdrawable assembly shall accept a standard 1/4" hex-style drive socket
         1) A complete power engagement shall occur when turning the mechanism ¼ turn in clockwise direction.
         2) Complete power disengagement shall occur when turning the mechanism ¼ turn in counter-clockwise direction.
      c. The withdrawable stabs design shall include a set of stab assembly-mounted shutters.
         1) The shutters shall automatically open before the power stabs can extend and connect to the vertical bus.
         2) The shutters shall close as soon as the power stabs are disconnected from the vertical bus and are completely inside the stab housing.
      d. The withdrawable stabs design shall include interlock mechanisms.
         1) The through-the-door mechanism shall allow the unit to be locked in the ‘Power Stabs Disconnected’ position.
            (a) This mechanism shall be such that it can be padlocked to prevent the connection of the stabs to the vertical bus even when the unit is inserted into the vertical section.
(b) The unit door shall be capable of opening with the padlock and lockout engaged

2) The unit disconnect handle must be in the OFF position (load side of the disconnect device removed from line power) before the stabs can be disconnected from the vertical bus
   (a) This mechanism shall also allow the removal of the unit from the vertical section but only after the disconnect handle has been turned OFF and the power stabs have been disconnected from the vertical bus
   (b) The unit stabs have to be disconnected (withdrawn) before the unit can be re-inserted into the vertical section

e. The withdrawable stabs design shall include feedback mechanisms that are verifiable with the unit door closed
   1) A two-position indication system shall be provided (Power Stabs Connected/Disconnected) and shall be visible from the door
      (a) Connected with Red Indication–Primary voltage stabs fully engaged and connected to the vertical bus
      (b) Disconnected with Green Indication–Primary voltage stabs fully disconnected from the vertical bus
   2) A set of probes shall be located on the front of the unit
      (a) Power stabs position: a positive continuity check between these probes shall verify that all three power stabs have been disconnected from the vertical bus and completely withdrawn inside the stabs housing
      (b) Stab-mounted shutters position: a positive continuity check between these probes shall verify that the shutters are closed, meaning that all three power stabs have been disconnected and withdrawn inside the stab housing

f. The withdrawable power stabs with door closed mechanism shall not increase the original unit height design so total space in the motor control center is optimized

g. A remote operating device shall be supplied to allow the connection and disconnection of the power stabs with the door closed
   1) The minimum distance shall be not less than three times the minimum default value recommended by the NFPA 70E (Arc Flash Protection Boundary–Annex D)

7. Disconnect Handle.
   a. Plug-in units shall be provided with a heavy-duty, non-conductive, industrial duty, flange mounted handle mechanism for control of each disconnect switch or circuit breaker
   b. Use of rotary operators is not acceptable
   c. The disconnect handle may pivot in the vertical or horizontal plane
   d. The on-off condition shall be indicated by the handle position, red and green color indicators with the words ON and OFF, and the international symbols 1 and 0 along with a pictorial indication of the handle position
   e. Handles shall be capable of being locked in the OFF position with up to three padlocks
   f. Plug-in units shall be provided with interlocks per NEMA and UL requirements
   g. Interlocks shall be provided for the following:
      1) Prevention of unit insertion or withdrawal with the disconnect in the ON position
      2) Prevention of the unit door from being opened when the disconnect is in the ON position
         (a) A feature for intentionally defeating this interlock by qualified personnel shall be provided
      3) Prevention of the disconnect switch from being moved to the ON position if the unit door is open
   a. Where specified, units shall be furnished with pushbuttons, selector switches, or pilot lights as shown on the contract drawings.
   b. Pilot devices shall be rated NEMA Type 4/13 water tight/oil tight.
   c. For units with vertically operated disconnect handles:
      1) When three or less pilot devices are utilized, they shall be Allen-Bradley Bulletin 800T or 800H 30.5mm devices or approved equal.
      2) When more than three devices are required, the use of Allen-Bradley Bulletin 800F 22.5mm devices (or approved equal) is permitted.
   d. For units with horizontally operated disconnect handles:
      1) The devices shall be Allen-Bradley Bulletin 800F.

   a. Control terminal blocks shall be provided on all contactor and starter units.
      1) Control terminal blocks shall be a pull-apart design on all plug-in units for easy removal of the unit from the structure.
   b. Control terminal blocks on non-plug-in contactor and starter units shall be fixed type.
   c. Power terminal blocks shall be provided on all contactor and starter units, rated NEMA size 3 (100 A) and below that utilize vertically operated disconnects.
      1) Power terminal blocks shall be pull-apart for NEMA size 1 and 2 (30 A and 60 A contactors).
      2) Power terminal blocks for NEMA size 3 starters (100 A contactors) shall be non-pull-apart.
   d. Terminal blocks shall not be located adjacent to or inside the vertical wireway.

10. Doors.
   a. Each unit shall be provided with a removable door mounted on removable pin-type hinges.
   b. The unit doors shall be capable of being opened at least 110 degrees.
   c. The unit doors shall be removable from any location in the MCC without disturbing any other unit doors.
   d. The unit door shall be fastened to the structure so it can be closed to cover the unit space when the unit is removed.
   e. The unit doors shall be held closed with quarter-turn latches.

2.09 COMBINATION NEMA RATED ACROSS THE LINE STARTERS
   A. Starters shall meet applicable NEMA and UL requirements.
   B. Starters shall be minimum NEMA Size 1.
      1. Fractional NEMA sizes are not acceptable.
      2. The motor starter shall be Allen-Bradley Bulletin 500 or 300 or approved equal.
      3. In addition to the hold-in contact, starters shall be provided with one normally open and one normally closed auxiliary contact.
      4. Provide a control power transformer with a rated secondary voltage of 120V AC. The control power transformer shall be provided with primary and secondary fusing.
      5. Overload relays shall have a reset button located on the outside of the unit door.
      6. Provide a door mounted selector switch for Hand-Off-Auto operation. The Hand mode shall provide local control at the MCC unit door. In the Auto mode, control shall be provided through a remote contact.

2.10 SOLID-STATE REDUCED VOLTAGE MOTOR CONTROLLERS (SSRV)
   A. Provide a control power transformer with a rated secondary voltage of 120V AC. The control power transformer shall be provided with primary and secondary fusing.
B. The controller shall be Allen-Bradley SMC Flex and shall include the following features:
1. Integrated bypass contactor that is closed once the motor is up to full speed
2. Electronic overload protection with adjustable trip class
3. Four programmable auxiliary contacts
4. Selectable control capabilities: soft start, kickstart, current limit start, dual ramp, full voltage, linear speed, preset slow speed, soft stop
5. Additional control capabilities: [Pump Control] [Braking control selectable - SMB™ Smart Motor Braking, Accu-Stop™, Slow Speed with Braking] [none required]
6. LCD display
7. Keypad programming for configuration
8. Built-in, selectable protective functions for: overload, jam, stall, excessive starts per hour, underload, over/under voltage, voltage unbalance
9. Metering capabilities for: current, voltage, kW, kWH, power factor, motor thermal capacity utilized, elapsed time

2.11 VARIABLE FREQUENCY DRIVES
A. Variable frequency drives shall be Allen-Bradley PowerFlex®
B. Provide a control power transformer with a rated secondary voltage of 120V AC. The control power transformer shall be provided with primary and secondary fusing.
C. Provide door-mounted pilot devices per the contract drawing wiring diagrams.
D. Provide door-mounted 120V AC non-push-to-test pilot lights with LED lamps for On [Red] and At-Speed [White] status indication.
E. Provide a door-mounted human interface module for programming, display and control.
F. Provide one isolated, configurable analog input and output.

2.12 SOFTWARE
A. Provide all software required to interface the motor control center to the PLC based control system.
B. Preconfigured Software.
   1. The software communication driver shall allow the software to be installed and operated on the EtherNet/IP, ControlNet, or DeviceNet network
   2. The software shall be capable of functioning as a standalone software package or as an ActiveX control in a Human Machine Interface (HMI)

PART 3 EXECUTION
3.01 INSTALLATION
A. Contractor shall install MCC in accordance with manufacturer’s instructions.
B. Contractor shall tighten accessible bus connections and mechanical fasteners to the manufacturer’s torque requirements.
C. Contractor shall adjust circuit breaker settings based upon field requirements.
D. Contractor shall adjust solid state overloads to match the installed motor characteristics.

3.02 MANUFACTURER’S SERVICES
A. The manufacturer of the MCC shall provide start-up services as part of the supply of the MCC.

3.03 TRAINING
A. The manufacturer shall provide training for the Owner’s designated personnel in troubleshooting and using a networked MCC.

END OF SECTION
SECTION 26 27 26
WIRING DEVICES

PART 1 GENERAL
1.01 DESCRIPTION OF WORK
A. The wiring devices are shown by symbols on the Drawings as part of the overall electrical systems and in the Legend and Schedules.

1.02 QUALITY ASSURANCE
A. Wiring devices shall be "specification grade" or better.
B. Products from the following manufacturers have been determined to be acceptable.
   1. General Electric
   2. Hubbell

PART 2 PRODUCTS
2.01 DEVICES
A. Provide wiring devices of the type, color, and electrical rating for the service indicated.
B. The types of the electrical wiring devices required for the project include the following:
   1. Receptacles
      a. General Duty Duplex: Duplex general duty type receptacles shall be 2 pole, 3 wire grounding with green hexagonal equipment ground screw, ground terminal internally connected to mounting yoke, 20 ampere, 125 volts, with metal plaster ears, side wiring only, NEMA configuration 5-20R unless and except where otherwise indicated. All receptacles shall be ivory colored, style 5362.
      b. Weatherproof Receptacles: Weatherproof receptacles shall consist of the receptacle type indicated, mounted in a box with a gasketed, weatherproof, cast metal cover plate and separate cap over each receptacle opening. The cap shall be permanently attached to the cover plate by a spring hinged flap. The weatherproof integrity shall not be affected when heavy duty specification attachment plugs are inserted. Cover plates on outlet boxes mounted flush in the wall shall be gasketed to the wall in a watertight manner.
      c. GFI Receptacles: Ground fault interrupter receptacles shall be feed through type capable of protecting connected downstream receptacles on single circuit, ivory, grounding type, UL rated Class A, Group 1, 20 ampere rating, 125 volts with solid state ground fault sensing and signaling, with 5 milliampere ground fault trip level, equipped with 20 ampere plug configuration, NEMA 5-20R.
      d. All other receptacles shall be of the appropriate type and voltage.
      e. All isolated ground receptacles shall be Hubbel No. IG 5352 or approved equal.
   2. Toggle Switches: Wall switches shall be general duty, totally enclosed with bodies of phenolic compound, butt contact, quiet AC type, with an integral mounting strap with provisions for side wiring with captively held binding screws, ivory, color-coded for current rating, style 1200.
      a. 120 volt circuits: 20 amperes at 120 volts AC
      b. 277 volt circuits: 20 amperes at 277 volts AC
   3. Device plates shall be one piece type, single or multiple gang switch and duplex outlet wall plates for wiring devices, provide metal screws for securing plates to devices, screw heads colored to match finish of plate, and wall plates possessing the following additional features as indicated on the Drawings.
      a. For walls in wet and corrosive areas, plates shall be aluminum or stainless steel with rounded or beveled edges.
      b. In normal areas, plates shall be aluminum.
      c. Plastic device plates shall be noncombustible, mar-proof thermosetting, with 0.100 inch thickness minimum. Color shall match the wiring device.
PART 3 EXECUTION

3.01 TESTING

A. Test wiring devices to ensure electrical continuity of grounding connections, after energizing circuitry, demonstrate compliance with requirements of the project. Test each receptacle for proper polarization and ground continuity.

END OF SECTION
SECTION 26 28 18  
MOTOR AND CIRCUIT DISCONNECTS

PART 1 GENERAL  
1.01 DESCRIPTION OF WORK  
A. The Contractor shall furnish and install all disconnects as noted on the Drawings.

1.02 QUALITY ASSURANCE  
A. The following manufacturers are approved on this project:  
   1. Square D  
   2. Eaton  
B. Motor and circuit disconnects shall comply with all applicable standards.

PART 2 PRODUCTS  
2.01 SAFETY SWITCHES  
A. Shall be fusible or non-fusible as shown on the Drawings.  
B. Shall have the following features:  
   1. Switch mechanism shall be the quick make, quick-break type.  
   2. Copper blades, visible in the OFF position.  
   3. An arc chute for each pole.  
   4. External operating handle shall indicate ON and OFF positions and shall have lock-open padlocking provisions.  
   5. Mechanical interlock shall permit opening of the door only when the switch is in the OFF position defeatable by a special tool to permit inspection.  
   6. Where fuses are required, fuse holders shall be provided that accept only Class R fuses.  
   7. Solid neutral for each switch being installed in a circuit which includes a neutral conductor.  
   8. Enclosures:  
      a. Shall be the NEMA types shown on the Drawings for the switches.  
      b. Where the types of switch enclosures are not shown, they shall be NEMA Type 1 for indoor and NEMA Type 4X (stainless steel) for outdoor.  
      c. NEMA 4X enclosures shall be used in "wet and corrosive" interior locations.  
C. Shall be heavy duty and horsepower rated as required unless indicated otherwise.

PART 3 EXECUTION  
3.01 INSTALLATION  
A. Install safety switches where indicated, in accordance with the manufacturer's written instructions, the applicable requirements of NEC and the National Electrical Contractors Association's "Standard of Installation", and in accordance with recognized industry practices, to ensure that products serve the intended function.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Enclosed NEMA controllers for low-voltage (600 V and less) applications:
B. Overcurrent protective devices for motor controllers, including overload relays.
C. Manual motor controllers.
D. Magnetic motor controllers.
E. Combination magnetic motor controllers and disconnects.

1.02 RELATED REQUIREMENTS
A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
B. Section 26 05 29 - Hangers and Supports for Electrical Systems.

1.03 REFERENCE STANDARDS
B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.

1.05 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.
B. Products: Listed, classified, and labeled as suitable for the purpose intended.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Schneider Electric, Square D Products
B. Allen Bradley
ENCLOSED CONTROLLERS

A. Provide enclosed controller assemblies consisting of all required components, control power transformers, instrumentation and control wiring, accessories, etc. as necessary for a complete operating system.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Description: Enclosed controllers complying with NEMA ICS 2, and listed and labeled as complying with UL 60947-1 and UL 60947-4-1; ratings, configurations and features as indicated on the drawings.

D. Service Conditions:
   1. Provide controllers and associated components suitable for operation under the following service conditions without derating:
      a. Altitude:
         1) Class 1 Km Equipment (devices utilizing power semiconductors, e.g. variable frequency controllers): Less than 3,300 feet (1,000 m).
         2) Class 2 Km Equipment (electromagnetic and manual devices): Less than 6,600 feet (2,000 m).
      b. Ambient Temperature: Between 32 degrees F (0 degrees C) and 104 degrees F (40 degrees C).
   2. Provide controllers and associated components suitable for operation at indicated ratings under the service conditions at the installed location.

E. Short Circuit Current Rating:

F. Conductor Terminations: Suitable for use with the conductors to be installed.

G. Enclosures:
   2. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
   3. Finish: Manufacturer's standard unless otherwise indicated.

H. Instrument Transformers:
   2. Select suitable ratio, burden, and accuracy as required for connected devices.

OVERCURRENT PROTECTIVE DEVICES

A. Overload Relays:
   1. Provide overload relays and, where applicable, associated current elements/heaters, selected according to actual installed motor nameplate data, in accordance with manufacturer's recommendations and NFPA 70; include consideration for motor service factor and ambient temperature correction, where applicable.
   2. Inverse-Time Trip Class Rating: Class 20 unless otherwise indicated or required.
   3. Trip-free operation.
   4. Visible trip indication.
   5. Resettable.
      a. Employ manual reset unless otherwise indicated.
      b. Do not employ automatic reset with two-wire control.

MANUAL CONTROLLERS

A. Manual Motor Controllers: NEMA ICS 2, AC general-purpose, Class A, manually operated, full-voltage controller with overload element, red pilot light, NO auxiliary contact, and push button operator.
2.05 AUTOMATIC CONTROLLERS

A. Magnetic Motor Controllers: NEMA ICS 2, AC general-purpose Class A magnetic controller for induction motors rated in horsepower.

B. Overload Relays: NEMA ICS 2; bimetal.

2.06 ACCESSORIES

A. Auxiliary Contacts: NEMA ICS 2, 2 normally open contacts in addition to seal-in contact.

B. Pilot Device Contacts: NEMA ICS 5, Form Z, rated A150.

C. Control Power Transformers: 120 volt secondary, ____ VA minimum, in each motor starter. Provide fused primary, secondary, and bond unfused leg of secondary to enclosure.

2.07 DISCONNECTS

A. Combination Controllers: Combine motor controllers with disconnects in common enclosure. Obtain IEC Class 2 coordinated component protection.

B. Thermal Magnetic Circuit Breakers: Integral thermal and instantaneous magnetic trip in each pole; UL listed.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install controllers in accordance with NECA 1 (general workmanship).

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Provide required support and attachment components in accordance with Section 26 05 29.

E. Install enclosed controllers plumb and level.

F. Provide grounding and bonding in accordance with Section 26 05 26.

G. Install all field-installed devices, components, and accessories.

H. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

I. Set field-adjustable controllers and associated components according to installed motor requirements, in accordance with manufacturer's recommendations and NFPA 70.

J. Select and install overload heater elements in motor controllers to match installed motor characteristics.

3.02 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Motor Starters: Perform inspections and tests listed in NETA ATS, Section 7.16.1.1. Tests listed as optional are not required.

C. Correct deficiencies and replace damaged or defective enclosed controllers or associated components.

D. Perform inspections and tests listed in NETA ATS, Section 7.16.1.

END OF SECTION
SECTION 26 29 23
VARIABLE FREQUENCY DRIVES

PART 1 GENERAL

1.01 DESCRIPTION
A. VF (Variable frequency) drives shall be utilized to control the speed of the motors, as shown on the drawings.

1.02 QUALITY ASSURANCE
A. VF drives shall be designed, constructed, and tested in accordance with NEMA, UL, NEC and IEEE recommendations when applicable.
B. Each VF drive shall be marked with an identifying UL label within the enclosure. Controllers that are not UL listed will not be considered.
C. Manufacturers: VF drives shall be the product of firms regularly engaged in the manufacture of VF drives of the type required. The firm's products shall have been in satisfactory use in similar situations for not less than 5 years.
D. VF drives shall be pretested (burned-in) at full load and full speed and cycled on a dynamometer in an ambient of no less than 40 degrees C.
E. VF drive shall comply with FCC rules and regulations Part 15, Subpart J, regarding radio frequency interference.
F. Total harmonic distortion shall be less than 10% with less than 4% 5th harmonic content.
G. Products from the following manufacturers are acceptable
   1. Allen Bradley
   2. Square D

1.03 SUBMITTALS
A. Submit manufacturer's data on the proposed VF drives. Data shall be sufficient to verify all ratings and requirements as called for in these specifications and shown on the Drawings.

1.04 DELIVERY, STORAGE, AND PROTECTION
A. Store drives indoors and protect from weather.
B. Handle drives carefully to prevent damage, denting or scoring finish.

PART 2 PRODUCTS

2.01 VARIABLE FREQUENCY DRIVES
A. The VF drive shall convert 480 volts, +10% -5%, three phase, 60 Hz utility power to an adjustable frequency and voltage output for speed control from 10% to 100% of base speed. The VF drive shall be designed for variable torque and/or constant torque applications as required for the equipment being driven. The Contractor shall determine the torque requirements by coordinating with the equipment suppliers.
B. Drives shall have ethernet/IP capabilities.
C. Acceleration and deceleration ramp rates shall be independently adjustable from 6 seconds to 60 seconds for soft starting and controlled stopping.
D. Current limit means shall be adjustable from 75% to 120% of motor full load current.
E. Automatic restarting upon application of power after a loss of line power shall not trip out the drive or blow any fuses.
F. Short-time rating shall be 150% of continuous rated output current for one minute.
G. Automatic speed reference port shall be isolated and shall be field convertible for a 4 to 20 ma or 0 - 10 v dc process control signal.
H. Protection:
   1. Unit shall be UL listed for 42,000 rms symmetrical amp fault withstand capability.
   2. Current limiting input fuses.
   3. Coordinated protection shall prevent component failures for the following:
      a. Output phase-to-phase short circuit
      b. Output ground fault
      c. Input undervoltage condition
      d. VF drive over-temperature condition
      e. Instantaneous overload
      f. DC bus overvoltage condition
      g. Sustained overload exceeding 115% of controller continuous rated output current
      h. Shoot-through condition

I. Diagnostic and status indicators
   1. VF drive shall be equipped with indicators to display status functions for the following:
      a. Bus overvoltage, ground fault, undervoltage, instantaneous overcurrent, over-
         temperature, overload timer, overload power up delay, drive enable, power supply,
         and motor current limit.

J. Pilot devices and meters
   1. The following devices shall be mounted on the front cover of the drive: Power on pilot
      light, run pilot light, drive fail pilot light, manual speed potentiometer, speed indicator,
      "hand-off-automatic" selector switch.

K. VF drives shall be equipped with an internal disconnect.

L. VF drive shall be suitable for the following service conditions:
   1. Elevation: To 3300 feet without derating.
   2. Ambient temperature range: 0 to 40 degree C.
   3. Humidity: To 95% non-condensing

M. Provide line reactors and/or dv/dt filters as shown on the drawings.

PART 3 EXECUTION

3.01 INSPECTION
   A. Examine areas and conditions under which drives are to be installed. Do not proceed with the
      work until all unsatisfactory conditions have been corrected in a manner acceptable for proper
      installation.

3.02 INSTALLATION
   A. Install drives in accordance with manufacturer's written instructions, applicable requirements of
      the NEC and National Electrical Contractors Association "Standard of Installation", to insure the
      drives serve their intended purposes.
   B. Anchor enclosures firmly to walls or structural surfaces, ensuring that they are permanently and
      mechanically secure.
   C. Coordinate installation of drives with cable and raceway installation work.
   D. Provide electrical connections within enclosures.

END OF SECTION
SECTION 26 51 10
LIGHTING

PART 1 GENERAL
1.01 SCOPE OF WORK
A. Furnish and install all electric lighting fixtures complete with lamps, as shown on the Lighting Fixture Schedule.

1.02 DELIVERY, STORAGE, AND PROTECTION
A. In accordance with Section 01600.

PART 2 PRODUCTS
2.01 LIGHT FIXTURES
A. Fixtures shall be furnished as specified on the Lighting Fixture Schedule. Driver/ballast shall be for the scheduled fixture and suited to the electrical system specified.
B. All components shall conform to the general requirements and to U.L. standards for the following:
   1. Attachments, plugs and receptacles
   2. Ballasts, fluorescent - lamp
   3. Cabinets and boxes
   4. Conduit, flexible steel
   5. Fixtures, electric lighting
   6. Flexible cord and fixture wire
   7. Lampholders, edison base
   8. Lampholders, starters and starter holder for fluorescent lamps
   9. Lamps, portable electric
   10. Wire connectors and soldering lugs
   11. Wires and cables, rubber covered
   12. Wires, asbestos and asbestos-varnished, cloth insulated
   13. Wires, thermoplastic - insulated
   14. Wires, weatherproof and slow burning
C. Lighting Fixture Wiring
   1. Fixture wiring shall be large enough to handle the individual or combined power loads of each fixture, but in no case shall it be smaller than # 14, type AF stranded wire. The fixtures shall be U.L. listed for use in wet locations for "Wet" areas as noted on the Drawings. In the other areas they shall be U.L. listed. They shall carry IBEW wiring and fabrication labels.
   2. General lighting system branch circuit conductors shall be installed in conduit from the panelboards to outlets and between outlets as indicated on the Drawings.
   3. No. 12 wire shall be the smallest conductor used for any lighting branch circuits.
D. Lighting Fixture Locations
   1. Lighting fixture locations are carefully coordinated with ceiling patterns, outlets, walls, etc. Nonsymmetrical layouts are not acceptable unless previously approved. The fixtures shall be coordinated with the ceiling support system. The Contractor shall carefully review the Reflected Ceiling Plan and check for any changes before locating fixtures.

PART 3 EXECUTION
3.01 INSTALLATION
A. Lighting fixtures shall be suspended from structural members or from ceiling structural members with hardware suitable for the area where the fixtures are being installed.

END OF SECTION
SECTION 26 51 20
EMERGENCY LIGHTING

PART 1 GENERAL
1.01 DESCRIPTION OF WORK
A. All emergency and exit lighting shall be furnished and installed in accordance with the Drawings and the following Specifications.

1.02 QUALITY ASSURANCE
A. Emergency and exit lighting shall meet all applicable UL, NFPA, NEC and OSHA rules and regulations.
B. Manufacturer: Firms regularly engaged in the manufacture of emergency fixtures and components of types and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.

PART 2 PRODUCTS
2.01 ACCEPTABLE MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements of this Section. Provide products as indicated in Light Fixture Schedule (refer to Electrical Drawings).
B. Acceptable Substitutions: See Section 01600 - Product Requirements for substitution procedures. All substitutions for emergency and exit lighting shall be approved in advance by the Engineer.

2.02 EMERGENCY LIGHTING
A. Provide emergency lighting as noted on the Drawings. Emergency lighting shall be complete including, but not limited to, housings, lamps, lamp holders, reflectors, ballasts, starters and wiring.
B. Provide individual battery packs to provide emergency power, as noted on the Drawings.
C. All emergency lighting shall include an exposed test switch with an LED indicator.

2.03 EXIT LIGHTING
A. Provide exit lighting as noted on the Drawings. Exit lighting shall be complete including, but not limited to, housings, lamps, lamp holders, reflectors, ballasts, starters and wiring.
B. Provide individual battery packs to provide emergency power, as noted on the Drawings.
   1. Battery packs shall be capable of energizing fixture for a minimum of 90 minutes.
C. All exit lights shall be equipped with an exposed test switch with an LED indicator.

PART 3 EXECUTION
3.01 INSTALLATION OF EMERGENCY AND EXIT LIGHTING
A. Install all emergency and exit lighting at locations and heights as indicated in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NFPA, OSHA and with recognized industry practices to ensure that requirements are fulfilled.
B. Coordinate with other electrical work as appropriate to properly interface installations with other work.
C. Fasten fixtures securely to structural supports.
D. Exercise great care when handling lenses, avoiding contact with oily and/or foreign substances.
E. Clean fixtures of dirt and debris upon completion of installation. Protect installed fixtures from damage during remainder of project.
3.02 FIELD QUALITY CONTROL
   A. Upon completion of installation of emergency and exit lights, and after building circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting. At the time of Substantial Completion, replace lamps in light fixtures which are observed to be noticeably dimmed after Contractor's use and testing, as judged by Engineer.

3.03 GROUNDING
   A. Provide tight equipment grounding connections for each light fixture installation.

END OF SECTION
SECTION 27 10 10
FIBER OPTIC CABLING

PART 1 - GENERAL

1.01 DESCRIPTION
A. Contractor shall furnish and install the network switches and fiber-optic cabling as required to install the system as shown on the drawings.

1.02 GENERAL REQUIREMENTS
A. Equipment shall be the product of firms regularly engaged in the manufacture of managed network switches and fiber optic cabling, whose products have been in satisfactory use in similar service for not less than five years.

B. Acceptable suppliers of the network switches are as follows:
   1. Network switches shall be as specified on the drawings.

C. Acceptable suppliers of the fiber-optic cabling are as follows:
   1. General Cable
   2. Corning
   3. Berk-Tech
   4. Other manufacturer's will be considered, but the proposed cabling shall meet all specification requirements and be fully equal to the system specified

PART 2 - PRODUCTS

2.01 FIBER-OPTIC CABLING
A. Cable shall contain 24 12 fibers rated for multimode operation.
B. Fibers shall be tightly buffered.
C. Plenum rated cable shall be used for all interior installations. Installed cable shall meet or exceed the following specifications:
   1. Tight buffered 900 um, mechanical strippable Teflon (for plenum applications).
   2. EIA/TIA -598 color coding for fiber optic cable.
   3. Aramid yarn strength member, capable of supporting a short-term tensile load of 400 lb. without stretching.
   4. Capable of bend radii as small as 20 x outside cable diameter (under installation load) and 10 x outside cable diameter (long term load).
   5. Capable of a minimum crush resistance of 850 lb./in.
D. Outside plant cable shall be used for all applications where cable is to be run in underground conduits. Outside plant cable may not be used for interior applications and shall meet the following specifications:
   1. Gel filled buffer tube, 250 um, acrylate.
   2. EIA/TIA-598 color coding for fiber optic cable.
   3. Flooded core
   4. Capable of bend radii as small as 20 x outside cable diameter (under installation load) and 10 x outside cable diameter (long term load).
   5. Capable of a minimum crush resistance of 850 lb./in.
E. At no time shall more than 400 pounds of tension be placed on any fiber cable while it is being pulled through tray or conduit. It is preferred that all fiber cable be pulled with hand power only. If power winches or mechanical advantage devices are used to pull cable, a tensiometer must be used to insure that maximum tension is not exceeded. Alternatively, a "mechanical fuse" rated at 350 pounds may be included in the linkage. Torsion shall be avoided by the use of a swivel at the cable end. While under tension, a minimum bend radius of 20 times the outside cable diameter will be maintained through the use of pulleys and sheaves where required. After pulling, no bend may have a radius, at rest, of less than 10 times the outside cable diameter.
Fiber ends are to be terminated in ST-type connectors with composite ferrules. They must be of the "epoxy and polish".

2.02 NETWORK SWITCHES
A. New network switches shall be fully compatible with the existing network switches that are already in use at the facilities as specified on the drawings.
B. New switches shall be capable of accepting fiber-optic cabling.
C. Patch cords shall be supplied and installed to connect the new switches to the existing network stacks.

PART 3 - EXECUTION
3.01 STORAGE AND HANDLING
A. Store all equipment and cabling inside and protect from weather.
B. Handle all equipment carefully to prevent breakage, denting or scouring finish.

3.02 INSTALLATION
A. Provide and install the system in accordance with all applicable codes and the manufacturer's recommendations.

3.03 TESTING
A. The complete system shall be tested in compliance with manufacturer's recommendations and industry standards. Contractor shall certify that the system is in perfect working condition.

END OF SECTION
SECTION 31 10 00
SITE CLEARING

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Clearing and protection of vegetation.
B. Removal of existing debris.

1.02 RELATED REQUIREMENTS
A. Section 01 10 00 - Summary: Limitations on Contractor’s use of site and premises.
B. Section 01 50 00 - Temporary Facilities and Controls: Site fences, security, protective barriers, and waste removal.
C. Section 01 70 00 - Execution and Closeout Requirements: Project conditions; protection of bench marks, survey control points, and existing construction to remain; reinstallation of removed products.
D. Section 31 22 00 - Grading: Fill material for filling holes, pits, and excavations generated as a result of removal operations.

1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Site Plan: Showing:
   1. Vegetation removal limits.
   2. Areas for temporary construction and field offices.

PART 2 PRODUCTS

2.01 MATERIALS
A. Fill Material: As specified in Section 31 22 00 - Grading

PART 3 EXECUTION

3.01 SITE CLEARING
A. Comply with other requirements specified in Section 01 70 00.
B. Minimize production of dust due to clearing operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.

3.02 EXISTING UTILITIES AND BUILT ELEMENTS
A. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.
B. Protect existing utilities to remain from damage.
C. Do not disrupt public utilities without permit from authority having jurisdiction.
D. Protect existing structures and other elements that are not to be removed.

3.03 VEGETATION
A. Scope: Remove trees, shrubs, brush, and stumps in areas to be covered by building structure, paving, playing fields, lawns, and planting beds.
B. Do not begin clearing until vegetation to be relocated has been removed.
C. Do not remove or damage vegetation beyond the limits indicated on drawings.
   1. 40 feet outside the building perimeter.
   2. 10 feet each side of surface walkways, patios, surface parking, and utility lines less than 12 inches in diameter.
   3. 15 feet each side of roadway curbs and main utility trenches.
   4. 25 feet outside perimeter of pervious paving areas that must not be compacted by construction traffic.
5. Exception: Specific trees and vegetation indicated on drawings to be removed.

D. Install substantial, highly visible fences at least 3 feet high to prevent inadvertent damage to vegetation to remain:
   1. At vegetation removal limits.
   2. Around other vegetation to remain within vegetation removal limits.

E. In areas where vegetation must be removed but no construction will occur other than pervious paving, remove vegetation with minimum disturbance of the subsoil.

F. Vegetation Removed: Do not burn, bury, landfill, or leave on site, except as indicated.
   1. Chip, grind, crush, or shred vegetation for mulching, composting, or other purposes; preference should be given to on-site uses.
   2. Trees: Sell if marketable; if not, treat as specified for other vegetation removed; remove stumps and roots to depth of 18 inches.
   3. Existing Stumps: Treat as specified for other vegetation removed; remove stumps and roots to depth of 18 inches.
   4. Sod: Re-use on site if possible; otherwise sell if marketable, and if not, treat as specified for other vegetation removed.
   5. Fill holes left by removal of stumps and roots, using suitable fill material, with top surface neat in appearance and smooth enough not to constitute a hazard to pedestrians.

G. Dead Wood: Remove all dead trees (standing or down), limbs, and dry brush on entire site; treat as specified for vegetation removed.

H. Restoration: If vegetation outside removal limits or within specified protective fences is damaged or destroyed due to subsequent construction operations, replace at no cost to Owner.

3.04 DEBRIS

   A. Remove debris, junk, and trash from site.
   B. Leave site in clean condition, ready for subsequent work.
   C. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION
SECTION 31 22 00
GRADING

PART 1 GENERAL

1.01 SCOPE OF WORK
A. Furnish all labor, materials, equipment and incidentals required for the removal of topsoil, rough grading, finish grading, and removal and disposal of topsoil and sub-soil which is within the limits of the work necessary for construction in accordance with the specifications and in reasonably close conformity with the lines, grades, thicknesses, and typical cross sections shown on the Drawings or established by the Engineer.

1.02 RELATED REQUIREMENTS
A. Section 31 10 00 - Site Clearing.
B. Section 31 23 16 - Excavation.
C. Section 31 23 23 - Fill: Filling and compaction.
D. Section 31 23 16.13 - Trenching: Trenching and backfilling for utilities.

1.03 SUBMITTALS
A. Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

PART 2 PRODUCTS

2.01 MATERIALS
A. Topsoil: See Section 31 23 23.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that survey bench mark and intended elevations for the Work are as indicated.
B. Verify the absence of standing or ponding water.

3.02 PREPARATION
A. Identify required lines, levels, contours, and datum.
B. Stake and flag locations of known utilities.
C. Locate, identify, and protect from damage above- and below-grade utilities to remain.
D. Notify utility company to remove and relocate utilities.
E. Provide temporary means and methods to remove all standing or ponding water from areas prior to grading.
F. Protect site features to remain, including but not limited to bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs, from damage by grading equipment and vehicular traffic.
G. Protect trees to remain by providing substantial fencing around entire tree at the outer tips of its branches; no grading is to be performed inside this line.
H. Protect plants, lawns, rock outcroppings, and other features to remain as a portion of final landscaping.

3.03 ROUGH GRADING
A. Remove topsoil from areas to be further excavated, re-landscaped, or re-graded, without mixing with foreign materials.
B. Do not remove topsoil when wet.
C. Remove subsoil from areas to be further excavated, re-landscaped, or re-graded.
D. Do not remove wet subsoil, unless it is subsequently processed to obtain optimum moisture content.
E. When excavating through roots, perform work by hand and cut roots with sharp axe.
F. See Section 31 23 23 for filling procedures.
G. Benching Slopes: Horizontally bench existing slopes greater than 1:4 to key fill material to slope for firm bearing.
H. Stability: Replace damaged or displaced subsoil to same requirements as for specified fill.
I. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack surface water control.

3.04 SOIL REMOVAL
A. Stockpile topsoil to be re-used on site; remove remainder from site.
B. Stockpile excavated subsoil on site.
C. Stockpiles: Use areas designated on site; pile depth not to exceed 8 feet; protect from erosion.

3.05 FINISH GRADING
A. Before Finish Grading:
   1. Verify building and trench backfilling have been inspected.
   2. Verify subgrade has been contoured and compacted.
B. Remove debris, roots, branches, stones, in excess of 1/2 inch in size. All efforts should be made to remove organic material from placed soil. Remove soil contaminated with petroleum products in accordance with relevant environmental regulations.
C. Where topsoil is to be placed, scarify surface to depth of 3 inches.
D. In areas where vehicles or equipment have compacted soil, scarify surface to depth of 3 inches.
E. Place topsoil in areas where seeding are indicated.
F. Place topsoil where required to level finish grade.
G. Place topsoil to the following compacted thicknesses:
   1. Areas to be Seeded with Grass: 6 inches.
   2. Shrub Beds: 18 inches.
   3. Flower Beds: 12 inches.
H. Place topsoil during dry weather.
I. Remove roots, weeds, rocks, and foreign material while spreading.
J. Near plants spread topsoil manually to prevent damage.
K. Fine grade topsoil to eliminate uneven areas and low spots. Maintain profiles and contour of subgrade.
L. Lightly compact placed topsoil.
M. Maintain stability of topsoil during inclement weather. Utilize fabrics, netting, cover etc. where appropriate. Replace topsoil in areas where surface water has eroded thickness below specifications.

3.06 TOLERANCES
A. Top Surface of Subgrade: Plus or minus 0.10 foot (1-3/16 inches) from required elevation.
B. Top Surface of Finish Grade: Plus or minus 0.04 foot (1/2 inch).

3.07 REPAIR AND RESTORATION
A. Existing Facilities, Utilities, and Site Features to Remain: If damaged due to this work, repair or replace to original condition.
B. Trees to Remain: If damaged due to this work, trim broken branches and repair bark wounds; if root damage has occurred, obtain instructions from Engineer as to remedy.
C. Other Existing Vegetation to Remain: If damaged due to this work, replace with vegetation of equivalent species and size.

3.08 FIELD QUALITY CONTROL
A. See Section 31 23 23 for compaction density testing.

3.09 CLEANING
A. Remove unused stockpiled topsoil and subsoil. Grade stockpile area to prevent standing water.
B. Leave site clean and raked, ready to receive landscaping.

END OF SECTION
SECTION 31 23 16.13
TRENCHING

PART 1 GENERAL

1.01 SCOPE OF WORK
A. Furnish all labor, materials, equipment and incidentals required for the trenching for site utilities as shown on the Drawings and as specified herein.

1.02 SECTION INCLUDES
A. Backfilling and compacting for utilities outside the building to utility main connections.

1.03 RELATED REQUIREMENTS
A. Section 31 22 00 - Grading: Site grading.
B. Section 31 23 16 - Excavation: Building and foundation excavating.
C. Section 31 23 23 - Fill: Backfilling at building and foundations.

1.04 DEFINITIONS
A. Finish Grade Elevations: Indicated on drawings.
B. Subgrade Elevations: Indicated on drawings.

1.05 REFERENCE STANDARDS
B. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)); 2012.
D. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN m/m³)); 2012.
F. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth); 2010.

1.06 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Fill Composition Test Reports: Results of laboratory tests on proposed and actual materials used.
C. Compaction Density Test Reports.

1.07 DELIVERY, STORAGE, AND HANDLING
A. When necessary, store materials on site in advance of need.
B. When fill materials need to be stored on site, locate stockpiles where indicated.
   1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
   2. Prevent contamination.
   3. Protect stockpiles from erosion and deterioration of materials.
   4. Cover material to prevent oversaturation or overly high moisture contents.

PART 2 PRODUCTS

2.01 FILL MATERIALS
A. See Section 02316 Fill and Backfill.
2.02 SOURCE QUALITY CONTROL
   A. See Section 01 40 00 - Quality Requirements, for general requirements for testing and analysis of soil material.
   B. Where fill materials are specified by reference to a specific standard, test and analyze samples for compliance before delivery to site.
   C. If tests indicate materials do not meet specified requirements, change material and retest.
   D. Provide materials of each type from same source throughout the Work.
   E. Retest imported materials at a given rate (per Engineer’s recommendation) to confirm consistency.

PART 3 EXECUTION
3.01 EXAMINATION
   A. Verify that survey bench marks and intended elevations for the work are as indicated.

3.02 PREPARATION
   A. Identify required lines, levels, contours, and datum locations.
   B. Grade top perimeter of trenching area to prevent surface water from draining into trench. Provide temporary means and methods, as required, to maintain surface water diversion until no longer needed, or as directed by the Engineer.

3.03 TRENCHING
   A. Notify Engineer of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.
   B. Slope banks of excavations deeper than 4 feet to angle of repose or less until shored.
   C. Do not interfere with 45 degree bearing splay of foundations.
   D. Cut trenches wide enough to allow inspection of installed utilities.
   E. Hand trim excavations. Remove loose matter.
   F. Remove large stones and other hard matter that could damage piping or impede consistent backfilling or compaction.
   G. Remove excavated material that is unsuitable for re-use from site.
   H. Remove excess excavated material from site.
   I. Provide temporary means and methods, as required, to remove all water from trenching until directed by the Engineer. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack of dewatering or surface water control.
   J. Determine the prevailing groundwater level prior to trenching. If the proposed trench extends less than 1 foot into the prevailing groundwater, control groundwater intrusion with perimeter drains routed to sump pumps, or as directed by the Engineer.

3.04 PREPARATION FOR UTILITY PLACEMENT
   A. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill.
   B. Compact subgrade to density equal to or greater than requirements for subsequent fill material.
   C. Until ready to backfill, maintain excavations and prevent loose soil from falling into excavation.

3.05 BACKFILLING
   A. Backfill to contours and elevations indicated using unfrozen materials.
   B. Fill up to subgrade elevations unless otherwise indicated.
   C. Employ a placement method that does not disturb or damage other work.
   D. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.
E. Maintain optimum moisture content of fill materials to attain required compaction density.
F. Granular Fill: Place and compact materials in equal continuous layers not exceeding 6 inches compacted depth.
G. Soil Fill: Place and compact material in equal continuous layers not exceeding 8 inches compacted depth.
H. Slope grade away from building minimum 2 inches in 10 feet, unless noted otherwise. Make gradual grade changes. Blend slope into level areas.
I. Correct areas that are over-excavated.
   1. Thrust bearing surfaces: Fill with concrete.
   2. Other areas: Use general fill, flush to required elevation, compacted to minimum 97 (standard) or 95 (modified) percent of maximum dry density.
J. Compaction Density Unless Otherwise Specified or Indicated:
   1. Under paving, slabs-on-grade, and similar construction: ___ (standard) and 95 (modified) percent of maximum dry density.
   2. At other locations: 95 (standard) or 90 (modified) percent of maximum dry density.
K. Reshape and re-compact fills subjected to vehicular traffic.

3.06 BEDDING AND FILL AT SPECIFIC LOCATIONS
A. Use general fill unless otherwise specified or indicated.
B. Utility Piping, Conduits, and Duct Bank:
   2. Cover with general fill.
   3. Fill up to subgrade elevation.
   4. Compact in maximum 8 inch compacted lifts to 97 (standard) or 95 (modified) percent of maximum dry density.
C. At Pipe Culverts:
   2. Cover with general fill.
   3. Fill up to subgrade elevation.
   4. Compact in maximum 8 inch lifts to 95 percent of maximum dry density.

3.07 TOLERANCES
A. Top Surface of General Backfilling: Plus or minus 1 inch from required elevations.
B. Top Surface of Backfilling Under Paved Areas: Plus or minus 1 inch from required elevations.

3.08 FIELD QUALITY CONTROL
A. See Section 01 40 00 - Quality Requirements, for general requirements for field inspection and testing.
B. Perform compaction density testing on compacted fill in accordance with ASTM D1556, ASTM D2167, or ASTM D6938.
C. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D1557 ("modified Proctor"), AASHTO T 180, or ASTM D698 ("standard Proctor").
D. If tests indicate work does not meet specified requirements, remove work, replace and retest.
E. Frequency of Tests: one (1) test per 2,500 SF per lift.

3.09 CLEANING
A. Leave unused materials in a neat, compact stockpile.
B. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.
C. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

END OF SECTION
SECTION 31 23 16
EXCAVATION

PART 1 GENERAL
1.01 SCOPE OF WORK
   A. Furnish all labor, materials, equipment and incidentals required for all excavation required to complete the Work as shown on the Drawings and as specified herein.

1.02 RELATED REQUIREMENTS
   A. Section 31 22 00 - Grading: Soil removal from surface of site.
   B. Section 31 22 00 - Grading: Grading.
   D. Section 31 23 23 - Fill: Fill materials, filling, and compacting.
   E. Section 31 23 16.13 - Trenching: Excavating for utility trenches outside the building to utility main connections.

1.03 PROJECT CONDITIONS
   A. Verify that survey bench mark and intended elevations for the Work are as indicated.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION
3.01 EXAMINATION
   A. Verify that survey bench mark and intended elevations for the work are as indicated.

3.02 PREPARATION
   A. Identify required lines, levels, contours, and datum locations.
   B. See Section 31 22 00 for additional requirements.
   C. Grade top perimeter of excavation to prevent surface water from draining into excavation. Provide temporary means and methods, as required, to maintain surface water diversion until no longer needed, or as directed by the Engineer.

3.03 EXCAVATING
   A. Excavation shall include the loosening, loading, removing, and transporting and disposing of all materials, wet or dry, necessary to be removed for the purpose of construction; all dewatering, bailing, sheeting and bracing necessary to maintain trenches and pits in a safe and workable condition and sufficiently dry to enable proper execution of the work. Shoring construction to be designed by professional engineer licensed in the state of Delaware.
   B. Underpin adjacent structures that could be damaged by excavating work.
   C. Excavate to accommodate new structures and construction operations.
   D. Notify Engineer of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.
   E. Slope banks of excavations deeper than 4 feet to angle of repose or less until shored.
   F. Do not interfere with 45 degree bearing splay of foundations.
   G. Cut utility trenches wide enough to allow inspection of installed utilities.
   H. Hand trim excavations. Remove loose matter.
   I. Remove lumped subsoil, boulders, and rock up to 1/3 cubic yard measured by volume. See Section 31 23 16.26 for removal of larger material.
   J. Correct areas that are over-excavated and load-bearing surfaces that are disturbed; see Section 31 23 23.
K. Correct areas that are over-excavated and load-bearing surfaces that are disturbed; any such excavation under or adjacent to the 45 degree bearing splay of new or existing structures which may cause a weakening of the structure shall be filled with concrete, as directed by the Engineer, at the expense of the Contractor.

L. Where the bottom of the excavation at subgrade is found to be unstable, frozen, excessively soft or loose or to include deleterious materials such as ashes, cinders, all types of refuse, vegetable or other organic material, or large pieces or fragments of inorganic material which, in the judgement of the Engineer should be removed, such unsuitable material shall be removed to expose firm native soils to the width and depth directed by the Engineer and at no cost to the Owner.

M. Where the bottom of the excavation at subgrade is found to consist of material which is unstable to such a degree that, in the opinion of the Engineer, it cannot be removed and replaced with an approved material compacted as required in place to support the pipe properly, a foundation for the structure consisting of piling, timbers or other materials, shall be constructed in accordance with Drawings prepared by the Engineer. The Contractor shall be reimbursed for this Extra Work in accordance with Section 01 20 00 - Price and Payment Procedures.

N. Provide suitable means to promptly and effectively remove water from all excavations and keep such excavations dry until the work or structures to be built therein have been satisfactorily completed.

O. Provide for all dewatering necessary in order that the construction may proceed in a safe workmanlike manner.

P. Provide for the disposal of the water removed from the excavation in such a manner as shall not create a nuisance, cause water pollution, cause injury to public health, private property, any portion of the work completed or in progress, the surface of the streets, or any impediment to the use of the site.

Q. In no case shall water be permitted to run over the excavated subgrade or foundation or through the conduits.

R. Provide well points, pumps or other approved means to keep the ground water sufficiently low, in the opinion of the Engineer, to permit the placing of concrete, masonry, or pipe in first class condition; and sufficiently long thereafter to protect the concrete, masonry, or joints against washing or damage.

S. Provide temporary means and methods, as required, to remove all water from excavations until directed by the Engineer. Remove and replace soils deemed suitable by classification and which are excessively moist due to lack of dewatering or surface water control.

T. Determine the prevailing groundwater level prior to excavation. If the proposed excavation extends less than 1 foot into the prevailing groundwater, control groundwater intrusion with perimeter drains routed to sump pumps, or as directed by the Engineer. If the proposed excavation extends more than 1 foot into the excavation, control groundwater intrusion with a comprehensive dewatering procedures, or as directed by the Geotechnical Engineer.

U. Remove excavated material that is unsuitable for re-use from site.

V. Stockpile excavated material to be re-used in area designated on site 31 22 00.

W. Remove excess excavated material from site.

3.04 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for general requirements for field inspection and testing.

B. Provide for visual inspection of load-bearing excavated surfaces before placement of foundations.
3.05 PROTECTION

A. Divert surface flow from rains or water discharges from the excavation.
B. All excavation work is to be conducted in accordance with OSHA Safety and Health Regulations for Construction (29 CFR 1926; Subpart P - Excavations).
C. For pipe and utility trenches, excavations shall be dug such that the pipe can be laid to the alignment and depth required.
D. Excavations shall be braced and drained that the workmen may work therein safely and efficiently.
E. For pipe and utility trenches, the width of the trench shall be ample to permit the pipe to be laid and jointed properly, and the backfill to be placed and compacted in accordance with Section 02316.
F. Excavations shall be of such extra width, when required, as will permit the convenient placing of timber supports, sheeting and bracing, and handling of fittings.
G. Prevent displacement of banks and keep loose soil from falling into excavation; maintain soil stability.
H. Protect open excavations from rainfall, runoff, freezing groundwater, or excessive drying so as to maintain foundation subgrade in satisfactory, undisturbed condition.
I. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.
J. Keep excavations free of standing water and completely free of water during concrete placement.

END OF SECTION
SECTION 31 23 23
FILL

PART 1 GENERAL

1.01 SCOPE OF WORK
A. Furnish all labor, materials, equipment, and incidental required to complete all fill and backfill required to complete the Work as shown on the Drawings and as specified herein.

1.02 RELATED REQUIREMENTS
A. Section 01 57 13 - Temporary Erosion and Sediment Control: Slope protection and erosion control.
B. Section 31 22 00 - Grading: Site grading.
C. Section 31 23 16 - Excavation: Removal and handling of soil to be re-used.
D. Section 31 23 16.13 - Trenching: Excavating for utility trenches outside the building to utility main connections.

1.03 DEFINITIONS
A. Finish Grade Elevations: Indicated on drawings.
B. Subgrade Elevations: Indicated on drawings.

1.04 REFERENCE STANDARDS
B. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)); 2012.
C. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN m/m³)); 2012.
D. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2011.

1.05 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Materials Sources: Submit name of imported materials source.
C. Fill Composition Test Reports: Results of laboratory tests on proposed and actual materials used, including manufactured fill.

1.06 DELIVERY, STORAGE, AND HANDLING
A. When necessary, store materials on site in advance of need.
B. When fill materials need to be stored on site, locate stockpiles where designated.
   1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
   2. Prevent contamination.
   3. Protect stockpiles from erosion and deterioration of materials.

PART 2 PRODUCTS

2.01 FILL MATERIALS
A. General Fill: Subsoil excavated on-site.
   1. Graded.
   2. Free of lumps larger than 3 inches, rocks larger than 2 inches, and debris.
   3. Conforming to ASTM D2487 Group Symbol CL.
B. Structural Fill - Granular Soil Fill Type conforming to ASTM D 2487 Group Symbol GW, GP, GM, SM, SW, and SP classified in accordance with the Unified Soil Classification System (USCS). Furthermore, the material to be utilized as structural fill should have a Plasticity Index (Pl) less than 20. Free of lumps larger than 3 inches, rock fragments larger than 2 inches, organic matter, and debris.

C. Drainage Fill - ASTM C 33 Size AASHTO 57 stone: Crushed stone or gravel; washed, free of clay, shale, organic matter.

D. Dense Graded Aggregate Fill - Well graded aggregate crushed stone CR-6. Conforming to the State of the State in which the Project is located Department of Transportation standards.

E. Concrete for Fill: Lean concrete.

F. Granular Fill - Gravel: Angular crushed washed stone; free of shale, clay, friable material and debris.

G. Granular Fill - Pea Gravel: Natural stone; washed, free of clay, shale, organic matter.

H. Sand: Natural river or bank sand; free of silt, clay, loam, friable or soluble materials, and organic matter.

I. Topsoil: Topsoil excavated on-site.

2.02 ACCESSORIES

A. Vapor Retarder: 10 mil thick, polyethylene.

2.03 SOURCE QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for general requirements for testing and analysis of soil material.

B. Where fill materials are specified by reference to a specific standard, test and analyze samples for compliance before delivery to site.

C. If tests indicate materials do not meet specified requirements, change material and retest.

D. Provide materials of each type from same source throughout the Work.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that survey bench marks and intended elevations for the Work are as indicated.

B. Identify required lines, levels, contours, and datum locations.

C. Verify subdrainage, dampproofing, or waterproofing installation has been inspected.

D. Verify structural ability of unsupported walls to support imposed loads by the fill.

E. Verify areas to be filled are not compromised with surface or ground water.

3.02 PREPARATION

A. Prior to the construction of berms, foundations, ground slabs or roads/parking lots, or the placement of fill in structural areas, all existing organic bearing materials, frozen or wet, excessively soft or loose soils, and other deleterious materials should be removed and wasted.
B. After the stripping operations have been completed, the exposed subgrade soils should be inspected by the Geotechnical Engineer. The exposed subgrade materials should be sealed with a smooth-drum roller and proofrolled utilizing a heavily-loaded dump truck or other pneumatic tired vehicle of similar size and weight, if conducted during dry weather. If the site is wet at the time of stripping and filling, then the Contractor should first install surface drainage features (swales, drains, sloping surface, etc.). The inspecting Engineer should determine the means to evaluate the stripped subgrade if the operation is scheduled when the site is wet. The purpose of subgrade sealing and proofrolling is to provide surficial densification and to locate any isolated areas of soft or loose soils requiring undercutting. Proofrolling is not advised in wet areas which may destabilize under repeated vehicular loading. Precipitation may result in standing water (perched water) at low areas. If the water is allowed to pond, the natural soils may deteriorate and overexcavation or subgrade improvement may be necessary at those areas. The Geotechnical Engineer should be consulted to evaluate subgrade conditions during construction. The Geotechnical Engineer may require the use of lightly loaded equipment to proofroll in an effort not to destabilize the subgrade.

C. For the proofrolling and fill compaction operations, fill limits should be extended at least five feet beyond the wastewater treatment facility boundaries including new road/parking lot and ancillary structures.

D. Scarify and proof roll subgrade surface to a depth of 6 inches to identify soft spots.

E. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill.

F. Compact subgrade to density equal to or greater than requirements for subsequent fill material.

G. Until ready to fill, maintain excavations and prevent loose soil from falling into excavation.

3.03 FILLING

A. For the proofrolling and fill compaction operations, fill limits should be extended at least five feet beyond the wastewater treatment facility boundaries including new road/parking lot and ancillary structures.

B. Fill to contours and elevations indicated using unfrozen materials.

C. Fill up to subgrade elevations unless otherwise indicated.

D. Employ a placement method that does not disturb or damage other work.

E. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.

F. Maintain optimum moisture content of fill materials to attain required compaction density.

G. Granular Fill: Place and compact materials in equal continuous layers not exceeding 8 inches loose materials or 6 inches compacted depth.

H. Soil Fill: Place and compact material in equal continuous layers not exceeding 10 inches loose materials or 8 inches compacted depth.

I. Slope grade away from building minimum 2 inches in 10 feet, unless noted otherwise. Make gradual grade changes. Blend slope into level areas.

J. Correct areas that are over-excavated.

1. Load-bearing foundation surfaces: Use structural fill, flush to required elevation, compacted to 95 percent of maximum dry density of the Modified Proctor (AASHTO T180/ASTM D1557) testing procedures.

2. Other areas: Use general fill, flush to required elevation, compacted to minimum 90 percent of maximum dry density of the Modified Proctor (AASHTO T180/ASTM D1557) testing procedures.

K. Compaction Density Unless Otherwise Specified or Indicated:

1. Under paving, slabs-on-grade, and similar construction: 97 percent of maximum dry density of the Modified Proctor (AASHTO T180/ASTM D1557) testing procedures.
2. At other locations: 90 percent of maximum dry density of the Modified Proctor (AASHTO T180/ASTM D1557) testing procedures.

L. Reshape and re-compact fills subjected to vehicular traffic.

M. Maintain temporary means and methods, as required, to remove all water while fill is being placed as required, or until directed by the Engineer. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack of dewatering or surface water control.

3.04 FILL AT SPECIFIC LOCATIONS

A. Use general fill unless otherwise specified or indicated.

B. Under Interior Slabs-On-Grade:
   1. Use granular fill.
   2. Depth: 4 inches deep.
   3. Compact to 95 percent of maximum dry density of Modified Proctor (AASHTO T180/ASTM D1557).

C. At Foundation Walls and Footings:
   1. Use general fill.
   2. Fill up to subgrade elevation.
   3. Compact each lift to 95 percent of maximum dry density of Modified Proctor (AASHTO T180/ASTM D1557).
   4. Do not backfill against unsupported foundation walls.
   5. Backfill simultaneously on each side of unsupported foundation walls until supports are in place.

D. Over Subdrainage Piping at Foundation Perimeter and Under Slabs:
   1. Drainage fill: Section 33 41 00.
   2. Cover drainage fill with general fill.
   3. Fill up to subgrade elevation.
   4. Compact to 90 percent of maximum dry density of Modified Proctor (AASHTO T180/ASTM D1557).

E. Over Buried Utility Piping, Conduits, and Duct Bank in Trenches:
   2. Cover with general fill.
   3. Fill up to subgrade elevation.
   4. Compact in maximum 8 inch loose soil lift to 90 percent of maximum dry density of Modified Proctor (AASHTO T180/ASTM D1557).

F. Under Interior Tank Slabs-On-Grade:
   1. Use dense graded aggregate fill.
   2. Depth: 6 inch thick layer. Unless otherwise indicated on the plans or as required by geotechnical engineer.
   3. Compact 95 percent of maximum dry density of Modified Proctor (AASHTO T180/ASTM D1557).

G. At Lawn Areas:
   1. Use general fill.
   2. Fill up to 6 inches below finish grade elevations.
   3. Compact to 85 percent of maximum dry density of Modified Proctor (AASHTO T180/ASTM D1557).
   4. See Section 31 22 00 for topsoil placement.

3.05 TOLERANCES

A. Top Surface of General Filling: Plus or minus 1 inch from required elevations.

B. Top Surface of Filling Under Paved Areas: Plus or minus 1 inch from required elevations.
3.06 CLEANING

A. See Section 01 74 19 - Construction Waste Management and Disposal, for additional requirements.

B. Leave unused materials in a neat, compact stockpile.

C. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

END OF SECTION
SECTION 33 38 01
GEOSYNTHETIC CLAY LINER (GCL) (Addendum #1)

PART 1 - GENERAL

1.01 DESCRIPTIONS

A. The work in this section includes all labor, materials, equipment, transportation, supervision, and incidental required to perform all furnishing, placing, and all other necessary work to provide and install the geosynthetic clay liner (GCL) as indicated on the Drawings and specified herein.

B. Furnish and install GCL between the 40 mil and 60 mil HDPE geomembrane lagoon liner components as shown on the plans. All work shall be performed in accordance with the Drawings and specifications and GCL manufacturer's recommendations, whichever is more stringent.

C. Furnish sufficient GCL to include overlaps at field seams, anchor trenches, repairs, and incidental waste during installation.

D. It is the responsibility of the CONTRACTOR to ensure a quality-finished product.

E. The CONTRACTOR shall be prepared to install the GCL in conjunction with other components of the base liner system.

1.02 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. Use the latest revision or newly published testing standard available unless otherwise indicated.

B. American Society for Testing Materials (ASTM)
   1. ASTM D 4643 - Determination of Water (Moisture) Content of Soil by the Microwave Oven
   2. ASTM D 5261 - Measuring Mass Per Unit Area of Geotextile
   3. ASTM D 5887 - Measurement of Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter
   4. ASTM D 5890 - Swell Index of Clay Mineral Component of Geosynthetic Clay Liners
   5. ASTM D 5891 - Fluid Loss of Clay Component of Geosynthetic Clay Liners
   6. ASTM D 5993 - Measuring Mass Per Unit Area of Geosynthetic Clay Liners
   7. ASTM D 6496 - Determining Average Bonding Peel Strength Between top and Bottom layers of Needle-punched Geosynthetic Clay Liners
   8. ASTM D 6768 - Tensile Strength of Geosynthetic Clay Liners

C. Geosynthetics Research Institute (GRI)
   1. GRI GCL3 - Test Methods, Required Properties, and Testing Frequencies of Geosynthetic Clay Liners (GCLs)

1.03 SUBMITTALS

A. Submit the following to the ENGINEER a minimum of 21 days for approval prior to GCL deployment:
   1. A physical sample of the GCL labeled with manufacturer's name, product identification, lot number, and roll number.
   2. Proposed GCL layout plan to cover the lined area shown in the Drawings for ENGINEER's review. Details shall show the termination of the GCL liner, overlaps, the methods of sealing around penetrations and methods of anchoring.
   3. Written manufacturing QC certification and test results that the GCL meets the properties at the testing frequencies listed in GRI GCL3, Table 1(b).
   4. Written certification that GCL manufacturer has continuously inspected GCL for the presence of foreign objects and found GCL to be free of foreign objects.
   5. Written certification from the GCL manufacturer that the bentonite will not shift during transportation or installation thereby causing thin spots in the body of the GCL.
6. Written list of the specific rolls to be shipped to the project site, including inventory tickets, lot numbers, roll numbers or batch identifications.

B. Project Closeout
   1. Warranties (see Part 1.5).

1.04 DELIVERY, STORAGE, AND HANDLING
   A. Packing and Shipping
      1. GCL shall be supplied in rolls wrapped individually in relatively impermeable and opaque protective covers.
      2. GCL rolls shall be marked or tagged with the following information:
         a. Manufacturer's name
         b. Product identification
         c. Lot number
         d. Roll number
         e. Roll dimensions
         f. Manufacturer's style number
   B. Storage and Protection:
      1. The CONTRACTOR shall identify an on-site storage area for GCL rolls from time of delivery until installed, per approval of the ENGINEER. GCL, which have been delivered to the project site, shall be stored in their original, unopened wrapping in a dry area and protected from precipitation, water, dirt, the direct heat (ultraviolet light exposure) of the sun, and other sources of damage. The material shall be stored above ground surface and beneath a roof or other protective covering.
      2. Preserve integrity and readability of GCL roll labels prior to installation.

1.05 WARRANTY
   A. The GCL manufacturer shall provide a 2-year material warranty and a 1-year installation warranty from the GCL manufacturer and the Geosynthetic Installer, respectively. The warranty required herein shall be provided in addition to any warranty required by the General Conditions or provided by the GCL manufacturer and the Geosynthetic Installer, whichever is longer.

1.06 CONSTRUCTION QUALITY CONTROL AND QUALITY ASSURANCE
   A. All tests and test frequencies specified in this section are Quality Control (QC) tests, and these tests are the responsibility of the CONTRACTOR.
   B. The ENGINEER will monitor GCL installation and construction and certify that construction is in accordance with Contract Documents and Construction Quality Assurance Plan.
   C. The ENGINEER will reject any GCL material that is not certified or through conformance testing does not comply with this Section. The Contractor shall replace the rejected material at no increase in Contract price.

PART 2 - PRODUCTS

2.01 MANUFACTURERS
   A. The Manufacturer of the GCL shall have a minimum of 5 years of continuous experience in the manufacture of similar GCL products. The Manufacturer must demonstrate, by submitting a list of previous projects, a minimum of 15 million square feet (1.5 million square meters) of manufacturing experience of similar GCL products.

2.02 MATERIALS
   A. The active ingredient of the GCL shall be natural sodium bentonite. The bentonite shall be encapsulated between two carrier geotextiles.
   B. The material furnished for use as the GCL shall be a reinforced, needle punched material such as Bentomat® DN or Bentomat ST, manufactured by CETCO, Bentofix NSL, manufactured by Terrafix, or approved equal.
C. The GCL shall have a maximum hydraulic conductivity of $5 \times 10^{-9}$ cm/sec and a maximum
index flux of $1 \times 10^{-8}$ m3/m/sec as determined by ASTM D 5887. These tests shall use
deaired, distilled/deionized water at 80 psi cell pressure, 77 psi headwater pressure, and 75 psi
tailwater pressure.
D. Minimum 20 degree interface friction angle with 40 mil and 60 mil HDPE geomembranes, and
subgrade, as specified in Section 10922 - Textured High Density Polyethylene liner.
E. The geotextiles shall allow sufficient bentonite flow-through such that the permeability of the
overlap seams is equal to or less than the permeability of the body of the GCL sheet without
the addition of granular or paste bentonite.
F. The bentonite shall be continuously adhered to both geotextiles to ensure that the bentonite will
not be displaced during handling, transportation, storage and installation, including cutting,
patching and fitting around penetrations.
G. The bentonite sealing compound or bentonite granules used to seal penetrations and make
repairs shall be made of the same natural sodium bentonite as the GCL and shall be as
recommended by the GCL manufacturer.

PART 3 - EXECUTION
3.01 SURFACE PREPARATION
A. The GCL liner installation shall not begin until the subsurface has been prepared to accept the
GCL liner and approved by the ENGINEER. The compacted soil layer surface shall be
maintained in a firm and dry condition during the installation of GCL liner.
B. Surfaces for GCL placement shall be smooth and free of rocks, sharp stones, sticks, roots,
sharp objects, or debris of any kind. The surface should provide a firm, unyielding foundation
for the GCL with no sudden, sharp or abrupt changes or breaks in grade.
C. Each section of the subsurface to be covered with a GCL shall be walked by both the
CONTRACTOR and ENGINEER to ensure that no condition or material exists that will
jeopardize the integrity of the geosynthetic.

3.02 INSTALLATION
A. The GCL liner shall be deployed daily with lengths and widths that can be covered by similar
size sheet of geomembrane liner or a temporary waterproof tarpaulin. Only those sheets of
GCL liner material, which can be anchored and covered that same day, shall be unpackaged
and placed in position.
B. GCL liner shall not be installed early in the morning where the subsurface is excessively moist.
It shall not be installed in standing water or during rain. The GCL liner shall be dry when
installed and must be dry when covered with geomembrane liner.
C. Handle GCL in a manner to ensure it is not damaged. At a minimum, comply with the
following:
   1. On slopes, anchor the GCL securely and deploy it down the slope in a controlled manner.
   2. Weight the GCL with sandbags, rubber tires, or equivalent in the presence of wind. The
      leading edge of the GCL liner shall be secured at all times with sandbags or other means
      sufficient to hold it down during high winds.
   3. The GCL liner shall be installed in a relaxed condition but with no creases and shall be
      free of tension or stress upon completion of the installation. Stretching of GCL sheet to fit
      will not be allowed.
   4. Cut GCL with a geotextile cutter (hook blade), scissors, or other approved device.
      Protect adjacent materials from potential damage due to cutting of GCL.
   5. Prevent damage to underlying layers during placement of GCL.
   6. During GCL deployment, do not entrap in or beneath GCL, stones, or trash that could
damage GCL and the overlying geomembrane liner.
   7. Visually examine entire GCL surface. Ensure no potentially harmful foreign objects, such
      as needles, are present.
   8. Do not place GCL during periods of heavy rain or in areas of ponded water.
9. Replace GCL that is significantly hydrated before placement of overlying geomembrane. The GCL shall be considered significantly hydrated when the liner is more than 3/8 inches (10 mm) thick or the moisture content of the bentonite is greater than 40% (ASTM D 4643 modified to include wet weight in the denominator).

10. Only deploy the amount of GCL that can be covered during that day by geomembrane.

11. Orient the preferred GCL surface in relation to the geosynthetic layers as directed by the ENGINEER.

12. On side slopes, run GCL to the bottom of the slope as indicated.

D. Overlaps:
1. Overlap GCL a minimum of 12 inches on all sides. The overlaps shall not be nailed or stapled to the underlying materials.
2. No horizontal seams are allowed on side slopes.

E. Defects and Repairs:
1. Repair all flaws or damaged areas by placing a patch of the same material extending at least 1 foot (300 mm) beyond the flaw or damaged area.
2. Apply a fillet of granular bentonite to overlapped area at a rate required by the manufacturer or a minimum of one-quarter pound per linear foot, whichever is greater. The granular bentonite shall be applied continually along the overlap zone.
3. Patches shall not be nailed or stapled.
4. Inform the ENGINEER immediately on all defects. Record all defects and repairs on the GCL panel layout and record drawings.

F. Interface with Other Products: Ensure the following when deploying overlying material.
1. GCL and underlying materials are not damaged.
2. Minimal slippage of GCL on underlying layers occurs.
3. No excess tensile stresses occur in GCL.

3.03 EQUIPMENT
A. Storage
1. Wooden pallets for aboveground storage of GCL.
2. Heavy, waterproof tarpaulin or similar materials for protecting unused GCL.

B. Installation
1. No equipment shall be driven on the GCL, unless approved by the Engineer.
2. Front-end loader, crane or similar equipment for GCL deployment with a spreader bar to prevent slings from damaging edges.
3. 15 feet long (4.5m), 3 inch (75mm) outer diameter schedule 120 steel pipe to be inserted into roll core for lifting.
4. Sand bags for securing tarpaulin.
5. 3 inch (75mm) wide grips for moving GCL panels into place for each installation technician.
6. Bentonite Sealing Compound and/or Granular Bentonite for securing around penetrations and structures as shown on the contract documents.

3.04 DOCUMENTATION OF CONSTRUCTION
A. Upon project completion, the ENGINEER shall prepare a Construction Documentation Report. This report will document that the work was accomplished according to the Construction Contract Documents, and summarize quality control and quality assurance tests and inspection. The report will include the following in the GCL section of the Construction Documentation Report:

B. Summary of the project construction activities. If appropriate, supplementary information such as modifications approved by the ENGINEER shall be included to justify deviations from the original contract documents. Justification for all such deviations must be fully documented in the Report.
C. Test and inspection results.
   1. Results of any prequalification testing, MQC testing, or any conformance testing as deemed necessary by the ENGINEER.

D. QA and QC records regarding panel deployment, overlap sealing, and repair locations.

E. The CONTRACTOR and INSTALLER shall provide necessary signatures, MQC test results, Panel layout and record DRAWINGS, and inspection results as described by aforementioned items.

END OF SECTION
SECTION 33 38 02
TEXTURED HDPE GEOMEMBRANE (Addendum #1)

PART 1 - GENERAL

1.01 SCOPE
A. Work in this Section includes the manufacture, fabrication, testing, supply and installation of 60 mil thick textured high density polyethylene (HDPE) geomembrane for primary lagoon bottom liner and 40 mil thick textured HDPE for the secondary liner. A geosynthetic clay liner (GCL), as specified in Section 33 38 01 - Geosynthetic Clay Liner shall separate the primary and secondary HDPE liners.

1.02 QUALITY CONTROL AND QUALITY ASSURANCE
A. All tests and test frequencies specified in this section are Quality Control (QC) tests, and these tests are the responsibility of the CONTRACTOR.
B. The ENGINEER will monitor geomembrane installation and construction and certify that construction is in accordance with Contract Documents and Construction Quality Assurance Plan.
C. Leak detection testing of the entirety of each geomembrane liner, including areas on the base will be required as part of construction activities.

1.03 REFERENCES
A. The publications listed below form a part of this specification to the extent referenced.
   1. ASTM International Standard Test Methods/Practices
   2. ASTM D 792 Specific Gravity (Relative Density) and Density of Plastics by Displacement
   3. ASTM D 1004 Initial Tear Resistance of Plastic Film and Sheeting
   4. ASTM D 1238 Flow Rates of Thermo-plastics by Extrusion Plastometer
   5. ASTM D 1248 Polyethylene Plastics Molding and Extrusion Materials
   6. ASTM D 1505 Density of Plastics by the Density-Gradient Technique
   7. ASTM D 3895 Oxidative Inductive Time of Polyolefins by Thermal Analysis
   8. ASTM D 4218 Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
   9. ASTM D 4833 Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
   10. ASTM D 5199 Measuring Nominal Thickness of Geotextiles and Geomembranes
   11. ASTM D 5321 Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
   12. ASTM D 5397 Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test
   14. ASTM D 5721 Air-Oven Aging of Polyolefin Geomembranes
   15. ASTM D 5885 Oxidative Induction Time of Polyolefin Geosynthetics by High Pressure Differential Scanning Calorimetry
   16. ASTM D 5994 Measuring the Core Thickness of Textured Geomembranes
   17. ASTM D 6392 Determining the Integrity of Non-reinforced Geomembrane Seams Produced Using Thermo-Fusion Methods
   18. ASTM D 6693 Tensile Properties of Plastics
   19. ASTM D 7002 Standard Practice for Leak Location on Exposed Geomembranes Using the Water Puddle System
   20. ASTM D 7240 Standard Practice for Leak Location using Geomembranes with an Insulating Layer in Intimate Contact with a Conductive Layer via Electrical Capacitance Technique (Conductive Geomembrane Spark Test
   21. ASTM D 7466 Measuring the Asperity Height of Textured Geomembrane
B. Geosynthetics Research Institute (GRI) Standard Practices
   1. GRI GM-6 Pressurized Air Channel Test for Dual Seamed Geomembranes
   2. GRI GM-9 Cold Weather Seaming of Geomembranes
   3. GRI GM-10 Stress Crack Resistance of Geomembrane Sheet
   4. GRI GM-12 Measurement of the Asperity Height of Textured Geomembranes Using a Depth Gage
   5. GRI GM-13 Test Values, Testing Frequencies for HDPE Geomembranes

C. Construction Quality Assurance Plan

1.04 SUBMITTALS

A. Manufacturer and INSTALLER. Submit the following information to the ENGINEER:
   1. Corporate background information, manufacturing capabilities and proof of Manufacturer's Qualifications
      a. List at least ten (10) completed facilities for which the Manufacturer has manufactured a HDPE geomembrane.
      b. Show a minimum of five years continuous experience for which the INSTALLER has installed HDPE geomembrane.
      c. The name or names of the master seamer(s) who will be proposed for the project and a list of completed facilities for which the master seamer has installed HDPE geomembrane.
   2. Manufacturer's Brochure: Submit complete manufacturer's specifications, descriptive drawings, and literature for the HDPE geomembrane-ne, including the product identification and supplier of the polymer resin and recommended method for handling and storage of all materials prior to installation.
   3. Quality Control Program: Submit a complete description of the geomembrane manufacturer's formal quality control programs for manufacturing, fabricating, handling, installing, and testing. The document shall include a complete description of seaming by extrusion welding and hot wedge welding.
   4. HDPE Geomembrane Prequalification. Submit independent quality control laboratory test results demonstrating compliance with material properties listed in Table 1, HDPE Resin Properties (Without Carbon Black), and Table 2, Textured HDPE Geomembrane Properties.
   5. Origin (Resin Supplier's name, resin production plant) and identification (brand name, number) of the HDPE resin.
   6. Panel Layout Drawing: As a minimum, drawings shall include an approximate panel deployment sequence, panel orientation, type of weld to be used for each seam, incorporate restrictions on panel and seam orientation, methods of deployment, and details of each step in the construction of any penetrations.
   7. A description of the proposed means, methods and materials for leak detection.

B. Manufacturer Quality Control Certificates
   1. The CONTRACTOR shall submit test reports to the ENGINEER within 48 hours of completion of the test. Manufacturer quality control certificates are required prior to HDPE geomembrane shipment. The tests and frequencies are specified in Part 2, Manufacturer Quality Control Tests and material properties. The following information must be submitted for approval prior to shipping the material:
   2. HDPE Resin
      a. Copy of quality control certificates issued by the HDPE Resin Supplier shall include production date(s) of the HDPE resin and statement that no reclaimed polymer was added to the resin. However, the use of polymer recycled during the manufacturing process may be permitted if done with appropriate cleanliness and if recycled polymer is the same HDPE as the parent material and does not exceed ten (10) percent by weight.
3. HDPE Geomembrane  
   a. Quality control certificates for each roll of geomembrane. The quality control certificates shall include: Roll numbers and identification; certification by the manufacturer that the geomembrane meets specified properties; list of quantities and descriptions of materials other than the base polymer which comprise the geomembrane.

C. List of Personnel  
   1. The CONTRACTOR shall submit a list of proposed seaming personnel and their experience records. All personnel must be approved before they perform seaming operations.

D. Submittals Required for Project Closeout  
   1. Record Drawings. Submit HDPE geomembrane record drawings to the ENGINEER.
   2. Warranties

1.05 DELIVERY, STORAGE, AND HANDLING  
A. Handling  
   1. The CONTRACTOR'S personnel shall handle the material with care, shall use adequate equipment and shall take all precautions necessary to prevent damaging the HDPE geomembrane.

B. Inspection upon Delivery  
   1. Upon delivery at the site, the CONTRACTOR, in the presence of an ENGINEER, shall conduct a visual inspection of rolls or factory panels for defects and for damage.

C. Storage  
   1. The CONTRACTOR shall be responsible for ensuring that the stored materials are protected from damage.

1.06 WARRANTY  
A. The HDPE Geomembrane Manufacturer shall provide a prorated 5-year material warranty. The CONTRACTOR shall warrant the HDPE geomembrane to be free of workmanship defects for a period of 1-year following the date of final completion of the work under this contract. The warranty required herein shall be provided in addition to any warranty required by the contract general conditions.

PART 2 - PRODUCTS  
2.01 MANUFACTURER'S QUALIFICATIONS  
A. The Manufacturer must have at least five (5) years documented experience in the manufacture of HDPE geomembrane rolls, and/or documented experience totaling 1,000,000 m^2 (10,000,000 ft^2) of manufactured HDPE geomembrane rolls for at least ten (10) completed facilities, or as approved by the ENGINEER.

2.02 HDPE GEOMEMBRANES  
A. Single Source  
   1. All HDPE geomembrane sheets and HDPE extrudate for the construction of the project must be obtained from a single material supplier and manufacturer. It must be certified and warranted that the sheets, extrudate, and pipe boots are compatible with one another. The CONTRACTOR shall provide manufacturer's warranties for the sheets, HDPE extrudate material, and pipe boots.

2.03 MATERIAL PROPERTIES  
A. HDPE Geomembrane  
   1. HDPE resin shall meet or exceed the requirements of Table 1, HDPE Resin Properties (without Carbon Black). HDPE geomembrane shall meet or exceed the requirements of Table 2, Textured HDPE Geomembrane Properties. Equivalent test methods are subject to the approval of the ENGINEER.
B. Extrudate
   1. Extrudate shall be the same resin as the HDPE geomembrane. The manufacturer shall provide documentation and shall certify that the extrudate meets this requirement.

C. Material Composition
   1. The HDPE geomembrane shall consist of new, first-quality products designed and manufactured specifically for the purpose of this project, as satisfactorily demonstrated by prior use. The HDPE geomembrane shall be unmodified HDPE containing no plasticizer, fillers, chemical additives, reclaimed polymers, or extenders. Approximately 2 to 3 percent carbon black shall be added to the resin for ultraviolet resistance per ASTM D 4218.

D. Textured Surface
   1. Textured-surface geomembrane shall be manufactured so that the surface irregularities that produce the specified friction are on both sides of the sheet. The HDPE geomembrane thickness required shall not include the high points of the textured surface.
   2. The geomembrane sheet shall have a soil/geosynthetic and geosynthetic/geosynthetic interface friction angle meeting the requirements of Table 2. It is the responsibility of the CONTRACTOR to submit pre-qualified geosynthetic materials or soil samples to an approved laboratory for testing during material selection for approval. Adhesion may be considered in determining the effective interface friction angle.

2.04 MANUFACTURER QUALITY CONTROL TESTS
A. Test Reports
   1. Specified tests shall be performed by the Manufacturer.

B. Manufacturer Quality Control Tests
   1. HDPE resin shall be tested at a frequency of one test per resin batch. One batch is defined as one rail car load of resin. As a minimum perform tests for Density and Melt Index. Compliance with the Polymer Composition test requirement shall be established with a manufacturer's certificate of compliance. The finished rolls shall be identified by a roll number corresponding to the resin batch used.
   2. HDPE geomembrane shall be tested for properties at the specified frequencies required by Table 2.

PART 3 - INSTALLATION
3.01 INSTALLER'S QUALIFICATIONS
A. Installation shall be performed under the direction of an installation superintendent. The installer's field superintendent shall have previously installed or supervised the installation of a minimum of 1,000,000 m² (10,000,000 ft²) of HDPE geomembrane. Actual seaming shall be performed under the direction of a "master seamer" who may be the same person as the field superintendent and who has seamed a minimum of 200,000 m² (2,000,000 ft²) of HDPE geomembrane using the type of seaming apparatus as that proposed for use for this project. The field superintendent must be on site whenever installation and/or seaming is being performed.
   1. Licensed Installer
      a. The INSTALLER shall be approved and/or licensed by the geomembrane manufacturer.
   2. Experience of Personnel
      a. All personnel performing seaming operations shall be qualified by experience and by successfully passing trial seam tests and shall be approved by the Engineer prior to installing the Work. The "Master Seamer" shall have experience seaming a minimum of 200,000 m² (2,000,000 ft²) of HDPE geomembrane using the same type of seaming apparatus to be used on the site-specific geomembrane and shall provide direct supervision over less experienced seamers.
3.02 INSTALLATION EQUIPMENT

A. Seaming Methods
   1. Approved processes for field seaming are extrusion welding and fusion welding. Solvent or adhesive welding is prohibited. Proposed alternate processes shall be documented and submitted to the ENGINEER for approval. Only apparatus which have been specifically approved by make and model shall be used.

B. Welding Equipment
   1. The CONTRACTOR shall provide welding equipment with gauges showing temperatures at the nozzle or barrel (extrusion welder) and at the wedge (fusion welder). The fusion-welding apparatus must be automated self-propelled devices, and shall be equipped with gauges giving the important temperatures and pressures.

C. Field Tensiometer
   1. The CONTRACTOR shall provide a field tensiometer for on site peel and shear testing of HDPE geomembrane seams for Quality Control capable of performing testing equivalent to ASTM D 6392.

D. Punch Press
   1. The CONTRACTOR shall provide a punch press for the on site preparation of specimens for testing.

3.03 PREPARATION

A. Surface Preparation
   1. Prior to HDPE geomembrane panel deployment, the CONTRACTOR shall inspect the surface upon which the geomembrane will be placed. The surface shall be smooth, free of rocks, soil particles greater than 3/4-inch, protrusions, sharp objects, and deleterious material that could puncture or abrade the geomembrane.

B. Certification of Subgrade Acceptance
   1. The CONTRACTOR shall be responsible for preparing the Prepared Subbase or Geocomposite Drainage Layer according to the Contract Documents and geomembrane manufacturer's recommendations. Prior to geomembrane installation, the INSTALLER shall certify in writing that the surface upon which the geomembrane will be installed is acceptable. A copy of the Certificate of Acceptance is provided in subsection 3.14. The Certificate of Acceptance shall be given by the CONTRACTOR/INSTALLER to the ENGINEER prior to commencement of geomembrane installation in the area under consideration.

C. Damaged Prepared Subbase
   1. Prior to geomembrane panel deployment, the CONTRACTOR shall repair damage to the Prepared Subbase which has occurred due to his or the installer's activities.

D. Anchor Trench
   1. HDPE geomembrane anchor trenches shall be constructed to the lines and grades shown on the Drawings. The geomembrane in the anchor trench shall be constructed as shown on the Drawings, and backfilled as indicated with care not to damage the geomembrane.

3.04 PANEL DEPLOYMENT

A. The deployment shall be performed in accordance with this section and the Construction Quality Assurance Plan.
   1. Identification
      a. Each field panel shall be given a unique "identification code" consistent with the layout plan.
   2. Installation Sequence
      a. The INSTALLER shall be responsible for the final installation sequence of geomembrane panels.
3. Orientation
   a. Panels shall be oriented perpendicular to the line of the slope crest. Seams parallel to or less than a 45 degree angle from any crest or toe of slope are defined as horizontal seams. Horizontal seams are prohibited on slopes greater than 10 (horizontal): 1 (vertical) and shall be at least 5 feet from the crest or toe of slopes greater than 10:1.

4. Wrinkles
   a. HDPE geomembrane panels shall be unrolled using methods that will minimize wrinkles and will not damage, stretch, or crimp the geomembrane and shall protect the underlying subsurface from damage. Folded wrinkles that cannot be controlled or eliminated by other means shall be removed by cutting and patching.

5. Bridging
   a. Material shall be installed to allow for temperature related shrinkage and to avoid bridging of the geomembrane.

6. Seam Layout
   a. Panels shall be placed such that the seam layout conforms as closely as practicable to the approved panel layout drawing. No panels may be seamed in the field without the ENGINEER’S approval. In addition, panels not specifically shown on the seam layout drawing may not be used without the ENGINEER’S prior approval. Seams shall be identified using the identification codes shown on the panel and seam layout drawing.

7. Physical Damage
   a. Personnel walking on the material shall not engage in activities or wear footwear that could damage the material. Smoking shall not be permitted on or near the geosynthetics.
   b. Vehicular traffic shall not be permitted on the geosynthetics. Equipment shall not damage the material by handling, trafficking, or leakage of hydrocarbons. The surface shall not be used as a work area for storing tools and supplies, or other uses.
   c. During deployment, pulling of GDN panels over textured geomembrane shall consider means and methods not to damage the geotextile or the geomembrane.

3.05 FIELD SEAMS
   A. Seam Strength
      1. All field seams shall meet or exceed the requirements of Table 3 for HDPE Geomembrane Seam Properties.
   
   B. Overlapping
      1. Panels of geomembrane must have a finished overlap of a minimum of three (3) inches for extrusion welding and four (4) inches for fusion welding, but in any event, sufficient overlap shall be provided to allow peel tests to be performed on the seam.
      2. Field seams shall have a minimum width of one (1) inch.
   
   C. Weather Conditions for Seaming
      1. Unless authorized in writing by the ENGINEER, no seaming shall be attempted at ambient temperatures below 32°F (0°C) or above 104°F (40°C). If seaming is authorized at temperatures below 32°F (0°C), pre-heating devices shall be placed on all welding machines, and seaming shall be performed in accordance with Geosynthetic Research Institute (GRI) Test Method GM9 Standard Practice “Cold Weather Seaming of Geomembranes.”
      2. Between ambient temperatures of 32°F (0°C) and 50°F (10°C), seaming may be carried out if the geomembrane is preheated by either the sun or a hot air device, and if there is not excessive cooling resulting from the wind. Above an ambient temperature of 50°F (10°C), no preheating is required.
      3. In all cases, the geomembrane shall be dry and protected from wind damage.
D. General Seaming Procedures
1. Prior to seaming, the seam area shall be clean and free of moisture, dust, dirt, debris of any kind, and foreign material.
2. Seams shall be aligned with the fewest possible number of wrinkles and "fish mouths."
3. For seams which are to be extrusion welded, and as necessary for fusion welds, the seam overlap shall be ground in accordance with the Manufacturer's instructions, in a way that does not damage the geomembrane.
4. Welding speed and pressure, preheating temperature, nozzle (die) temperature, ambient air and sheet temperatures, and extrudate bead thickness shall be consistent with Manufacturer's recommendations or welding criteria established during start-up operations unless approved by the ENGINEER.

3.06 PROTECTION
A. The CONTRACTOR and INSTALLER shall take precautions as necessary to protect the geomembrane from damage due to exposure to the elements, or as part of deployment and seaming operations.

3.07 FIELD QUALITY CONTROL TRIAL SEAMS
A. Trial seams shall be performed in the presence of the ENGINEER. Trial seams shall be made on scrap pieces of geomembrane under the same conditions that production seaming will be performed to verify that seaming conditions are satisfactory. Trial seams shall be made, at a minimum, at least once every four hours or as directed by the ENGINEER for each seaming apparatus used that day. Each seamer shall make at least one trial seam each day.
B. The trial seam sample shall be at least three (3) feet long by one (1) foot wide (after seaming) with the seam centered lengthwise. Four adjoining specimens, each one (1) inch (25 mm) wide, shall be cut from the trial seam sample by the INSTALLER at locations selected randomly by the ENGINEER. Two of the specimens shall be tested in peel and two tested in shear; none should fail in the seam.

3.08 FIELD NONDESTRUCTIVE SEAM TESTING
A. To check for seam continuity, the INSTALLER shall nondestructively test 100 percent of field seams over their entire length using a vacuum test unit, air pressure test, or other approved method. Air pressure testing is only applicable to those processes which produce a double seam with an enclosed space, and shall follow GRI GM6, Pressurized Air Channel Test for Dual Seamed Geomembranes.
1. Vacuum Testing Equipment
   a. Test equipment, including but not limited to the following shall be furnished by the INSTALLER:
      1) The vacuum box shall have a transparent viewing window on top and a soft, closed cell neoprene gasket attached to the bottom. The equipment shall be capable of inducing and holding a vacuum of 5 psig (10 in of Hg vacuum).
      2) A steel vacuum tank and pump assembly equipped with a pressure controller and pipe connections; rubber pressure/vacuum hose with fittings; bucket and wide paint brush; soapy solution.
   b. Energize the vacuum pump and adjust the tank vacuum to approximately 5 psig (10 in. of Hg vacuum) (35 kPa absolute); apply soapy solution to wet a strip of geomembrane; place the box over the wetted area; close the bleed valve and open the vacuum valve; ensure that a leak tight seal is created by the gasket; for a period of not less than 10 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles; and if no bubbles appear after 10 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3 inches (75 mm) overlap, and repeat the process.
   b. All areas where soap bubbles appear indicate leaks or poor seam continuity and shall be marked, repaired and retested.
3. Air Pressure Test Equipment
   a. An air pump (manual or motor driven) equipped with pressure gauge capable of
      generating and sustaining a pressure between 25 and 30 psi (160 and 200 kPa); a
      rubber hose with fittings and connections; and a sharp hollow needle, or other
      approved pressure feed device.

4. Air Pressure Test Procedure
   a. Seal both ends of the seam to be tested (to a maximum length of 300 feet); insert
      needle or other approved pressure feed device into the channel created by the dual
      track fusion weld; and energize the air pump to a pressure between 25 and 30 psi
      (160 and 200 kPa), close valve, and sustain pressure for a minimum of 5 minutes;
   b. If pressure drop exceeds 2 psi (15 kPa), or does not stabilize, locate faulty area,
      repair and retest; and
   c. Remove needle or other approved pressure feed device and seal ends and needle
      puncture.

3.09 FIELD DESTRUCTIVE SEAM TESTING

A. Test Location
   1. Destructive seam tests shall be performed at locations determined after seaming, at the
      ENGINEER’s discretion. The INSTALLER shall not be informed in advance of the
      locations where the seam samples will be taken.

B. Test Frequency
   1. As a minimum, one test location shall be selected per 500 feet of seam length produced
      by each welding machine. (This minimum frequency is to be determined as an average
      taken throughout the entire facility.)

C. Procedure
   1. A 42 inch (106 cm) long sample is taken by the INSTALLER from the seam and cut into
      three individual 14 inch (36 cm) samples. Individual samples go to the CQC organization,
      the ENGINEER and the COUNTY. The CQC organization shall cut their samples into 5
      shear and 5 peel (alternating adjacent) test specimens and conduct the tests immediately
      in accordance with ASTM D 6392 or equivalent testing method. The remaining sample is
      archived by the COUNTY. The COUNTY will be responsible for storing the archive
      samples.

D. Geosynthetic Laboratory Testing
   1. If destructive seam testing is to be performed off-site, packaging and shipping of
      destructive test samples shall be conducted in a manner which will not damage the test
      sample. The ENGINEER shall verify that packaging and shipping conditions are
      acceptable. This procedure shall be fully outlined prior to construction.
   2. Testing shall include "Shear Testing" and "Peel Testing" (ASTM D6392). The minimum
      acceptable values to be obtained in these tests are those indicated in Table 3, HDPE
      Geomembrane Seam Properties. At least 5 specimens shall be tested for each test
      method. At least 4 of the 5 specimens tested shall meet or exceed the requirements
      indicated in Table 3.
   3. The CONTRACTOR’s laboratory test results shall be presented in writing to the
      ENGINEER and the COUNTY as required by ASTM D 6392.

E. Procedures for Destructive Test Failures
   1. All acceptable seams must be bounded by two locations from which samples passing
      laboratory destructive tests have been taken.
   2. The following procedures shall apply whenever a sample fails a destructive test, whether
      that test is conducted by the ENGINEER, the INSTALLER, the CONTRACTOR’s
      independent QC laboratory, or by field tensiometer. The INSTALLER has two options:
      a. The INSTALLER can reconstruct the seam between any two passing test locations;
      b. The INSTALLER can trace the welding path to an intermediate location (at 3 m or 10
         feet minimum from the point of the failed test in each direction) and take a single
         specimen for an additional field test at each location. If these additional specimens
pass the test, then full samples are taken. If these samples pass the tests, then the seam is reconstructed between these locations. If either sample fails, then the process is repeated to establish the zone in which the seam should be reconstructed.

3. The INSTALLER shall notify the ENGINEER before beginning either option. The ENGINEER shall be present during this entire process to document all actions taken in conjunction with destructive test failures.

3.10 LEAK DETECTION TESTING

A. Liner leak testing shall be performed by the CONTRACTOR on each completed phase of geomembrane liner installation such that holes and/or defects in the liner panels, or in the seams, are identified and repaired in accordance with Section 3.11 as part of the liner installation cost. Leak testing must be completed by:

1. Spark Testing performed in accordance with ASTM D 7240 Standard Practice for Leak Location using Geomembranes with an Insulating Layer in Intimate Contact with a Conductive Layer via Electrical Capacitance Technique (Conductive Geomembrane Spark Test).

2. Electrical Leak Location performed in accordance with ASTM D 7002 Standard Practice for Leak Location on Exposed Geomembranes Using the Water Puddle System (note this method may only be used on the bottom liner).

3. Other ENGINEER-approved method.

B. CONTRACTOR is responsible for proposing materials and field testing methods to detect, locate and ultimately repair all leaks identified, and to notify the ENGINEER of the testing and repair schedule. The CONTRACTOR shall submit a description of the proposed means, methods and materials for leak detection for review and approval of the ENGINEER.

C. Confirmatory liner leak testing may be completed by the ENGINEER. CONTRACTOR shall repair all leaks identified as part of the liner installation cost.

3.11 DEFECTS AND REPAIRS

A. Identification

1. The entire geomembrane, including seams, shall be visually examined by the ENGINEER for identification of visual defects. All areas showing defects and/or requiring repairs shall be repaired at no additional cost to the COUNTY.

2. Work shall not proceed with any materials which will cover locations which have been repaired until the ENGINEER has re-examined the repaired area and applicable laboratory test results with passing values are available.

3. Panels or portions of panels which, in the opinion of the ENGINEER, are damaged beyond repair shall be removed from the site and replaced. Damage which, in the ENGINEER’S opinion, can be repaired may be repaired or replaced.

B. Repair Procedures

1. Any portion of the geomembrane exhibiting a flaw or failing a destructive or nondestructive test, shall be repaired. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure shall be agreed upon between the INSTALLER and ENGINEER. The procedures available include patching, grinding and rewelding, spot welding, capping, and removing a bad seam and replacing with a strip of new material welded into place.

C. Verification of Repairs

1. Each repair shall be nondestructively tested. Repairs which pass the non-destructive test shall be taken as an indication of an adequate repair. At the discretion of the ENGINEER, large repairs may require destructive test sampling.

D. Wrinkles

1. When seaming of the geomembrane is completed (or when seaming of a large area of the geomembrane is completed) and prior to placing overlying materials, the ENGINEER shall indicate which wrinkles shall be cut and reseamed by the INSTALLER.
E. Bridging
   1. The HDPE geomembrane shall be continuously supported on the accepted subgrade. Bridging (unsupported geomembrane) is not permissible. INSTALLER shall take necessary steps to prevent bridging and repair or replace any geomembrane so affected.

3.12 PLACEMENT OF PROTECTIVE SOIL COVER/COLLECTION PIPE BEDDING MATERIALS
A. The geomembrane shall not be left exposed (uncovered) to the elements for any period later than thirty (30) days.
B. All Protective Soil Cover/drainage layer materials placed over geosynthetics shall be installed without damaging the geosynthetics. Equipment used for placing soil shall not be driven directly on the geomembrane unless authorized in writing by ENGINEER. A minimum thickness of one (1) foot (0.3 m) of soil or drainage layer is required between a low ground pressure dozer and the geomembrane. Placement of material overlying the geosynthetics shall be in conformance with the following guidelines for equipment ground pressure:

<table>
<thead>
<tr>
<th>EQUIPMENT GROUND PRESSURE</th>
<th>MINIMUM SOIL THICKNESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>kPa (psi)</td>
<td>meters (inches)</td>
</tr>
<tr>
<td>&lt;35 (&lt;5)</td>
<td>0.30 (12)</td>
</tr>
<tr>
<td>35 - 45 (5 - 6)</td>
<td>0.38 (15)</td>
</tr>
<tr>
<td>45 - 60 (6 - 8)</td>
<td>0.45 (18)</td>
</tr>
<tr>
<td>60 - 85 (8 - 11)</td>
<td>0.60 (24)</td>
</tr>
</tbody>
</table>

C. In heavily trafficked areas such as access ramps, protective cover/drainage layer thickness shall be at least three (3) feet (0.9 m).
D. With ENGINEER'S approval, CONTRACTOR may construct a test pad to demonstrate that construction equipment placing or driving across the protective cover/drainage layers does not damage the liner. The CONTRACTOR shall bear all costs associated with the inspections and damage repairs due to sharp turning or braking of the equipment driving across the protective/drainage layers.

3.13 DOCUMENTATION OF CONSTRUCTION
A. Upon project completion, the ENGINEER shall prepare a Construction Documentation Report. This report will document that the work was accomplished according to the Construction Contract Documents, and summarize quality control and quality assurance tests and inspection. At a minimum, the report shall contain the following information:
   1. Identification of parties and their roles and responsibilities with signatures of key personnel and an officer of their employer's company.
   2. Scope of work.
   3. Summary of the project construction activities.
   4. Quality assurance methodology.
   5. Test and inspection results.
      a. Results of prequalification testing (including extrudate);
      b. The results of all destructive and non-destructive seam tests.
      c. Subgrade acceptance forms.
   6. Quality assurance certification statement, sealed and signed by a licensed professional ENGINEER.
   7. Geomembrane record drawings.
   8. QA and QC records regarding panel deployment, seaming, and repairs.
B. The CONTRACTOR and INSTALLER shall provide necessary signatures, test results, record drawings, and inspection results as described by aforementioned items.

3.14 TABLES
A. NOTE TO TABLES: ENGINEER to approve test procedures, or modified procedures, as test methods are changed or updated frequently.
### TABLE 1
**TEXTURED HDPE GEOMEMBRANE RESIN PROPERTIES**
*(WITHOUT CARBON BLACK)*

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>QUALIFIED</th>
<th>UNIT</th>
<th>TEST METHOD</th>
<th>SPECIFIED VALUE 60 MIL AND 40 MIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polymer Specific Gravity</td>
<td>Minimum</td>
<td>g/cc</td>
<td>ASTM D 792 Method A or ASTM D 1505</td>
<td>&gt;0.93</td>
</tr>
<tr>
<td>Polymer Melt Index</td>
<td>Range</td>
<td>g/10 min</td>
<td>ASTM D 1238 (Condition E 190/216)</td>
<td>&lt;1.0</td>
</tr>
</tbody>
</table>

### TABLE 2
**TEXTURED HDPE GEOMEMBRANE PROPERTIES**
*(60 mil Primary and 40 mil Secondary)*

<table>
<thead>
<tr>
<th>Property</th>
<th>Qualified</th>
<th>Unit</th>
<th>Test Method</th>
<th>Specified Value 60 mil</th>
<th>Specified Value 40 mil</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness</td>
<td>min. avg.</td>
<td>mils</td>
<td>ASTM D 5994</td>
<td>57</td>
<td>37</td>
<td>Per roll</td>
</tr>
<tr>
<td></td>
<td>minimum</td>
<td>mils</td>
<td></td>
<td>54</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>Asperity Height (3)</td>
<td>min.</td>
<td>mils</td>
<td>ASTM D 7466</td>
<td>16</td>
<td>16</td>
<td>Every 2nd roll</td>
</tr>
<tr>
<td>Density</td>
<td>min. avg.</td>
<td>g/cc</td>
<td>ASTM D 792 or ASTM D 1505</td>
<td>0.940</td>
<td>0.940</td>
<td>1 per 50 rolls</td>
</tr>
</tbody>
</table>

**Tensile Properties (each direction)**

<table>
<thead>
<tr>
<th>Property</th>
<th>Qualified</th>
<th>Unit</th>
<th>Test Method</th>
<th>Specified Value</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Yield Strength</td>
<td>min.</td>
<td>lb/in</td>
<td>ASTM D 6693 Type IV</td>
<td>126</td>
<td>84</td>
</tr>
<tr>
<td>2. Break Strength</td>
<td>min.</td>
<td>lb/in</td>
<td></td>
<td>90</td>
<td>60</td>
</tr>
<tr>
<td>3. Yield Elongation</td>
<td>min.</td>
<td>percent</td>
<td></td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>4. Break Elongation</td>
<td>min.</td>
<td>percent</td>
<td></td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Tear Resistance</td>
<td>min.</td>
<td>lbs</td>
<td>ASTM D 1004</td>
<td>42</td>
<td>28</td>
</tr>
<tr>
<td>Puncture Resistance</td>
<td>min.</td>
<td>lbs</td>
<td>ASTM D 4833</td>
<td>90</td>
<td>60</td>
</tr>
<tr>
<td>Stress Crack Resistance (1)</td>
<td>Minimum</td>
<td>hours</td>
<td>ASTM D 5397</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>Carbon Black Content</td>
<td>Range</td>
<td>percent</td>
<td>ASTM D 4218</td>
<td>2.0-3.0</td>
<td></td>
</tr>
<tr>
<td>Carbon Black Dispersion</td>
<td>Rating</td>
<td>N/A</td>
<td>ASTM D 5596 Categories1, 2 or 3 per GRI GM 13</td>
<td>1 per 10 rolls</td>
<td></td>
</tr>
<tr>
<td>Oxidation Induction Time Standard</td>
<td>min.</td>
<td>minutes</td>
<td>ASTM D 3895</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>OIT, or High Pressure OIT</td>
<td>min.</td>
<td>minutes</td>
<td>ASTM D 5885</td>
<td>400</td>
<td>400</td>
</tr>
<tr>
<td>Oven Aging at 85oC Standard OIT,</td>
<td>min.</td>
<td>% retained after 90</td>
<td>ASTM D 3895</td>
<td>55</td>
<td>55</td>
</tr>
<tr>
<td>or High Pressure OIT</td>
<td></td>
<td>days</td>
<td>ASTM D 5885</td>
<td>80</td>
<td>80</td>
</tr>
</tbody>
</table>
UV Resistance (2)  
High Pressure OIT  
<table>
<thead>
<tr>
<th>Property</th>
<th>Unit</th>
<th>Test Method</th>
<th>Specified Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>min. % retained after 1600 hours</td>
<td></td>
<td>ASTM D 5885</td>
<td>50</td>
</tr>
<tr>
<td>min. % retained after 1600 hours</td>
<td></td>
<td>ASTM D 5885</td>
<td>50</td>
</tr>
<tr>
<td>Coefficient of Interface Friction</td>
<td>degrees</td>
<td>ASTM D 5321</td>
<td>20</td>
</tr>
<tr>
<td>Coefficient of Interface Friction</td>
<td>degrees</td>
<td>ASTM D 6243</td>
<td>20</td>
</tr>
</tbody>
</table>

NOTES:

1) P-NCTL test is not appropriate for testing geomembranes with textured or irregular surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials. The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer’s mean value via MQC testing.

2) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C. UV resistance is based on percent retained value regardless of the original HP-OIT value.

3) Of 10 readings; 8 out of 10 must be = 7 mils, and the lowest individual reading must be = 5 mils.

4) Interface friction angle tests with GCL or prepared subbase (ASTM D5321) at normal stresses of 250 psf, 500 psf, and 1,500 psf. Mist geomembrane surface or GCL contact surface with 20% (by wt.) of water during assembling and applying load for 24 hours prior to shearing. Minimum displacement is 3 inches at a displacement rate of 0.04 inches per minute. Record asperity height and peak shear strength values. Each interface shall be tested separately. An equivalent shear strength (friction angle and adhesion value) that is equal to or better than the above minimum values shall be demonstrated by performing a slope stability analysis using such test data. The analysis shall be submitted by the CONTRACTOR to the ENGINEER for approval.

**TABLE 3**

TEXTURED HDPE GEOMEMBRANE SEAM PROPERTIES

<table>
<thead>
<tr>
<th>Property</th>
<th>Unit</th>
<th>Test Method</th>
<th>Specified Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seam Shear Strength</td>
<td></td>
<td>ASTM D 6392</td>
<td>120</td>
</tr>
<tr>
<td>Seamshear Strength (Fusion &amp; Extrusion)</td>
<td>min.</td>
<td>lb/in</td>
<td>60 mil</td>
</tr>
<tr>
<td>Shear Elongation</td>
<td></td>
<td>ASTM D 6392</td>
<td>50</td>
</tr>
<tr>
<td>Shear Elongation (Fusion &amp; Extrusion)</td>
<td>min.</td>
<td>Percent</td>
<td>40 mil</td>
</tr>
<tr>
<td>Peel Adhesion:</td>
<td></td>
<td>ASTM D 6392</td>
<td>91</td>
</tr>
<tr>
<td>Fusion</td>
<td>min.</td>
<td>lb/in</td>
<td>60</td>
</tr>
<tr>
<td>Extrusion</td>
<td>min.</td>
<td>lb/in</td>
<td>52</td>
</tr>
</tbody>
</table>

NOTES:

1) The geomembrane shall yield before failure of the seam for shear tests. Seam separation shall not extend more than 25 percent into the seam for peel adhesion tests. Testing shall be discontinued when the sample has visually yielded. At least 4 of 5 specimens tested in shear and in peel shall exhibit a film tear bond (FTB) failure not in the seam area.

2) Shear elongation test should be omitted for field testing.
(3) Seam shear and peel strengths listed are for 4 out of 5 samples; the 5th specimen can be as low as 80% of the listed values.
3.15 CERTIFICATE

CERTIFICATE OF ACCEPTANCE
OF SOIL SUBBASE BY INSTALLER

INSTRUCTIONS: This part of the certificate shall be completed by the CONTRACTOR.

CONTRACTOR: PROJECT:
NAME: LOCATION:
ADDRESS: PROJECT:

LOCATION OF SOIL SUBBASE SURFACE TO BE UTILIZED (INCLUDE SKETCH, IF NEEDED)

__________________________________________________________

CONTRACTOR AUTHORIZED REPRESENTATIVE

NAME ________________________________________
TITLE ________________________________________
SIGNATURE/DATE ________________________________

INSTRUCTIONS: This part of the certificate shall be completed by the HDPE Geomembrane INSTALLER

I UNDERSIGNED, DULY AUTHORIZED REPRESENTATIVE OF:

(HDPE GEOMEMBRANE INSTALLATION COMPANY)
DO HEREBY ACCEPT THE SOIL SUBBASE (SOIL SUPPORTING THE GEOMEMBRANE) OR GCL AND SHALL BE RESPONSIBLE FOR ITS INTEGRITY AND SUITABILITY, IN ACCORDANCE WITH THE SPECIFICATIONS FROM THIS DATE TO COMPLETION OF THE INSTALLATION.

INSTALLER AUTHORIZED REPRESENTATIVE:

NAME ________________________________________
TITLE ________________________________________
SIGNATURE/DATE ________________________________

END OF SECTION
SECTION 33 38 06
NONWOVEN GEOTEXTILES

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. The CONTRACTOR shall furnish all labor, materials, tools, supervision, transportation, and installation equipment necessary for the installation of geotextiles, as specified herein, as shown on the Drawings.

B. The CONTRACTOR shall be prepared to install geotextiles in conjunction with the earthwork and other components of the liner system.

1.02 RESPONSIBILITY

A. The CONTRACTOR shall coordinate work with a Geotextile Manufacturer, and Installer, who shall meet the following qualifications. The CONTRACTOR shall exercise care around the geosynthetic materials and installation and shall be held responsible for any damage in the completed system caused by the CONTRACTOR’S personnel.

B. Manufacturer of Geotextiles

1. The Geotextile Manufacturer shall be responsible for the production and delivery of geotextile rolls and shall be manufacturing geotextiles for more than two years. The Manufacturer shall submit a statement to the ENGINEER listing:
   a. Certified minimum property values of the proposed geotextiles and the tests used to determine those properties.
   b. Production capacity available and projected delivery dates for this project.

C. Installer

1. The Installer shall be responsible for field handling, storing, deploying, seaming or connecting, temporary restraining (against wind), anchoring, and other site aspects of the geotextiles.

2. The Installer shall be trained and qualified to install geotextiles.

1.03 SUBMITTALS

A. The CONTRACTOR shall submit to the ENGINEER conformance testing with the following information on geotextile production:

1. Manufacturing quality control certificates for each batch of resin and each shift's production. The certificates shall be signed by responsible parties employed by the Manufacturer (such as the production manager), and notarized.

2. The quality control certificate shall include:
   a. lot, batch, or roll numbers and identification;
   b. sampling procedures;
   c. results of quality control tests, including a description of the test methods used; and
   d. A statement certifying that the minimum values of the specifications are met.

1.04 CONSTRUCTION QUALITY ASSURANCE AND CONTROL

A. The installation of geotextiles shall be monitored as specified in this section.

PART 2 - PRODUCTS

2.01 GEOTEXTILE PROPERTIES

A. Unless otherwise noted on the Drawings, geotextile Installer or supplier shall furnish materials whose Minimum Average Roll Values (MARV) meet or exceed the criteria specified in Tables 02712-1 and 02712-2. The Manufacturer shall provide test results for these procedures, as well as a certification that the material properties meet or exceed the specified values. The geotextiles provided by the supplier shall be stock products. The supplier shall not furnish products specifically manufactured to meet the specifications of this project unless authorized by The OWNER and the ENGINEER.
B. **MARV** shall be based on Manufacturer's data and shall be calculated as the mean value of the property of interest plus or minus two standard deviations, as appropriate. Where material properties vary among the machine and cross-machine directions, the MARV shall apply to the direction providing the lowest value (when a minimum is specified) or the highest value (when a maximum value is specified).

C. In addition to the property values listed in Tables 02712-1 and 02712-2, the geotextiles shall retain their structure during handling, placement, and long-term service.

D. The CONTRACTOR shall supply documentation demonstrating the in-ground durability of the proposed geotextile. This documentation shall be submitted to the ENGINEER 21 days prior to the start of construction, unless otherwise approved by the ENGINEER. Approval of the geotextile products based on the documentation is at the discretion of The OWNER and the ENGINEER.

**2.02 MANUFACTURING QUALITY CONTROL**

A. The Manufacturer shall sample and test the geotextile material, at minimum frequencies specified in Table 02712-2 to demonstrate that the material conforms to the requirements in Tables 02712-1. As a minimum, the CONTRACTOR shall comply with the submittal requirement of Part 1.04 of this Section and the CQA Plan.

B. Sampling shall, in general, be performed on sacrificial portions of the material such that repair of the material is not required.

C. Samples that do not meet the specified properties shall result in rejection of the applicable rolls.

D. At the Manufacturer's discretion and expense, additional testing of individual rolls may be performed to more closely identify the non-complying rolls and/or to qualify individual rolls.

**2.03 PACKING AND LABELING**

A. Geotextiles shall be supplied in rolls wrapped in relatively impermeable and opaque protective covers.

B. Geotextile rolls shall be marked or tagged with the following information:
   1. manufacturer's name;
   2. product identification;
   3. lot or batch number;
   4. roll number; and
   5. roll dimensions.

C. If any special handling is required, it shall be so marked on the geotextile itself; e.g., "This Side Up" or "This Side Against Soil to be Retained".

**2.04 TRANSPORTATION**

A. Transportation of the geotextiles is the responsibility of the CONTRACTOR. The CONTRACTOR shall be liable for all damages to the materials incurred prior to and during transportation to the site.

**2.05 HANDLING AND STORAGE**

A. Handling, storage, and care of the geotextiles prior to and following installation at the site, is the responsibility of the CONTRACTOR. The CONTRACTOR shall repair or replace the materials incurred prior to final acceptance of the lining system by the OWNER.

B. The CONTRACTOR shall be responsible for storage of the geotextile material at the site.

C. The geotextiles shall be protected from sunlight, moisture, excessive heat or cold, puncture, or other damaging or deleterious conditions. The geotextile shall be protected from mud, dirt and dust. Any additional storage procedures required by the Manufacturer shall be the CONTRACTOR’S responsibility.
PART 3 - EXECUTION

3.01 CONFORMANCE TESTING

A. Upon delivery to the site or at the location of the manufacturing, samples of the geotextile shall be removed by the ENGINEER or his designee and sent to a laboratory selected by The OWNER for testing to ensure conformance to the requirements of this Section.

B. Samples shall be taken at the frequencies as shown in Table 02712-2.

C. The ENGINEER may increase the frequency of sampling in the event that test results do not comply with requirements specified in Part 2.01 of this Section. This additional testing shall be performed at the expense of the CONTRACTOR.

D. Any geotextiles that are not certified in accordance with Part 1.04 of this Section, or that conformance testing indicates do not comply with Part 2.01 of this Section shall be rejected and replaced with new material in accordance with the Specifications, at no additional cost to the OWNER.

3.02 HANDLING AND PLACEMENT

A. The CONTRACTOR shall handle all geotextile in such a manner as to ensure they are not damaged in any way.

B. The CONTRACTOR shall take any necessary precautions to prevent damage to underlying layers during placement of the geotextile.

C. After unwrapping the geotextile from its opaque cover, the geotextile shall not be left exposed for a period in excess of 20 days.

D. White colored geotextile will be used, precautions shall be taken against "snowblindness" of personnel.

E. The CONTRACTOR shall take care not to entrap stones, excessive dust, or moisture in the geotextile during placement.

F. The CONTRACTOR shall weight all geotextiles with sandbags, or the equivalent, in the presence of wind. Such sandbags shall be installed during placement and shall remain until replaced with protective soil cover or other components of the liner system.

G. The CONTRACTOR shall examine the entire geotextile surface after installation to ensure that no potentially harmful foreign objects are present. The CONTRACTOR shall remove any such foreign objects and shall replace any damaged geotextile.

3.03 SEAMS AND OVERLAPS

A. All nonwoven geotextiles shall be continuously sewn or heat fusing (i.e., spot sewing is not allowed). Geotextiles shall be overlapped a minimum of 6 inches prior to seaming. No horizontal seams shall be allowed on slopes steeper than 5 horizontal to 1 vertical (i.e., seams shall be along, not across, the slopes). Other seaming techniques may be approved by The OWNER or the ENGINEER.

B. Polymeric thread, with chemical resistance properties equal to or exceeding those of the nonwoven geotextile, shall be used for all sewing. The seams shall be sewn to provide a flat (prayer) seam, "J" seam, or "butterfly-folded" seam and shall be a two-thread, double-lock stitch or a double row of single-thread, chain stitch.

C. When sewing a flat seam, the stitching shall be approximately 1-1/2 inches (+ 1/4") from the outside edge of the fabric (not in the selvage or at the selvage edge). The "J" fold and Butterfly fold seams require a fold 1-1/4 inches to 2 inches from the fabric edge with the stitching approximately 1 inch from the folded edge.

D. During placement of geotextile in contact with geomembrane, care will be taken not to entrap stones, sharp objects, or broken needles that could damage geomembrane.
3.04 REPAIR

A. Any holes or tears in the geotextile shall be repaired as follows:
   1. On slopes steeper than 5 horizontal to 1 vertical, a patch made from the same geotextile shall be double seamed into place (with each seam 0.5 inch apart and no closer than 2 inches from any edge). Should any tear exceed 10 percent of the width of the roll, that roll shall be removed from the slope and replaced with new material.
   2. On slopes flatter than or equal to 5 horizontal to 1 vertical, a patch made from the same geotextile shall be spot-seamed in place with a minimum of 2 feet overlap in all directions.

B. Care shall be taken to remove any soil or other material which may have penetrated the torn geotextile.

3.05 PLACEMENT OF SOIL MATERIALS

A. The CONTRACTOR shall place all soil materials on top of a geotextile, in such a manner as to ensure that:
   1. the geotextile and underlying materials are not damaged;
   2. minimum slippage occurs between the geotextile and underlying layers; and
   3. excess stresses are not produced in the geotextile.

3.06 INSTALLATION

A. The geotextile shall be placed directly on top of the geomembrane or geonet, as shown on the Drawings.

B. Placement of the protective soil or drainage material over the geotextile may be performed using a low ground-pressure dozer. The tracked equipment shall operate only over previously placed drainage material or protective soil cover. The CONTRACTOR shall not operate equipment directly on geotextile, geomembrane or geocomposite.

C. The equipment used to spread Drainage Material or protective cover shall not exert ground pressures exceeding the values in Table 01410-1.

D. The CONTRACTOR shall consult with the ENGINEER before using any equipment to place or spread the Gravel Drainage Material or protective material.
3.07 PRODUCT PROTECTION

A. The CONTRACTOR shall use all means necessary to protect all prior work and materials and completed work of other Sections. The CONTRACTOR is specifically required to protect the work against flooding.

B. In the event of damage, the CONTRACTOR shall immediately make all repairs and replacements necessary, to the approval of the ENGINEER and at no additional cost to the OWNER.

| TABLE 02712-1 CONTRACTOR’S CONFORMANCE TESTING PRIOR TO DELIVERY GEOTEXTILE (NEEDLE PUNCHED NONWOVEN) |
|-------------------------------------------------|---------------------------------|-----------------|-----------------|-----------------|
| PROPERTIES AND REQUIREMENTS                     | QUALIFIER | UNITS | SPECIFIED VALUES(1) | TEST METHOD |
| Type                                            | ---       | ---   | Nonwoven           | ---          |
| Polymer Composition                             | Minimum   | %     | 95 % polypropylene or polyester by weight |            |
| AOS                                             | Minimum   | Sieve size | 70 | CW-02215 or ASTM D 4751 |
| Permeability                                    | Minimum   | cm/sec | 0.50 | ASTM D 4491 |
| Mass Per Unit Area                              | Minimum   | oz/yd² | 10 | ASTM D 3776 |
| Grab Strength(2)                                | Minimum   | lb     | 290 | ASTM D 4632 |
| Tear Strength(2)                                | Minimum   | lb     | 100 | ASTM D 4533 |
| Puncture Strength                               | Minimum   | psi    | 500 | ASTM D 3787 |
| Burst Strength                                  | Minimum   | %      | 70 | ASTM D 4355 |
| UV Resistance(3)                                | Minimum   | mils   | 135 | ASTM D 1777 |

Notes:
(1) All values represent minimum average roll values (i.e., any roll in a lot should meet or exceed the values in this table).
(2) Minimum value measured in machine and cross machine direction.
(3) Ultraviolet Resistance requirement is at 500 hours of exposure.
(4) Minimum of 1 test for each 100,000 square feet installed. At least three tests shall be completed for each property indicated in this table.

| TABLE 02712-2 ENGINEER’S REQUIRED CONFORMANCE TESTING PRIOR TO INSTALLATION NONWOVEN GEOTEXTILE |
|-------------------------------------------------|---------------------------------|-----------------|-----------------|
| PROPERTY                                         | ASTM   | MINIMUM FREQUENCY(1) |
| Mass Per Unit Area                               | D3776  | Every 100,000 ft²   |
| Mullen Burst Strength                            | D3786  | Every 100,000 ft²   |
| Grab Tensile                                     | D4632  | Every 100,000 ft²   |
| Apparent Opening Size                            | D4751  | 1 per production lot (filter geotextiles only) |
| Hydraulic Conductivity                           | D4491  | 1 per production lot (filter geotextiles only) |
| Puncture Resistance                              | D3787  | Every 100,000 ft²   |
| Trapezoidal Tear                                 | D4533  | Every 100,000 ft²   |
| U.V. Resistance                                  | D4355  | Every 100,000 ft²   |

NOTE:
(1) At least three tests shall be completed for each property indicated in Table 02712-2.
SECTION 33 38 07
GEOCOMPOSITE

PART 1 - GENERAL

1.01 SUMMARY
A. Section Includes: Bonded geotextile-geonet drainage composite to be used for underliner gas
venting.

1.02 RELATED SECTIONS
A. Section 33 38 04 - HDPE Geomembrane
B. Section 33 38 06 - Nonwoven Geotextiles.

1.03 REFERENCED STANDARDS:
A. ASTM International (ASTM):
   1. D413, Standard Test Methods for Rubber Property/Adhesion to Flexible Substrate.
   3. D792, Standard Test Methods for Density and Specific Gravity (Relative Density) of
      Plastics by Displacement.
   4. D1238, Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion
      Plastometer.
   8. D3776, Standard Test Methods for Mass Per Unit Area (Weight) of Fabric.
   9. D4716, Standard Test Method for Determining the (In-plane) Flow Rate per Unit Width
      and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head.
      and Samples.
 12. D5321, Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or
      Geosynthetic and Geosynthetic Friction by the Direct Shear Method.
 13. D7005, Standard Test Method for Determining the Bond Strength (Ply Adhesion) of
      Geocomposites.
B. Where reference is made to one of the above standards, the revision in effect at the time of bid
opening shall apply.

1.04 QUALIFICATIONS:
A. Each manufacturing and fabricating firm shall demonstrate 5 years continuous experience,
   including a minimum of 5,000,000 SF of drainage composite production in the past 3 years.
B. Installer shall attend pre-installation conference.

1.05 DEFINITIONS
A. Manufacturer: Manufacturer producing drainage composites from geonet cores and
   geotextiles.
B. Installer: The Installers are the individuals actually performing the hands-on work in the field.

1.06 SUBMITTALS
A. Product Data including:
   1. Manufacturer’s specifications and general recommendations for geotextile-geonet
      drainage composite.
B. Shop Drawings:
   1. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
2. Shop Drawings:
   a. Manufacturer's documentation that raw materials and roll materials comply with 
      required drainage composite physical properties.
   b. Manufacturer and Installer quality control manuals.
   c. Original test results for resins and roll material at frequency specified in respective 
      quality control manuals. Include or bracket the rolls delivered for use in the Work.
   d. Layout plan with proposed size, number, position and sequencing of drainage 
      composite rolls and direction of all field seams.
   e. Proposed details of anchor trench if different than included in Contract Documents.
   f. Details of overlap and seaming of the drainage net, connections and other 
      reconstruction details.

C. Miscellaneous Submittals:
   1. Qualification documentation specified in Article 1.2.
   2. Installation schedule. Schedule shall demonstrate that installed composite drainage net is 
      being adequately covered to prevent excessive UV exposure according to manufacturer’s 
      recommendations as included in manufacturer’s quality assurance program during 
      installation.
   3. 45 days prior to the date of the materials intended use, submit the following information in 
      accordance with Section 01 30 00.
      a. Manufacturer’s background information.
      b. Information on factory size, equipment, personnel, number of shifts per day and 
         production capacity per shift.
   4. List of material properties and samples of drainage net with attached certified test results.
   5. Manufacturer’s quality control program and manual including description of laboratory 
      facilities.
   6. A list of ten completed facilities where the drainage net is used including:
      a. Name and purpose of facility, its location and date of installation.
      b. Name of owner, project manager, design engineer, and installer.
      c. Composite drainage net thickness and surface areas.
      d. Information on performance of the facility.

1.07 DELIVERY, STORAGE AND HANDLING

A. See Section 01 60 00.
B. Ship, label, handle, and store drainage composites in accordance with ASTM D4873, 
   manufacturer’s recommendations, and as specified herein but as a minimum shall be protected 
   from UV exposure and elevated from the ground a minimum of 3 IN.
C. Wrap each roll in an opaque and waterproof layer of plastic during shipment and storage. Do 
   not remove the plastic wrapping until deployment.
D. Label each roll with the manufacturer's name, drainage composite type, lot number, roll 
   number, and roll dimensions (length, width, gross weight).
E. Repair or replace, as directed by the Engineer, drainage composite or plastic wrapping 
   damaged as a result of storage or handling.
F. Do not expose drainage composite to temperatures in excess of 71 DegC (160 DegF) or below 
   0 DegC (32 DegF) unless recommended by the Manufacturer.
G. Do not use hooks, tongs or other sharp 1 instruments for handling the drainage composite.
H. Do not lift rolls by use of cables or chains in contact with the drainage composite.
I. Do not drag drainage composite along the ground or across textured geomembranes.
J. No mechanical equipment shall be driven directly on top of the drainage net.
1.08 MATERIAL WARRANTY
   A. The composite drainage net manufacturer shall warrant the material, against manufacturing
defect and material degradation (prorated basis) for a period of twenty years from the date ofinstallation. The manufacturer shall replace any material that fails from the above causes within
the warranty period. The manufacturer shall furnish a written warranty covering the
requirement of this paragraph.

1.09 GUARANTEE
   A. The Contractor shall guarantee the drainage net against defects in installation and
workmanship for the period of two years commencing with the date of Final Acceptance. The
guarantee shall include the services of qualified service technicians and all materials required
for the repairs at no expense to the Owner.

PART 2 - PRODUCTS
2.01 ACCEPTABLE MANUFACTURERS
   A. Subject to compliance with the Contract Documents, the following Manufacturers are
acceptable:
      1. GSE Lining Technology, Inc. Houston, TX.
      2. Argru America, Inc. Georgetown, SC.
      3. Substitutions: See Section 01 60 00 - Product Requirements.
   B. Manufacturer will allow the Engineer to visit the plant during the manufacture of the material, if
desired.

2.02 MATERIALS AND MANUFACTURE
   A. Geonet Core:
      1. Use nonthermally degraded polyethylene polymer which is clean and free of any foreign
contaminants.
      2. Manufactured geonet to conform to the property requirements listed in Table 1 and be free
of defects including tears, nodules or other manufacturing defects which may affect its
serviceability.
      3. The drainage net shall be manufactured by extruding two sets of polyethylene strands to
form a three dimensional structure to provide planar water flow.
      4. Composite drainage net shall be GSE FabriNet Geocomposite or equal.
      5. Orthogonal patterns shall not be accepted.
   B. Geotextile:
      1. A geotextile filter fabric shall be heat bonded to both sides of the drainage net. Heat
bonding shall be performed by the manufacturer prior to shipping to the site. The
geotextile filter fabric shall be 8 OZ/SY nonwoven needle punched polypropylene fabric.

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>TEST METHOD</th>
<th>TEST VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>POLYMER MELT INDEX</td>
<td>ASTM D1238</td>
<td>&lt;1.0G/10 MIN.</td>
</tr>
<tr>
<td>Carbon Black Content</td>
<td>ASTM D1603</td>
<td>2-3 %</td>
</tr>
<tr>
<td>Thickness</td>
<td>ASTM D5199</td>
<td>300 mil</td>
</tr>
<tr>
<td>Density (net component only)</td>
<td>ASTM D1505</td>
<td>0.94 g/cm^3</td>
</tr>
<tr>
<td>Peak Tensile Strength (ultimate in machine direction for net only)</td>
<td>ASTM D751</td>
<td>75 lbs/in</td>
</tr>
<tr>
<td>Peel Adhesion</td>
<td>ASTM 0413</td>
<td>1.0 lbs/in</td>
</tr>
<tr>
<td>Transmissivity:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gradient=0.1, Pressure=10,000 psf</td>
<td>ASTM D4716</td>
<td>8x10^-3 m^2/s</td>
</tr>
</tbody>
</table>
C. Drainage Composite:
   1. Create a composite by heat bonding geotextiles to the geonet. The bond between the
      geotextile and the geonet shall exhibit a MARV ply adhesion of 1 LBS/IN when tested in
      accordance with ASTM D7005.
   2. Transmissivity $9 \times 10^{-4}$ square meters per second at 100 HRS.
   3. The composite drainage net shall contain UV inhibitors.

2.03 SOURCE QUALITY CONTROL
   A. Transmissivity Testing:
      1. Measure transmissivity (ASTM 4716) using water at 68 DegF with a normal compressive
         load of 10,000 psf and a hydraulic gradient of 0.3.
      2. Attach geotextiles to the geonet in the same configuration as will be used in the field.
      3. Boundary conditions are soil interface on the upper geotextile and HDPE geomembrane
         against the lower geotextile.
      4. The duration of loading shall be 100 HRS.
      5. Testing frequency: 1 test for every 50,000 SF of installed product.
   
B. Interface Friction Tests:
   1. Test materials using ASTM D5321.
   2. This material is part of a system. The system shall meet the requirements before the
      component material can be deemed acceptable.

2.04 QUALITY CONTROL DOCUMENTATION
   A. Prior to installation commencement of any drainage net material, the Contractor shall provide to
      the Owner the following information certified by the manufacturer for the delivered drainage net.
      1. Each roll delivered to the project site shall have the following identification information:
         a. Manufacturer’s name.
         b. Product identification.
         c. Thickness.
         d. Roll number.
         e. Roll dimensions.
      2. Quality control certificates, signed by the manufacturer’s quality assurance manager. Each
         certificate shall have roll identification number, sampling procedures, frequency, and test
         results. At a minimum, the following test results shall be provided every 50,000 SF of
         manufactured drainage net in accordance with test requirements specified in Paragraph
         2.02.
         a. Resin density.
         b. Resin melt index.
         c. Thickness.
         d. Carbon black content.
         e. Transmissivity.
         f. Tensile strength.

PART 3 - EXECUTION

3.01 EXAMINATION
   A. Prior to placement of the drainage composite, clean the substrate of all soil, rock, and other
      materials which could damage the composite.
   
B. The geocomponent drainage media shall be placed only on geomembrane that has been
   approved by the Geomembrane Installer.

3.02 INSTALLATION
   A. Install geocomposite drain in accordance with manufacturer’s written recommendations.
   
B. Deploy the drainage composite ensuring that the drainage composite and underlying materials
   are not damaged. Replace or repair faulty or damaged drainage composite as directed by
   Engineer.
C. Unroll secured drainage composite downslope keeping in slight tension to minimize wrinkles and folds.
D. Maintain free of dirt, mud, or any other foreign materials at all times during construction. Clean or replace rolls which are contaminated.
E. Place adequate ballast to prevent uplift by wind.
F. Overlap adjacent rolls a minimum of 6 IN. Overlap new drainage composite over existing as shown on the Drawings. For end widths of panels, the composite drainage net shall overlap a minimum of 6 IN with the upslope panel placed over the downslope panel. The bottom 6 IN of fabric on the top piece of composite and the top 6 IN of fabric on the bottom piece of composite shall be removed on all end seams to create net to net contact.
G. Use manufacturer's fasteners, plastic fasteners, or polymer braid to join adjacent rolls. Metallic fasteners will not be allowed. Space fasteners a maximum of 5 FT along downslope roll overlaps and a maximum of 1 FT along cross slope roll overlaps. Use fasteners of contrasting color from the drainage composite to facilitate visual inspection. Do not weld drainage composite to geomembranes.
H. Heat tack overlap of the upper geotextile to the upper geotextile of the adjacent rolls.
I. Repairs holes or tears in the drainage composite by placing a patch of drainage composite extending a minimum of 2 FT beyond the edges of the hole or tear. Use approved fasteners, spaced every 6 IN around the patch, to fasten the patch to the original roll. All repairs and parches shall be approved by the Engineer.
J. Penetration details shall be as recommended by the Manufacturer and as approved by the Engineer.
K. Composite drainage net shall only be cut using scissors or J-hook blades. Care shall be taken not to leave tools on the drainage net.
L. All composite drainage net shall be covered within the manufacturer’s recommended UV exposure limit. Contractor shall provide a temporary cover if specified cover material will not place within the manufacturer’s recommended exposure limit.
M. Composite drainage net shall be anchored as shown on the Drawings.
N. The unbounded fabric on the top of the composite drainage net shall be sewn or hot-wedge welded along side seams of adjacent panels.
O. A 12-inch wide strip of composite shall be sewn or hot-wedge welded cross all end seams.
P. Horizontal seams on 4 to 1 slopes shall not be allowed unless it is demonstrated to the Engineer that it is absolutely necessary.

3.03 3.3 FIELD QUALITY CONTROL

A. Provide as-constructed drawing showing roll number; layout; joint locations; and repair and patch locations.
B. Prior to installation of the drainage composite, the Contractor shall provide the Engineer quality control certificates signed by the manufacturer's quality assurance manager for every 50,000 SF of geocomposite drainage media to be installed.
C. Drainage composite left uncovered may, at the discretion of the Engineer, be sampled and tested for conformance with material specifications. Non-conforming filter fabric that has been left uncovered shall be removed and replaced at no additional cost to the Owner.
D. Damage to the drainage composite occurring during the placement of the material overlying the composite drainage net shall be repaired immediately at no additional expense to the Owner.

END OF SECTION
SECTION 40 23 36
PROCESS PIPING

PART 1 GENERAL

1.01 SCOPE OF WORK
A. Furnish all labor, materials, equipment, and incidentals required and all pipe and appurtenances as shown on the Drawings and specified herein.

1.02 RELATED SECTIONS
A. Section 31 23 23 - Fill.
B. Section 09 91 23 - Paints and Coatings.

1.03 REFERENCES
B. ASME B31.9 - Building Services Piping; The American Society of Mechanical Engineers; 1996 (ANSI/ASME B31.9).
C. ASME (BPV IX) - Boiler and Pressure Vessel Code, Section IX - Welding and Brazing Qualifications; The American Society of Mechanical Engineers; 2001.
1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.
C. Project Record Documents: Record actual locations of valves.

1.05 QUALITY ASSURANCE
A. All non-metallic below grade piping shall be installed with a 12 gauge coated copper wire attached to the crown of the pipe with duct tape in not less than 2 places per length of pipe to provide detectors a means of locating buried lines.
B. Upon completion of backfilling for trenches, the Contractor shall be responsible for matching the existing surface conditions.
C. Identify and label all visible pipe with markings indicating the direction of flow and content (i.e. RAS, WAS, Raw Wastewater, Final Effluent, Nitrate Recycle, etc.).
1.06 REGULATORY REQUIREMENTS
A. Perform Work in accordance with State of the State in which the Project is located, plumbing code.
B. Conform to applicable code for installation of backflow prevention devices.

1.07 DELIVERY, STORAGE, AND PROTECTION
A. In accordance with Section 01 60 00.
B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system. During laying operations, no debris, tools, clothing or other materials shall be placed in the pipe.

1.08 ENVIRONMENTAL REQUIREMENTS
A. Do not install underground piping when bedding is wet or frozen.

PART 2 PRODUCTS

2.01 SANITARY SEWER PIPING, BURIED
A. Ductile Iron Pipe: AWWA C151/A21.51, minimum pressure class 350 psi
   1. Fittings:
      a. 90 Bends: Ductile or gray iron, standard thickness, conforming to AWWA C110 (ANSI 21.10).
      b. All other Bends/Fittings: Ductile or gray iron, conforming to AWWA C153 (ANSI 21.53).

2.02 PROCESS AND WATER PIPING, BURIED
A. Ductile Iron Pipe: AWWA C151/A21.51, minimum pressure class 350 psi
   1. Fittings:
      a. 90 Bends: Ductile or gray iron, standard thickness, conforming to AWWA C110 (ANSI 21.10).
      b. All other Bends/Fittings: Ductile or gray iron, conforming to AWWA C153 (ANSI 21.53).
   2. Joints: AWWA C111/A21.11, rubber gasket with 3/4 inch diameter rods and concrete thrust blocks as indicated on the Drawings. Under slabs and foundations, restrained joint fittings shall be provided.
   5. Fittings: Ductile or gray iron, standard thickness.
B. PVC Pipe: AWWA C900 and AWWA C905, minimum pressure class 150 psi
   1. Provisions must be made for expansion and contraction at each joint with an elastomeric gasket.
   2. Fittings:
      a. 90 Bends: Ductile or gray iron, standard thickness, conforming to AWWA C110 (ANSI 21.10).
      b. All other Bends/Fittings: Ductile or gray iron, conforming to AWWA C153 (ANSI 21.53).
   3. Joints: Under slabs and foundations, restrained joint fittings shall be provided.
   4. Random lengths shall not be less than 10 feet long.
C. HDPE Pipe/Tube: AWWA C901 or AWWA C906, minimum pressure class shall be 200 psi.
   1. Where applicable pipe outside diameter shall be DIPS
   2. Fittings: Plain end butt fused fittings shall be used when joining polyethylene materials. Fittings shall comply with ASTM D3261
   3. Joining: Butt fusion procedures shall be in accordance with the manufacturer’s recommendations.

D. HDPE Pipe and Tubing for High Temperature Applications (PE-RT)
   1. Pipe and Fittings:
      a. Materials:
         1) PE-RT material used for the manufacture of polyethylene pipe, tube and fittings shall be PE 4710 high density polyethylene meeting ASTM D3350 cell classification of 445574C and shall be listed in the name of the pipe and fitting manufacturer in PPI (Plastics Pipe Institute) TR-4 with a standard grade HDB rating of 1600 psi at 73°F and 800 psi at 180°F per ASTM D2837. The material shall contain a stabilizer system for high oxidative environments with a CC3 rating per ASTM D3350.
         2) Polyethylene pipe shall be manufactured in accordance with ASTM F2619, API 15LE and ASTM F714. The pipe shall be protected against UV degradation with 2-3% carbon black.
      b. Molded Fittings:
         1) Molded fittings shall be manufactured and tested in accordance with ASTM D3261 and D2513 and shall be so marked.
      c. Polyethylene Flange Adapters:
         1) Flange adapters shall be made with sufficient through-bore length to be clamped in a butt fusion-joining machine without the use of a stub-end holder. The sealing surface of the flange adapter shall be machined with a series of small v-shaped grooves (serrations).
      d. Back-up Rings & Flange Bolts:
         1) Flange adapters shall be fitted with back-up rings that are pressure rated equal to or greater than the mating pipe. The back-up ring bore shall be chamfered or radiused to provide clearance to the flange adapter radius. Flange bolts shall be SAE J429 Grade 2, or Grade 5 and used with corresponding heavy-hex nuts.
      e. MJ Adapters:
         1) MJ Adapters shall be provided with Stainless Steel Stiffeners. MJ Adapters 14” and above shall be provided with Heavy Duty Back-up Ring Kits.
   2. Joining:
      a. Heat Fusion Joining:
         1) Joints between plain end pipes and fittings shall be made by butt fusion. Joints between the main and saddle branch fittings shall be made using saddle fusion. The butt fusion and saddle fusion procedures used shall be procedures that are in accordance with ASTM F2620 and recommended by the pipe and fitting manufacturer. The contractor shall ensure that persons making heat fusion joints have received training in the manufacturer’s recommended procedure. The contractor shall maintain records of trained personnel, and shall certify that training was received not more than 12 months before commencing construction. External and internal beads shall not be removed.
            (a) Butt Fusion of Unlike Wall Thickness:
               1) Butt fusion shall be performed between pipe ends, or pipe ends and fitting outlets that have the same outside diameter and are not different in wall thickness by more than one Standard DR, for example, SDR 13.5 to SDR 17, or SDR 11 to SDR 13.5. Transitions between unlike wall thickness greater than one SDR shall be made with a transition nipple (a short length of the heavier wall pipe with one end machined
b. Joining by Other Means:
   1) Polyethylene pipe and fittings may be joined together or to other materials by means of (a) flanged connections (flange adapters and back-up rings), (b) mechanical couplings designed for joining polyethylene pipe or for joining polyethylene pipe to another material, (c) MJ Adapters or (d) electrofusion. When joining by other means, the installation instructions of the joining device manufacturer shall be observed.
      (a) ID Stiffener and Restraint:
         (1) A stiffener shall be installed in the bore of the polyethylene pipe when an OD compression mechanical coupling is used and when connecting plain end PE pipe to a mechanical joint pipe, fitting or appurtenance. External clamp and tie rod restraint shall be installed where PE pipe is connected to the socket of a mechanical joint pipe, fitting or appurtenance except where an MJ Adapter is used.

c. Branch Connections:
   1) Branch Connections. Branch connections to the main shall be made with saddle fittings, electrofusion fittings, or tees. Polyethylene saddle fittings shall be saddle fused to the main pipe per 3.1.

3. Testing:
   a. Fusion Quality: The contractor shall ensure the field set-up and operation of the fusion equipment, and the fusion procedure used by the contractor's fusion operator while on site. QA/QC controls for fusion joint quality include 1) operator training in identifying a properly made fusion; 2) if applicable, using equipment to record and document key parameters of the fusion process to determine whether the procedure performed adheres with recommended guidelines; 3) field testing of trial joints; 4) hydrostatic testing. The contractor at its expense shall make all necessary corrections to equipment, set-up, operation and fusion procedure, and shall re-make the rejected fusions.
   b. Trial Fusions. Upon request by the owner, the contractor shall verify field fusion quality by making and testing a trial fusion. The trial fusion shall be allowed to cool completely before conducting a Bend Back test per ASTM F2620 or a Guided Side Bend test per ASTM F3183. A Bend Back test shall be used for pipe with wall thicknesses of less than 1”, while a Guided Side Bend test shall be used for pipe with wall thicknesses of 1” and larger. If the trial fusion fails at the joint, the field fusions represented by the trial fusion shall be rejected.
   c. Leak Testing. Hydrostatic leak testing shall be conducted in accordance with Performance Pipe Technical Note 802 Leak Testing and ASTM F2164. Pneumatic pressure testing is prohibited.

2.03 PROCESS AND WATER PIPING, ABOVE GRADE

A. Steel Pipe 8 Inches and Smaller: ASTM A 53/A 53M, Schedule 40, Black Steel; unless otherwise noted to be galvanized.
   1. Fittings and unions: AWWA C206 and AWWA C208 with a minimum working pressure of 150 psi.
   2. Screw Joints: Perfectly tight with a still mixture of graphite and mineral oil, or an approved, non-toxic, non-hardening pipe joint compound applied to the male threads only.
   3. Flanges: AWWA C207.
   4. The interior of the pipe shall not be coated
   5. The exterior of the pipe shall be coated in accordance with Section 09900.

B. Steel Pipe 10 Inches and Larger: ASTM A 53/A 53M and AWWA C200, Schedule 20, Black Steel; unless otherwise noted to be galvanized.
   1. Fittings and unions: AWWA C206 and AWWA C208 with a minimum working pressure of 150 psi.
2. Flanges: Flanges shall be steel slip on or welding neck type, raised face, Class 150, conforming to ASTM A 105 and ANSI B16.5.
3. Pipe shall have beveled ends for welding.
4. Pipe ends shall be provided to suit the field joints indicated on the Drawings.
5. Field welded joints shall be single (outside) lap or butt type conforming to AWWA C206.
6. The interior of the pipe shall not be coated.
7. The exterior of the pipe shall be coated in accordance with Section 09900.

C. Ductile Iron Pipe: AWWA C151/A21.51, minimum pressure class 350 psi
1. Fittings: Ductile or gray iron, standard thickness, conforming to AWWA C110 (ANSI 21.10).

D. Stainless steel pipe, fittings and flanges and shall meet the following requirements:
1. Stainless Steel Pipe, 4” through 36”
   a. Material for Stainless Steel Pipe, 4” through 36”: AISI 304L Stainless steel.
   b. Pipe Standards for Stainless Steel Pipe, 4” through 36”: ASTM A312 or ASTM A778.
2. Stainless Steel Pipe, 3” or smaller
   a. Material for Stainless Steel Pipe, 3” and smaller: AISI 316L stainless steel.
   b. Pipe Standard for Stainless Steel Pipe, 3” and smaller: ASTM A312.
   c. Dimension Standard for Stainless Steel Pipe, 3” and smaller: ANSI/ASME B36.19M, Schedule 40S.
3. Stainless Steel Fittings 4” through 36”
   a. Material for Stainless Steel Fittings, 4” through 36”: AISI 304L stainless steel.
   b. Material Standard for Steel Fittings, 4” through 36”
      1) Fittings for ASTM A312 Pipe: ASTM A403
      2) Fittings for ASTM A778 Pipe: ASTM A774
   c. Dimension Standards for Stainless Steel Fittings, 4” through 36”
      2) Fitting Dimensions: ANSI B16.9
4. Stainless Steel Fittings, 3” and smaller
   a. Material for Stainless Steel Fittings, 3” and smaller: ASTM 316L stainless steel.
   b. Fitting Standard for Stainless Steel Fittings, 3” and smaller
      1) Forged/Wrought Stainless Steel Fittings: ASTM A182, Grade 316L
      2) Cast Stainless Steel Fittings: ASTM A351, Grade CF 8M.
   c. Dimension Standard for Stainless Steel Fittings, 3” and smaller: ANSI B316.3, Class 150
   d. Stainless Steel Pipe and Fitting Joints
   e. Stainless Steel Pipe and Fittings, 4” through 36”: Flange, welded, or clamp type coupling.
   f. Stainless Steel Pipe and Fittings, 3” and smaller: Threaded or Flange.
5. Flanges for Stainless Steel Pipe and Fittings
   a. Stainless Steel Flange Material
      1) Flanges for 4” through 36” Stainless Steel Pipe and fittings: AISI 304L stainless steel.
      2) Flanges for 3” and smaller Stainless Steel Pipe and Fittings: AISI 316L stainless steel.
   d. Stainless Steel Flange Type
1) Flanges for Stainless Steel Pipe, 4” through 36”: Welding neck, lap joint, or slip-on.
2) Flanges for Stainless Steel Fittings, 4” through 36”: Welding Neck.
3) Flanges for Stainless Steel Pipe and fittings, 3” and smaller: Threaded.
   e. Flange Face Type: 1/16” raised face.

6. Stainless Steel Flange Joint Accessories
   a. Stainless Steel Flange Joint Gaskets
      1) Gasket Type: ring.
      2) Gasket Thickness: 1/8”
      3) Gasket Material: Ethylene-Propylene diene terpolymer (EPDM) rubber.
   b. Bolts, Studs, and Nuts for Stainless Steel Flange Joints
      1) Bolt, Stud, and Nut Material: AISI Type 316 or Type 316N stainless steel.
      2) Bolt and Stud Standard: ASTM A193, Grade B8M, B8MN, or B8MLN.
      3) Nut Standard: ASTM A194, Grade 8M, B8MN, or M8MLN.
      4) Bolt, Stud and Nut Threads: UNC threads.
      5) Stud Length: Stubs shall extend through nuts a minimum of ¼”.

2.04 FLANGES, UNIONS, AND COUPLINGS
A. Unions for Pipe Sizes 3 Inches and Under:
   1. Ferrous pipe: Class 150 malleable iron threaded unions.
B. Flanges for Pipe Size Over 1 Inch:
   1. Ferrous pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.
C. Grooved and Shouldered Pipe End Couplings:
   1. Housing: Malleable iron clamps to engage and lock, designed to permit some angular deflection, contraction, and expansion; steel bolts, nuts, and washers; galvanized for galvanized pipe.
   2. Sealing gasket: "C" shape composition sealing gasket.
D. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.05 PIPE HANGERS AND SUPPORTS
A. Process Piping:
   2. Hangers for Pipe Sizes 1/2 Inch to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
   3. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
   4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
   5. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
   8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
B. Plumbing Piping - Water:
   2. Hangers for Pipe Sizes 1/2 Inch to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
   3. Hangers for Cold Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
   5. Hangers for Hot Pipe Sizes 6 Inches and Over: Adjustable steel yoke, cast iron pipe roll, double hanger.
6. **Multiple or Trapeze Hangers:** Steel channels with welded supports or spacers and hanger rods.
7. **Multiple or Trapeze Hangers for Hot Pipe Sizes 6 Inches and Over:** Steel channels with welded supports or spacers and hanger rods, cast iron roll.
8. **Wall Support for Pipe Sizes to 3 Inches:** Cast iron hook.
9. **Wall Support for Pipe Sizes 4 Inches and Over:** Welded steel bracket and wrought steel clamp.
10. **Wall Support for Hot Pipe Sizes 6 Inches and Over:** Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron pipe roll.
11. **Vertical Support:** Steel riser clamp.
12. **Floor Support for Cold Pipe:** Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
13. **Floor Support for Hot Pipe Sizes to 4 Inches:** Cast iron adjustable pipe saddle, locknut, nipple, floor flange, and concrete pier or steel support.
14. **Floor Support for Hot Pipe Sizes 6 Inches and Over:** Adjustable cast iron pipe roll and stand, steel screws, and concrete pier or steel support.
15. **Copper Pipe Support:** Carbon steel ring, adjustable, copper plated.

### 2.06 PIPE PENETRATION SEALS

A. **Wall/floor penetration seals** shall be used to continuously fill the annular space between pipe and wall/floor. Wall/floor penetration seals, once expanded, shall provide a seal between the pipe and wall/floor opening.

B. Where walls or floors have pipe penetrations that are continuously wet on one or both sides, the use of wall sleeves with water stops shall be employed along with the wall/floor penetration seal to achieve a watertight seal between pipe and wall/floor opening.

C. The wall/floor opening size and/or type shall be selected according to recommendations found in seal penetration manufacturer's representative catalog. The wall/floor opening refers to a steel or plastic sleeve, coredrilled hole or cast-formed hole.

D. **Penetration Seal Rubber Links**
   1. The wall/floor penetration seal shall be made of mechanically interlocked, solid synthetic rubber links. There shall be a sufficient quantity of links about the pipe that once expanded, shall achieve a 20-PSI hydrostatic seal between pipe and wall/floor opening.
   2. The elastomer element shall be EPDM elastomer.
   3. Penetration seal pressure plates shall be molded of glass reinforced nylon.
   4. Hardware Fasteners shall consist of stainless steel bolts and hex nuts.

E. **Wall Sleeves**
   1. Cast in place concrete wall sleeves are to be fabricated from galvanized heavy wall welded or seamless carbon steel pipe. All sleeves are to have a 2” wide, full perimeter water stop, welded on both sides.

### 2.07 TRACER WIRE AND ACCESS BOXES

A. All buried piping shall be installed with tracer wire. The tracer wire shall be installed continuously along the new pipe route with access points at 300 feet maximum. The tracer wire shall be brought to the ground surface at the access points. Access points may include valve boxes, handholes, manholes, vaults, or other covered access devices. Access point covers shall be clearly marked with a pipe description. Splices in the tracer wire shall be connected by means of a split bolt or compression type connector to ensure continuity. Wire nuts shall not be used. A waterproof or corrosion-proof connector for direct bury applications shall be used. After installation, the tracer wire shall be tested to verify continuity of the tracer wire system.

B. For locations where valve boxes are not present, the tracer wire access point shall be composed of one SnakePit Tracer Wire Access Box, or approved equal, installed at each proposed access point.
PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION
A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
B. Remove scale and dirt, on inside and outside, before assembly.
C. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION
A. Install in accordance with manufacturer's instructions.
B. Install to the required lines and grades with fittings, valves, and accessories at the required locations; spigots centered in the bells; and all valves and appurtenances properly aligned. The laying of pipe shall conform to the applicable portions of AWWA C600, AWWA C604, or AWWA C605.
C. Pressure test all piping in accordance with AWWA C600, AWWA C604, or AWWA C605 to a minimum test pressure of 150 psi, unless otherwise indicated.
D. All piping and fittings shall be rigidly supported.
E. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
F. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls, except as indicated otherwise on the Drawings.
G. Install piping to maintain headroom, conserve space, and not interfere with use of space.
H. Group piping whenever practical at common elevations.
I. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
J. Deflections from a straight line or grade made necessary by vertical or horizontal curves or offsets shall not exceed the manufacturer's recommendations. If the required alignment requires deflections in excess of those recommended, the Contractor shall either provide special bends, as approved by the Engineer, of a sufficient number of shorter lengths of pipe to provide angular deflections within the required limit.
K. Laying of pipe shall be commenced immediately after the excavation is started, and every means must be used to keep pipe laying closely behind the trenching. The Engineer may stop the trenching when, in the opinion of the Engineer, the trench is open too far in advance of the pipe laying operation. Pipe may be laid in the best manner adapted to securing speed and good results.
L. Inspect pipe and fittings for defects and all lumps, blisters, excess coal-tar coating and other foreign material shall be removed from the bell and spigot end of each cast iron or PVC pipe, or inside of PVC couplings and fittings. All pipe, couplings, adapters, and other pipe connections shall be wiped clean and dry before the pipe is laid.
M. After placing a length of pipe in the trench, center the spigot end in the bell and force the spigot end into the bell end.
N. Secure the pipe in place with approved backfill material tamped under it except at the bells. Pipe and fittings which do not allow a sufficient and uniform space for joints shall be removed and replaced with pipe and fittings of proper dimensions to insure each uniform space.
O. Prevent dirt from entering the joint space.
P. The cutting of cast iron pipe for inserting valves, fittings, or closure pieces shall be done in a neat and workmanlike manner without damage to the pipe or cement lining and so as to leave a smooth end at right angles to the axis of the pipe.

Q. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

R. Establish elevations of buried piping outside the building to ensure not less than 3 ft of cover.

S. Install vent piping penetrating roofed areas to maintain integrity of roof assembly.

T. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

U. Provide restrained joint fittings under all slabs.

V. Provide support for utility meters in accordance with requirements of utility companies.

W. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 09 91 23.

X. Excavate in accordance with Section 31 23 16 for work of this Section.

Y. Backfill in accordance with Section 31 23 23 for work of this Section.

Z. Install bell and spigot pipe with bell end upstream.

AA. Install valves with stems upright or horizontal, not inverted; unless indicated otherwise on the Drawings.

AB. PVC Pipe: Make solvent-welded joints in accordance with ASTM D 2855.

AC. Sleeve pipes passing through partitions, walls and floors.

AD. Inserts:
   1. Provide inserts for placement in concrete formwork.
   2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
   3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
   4. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

AE. Pipe Hangers and Supports:
   1. Install in accordance with ASME B31.9.
   2. Support horizontal piping as scheduled.
   3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
   4. Place hangers within 12 inches of each horizontal elbow.
   5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
   6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
   7. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
   8. Support cast iron drainage piping at every joint.

3.04 APPLICATION

A. Use grooved mechanical couplings and fasteners only in accessible locations.

B. Install unions downstream of valves and at equipment or apparatus connections.

C. Install gate valves for shut-off and to isolate equipment, part of systems, or vertical risers.

D. Provide lug end butterfly valves adjacent to equipment when provided to isolate equipment.

E. Provide spring loaded check valves or as otherwise indicated on the drawings on the discharge of all water and wastewater pumps.
3.05 ERECTION TOLERANCES
A. Drainage Piping: Establish invert elevations within 1/2 inch vertically of location indicated and slope to drain at minimum of 1/4 inch per foot slope.
B. Water Piping: Slope at minimum of 1/32 inch per foot and arrange to drain at low points.

3.06 SCHEDULES
A. Pipe Hanger Spacing:
   1. Metal Piping:
      a. Pipe size: 1/2 inches to 1-1/4 inches:
         1) Maximum hanger spacing: 6.5 ft.
         2) Hanger rod diameter: 3/8 inches.
      b. Pipe size: 1-1/2 inches to 2 inches:
         1) Maximum hanger spacing: 10 ft.
         2) Hanger rod diameter: 3/8 inch.
      c. Pipe size: 2-1/2 inches to 3 inches:
         1) Maximum hanger spacing: 10 ft.
         2) Hanger rod diameter: 1/2 inch.
      d. Pipe size: 4 inches to 6 inches:
         1) Maximum hanger spacing: 10 ft.
         2) Hanger rod diameter: 5/8 inch.
      e. Pipe size: 8 inches to 12 inches:
         1) Maximum hanger spacing: 14 ft.
         2) Hanger rod diameter: 7/8 inch.
      f. Pipe size: 14 inches and Over:
         1) Maximum hanger spacing: 20 ft.
         2) Hanger rod diameter: 1 inch.
   2. Plastic Piping:
      a. All Sizes:
         1) Maximum hanger spacing: 5 ft.
         2) Hanger rod diameter: 3/8 inch.

END OF SECTION
Mountaire Farms of Delaware, Inc.
Millsboro, DE
Wastewater Treatment System Upgrade

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SECTION 40 23 37

VALVES

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all tools, supplies, materials, equipment, and labor necessary for furnishing, epoxy coating, installing, adjusting, and testing of all valves and appurtenant work, complete and operable as shown on the Drawings and specified herein. Where buried valves are shown, furnish and install valve boxes to grade, with covers, extensions, and tee handles.

B. Furnish all labor, materials, equipment, and incidentals required and all valves and appurtenances as shown on the Drawings and specified herein.

1.02 REFERENCES

A. ANSI B16.1 Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.
B. ANSI B16.5 Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys.
C. ANSI/ASME B1.20.1 General Purpose Pipe Threads (inch).
E. ASTM A 36 Specification for Structural Steel.
H. ASTM A 536 Specification for Ductile Iron Castings
I. ASTM B 61 Specification for Steam or Valve Bronze Castings.
J. ASTM B 62 Specification for Composition Bronze or Ounce Metal Castings.
L. ASTM B 584 Specification for Copper Alloy Sand Castings or General Applications.
M. ANSI/AWWA C500 Gate Valves for Water and Sewerage Systems.
N. ANSI/AWWA C504 Rubber-Seated Butterfly Valves.
O. ANSI/AWWA C506 Backflow Prevention Devices - Reduced Pressure Principle and Double Check Valves Types.
P. ANSI/AWWA C507 Ball Valves 6 inches through 48 inches.
Q. AWWA C508 Swing-Check Valves for Waterworks Service, 2 inches Through 24 inches NPS.
R. AWWA C550 Protective Interior Coatings for Valves and Hydrants.
S. SSPC-SP-5 White Metal Blast Cleaning.
T. MSS-SP-70 Manufacturers Standardization Society of the Valve and Fitting Industry; Cast Iron Gate Valves. Flanged and Threaded Ends.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Shop Drawings: Shop drawings of all valves and operators including associated wiring diagrams and electrical data (if required).
C. Valve Schedule: Submit a complete valve schedule of all valves being supplied including each valve location, size, type, end connections, and operator type.
D. Valve Labeling: Submit a schedule of valves to be labeled indicating in each case the valve location and the proposed wording for the label.
E. Certification: The Manufacturer shall provide a certification stating that they have reviewed the Drawings and Specification for this project and have verified that the applicability of the specified equipment to be provided by the Manufacturer for the intended use per the Drawings and Specifications.
   1. The Manufacturer shall provide to the Engineer, as part of the certification, in writing any recommended revisions to the design based upon the Manufacturer's review of the Specifications and Drawings.
   2. The Manufacturer shall provide to the Engineer in writing any recommendations for revisions to the pipe and valve configuration and/or valve selection.

1.04 QUALITY ASSURANCE
   A. The Contractor shall demonstrate that each valve installed as a part of a piping system will operate under field conditions in a manner consistent with the design of the system.

1.05 DELIVERY, STORAGE, AND PROTECTION
   A. In accordance with Section 01 60 00.
   B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
   C. Provide temporary protective coating on cast iron and steel valves.
   D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system. During laying operations, no debris, tools, clothing or other materials shall be placed in the pipe.

PART 2 PRODUCTS

2.01 GENERAL
   A. The named manufacturers are only given to indicate acceptable manufacturers. It is the Contractor's responsibility to ensure that the provided valves meet the specific requirements of the specifications. The Engineer does not imply that the specified manufacturers meet the specific specified requirements.
   B. Valves shall be suitable for use in raw wastewater and sewage applications.
   C. The use of a manufacturer's name and/or model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
   D. Valves and appurtenances shall be of the size shown on the Drawings or as noted and as far as possible equipment of the same type shall be identical and from one manufacturer.
   E. Valves and appurtenances shall have the name of the manufacturer, nominal size, flow directional arrows, working pressure for which they are designed, cast in raised letters or indelibly marked upon some appropriate part of the body.
   F. Unless otherwise noted, items shall have a minimum working pressure of 150 psi or be of the same working pressure as the pipe they are connecting to, whichever is higher and suitable for the pressures noted where they are installed.
   G. Valves and appurtenances shall be of the same nominal diameter as the pipe or fittings they are connected to.
   H. Provide all special adaptors as required to ensure compatibility between valves, appurtenances and adjacent pipe.
   I. Valves and operators located outdoors but not within a building; within maximum 2 feet above liquid; in vaults; or where otherwise noted shall be especially designed for submerged service where water may completely submerge the valve and operator. All other units shall be as a minimum weather tight.
   J. The Contractor shall furnish all valves, operators, actuators, valve-operating units, stem extensions, and other accessories as shown, specified, or required to install a fully functional valve. All valves shall have the name of the manufacturer and the site of the valve cast on the body or bonnet or shown on a permanently attached plate in raised letters. All valves and gates shall be new and of current manufacture. All shut-off valves, 6-inch and larger, shall have
operators with position indicators. Where buried, these valves shall be provided with valve boxes and covers containing position indicators, and valve extensions. Shut-off valves mounted higher than 6 feet above working level shall be provided with chain operators.

K. Gate Valve Stems: Manually operated valves shall have silicon-bronze stems conforming to ASTM B 584-875, having minimum tensile strength of 60,000 psi, a minimum yield point of 24,000 psi, and elongation of 16% in 2 inches.

L. Protective Coating: Except where otherwise specified, ferrous surfaces, exclusive of stainless steel surfaces, in the water passages of all valves 4-inch and larger, as well as the exterior surfaces of all submerged valves, shall be coated as specified in Section 09 90 00 - Paints and Coatings. Flange faces of valves shall not be coated.

M. Valve Operators: Where shown, certain valves and gates shall be furnished with electric operators, provided by the valve or gate manufacturer. All operators of a given type shall be furnished by the same manufacturer. Where these operators are supplied by different manufacturers, the Contractor shall coordinate their selection to provide uniformity of each type of electric operator. All valve operators, regardless of type, shall be installed, adjusted, and tested by the valve manufacturer at the manufacturing plant.

N. Nuts and Bolts: All nuts and bolts on valve flanges and supports shall be Type 316 stainless steel.

2.02 VALVE OPERATORS

A. The valve manufacturer shall supply and integrally, rigidly mount all operators, including any type of manual or powered operators, on valves at the factory. The valves and their individual operators shall be shipped as a unit.

B. Unless otherwise noted, valves shall be manually operated; unburied valves shall have an operating wheel, handle or lever mounted on the operator; buried valves and those with operating nuts shall have a non-rising stem with an AWWA 2 inch nut. At least four tee handles shall be provided. Tee handles shown on the Drawings shall be permanently installed and rigidly supported.

C. Except as otherwise shown on the Drawings or specified herein, all valves 3 inch diameter or larger, with the valve center line located 6 feet or more above the operating floor, shall be provided with chain wheel operators complete with chain guides and hot dipped galvanized steel chain, which loop within 4 foot of the operating floor.

D. All operators shall be capable of moving the valve from the full open to full close position and in reverse and holding the valve at any position part way between full open or closed.

E. Gear Operators:
   1. Unless otherwise noted on the Drawings, gear operators shall be provided for all valves larger than 12 inch diameter and all buried valves with the operating shaft mounted horizontally (butterfly, plug, etc.).
   2. Gear operators shall be of the worm or helical gear type with output shaft perpendicular to the valve shaft, having a removable hand wheel mounted on the output shaft. Unless noted they shall conform to AWWA C504.
   3. Operators shall be capable of being removed from the valve without dismantling the valve or removing the valve from the line.
   4. Gearing shall be machine-cut steel designed for smooth operation. Bearings shall be permanently lubricated, with bronze bearing bushings provided to take all thrusts and seals and to contain lubricants. housings shall be sealed to exclude moisture and dirt, allow the reduction mechanisms to operate in lubricant and be of the same material as the valve body.
   5. Maximum handwheel size shall be 24 inch diameter.

F. Each operating device shall have cast on it the word "OPEN" and an arrow indicating the direction of operation.
G. Additional valve operators are included with the individual valve types and as noted on the Drawings.

2.03 GATE VALVES

A. Manufacturers:
   1. Clow
   2. American R/D
   3. Mueller
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. General:
   1. Gate valves shall meet or exceed the requirements of AWWA standard C500 covering solid wedge gate valves.
   2. Buried and submerged valves shall be furnished with mechanical joints and stainless steel hardware.
   3. Exposed valves shall be furnished with Class 125 flanged ends; provide valves.
   4. Valves shall be non-rising stem, opening by turning stem left or right and provided with 2" square operating nut or handwheel with the word 'open' and an arrow cast in the metal to indicate direction to open.
   5. The wedge shall be of cast iron completely encapsulated with rubber.
   6. The sealing rubber shall be permanently bonded to the cast iron wedge to meet ASTM tests for rubber metal bond ASTM D429.
   7. Valves shall be supplied with o-ring seals at all joints. No flat gaskets allowed.
   8. Stems for non-rising stem assemblies shall be cast bronze with integral collars in full compliance with AWWA. The non-rising stem stuffing box shall be the o-ring seal type with two o-rings located above thrust collar and one o-ring below. The two o-rings above the thrust collar shall be replaceable with valve fully open and subjected to full rated working pressure.
   9. There shall be two low torque thrust bearings located above and below the thrust collar. The stem nut shall be independent of the wedge and shall be made of solid bronze. There shall be a smooth, unobstructed waterway free of all pockets, cavities and depressions in the seat area.
   10. The body and bonnet shall be coated with fusion bonded epoxy both interior and exterior, complying with AWWA C-550 and be NSF 61 approved. Each value shall have maker's name, pressure rating and year in which manufactured cast on the body.
   11. Prior to shipment from the factory, each valve shall be tested by hydrostatic pressure equal to AWWA (twice the specified working pressure) requirements.
   12. Non-rising stem valves shall use a double O-Ring stem seal, except that packing shall be used where geared operators are required.
   13. Flanged valves to have face-to-face dimensions per ANSI B16.1 and flanges per ANSI B16.10.
   14. Provide geared operator and chainwheel, chain and chain guides for valves with handwheel centerline more than 6 foot above operating level.
   15. Unless otherwise indicated, valves 12 inch and smaller shall be capable of installation in the vertical or horizontal position, and sealing in both directions at the rated pressure.
   16. Valves shall be installed with the stem within the upright vertical position to the 90 degrees horizontal position. Valves shall not be installed with the stem projected downward.

C. Buried Valves:
   1. Conform to the requirements above, except mechanical joint bell ends per AWWA standard C111.
   2. All exposed valve hardware (nuts, bolts, washers, etc.) including bonnet, bonnet cover, stuffing box, gear adaptor and joints shall be Type 304 stainless steel.
   3. Non-rising stem design, double O-Ring seals for non-geared valves and shall incorporate packing for geared valves.
   4. Provide valve box, 2 inch operating nut and extension stem and stem cover.
D. Tapping Valves and Sleeves:
   1. Tapping valves shall comply with the above specifications except they shall have the
      flanged end and port opening modified for tapping service. Valve shall be capable of
      passing a full nominal sized cutter without damage to the valve. The tapping sleeve shall
      be gray cast iron or ductile iron mechanical joint type.

2.04 KNIFE GATE VALVES
A. Manufacturers:
   1. Orbinox
   2. DeZurik
   3. Substitutions: See Section 01 60 00 - Product Requirements.
B. Valves shall be flanged type suitable for dead-end service with either pipe flange removed,
   unless otherwise indicated on the drawings rated for a working pressure of 150 psi.
C. Face-to-face dimensions per MSS SP-81 with BI-DIRECTIONAL shut-off.
D. Valve shall have a maximum leakage rate of no more than 20 CC per inch of diameter per
   minute at 40 psi in both directions without the use of O-rings, guides or wedges obstructing the
   port.
E. The seating material shall be metal-to-metal or made from a resilient EPDM or Viton material
   and completely field replaceable.
F. To prevent atmospheric leakage, the valve features an adjustable packing assembly consisting
   of multiple layers of braided packing around gate, evenly compressed by a one-piece packing
   gland.
G. The valve is to have 100% full port flow with no guides or wedges obstructing the port.
H. The gate shall be finished ground on both sides, and made from stainless steel.
I. The body material shall be 304 stainless steel.
J. Valve is equipped with a manual handwheel operator assembly featuring a cast ductile iron
   handwheel, a heavy duty foot mounted yoke with an acid resistant bronze stem nut, including a
   304 stainless steel rising stem.
K. The gate shall be a beveled knife edge.
L. All wetted surfaces shall be Type 316 stainless steel.
M. Packing gland bolts shall be Type 316 stainless steel with plated, self-locking nuts.
N. The valves shall have full port straight through opening.
O. Flanges shall be drilled to match connecting pipe.

2.05 PLUG VALVES
A. Manufacturers:
   1. Val Matic
   2. Milliken
   4. Substitutions: See Section 01 60 00 - Product Requirements.
B. Plug valves shall be of the offset disc type, 1/4 turn, non-lubricated, serviceable (able to be
   repacked) under full line pressure and capable of sealing in both directions at the rated
   pressure.
C. The valves shall be designed, manufactured and tested in accordance with American Water
   Works Association Standards ANSI/AWWA C517.
D. Flanged valves shall have flanges with drilling to ANSI B16.1, Class 125.
E. Mechanical Joint valves shall fully comply with ANSI/AWWA C111/A21.11.
F. The plug shall be of one-piece construction and made of ASTM A126 Class B cast iron with a
   resilient facing per ASTM D2000-BG and ANSI/AWWA C504 requirements
G. Radial shaft bearings shall be constructed of self-lubricating type 316 stainless steel. The top thrust bearing shall be Teflon. The bottom thrust bearing shall be Type 316 stainless steel. Cover bolts shall be corrosion resistant with zinc plating.

H. The disc shall be completely out of the flow path when open.

I. All plug valves shall have a minimum port area of 100 percent.

J. Valve bodies shall be of cast iron, ASTM A 126, Grade B, or of ductile iron, ASTM A 536 and of the top entry, bolted bonnet design, cast with integral flanges conforming to the connecting piping. All exposed bolts, nuts and wasters shall be zinc or cadmium-plated, except for buried or submerged plug valves, which shall have Type 316 stainless steel hardware.

K. Shaft bearings shall be permanently lubricated, rigidly backed TFE, stainless steel or bronze at both upper and lower stem journals. The operator shaft shall have easily replaceable seals, which shall be externally adjustable and repackable without removing the bonnet from the valve, or shall have self-adjusting packing.

L. The valve seating surface shall provide full 360 degree seating by contact of a resilient seating material on the disc mating with welded-in 99% high nickel content overlay seating surface in the body.
   1. The seating design shall be resilient and of the continuous interface type having consistent opening and closing torques and shall be non-jamming in the closed position. Screw-in seats shall not be acceptable.
   2. Discs shall have a full resilient facing of neoprene or EPDM.

M. Actuators: The methods of mounting the actuator to the valve shall provide an air gap between the two. Actuator shall clearly indicate valve position and an adjustable stop shall be provided. Construction of actuator housing shall be semi-steel. Hardware on actuators shall be of the same materials as the valve.
   1. 8 inch and smaller valves shall be equipped with a 2 inch square nut for direct quarter turn operation. The packing gland shall include a friction collar and an open position memory stop. The friction collar shall include a nylon sleeve to produce friction without exerting pressure on the valve packing.
   2. When specified, 4 inch and larger valves shall include a totally enclosed and sealed worm gear actuator with position indicator (above ground service only) and externally adjustable open and closed stops. The worm segment gear shall be ASTM A536 Grade 65-45-12 ductile iron with a precision bore and keyway for connection to the valve shaft. Bronze radial bearings shall be provided for the segment gear and worm shaft. Alloy steel roller thrust bearings shall be provided for the hardened worm.
   3. All gear actuators shall be designed to withstand, without damage, a rim pull of 200 lb. on the handwheel and an input torque of 300 ft-lbs for nuts.
   4. Buried service actuators shall be packed with grease and sealed for temporary submergence to 20 feet of water.
   5. Exposed worm shafts shall be stainless steel.

N. Each plug valve shall be provided with its own securely attached lever. Provide adjustable limit stops for both opening and closing and a clearly marked position indicator.

O. Plug valves shall be installed so that the direction of flow through the valve and the shaft orientation is in accordance with the manufacturer's recommendations. Unless otherwise noted, shaft shall be horizontal, with plug opening up.

2.06 BUTTERFLY VALVES

A. Manufacturers:
   1. Crane Valve Company
   2. Crispin Valve; www.crispinvalve.com
   3. Substitutions: See Section 01 60 00 - Product Requirements.

B. Butterfly valves and operators up to 72 inch diameter shall conform to AWWA C504, Class B, except as otherwise noted on the Drawings.
C. Butterfly valves for above grade shall have face to face dimensions in accordance with Table 2 of AWWA C504 Standard for short-body valve.

D. The valve body shall be constructed of close grain cast iron per ASTM A 126, Class B with integrally cast hubs for shaft bearing housings of the through boss-type. Permanently self-lubricating body bushings shall be provided and shall be sized to withstand bearing loads.

E. The valve shaft shall be of Type 316 stainless steel and designed for both torsional and shearing stresses when the valve is operated under its greatest dynamic or seating torque.

F. Butterfly valves for use with air distribution piping shall have viton seat and seals and be suitable for high temperature air service.

G. The butterfly valve operator shall conform to the requirements of AWWA C504, as applicable and as specified herein.

H. Gearing for the actuators where required shall be totally enclosed in a gear case in accordance with AWWA C504.

I. Provide gear operators for valves 8 inches and larger, and chain-wheel operators for valves mounted over 6 feet above floor.

2.07 SWING CHECK VALVES

A. Manufacturers:
   1. Val Matic
   2. Milliken
   3. Substitutions: See Section 01 60 00 - Product Requirements.

B. Swing check valves shall meet the requirements of AWWA C508.

C. Valves shall be provided with flanges in accordance with ANSI B16.1, Class 125.

D. The valve body shall be full flow equal to nominal pipe diameter at all points through the valve. The 4 inch valve shall be capable of passing a 3 inch sphere. The seating surface shall be on a 45 degree angle to minimize disc travel. A threaded port with pipe plug shall be provided on the bottom of the valve to allow for field installation of a backflow actuator, without special tools or removing the valve from the line.

E. The top access port shall be full size, allowing removal of the disc without removing the valve from the line. The access cover shall be domed in shape to provide flushing action over the disc for operating in lines containing high solids content. A threaded port with pipe plug shall be provided in the access cover to allow for field installation of a mechanical, disc position indicator.

F. The disc shall be of one-piece construction, precision molded with an integral o-ring type sealing surface, and contain alloy steel and nylon reinforcement in the flexible hinge area. The flex portion of the disc shall be warranted for twenty-five years. Non-Slam closing characteristics shall be provided through a short 35 degree disc stroke and a memory disc return action.

G. The valve disc shall be cycle tested 1,000,000 times in accordance with ANSI/AWWA C508 and show no signs of wear, cracking, or distortion to the valve disc or seat and shall remain drop tight at both high and low pressures. The test results shall be independently certified.

H. The valve body and cover shall be constructed of ASTM A536 Grade 65-45-12 ductile iron or ASTM A126 class B for 30 inches and larger. Optional body materials include ASTM A-351 Grade CF8M, stainless steel (sizes 3" through 8").

I. The exterior and interior of the valve shall be coated with an ANSI/NSF 61 approved fusion bonded epoxy coating.
J. The valves shall be iron body, bronze mounted, single disc with a 150 psi working water pressure.
   1. When there is no flow through the line, the disc shall hang lightly against its seat in practically a vertical position. When open, the disc shall swing clear of the waterway.
   2. Check valves shall have bronze seat and body rings, extended bronze hinge pins and bronze nuts on the bolts of bolted covers.
   3. Valves shall be so constructed that disc and body seat may easily be removed and replaced without removing the valve from the line.

2.08 SPLIT DISC WAFFER CHECK VALVES
   A. Split disc wafffer check valves shall be suitable for high temperature air service.
   B. Body: Ductile Iron
   C. Seat: Viton
   D. Disc: 316 Stainless Steel
   E. Shaft: 304 Stainless Steel
   F. Spring: 316 Stainless Steel
   G. Plug: 304 Stainless Steel
   H. Washer: 304 Stainless Steel

PART 3 EXECUTION

3.01 INSTALLATION
   A. General: All valves, gates, operating units, stem extensions, valve boxes, and accessories shall be installed in accordance with the manufacturer’s written instructions and as shown and specified. 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 to provide easy access for operation, removal, and maintenance and to avoid conflicts between valve operators and structural members or handrails.
   C. Valve Accessories: Where combinations of valves, sensors, switches, and controls are specified, it shall be the responsibility of the Contractor to properly assemble and install these various items so that all systems are compatible and operating properly. The relationship between interrelated items shall be clearly noted on shop drawing submittals.
   D. All valves shall be field tested following installation to demonstrate that the valve operates under field conditions in a manner consistent with the design of the system.
   E. When joining PVC pressure pipe to fittings and accessories, pipe ends shall be cut square, deburred, beveled and cleaned in accordance with pipe manufacturer's recommendations. Bevel requirements for PVC pipe bell and PVC push-on fitting joints are the same as a factory bevel. If push on or mechanical joint butterfly valves are used, PVC pipe ends shall be beveled in accordance with the valve manufacturer's installation instructions.

END OF SECTION
SECTION 40 23 41
ELASTOMERIC CHECK VALVES - FLANGED CONCENTRIC TYPE

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidentals to install and test, complete and ready for operation, six (6) elastomeric check valve(s) as shown on the Drawings and as specified herein.

1.02 SYSTEM DESCRIPTION

A. The Check Valves shall be elastomeric duckbill type constructed of fabric reinforced elastomer in accordance with the operational conditions defined within this specification section. The valve shall be installed onto the carrier pipe by means of a flanged end connection to the pipe outlet.

B. The valve shall allow forward flow through the carrier pipe and through the valve at the specified flowrate and not exceed the allowable headloss specified. When forward flow through the carrier pipe is discontinued the valve shall prevent backflow through the carrier pipe by sealing closed when hydrostatic pressure is applied to the exterior of the valve. The valve shall be capable of withstanding the specified backpressure capacity without any leakage through the valve.

C. The valve shall include a supplemental closure mechanism to maintain closure of the bill opening during zero flow and zero hydrostatic load. This mechanism shall be an integral part of the valve and be comprised of a permanently set curvature of the bill portion extending over the entire length of the bill opening. Valves not constructed of sufficient sidewall rigidity and supplemental closure mechanism to achieve this closure requirement shall not be accepted. Refer to the section on valve construction for specific requirements for design of this mechanism.

D. The valve shall be configured as a concentric type where the bottom and the top of the valve is flared equally to provide the specified bill opening to diameter ratio dimension. The valve bill opening shall be aligned exactly vertical when installed to maintain symmetrically equal loads on each side of the valve under static and dynamic operation. Valves requiring rotation of the bill opening from the vertical for installation shall not be accepted.

E. Elastomeric check valves can be fabricated for various rigidities, backpressure capacities and headloss characteristics; it is the intent of these specifications to define the operational parameters and performance requirements of the valves and that the valves are fabricated in accordance with these specifications. Submittals containing generic valve constructions with headloss characteristics outside the required operating range and/or without representative headloss data shall not be accepted. Refer to the submittal section for required documentation.

1.03 OPERATION CONDITIONS

A. The valve manufacturer shall provide within their submittal documents, as defined in these specifications, confirmation that the valves proposed will perform as required under the specified operating conditions. Refer to the submittal section for required documentation.

B. The operational conditions and valve performance requirements are as follows:

1. Anaerobic Lagoon #1 & #2 Influent Flow Splitter:
   a. Quantity: Two (2)
   b. Size: 12 inch
   c. Maximum Flow Rate: 900 gpm
   d. Max Allowable Headloss at Max Flow: 1.0 feet
   e. The valve shall be suitable for installation in in a concrete structure submerged in raw poultry wastewater and contents of the anaerobic lagoon.

2. Raw Wastewater Bypass Pipe Into Anaerobic Lagoon #3:
   a. Quantity: One (1)
Mountaire Farms of Delaware, Inc.
Millsboro, DE
Wastewater Treatment System Upgrade

b. Size: 24 inch
c. Maximum Flow Rate: 3,500 gpm
d. Max Allowable Headloss at Max Flow: 1.0 feet
e. The valve shall be suitable for installation in the wastewater anaerobic lagoon.

3. Anaerobic Lagoon #3 Pump Station Building Floor Drain:
   a. Quantity: One (1)
   b. Size: 4 inch
c. The valve shall be suitable for installation in the wastewater anaerobic lagoon.

4. Anaerobic Lagoon #3 Underdrain Pump Station Force Main:
   a. Quantity: One (1)
   b. Size: 4 inch
c. The valve shall be suitable for installation in the wastewater anaerobic lagoon.

5. Clarifier Effluent Emergency Overflow Pipe:
   a. Quantity: One (1)
   b. Size: 24 inch
c. Maximum Flow Rate: 3,500 gpm
d. Max Allowable Headloss at Max Flow: <1 feet
e. The valve shall be suitable for installation in the wastewater anaerobic lagoon.

1.04 SUBMITTAL DOCUMENTS

A. The following documents must be submitted in their entirety within one complete package; submittal packages not including all of these items will be deemed incomplete and rejected without review. The following is an itemized list of documents to be included within the submittal package:
   1. Valve Dimensional Drawing
   2. Valve Installation Orientation Drawing
   3. US Manufacturer’s Certification Document
   4. Verification of Independent Laboratory Testing for Headloss and Velocity tests of duckbill check valves.
   5. Verification of Independent Laboratory Testing for Backpressure Capacity of duckbill check valves.
   6. Verification of Independent Laboratory Testing for manufacturing consistency of duckbill check valves of the same size and construction.
   7. Verification of Finite Element Analysis (FEA) conducted.
   8. Hydraulic Curve for each size valve showing headloss versus flow, operating point and backpressure capacity.

B. The following defines the specific requirements for each submittal item:
   1. Valve Dimensional Drawing - the drawing shall be a scaled version of the actual valve, generic drawings with listed dimensions will not be accepted. Dimensions required on the drawing include the following;
      a. Overall length
      b. Cuff diameter
      c. Cuff seating depth
      d. Overall height at the bill
      e. Length of opening at the bill
      f. Orientation of the curvature at the bill and curvature angle
      g. Location of Lifting Clevis
      h. Elastomer Material used in construction
      i. Elastomer Material used on exterior layer
   2. Valve Installation Orientation Drawing - the drawing shall be a scaled version of the actual valve, generic drawings with listed dimensions will not be accepted. The drawing shall show the valve installed on the pipe from side view and front view showing the bill opening
orientation. Adjacent floor elevations and wall locations shall be shown dimensionally and graphically accurate.

3. US Manufacturer’s Certification Document - the valve manufacturer shall certify in a written document that they have a minimum of fifteen years’ experience in fabrication and installations within the United States of America for valves of the same size as required within these specifications and that the valves provided for this project were in their entirety fabricated, vulcanized and packaged within the United States of America and completely American made.

4. Verification of Independent Laboratory Testing for Headloss and Velocity - the valve manufacturer shall provide summary documentation of a report conducted by an Independent Laboratory for hydraulic testing to determine headloss and jet velocity characteristics on a representative set of duckbill valves. The testing must include multiple constructions (stiffness) within each size designated by backpressure rating and must have been conducted for free discharge (discharge to atmosphere) and submerged conditions.

5. Verification of Independent Laboratory Testing for Backpressure Capacity - the valve manufacturer shall provide summary documentation of a report conducted by an Independent Laboratory for hydraulic testing to determine the backpressure capacity of the duckbill check valves with respect to their construction designation (thickness and fabric reinforcing ratio).

6. Verification of Independent Laboratory Testing for Manufacturing Consistency - the valve manufacturer shall provide summary documentation of a report conducted by an Independent Laboratory for hydraulic testing where multiple valves (at least four) of the same size and construction (stiffness) were tested to validate the submitted headloss characteristics and to prove the repeatability and consistency of the manufacturing process to produce the same hydraulic characteristics.

7. Verification of Finite Element Analysis (FEA) - the valve manufacturer shall provide summary documentation of Finite Element Analysis modeling on representative duckbill valve sizes to determine deflection, stress and strain characteristics under various load conditions. Modeling must have been done for flowing conditions (positive differential pressure) and reverse differential pressure.

8. Hydraulic Curve - the hydraulic curve shall be developed from the testing conducted by the Independent Laboratory for headloss and backpressure characteristics. Each valve curve shall indicate the headloss versus flow, the backpressure capacity of the valve and operating point as defined within the required operating conditions defined within these specifications.

C. Certification: The Manufacturer shall provide a certification stating that they have reviewed the Drawings and Specification for this project and have verified that the applicability of the specified equipment to be provided by the Manufacturer for the intended use per the Drawings and Specifications.

1. The Manufacturer shall provide to the Engineer, as part of the certification, in writing any recommended revisions to the design based upon the Manufacturer’s review of the Specifications and Drawings.

1.05 QUALITY ASSURANCE

A. The valve manufacturer shall have a minimum of ten (10) years’ experience in fabrication and installations within the United States of America for valves of the same size as required within these specifications. The manufacturer shall provide certification that the valves provided for this project were in their entirety fabricated, vulcanized and packaged within the United States of America and completely American made. Refer to submittal documents section for required certification documentation.

B. Manufacturer shall have conducted independent hydraulic testing to determine headloss and jet velocity characteristics on a representative set of duckbill valves. The testing must include multiple constructions (stiffness) within each size designated by backpressure rating and must
have been conducted for free discharge (discharge to atmosphere) and submerged conditions. Refer to submittal documents section for required submittal documentation.

C. Manufacturer shall have conducted an independent hydraulic test where multiple valves (at least four) of the same size and construction (stiffness) were tested to validate the submitted headloss characteristics and to prove the repeatability of the manufacturing process to produce the same hydraulic characteristics. Refer to submittal documents section for required submittal documentation.

D. Manufacturer to have conducted Finite Element Analysis (FEA) on representative duckbill valve sizes to determine deflection, stress and strain characteristics under various load conditions. Modeling must have been done for flowing conditions (positive differential pressure) and reverse differential pressure. Refer to submittal documents section for required submittal documentation.

1.06 WARRANTY

A. The elastomer check valve manufacturer shall provide a one year warranty against defective workmanship and/or defective materials when properly installed, operated and serviced in accordance with the manufacturer’s recommendations and shall be effective from the date of inspection and installation approval by the manufacturer’s representative.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Tideflex Technologies / Red Valve Company, of Carnegie, PA
B. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 VALVE CONSTRUCTION

A. The valve shall be a one piece elastomer construction with internal fabric reinforcing all vulcanized into a composite material. The valve shall be equipped with an elastomeric flange as an integral part of the valve. The amount and configuration of the internal reinforcing shall be sufficient to maintain structural integrity of the valve under the specified operating conditions and allowable headloss value. The reinforcing shall extend into the flanged area to provide uniform strength across the entire valve exterior.

B. The flange drilling shall conform to ANSI B16.1 Class 125/ANSI B16.5 Class 150 standards. Each valve shall be furnished with one set of stainless steel backing rings conforming to the same ANSI flange drilling standards.

C. The valve shall be concentric type with the valve bottom and top portion of the valve angled equally from the pipe insertion point into the cuff to the top of the bill opening of the valve.

D. The valve shall be dimensionally constructed for installation onto the pipe and the bill opening being vertically aligned to maintain symmetrically equal loading on each side of the valve. Rotating the valve out of vertical alignment to avoid peripheral interferences shall not be allowed.

E. The bill opening at the valve must be at least 1.57 times the nominal pipe diameter to maintain laminar flow through the valve. Valves submitted with a bill opening below this ratio and/or utilizing expanded cuff adapters will not be accepted.

F. Valves 24” diameter and larger shall be equipped with a metallic support completely encapsulated within the top portion of the valve elastomer wall to provide additional structural support to the valve during static and dynamic operating conditions.

G. The bill portion of the valve shall be curved at a minimum of 90 degrees from the direction of flow (can be specified up to 180 degree curvature). The curvature shall be permanently set through vulcanization and shall be an integral part of the valve body. This curvature shall provide closure of the bill opening under static conditions as well as dynamic backpressure conditions during periods of zero flow.
H. The valve manufacturer’s name, manufactured location, model number and serial number shall be bonded onto the exterior of the valve.

I. A lifting clevis shall be installed at the bill end of the check valve constructed of 304L stainless steel loop and hardware for valve sizes 36” and greater.

**PART 3 EXECUTION**

**3.01 DELIVERY, STORAGE AND MATERIAL HANDLING**

A. The elastomer check valves shall be placed on a pallet with the cuff portion seated flush against the surface of the pallet and the bill portion facing upward; shipping the valve on its side in any manner will not be accepted. The manufacturer shall provide supplemental supports and bracing to the interior and/or exterior to maintain the shape and form of the valve through the packaging and shipping process. The valve shall be adequately strapped to the pallet to prevent movement while handling and moving the entire pallet assembly; strapping shall not cause deflection or deformation of the valve. The valve shall be externally covered in clear plastic static wrap prior to leaving the manufacturing facility.

B. The elastomer check valves shall be stored in a cool, dry location and remained packaged on the shipping pallets for storage periods prior to installation. Do not remove any bracing or shipping rings until the valve is to be installed. During the storage period, avoid exposure to UV light, corrosive chemicals, and concentrated noxious gases (i.e. Ozone).

C. Refer to the manufacturer’s Installation, Operation and Maintenance Manual for handling procedures of the valve during installation and proper use of lifting clevis and clamp rings.

**3.02 INSTALLATION**

A. The manufacturer shall provide a representative to assist the installation contractor on installation procedures and to conduct a site inspection of the installed unit. The manufacturer’s representative shall submit documentation to the Engineer that the valve has been installed in accordance with the manufacturer’s recommended installation procedures.

**END OF SECTION**
SECTION 40 91 10
PROCESS AND INSTRUMENTATION EQUIPMENT

PART 1 GENERAL

1.01 SCOPE OF WORK
A. Furnish all labor, materials, equipment, and incidentals to install and test, complete and ready for operation, five (5) dissolved oxygen meter(s), four (4) pH meter(s), and three (3) ORP meter(s), as shown on the Drawings and as specified herein.

1.02 SYSTEM DESCRIPTION
A. The Dissolved Oxygen Meters shall be provided for continuous on-line measurement of dissolved oxygen in wastewater within a range of 0-15 mg/L in the activated sludge reactor tanks.
B. The pH/ORP Meters shall be provided for continuous on-line measurement of the pH and ORP in wastewater in the activated sludge reactor tanks.

1.03 DESIGN REQUIREMENTS
A. Controllers (Signal Process Controllers):
   1. Quantity: Seven (7)
      a. Anoxic Reactor #1
      b. Anoxic Reactor #1
      c. Nitrification Reactor #2
      d. Anoxic Reactor #3 (Influent)
      e. Anoxic Reactor #3 (Influent)
      f. Anoxic Reactor #3 (Middle)
      g. Anoxic Reactor #3 (Middle)
      h. The manufacturer shall review the Drawings and determine if additional controllers are required. IF additional controllers are required they shall be supplied at no additional cost to the Owner.
   2. Current Output: 4-20 mA (per sensor)
   3. Enclosure: NEMA 4X Pipe Mount with Sun screen
   4. Power Supply: 120 Vac
   5. Light Emitting Diode (LED) Readout: 4 digits
   6. Capable of connecting a minimum of 2 sensors

B. Dissolved Oxygen Sensors:
   1. Quantity: Five (5)
   2. Locations:
      a. Anoxic Reactor #1 (I-393)
      b. Nitrification Reactor #2 (I-492)
      c. Anoxic Reactor #3 (I-593)
      d. Anoxic Reactor #3 (I-596)
      e. Aerobic Reactor #4 (I-598)
   3. Measuring Electrode: Gold
   4. Isolated Reference Electrode: Silver
   5. Auxiliary Electrode: Silver
   6. Test Electrode: Gold
   7. Automatic Temperature Compensation
   8. Cable Length: 30 Feet (min.)
   9. Material: 316 Stainless Steel Body
   10. Mounting Type: Rigid Support
   11. Performance Requirements
      a. Measurement range: 0.01 to 20.00 mg/L
      b. Resolution: 0.01 mg/L
c. **Accuracy**
   1) Less than 5 ppm: ± 0.1 ppm
   2) Greater than 5 ppm: ± 0.2 ppm

d. **Repeatability:** ± 0.1 ppm

e. **Response Time:**
   1) Less than 40 seconds to 90% at 20 °C
   2) Less than 60 seconds to 95% at 20 °C

f. **Temperature sensor:** PT100 integrated, external sensor

g. **Temperature range:** 0 to 50 °C

h. **Temperature accuracy:** ± 0.2°C

C. **ORP Sensors:**
   1. **Quantity:** Three (3)
   2. **Locations:**
      a. Anoxic Reactor #1 (I-392)
      b. Anoxic Reactor #3 (I-592)
      c. Anoxic Reactor #3 (I-595)
   3. **ORP Electrode Type:** Platinum
   4. **ORP Range:** +/- 2000mv
   5. **Temperature Range:** 20 to 175 degrees Fahrenheit
   6. **Maximum Pressure:** 100 psi
   7. **Cable Length:** 30 Feet (min.)
   8. **Integral preamplifier**
   9. **Automatic Temperature Compensation (ATC).**
   10. **Mounting Type:** Rigid Support

D. **pH Sensors:**
   1. **Quantity:** Four (4)
   2. **Locations:**
      a. Anoxic Reactor #1 (I-394)
      b. Nitrification Reactor #2 (I-493)
      c. Anoxic Reactor #3 (I-594)
      d. Anoxic Reactor #3 (I-597)
   3. **pH Electrode Type:** Spherical Glass
   4. **pH Range:** 2 to 12
   5. **Temperature Range:** 20 to 175 degrees Fahrenheit
   6. **Maximum Pressure:** 100 psi
   7. **Cable Length:** 30 Feet (min.)
   8. **Integral preamplifier**
   9. **Automatic Temperature Compensation (ATC).**
   10. **Mounting Type:** Rigid Support

1.04 **SUBMITTALS**

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. **Product Data:** Provide manufacturer's data and installation instructions.

C. **Shop Drawings:** Indicate mounting and wiring details.

D. **Certificates:** Certify that products of this section meet or exceed specified requirements.

E. **Operation and Maintenance Data:** calibration requirements and procedures, routine cleaning and maintenance requirements for proper operation.

F. **Warranty:** Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

G. The manufacturer shall clearly identify any exception to this Section, related sections, or the Drawings. Failure to do this shall be grounds for rejection of the submittal.

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Prepared by Reid Engineering Co., Inc. 40 91 10- 2 Technical Specifications
February 5, 2020 DNREC Re-Submission
H. Certification: The Manufacturer shall provide a certification stating that they have reviewed the Drawings and Specification for this project and have verified that the applicability of the specified equipment to be provided by the Manufacturer for the intended use per the Drawings and Specifications.

1. The Manufacturer shall provide to the Engineer, as part of the certification, in writing any recommended revisions to the design based upon the Manufacturer's review of the Specifications and Drawings.

1.05 DELIVERY, STORAGE, AND PROTECTION

A. In accordance with manufacturer's instructions and Section 01 60 00 - Product Requirements for additional provisions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Hach
B. Endress-Hauser
C. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 DO SENSOR

A. Sensor housing shall be 316 stainless steel.
B. Sensor shall plug into the controller. The sensor shall have built-in self-identity logic so controller acknowledges sensors identity and calibration points which are stored in the sensors memory.
C. Sensor to air calibrate over bucket of water to match saturated air solubility chart.
D. Sensor shall have three (3) flushing nozzles which can be used with flushing solenoid valve assembly. Flushing media can be 60 psig air or water.
E. Electrode shall be designed to operate at least 12 months at 3-5 mg/L operation between replacement and should not require recalibration more than once every 6 months.

2.03 CONTROLLERS

A. Microprocessor-based sensor controller.
B. Change digital sensors connected to the controller by unplugging and plugging sensors as necessary.
C. Change analog sensors modules connected to the controller by unplugging and plugging analog sensor modules as necessary.
D. The controller uses a menu-driven operation system.
E. The controller display is graphic dot matrix LCD with LED backlighting.
F. The controller is equipped with a real-time clock.
G. The controller is equipped with two security levels.
H. The controller is equipped with a data logger with RS-232 capability.
I. The controller is equipped with an SD card reader for data download and controller software upload.
J. Four electromechanical, UL rated, SPDT relays (Form C) are provided for user-configurable contacts rated 100 to 230 Vac, 5 Amp at 30 Vdc resistive maximum.
1. The following can be programmed:
   a. Alarm
   b. Warning
   c. Timer/scheduled cleaning
   d. Feeder control
   e. Event control
   f. Pulse width modulation
g. Frequency modulation

2. The following can be assigned:
   a. Primary value measurement I
   b. Secondary value measurement I
   c. 3rd value measurement I
   d. 4th value measurement I
   e. Primary value Measurement II
   f. Secondary value measurement II
   g. 3rd value measurement II
   h. 4th value measurement II
   i. Real time clock
   j. Calculated values

K. Two analog 0/4-20 mA outputs are provided with a maximum impedance of 500 ohms.
   1. The following can be programmed:
      a. Alarms:
         1) Low alarm point
         2) Low alarm point deadband
         3) High alarm point
         4) High alarm point deadband
         5) Off delay
         6) On delay
      b. Controls:
         1) Linear
         2) Bi-linear
         3) Logarithmic
         4) PID
   2. The following can be assigned:
      a. Primary value measurement I
      b. Secondary value measurement I
      c. 3rd value measurement I
      d. 4th value measurement I
      e. Primary value measurement II
      f. Secondary value measurement II
      g. 3rd value measurement II
      h. 4th value measurement II
      i. Calculated values

L. The controller can be equipped with four additional 4-20 mA outputs with a maximum impedance of 500 ohms.

M. The controller can be equipped with the following forms of communication:
   1. MODBUS RS-232
   2. MODBUS RS-485
   3. Profibus DP

N. All user settings of the controller are retained for 10 years in flash memory.

O. The controller is equipped with a system check for:
   1. Power up test (monitoring and shutdown)
   2. Total power draw
   3. Memory devices
   4. Temperature mother board
2.04 ACCESSORIES
   A. Provide a AC Power / Signal protection device between all transmitters and PLC Control Panels for lightning and surge suppression for AC power and low voltage signal lines.
      1. Enclosure shall be a NEMA 4X polycarbonate case
      2. Input Voltage: 120VAC / 60 Hz
      3. Power "ON" indicator
      4. 15 Amp replaceable fuse
      5. UL Rated

PART 3 EXECUTION
3.01 INSTALLATION
   A. Install in accordance with manufacturer's instructions.

3.02 INTERFACE WITH OTHER WORK
   A. Signal converter shall send 4-20 mA signal to PLC.

3.03 STARTING EQUIPMENT
   A. Provide manufacturer's field representative to prepare and start equipment.
   B. Adjust for proper operation within manufacturer's published tolerances.
   C. Demonstrate proper operation of equipment to Owner's designated representative.

END OF SECTION
SECTION 40 91 20
MAGNETIC FLOW METERS

PART 1 GENERAL

1.01 SCOPE OF WORK
A. Furnish all labor, materials, equipment, and incidentals to install and test, complete and ready for operation, thirteen (13) magnetic flow meter(s) as shown on the Drawings and as specified herein.

1.02 RELATED SECTIONS
A. Division 26 - Electrical

1.03 SYSTEM DESCRIPTION
A. The process fluid to be measured will be raw, partially treated, and treated Poultry Processing and Sanitary wastewater.
B. Fluid temperature will range from 5 degrees C to 45 degrees C

1.04 DESIGN REQUIREMENTS
A. Anaerobic Lagoon #1 & #2 Eff. PS Flow Meter (I-181):
   1. Quantity:  One (1)
   2. Size: 16 inch
   3. Liner Material: Teflone
   4. Process Connection: Flange ANSI Class 150
   5. Flange Material: Carbon Steel
   6. Electrode Material: AISI 316 Ti (316 SS)
   7. Enclosure: NEMA 6 (10 feet of water for 72 hours)
   8. Transmitter Electronics: Remote mounted with cable to sensor
   9. Flow range: 700 - 6,000 gpm
   10. Flow Indicators: Digital flow indicator (gpm) and totalizer (gallons).
   11. The flow meter manufacturer shall verify that the flow meter to be provided is suitable for the minimum upstream and downstream straight pipe lengths provided in the design Drawings.

B. Short Circuit Pump Station Flow Meter (I-182):
   1. Quantity:  One (1)
   2. Size: 8 inch
   3. Liner Material: Teflone
   4. Process Connection: Flange ANSI Class 150
   5. Flange Material: Carbon Steel
   6. Electrode Material: AISI 316 Ti (316 SS)
   7. Enclosure: NEMA 6 (10 feet of water for 72 hours)
   8. Transmitter Electronics: Remote mounted with cable to sensor
   9. Flow range: 150 - 1,400 gpm
   10. Flow Indicators: Digital flow indicator (gpm) and totalizer (gallons).
   11. The flow meter manufacturer shall verify that the flow meter to be provided is suitable for the minimum upstream and downstream straight pipe lengths provided in the design Drawings.

C. Anaerobic Lagoon Eff. Pump Station Flow Meter (I-281):
   1. Quantity:  One (1)
   2. Size: 14 inch
   3. Liner Material: Teflone
   4. Process Connection: Flange ANSI Class 150
   5. Flange Material: Carbon Steel
   6. Electrode Material: AISI 316 Ti (316 SS)
7. Enclosure: NEMA 6 (10 feet of water for 72 hours)
8. Transmitter Electronics: Remote mounted with cable to sensor
9. Flow range: 500 - 4,000 gpm
10. Flow Indicators: Digital flow indicator (gpm) and totalizer (gallons).
11. The flow meter manufacturer shall verify that the flow meter to be provided is suitable for the minimum upstream and downstream straight pipe lengths provided in the design Drawings.

D. Nitrate Recycle Pump Station Flow Meter (I-481):
1. Quantity: One (1)
2. Size: 20 inch
3. Liner Material: Teflone
4. Process Connection: Flange ANSI Class 150
5. Flange Material: Carbon Steel
6. Electrode Material: AISI 316 Ti (316 SS)
7. Enclosure: NEMA 6 (10 feet of water for 72 hours)
8. Transmitter Electronics: Remote mounted with cable to sensor
9. Flow range: 1,400 - 13,000 gpm
10. Flow Indicators: Digital flow indicator (gpm) and totalizer (gallons).
11. The flow meter manufacturer shall verify that the flow meter to be provided is suitable for the minimum upstream and downstream straight pipe lengths provided in the design Drawings.

E. Clarifier Flocc Tank Flow Meter (I-681 & 682):
1. Quantity: Two (2)
2. Size: 24 inch
3. Liner Material: Teflone
4. Process Connection: Flange ANSI Class 150
5. Flange Material: Carbon Steel
6. Electrode Material: AISI 316 Ti (316 SS)
7. Enclosure: NEMA 6 (10 feet of water for 72 hours)
8. Transmitter Electronics: Remote mounted with cable to sensor
9. Flow range: 1,400 - 11,000 gpm
10. Flow Indicators: Digital flow indicator (gpm) and totalizer (gallons).
11. The flow meter manufacturer shall verify that the flow meter to be provided is suitable for the minimum upstream and downstream straight pipe lengths provided in the design Drawings.

F. Return Activated Sludge (RAS) Pump Station Flow Meter (I-781 & 782):
1. Quantity: Two (2)
2. Size: 12 inch
3. Liner Material: Teflone
4. Process Connection: Flange ANSI Class 150
5. Flange Material: Carbon Steel
6. Electrode Material: AISI 316 Ti (316 SS)
7. Enclosure: NEMA 6 (10 feet of water for 72 hours)
8. Transmitter Electronics: Remote mounted with cable to sensor
10. Flow Indicators: Digital flow indicator (gpm) and totalizer (gallons).
11. The flow meter manufacturer shall verify that the flow meter to be provided is suitable for the minimum upstream and downstream straight pipe lengths provided in the design Drawings.

G. Waste Activated Sludge Pump Station Flow Meter (I-783):
1. Quantity: One (1)
2. Size: 4 inch
3. Liner Material: Teflone
4. Process Connection: Flange ANSI Class 150
5. Flange Material: Carbon Steel
6. Electrode Material: AISI 316 Ti (316 SS)
7. Enclosure: NEMA 6 (10 feet of water for 72 hours)
8. Transmitter Electronics: Remote mounted with cable to sensor
9. Flow range: 40 - 300 gpm
10. Flow Indicators: Digital flow indicator (gpm) and totalizer (gallons).

H. Filter Influent Pump Station Flow Meter (I-784):
1. Quantity: One (1)
2. Size: 14 inch
3. Liner Material: Teflone
4. Process Connection: Flange ANSI Class 150
5. Flange Material: Carbon Steel
6. Electrode Material: AISI 316 Ti (316 SS)
7. Enclosure: NEMA 6 (10 feet of water for 72 hours)
8. Transmitter Electronics: Remote mounted with cable to sensor
9. Flow range: 500 - 4,000 gpm
10. Flow Indicators: Digital flow indicator (gpm) and totalizer (gallons).
11. The flow meter manufacturer shall verify that the flow meter to be provided is suitable for the minimum upstream and downstream straight pipe lengths provided in the design Drawings.

I. WAS Aerobic Digester #1 Transfer Pump Station Flow Meter (I-1181):
1. Quantity: One (1)
2. Size: 6 inch
3. Liner Material: Teflone
4. Process Connection: Flange ANSI Class 150
5. Flange Material: Carbon Steel
6. Electrode Material: AISI 316 Ti (316 SS)
7. Enclosure: NEMA 6 (10 feet of water for 72 hours)
8. Transmitter Electronics: Remote mounted with cable to sensor
9. Flow range: 100 - 500 gpm
10. Flow Indicators: Digital flow indicator (gpm) and totalizer (gallons).
11. The flow meter manufacturer shall verify that the flow meter to be provided is suitable for the minimum upstream and downstream straight pipe lengths provided in the design Drawings.

J. WAS Aerobic Digester #2 & #3 Pump Station Flow Meter (I-1281):
1. Quantity: One (1)
2. Size: 6 inch
3. Liner Material: Teflone
4. Process Connection: Flange ANSI Class 150
5. Flange Material: Carbon Steel
6. Electrode Material: AISI 316 Ti (316 SS)
7. Enclosure: NEMA 6 (10 feet of water for 72 hours)
8. Transmitter Electronics: Remote mounted with cable to sensor
9. Flow range: 100 - 500 gpm
10. Flow Indicators: Digital flow indicator (gpm) and totalizer (gallons).
11. The flow meter manufacturer shall verify that the flow meter to be provided is suitable for the minimum upstream and downstream straight pipe lengths provided in the design Drawings.
1.05 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Submit product data, including Manufacturer's data, for specified products. Include the following:
   1. Manufacturer's outline and mounting dimensions for all flow meters.
   2. Manufacturer's wiring diagrams, including field connections.
   3. Mounting Details.
   4. All equipment to be furnished under this Section must be approved prior to being released for manufacturing unless otherwise noted by the Engineer.
C. Certification: The Manufacturer shall provide a certification stating that they have reviewed the Drawings and Specification for this project and have verified that the applicability of the specified equipment to be provided by the Manufacturer for the intended use per the Drawings and Specifications.
   1. The Manufacturer shall provide to the Engineer, as part of the certification, in writing any recommended revisions to the design based upon the Manufacturer's review of the Specifications and Drawings.

1.06 QUALITY ASSURANCE
A. The flow meters covered by this Section are intended to be standard equipment, as modified by this Section, of proven ability, as manufactured by a single manufacturer, having long experience in the production of such flow meters. The flow meters furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and specified herein.
B. In the event that equipment which differs from this Section be offered and determined to be equal to that specified, such equipment shall be acceptable only on the basis that any revisions in the design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc. required to accommodate such a substitution shall be made at no cost to the Owner and be as approved by the Engineer.

1.07 DELIVERY, STORAGE, AND PROTECTION
A. In accordance with Section 01 60 00.

1.08 WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS
2.01 MANUFACTURERS
A. Rosemont
B. ABB
C. Sparling Instrument Co., Inc.
D. Endress Hauser
E. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 GENERAL
A. The magnetic flowmeter shall utilize characterized electromagnetic induction to produce a voltage linearly proportional to the average flow rate. The metering system shall consist of a sensor with field coils, transmitter and interconnecting cables to make a complete operating flow metering system. The meter shall be of the bi-polar pulsed dc type with continuous automatic zeroing.

2.03 CONSTRUCTION
A. The sensor shall be a flanged tube with non-conductive liner. The tube shall be constructed of Type 304 stainless steel with carbon steel flanges AWWA Class D if the coils are external to the tube. If the coils are encapsulated inside the tube, the tube and flanges may be of carbon
steel. Sensor rating shall be NEMA-4 and capable of withstanding accidental submergence in water. The power supply shall be 120-volt AC, 60 Hz. Power consumption shall not exceed 42 watts regardless of size. Accuracy of the flowmeter system shall be 0.5 percent of rate from 10 to 100 percent of scale. Below 1 full percentage scale [fps] it shall be 0.1 percent of full scale. Repeatability shall be 0.1 percent of rate. Liner material shall be neoprene or teflon. External surfaces shall be factory-finished with a corrosion resistant coating. The specific conductivity of the liquid shall not preclude meter operation.

2.04 COMPONENTS

A. Output: 4-20 mA DC into 800 ohms, isolated, standard
B. Adjustments: Calibration, Sensitivity, Damping, mA zero and span.
C. Linearity: plus or minus 0.5% full span
D. Repeatability: plus or minus 0.1% full span
E. Accuracy: Within plus or minus 2.0% full span
F. Signal Strength Meter: Analog type standard
G. Transducer: Single twin-crystal transducer with 20 feet armored flexible cable.
H. Standard Transducer Temperature Range: -300 degrees F to 320 degrees F.
I. Transmitter Temperature Range: -10 degrees F to 140 degrees F.
J. Power Requirements: 120 Volts, 60 Hz.
K. Transmitter Housing: NEMA 4X thermoplastic standard.
M. Internal Frequency Standard: Calibration assured by on-board frequency reference.
N. Grounding: Grounding rings or electrodes of the same material as the sensing electrodes shall be furnished mounted in each end of all meters one inch and larger in size. Provide grounding strap between adjacent pipe, grounding rings and flow tube, unless adjacent pipe is either non-conductive or lined with non-conductive materials, in which case provide grounding string between the rings and tube only. If grounding electrodes are provided, grounding rings shall also be provided for liner protection.
O. Transmitter: The transmitter shall be either meter and/or remote mounted as indicated on the Drawings and as specified in paragraph 1.04 Design Requirements. If the transmitter is remote mounted, the interconnecting cable shall be furnished by the manufacturer of the metering system. Remote transmitters shall be housed in NEMA-4X enclosures suitable for wall mounting. The transmitter shall produce a 4-20 mA dc output signal into a minimum load of 800 ohms linear to flow, and a scaled pulse when called for above for totalization.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer’s instructions and recommendations in the locations shown on the Drawings and as specified herein.

3.02 FIELD QUALITY CONTROL

A. Perform field inspection and testing in accordance with Section 01 40 00.
B. Each flow meter shall be tested prior to shipment and the documentation of the test shall be submitted with O & M Manual for the flow meters.
C. The services of a factory trained representative shall be provided for a total of two (2) days of testing and calibration of the flow meters.

END OF SECTION
SECTION 40 91 30
ULTRASONIC LEVEL SENSOR

PART 1 GENERAL

1.01 SCOPE OF WORK
A. Furnish all labor, materials, equipment, and incidentals to install and test, complete and ready
   for operation, one (1) Ultrasonic level sensors and transmitters as shown on the Drawings and
   as specified herein.

1.02 RELATED SECTIONS
A. Section 40 91 41 - Parshall Flumes

1.03 SYSTEM DESCRIPTION
A. The process fluid to be measured will be treated wastewater treatment system effluent.
B. Fluid temperature will range from 5 degrees C to 35 degrees C
C. The percent solids by weight of the fluid will range from 0.2 percent to 1.5 percent.

1.04 DESIGN REQUIREMENTS
A. Final Effluent Parshall Flume Flow Meter:
   1. Quantity: One (1)
   2. Designed for measuring effluent flow through a 9" Parshall Flume.
   3. Nominal Flow range: 0 - 3,500 gpm
   4. Flow Indicators: Digital flow indicator (gpm) and totalizer (gallons).

1.05 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Submit product data, including Manufacturer's data, for specified products.
   Include the following:
   1. Manufacturer's outline and mounting dimensions for all flow meters.
   2. Manufacturer's wiring diagrams, including field connections.
   3. Mounting Details.
   4. All equipment to be furnished under this Section must be approved prior to being released
      for manufacturing unless otherwise noted by the Engineer.
C. The manufacturer shall clearly identify any exception to this Section, related sections, or the
   Drawings. Failure to do this shall be grounds for rejection of the submittal.
D. Certification: The Manufacturer shall provide a certification stating that they have reviewed the
   Drawings and Specification for this project and have verified that the applicability of the
   specified equipment to be provided by the Manufacturer for the intended use per the Drawings
   and Specifications.
   1. The Manufacturer shall provide to the Engineer, as part of the certification, in writing any
      recommended revisions to the design based upon the Manufacturers review of the
      Specifications and Drawings.

1.06 QUALITY ASSURANCE
A. The flow meters covered by this Section are intended to be standard equipment, as modified by
   this Section, of proven ability, as manufactured by a single manufacturer, having long
   experience in the production of such flow meters. The flow meters furnished shall be designed,
   constructed, and installed in accordance with the best practices and methods and shall operate
   satisfactorily when installed as shown on the Drawings and specified herein.
B. In the event that equipment which differs from this Section be offered and determined to be
   equal to that specified, such equipment shall be acceptable only on the basis that any revisions
   in the design and/or construction of the structure, piping, appurtenant equipment, electrical
   work, etc. required to accommodate such a substitution shall be made at no cost to the Owner
   and be as approved by the Engineer.
1.07 DELIVERY, STORAGE, AND PROTECTION
   A. In accordance with Section 01 60 00.

1.08 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Siemens
   B. Endress-Hauser
   C. Rosemount

2.02 COMPONENTS
   A. Sensor:
      1. Type:
         a. The transducer shall generate an ultrasonic signal and receive an echo from the liquid surface.
      2. Operation/Function:
         a. The sensor shall be potted/encapsulated in a chemical and corrosion resistant PVC or CPVC housing. Sensors shall be capable of being completely submerged without damage.
         b. Temperature Limits: -5 degrees F to +120 degrees F.
         c. Relative Humidity: 0 to 100%.
         d. The sensor shall be provided with automatic air temperature and density compensation.
      3. Physical:
         a. Sensors located in areas where freezing condensation may occur shall be provided with special heaters or other type of transducer protection designed to prevent sensor icing.
         b. Sensors shall be suitable for surface, pipe, or flange mounting as indicated on the Drawings.
         c. The supplier shall be responsible for coordinating all sensor mounting requirements and shall furnish dimensional and elevational drawings to ensure proper and satisfactory installation.
   B. Transmitter:
      1. Type:
         a. Microprocessor based device which converts the sensor output signal to a flow output in gallons per minute, as well as, totalize flow in gallons for flow meters and liquid level in feet for level indication.
      2. Function/Performance:
         a. Temperature Limits: -5 degrees F to +120 degrees F.
         b. Accuracy: Shall be plus or minus 0.25 percent for the transducer and converter.
         c. Transmitter shall ignore momentary loss-of-echo signals.
         d. Output: Isolated 4-20 mA linear to gallons per minute.
         e. Power Requirements: 120 Volt/60 Hz
         f. Display: 4 digit 18 mm LCD, scaled to read in gallons per minute and total flow in gallons.
         g. All required device programming interface equipment is to be provided.
      3. Physical:
         a. Provide NEMA 4X enclosure.
         b. Provide sensor interconnecting cable between sensor and transmitter.
PART 3 EXECUTION

3.01 INSTALLATION
   A. Install in accordance with manufacturer's instructions and recommendations in the locations shown on the Drawings and as specified herein.

3.02 FIELD QUALITY CONTROL
   A. Each flow meter shall be tested prior to shipment and the documentation of the test shall be submitted with O & M Manual for the flow meters.
   B. The services of a factory trained representative shall be provided for a total of one (1) day of testing and calibration of the flow meters.

END OF SECTION
PART 1 GENERAL

1.01 SCOPE OF WORK
   A. Furnish all labor, materials, equipment, and incidentals to install and test, complete and ready for operation, thirteen (13) radar level sensors and transmitters as shown on the Drawings and as specified herein.

1.02 RELATED SECTIONS
   A. Division 26 - Electrical

1.03 SYSTEM DESCRIPTION
   A. The process fluid to be measured will be raw, partially treated, and treated Poultry Processing and Sanitary wastewater.
   B. Fluid temperature will range from 5 degrees C to 35 degrees C

1.04 DESIGN REQUIREMENTS
   A. Anaerobic Lagoon #1 & #2 Effluent Pump Station Wet Well Level Sensor (I-191):
      1. Quantity: One (1)
      2. Designed for measuring the liquid level in the AL #1 & #2 Eff. Pump Station wet well as specified here.
      3. Level range:
         a. Top 11.5 feet above Bottom (approx. Mounting Elevation)
         b. Normal High Water Level: 9.5 feet above Bottom
         c. Normal Low Water Level: 6.5 feet above Bottom
      4. Contractor shall verify with the Manufacturer that proper blanking distance is available based on proposed mounting location and support system.
      5. Indicators: Digital level indicator (feet).
      6. Pump Control Function:
         a. Low Water Level - All Pumps Off/Alarm
         b. Lead Pump Off
         c. Lag Pump Off
         d. Operating Range - Pump speed will be automatically adjusted to maintain set liquid level
         e. Lead Pump On
         f. Lag Pump On
         g. High Water Level - High Water Level Alarm
   B. Anaerobic Lagoon #3 Effluent Pump Station Wet Well Level Sensor (I-291):
      1. Quantity: One (1)
      2. Designed for measuring the liquid level in the Anaerobic Lagoon #3 as specified here.
      3. Level range:
         a. Normal High Water Level: 3.0 feet below Top of Berm
         b. Normal Low Water Level: 7.0 feet below Top of Berm
      4. Level sensor shall be mounted on a ridged support arm that can rotate to access the level sensor from the berm. Sufficient cable length shall be provided to allow proper rotation of the support arm. The support arm shall be of sufficient length to allow proper measurement to the normal low water level. Refer to Drawings to determine support arm length as a function of the lagoon side slope angle.
      5. Contractor shall verify with the Manufacturer that proper blanking distance is available based on proposed mounting location and support system.
      6. Indicators: Digital level indicator (feet).
      7. Pump Control Function:
         a. Low Water Level - All Pumps Off/Alarm
C. Anoxic Reactor #1 Level Sensor (I-391):
   1. Quantity: One (1)
   2. Designed for measuring the liquid level in the Anoxic Reactor #1 as specified here.
   3. Level range:
      a. Top 30 feet above Bottom (approx. Mounting Elevation)
      b. Normal High Water Level: 28 feet above Bottom
   4. Contractor shall verify with the Manufacturer that proper blanking distance is available based on proposed mounting location and support system.
   5. Indicators: Digital level indicator (feet).
   6. Control Function:
      a. High Water Level - High Water Level Alarm

D. Nitrification Reactor #2 Level Sensor (I-491):
   1. Quantity: One (1)
   2. Designed for measuring the liquid level in the Nitrification Reactor #2 as specified here.
   3. Level range:
      a. Top 28 feet above Bottom (approx. Mounting Elevation)
      b. Normal High Water Level: 26 feet above Bottom
   4. Contractor shall verify with the Manufacturer that proper blanking distance is available based on proposed mounting location and support system.
   5. Indicators: Digital level indicator (feet).
   6. Control Function:
      a. High Water Level - High Water Level Alarm

E. Anoxic Reactor #3 Level Sensor (I-591):
   1. Quantity: One (1)
   2. Designed for measuring the liquid level in the Anoxic Reactor #3 as specified here.
   3. Level range:
      a. Top 23.5 feet above Bottom (approx. Mounting Elevation)
      b. Normal High Water Level: 20.5 feet above Bottom
   4. Contractor shall verify with the Manufacturer that proper blanking distance is available based on proposed mounting location and support system.
   5. Indicators: Digital level indicator (feet).
   6. Control Function:
      a. High Water Level - High Water Level Alarm

F. Clarifier Influent Flocculation Tank Level Sensor (I-691):
   1. Quantity: One (1)
   2. Designed for measuring the liquid level in the Clarifier Influent Flocculation Tank as specified here.
   3. Level range:
      a. Top 17.0 feet above Bottom (approx. Mounting Elevation)
      b. Normal High Water Level: 14.0 feet above Bottom
      c. Normal Low Water Level: 9.5 feet above Bottom
   4. Contractor shall verify with the Manufacturer that proper blanking distance is available based on proposed mounting location and support system.
   5. Indicators: Digital level indicator (feet).
   6. Control Function:
      a. High Water Level - High Water Level Alarm

G. Filter Influent Pump Station Level Sensor (I-791):
   1. Quantity: One (1)
2. Designed for measuring the liquid level in the Filter Influent Pump Station wet well as specified here.
3. Level range:
   a. Top 18.7 feet above Bottom (approx. Mounting Elevation)
   b. Normal High Water Level: 8.0 feet above Bottom
   c. Normal Low Water Level: 1.0 feet above Bottom
4. Contractor shall verify with the Manufacturer that proper blanking distance is available based on proposed mounting location and support system.
5. Contractor shall verify that the dimensions of the proposed wet well will not interfere with the Radar Level Sensor at low water level. If additional appurtenances are required the Contractor shall provide them at no additional cost to the Owner.
6. Indicators: Digital level indicator (feet).
7. Pump Control Function:
   a. Low Water Level - All Pumps Off/Alarm
   b. Lead Pump Off
   c. Lag Pump Off
   d. Operating Range - Pump speed will be automatically adjusted to maintain set liquid level
   e. Lead Pump On
   f. Lag Pump On
   g. High Water Level - High Water Level Alarm

H. Plant Site Pump Station #1 Level Sensor (I-991):
1. Quantity: One (1)
2. Designed for measuring the liquid level in the Plant Site Pump Station #1 wet well as specified here.
3. Level range:
   a. Top 12.5 feet above Bottom (approx. Mounting Elevation)
   b. Normal High Water Level: 7.0 feet above Bottom
   c. Normal Low Water Level: 2.0 feet above Bottom
4. Contractor shall verify with the Manufacturer that proper blanking distance is available based on proposed mounting location and support system.
5. Contractor shall verify that the dimensions of the proposed wet well will not interfere with the Radar Level Sensor at low water level. If additional appurtenances are required the Contractor shall provide them at no additional cost to the Owner.
6. Indicators: Digital level indicator (feet).
7. Pump Control Function:
   a. Low Water Level - All Pumps Off/Alarm
   b. Lead Pump Off
   c. Lag Pump Off
   d. Operating Range - Pump speed will be automatically adjusted to maintain set liquid level
   e. Lead Pump On
   f. Lag Pump On
   g. High Water Level - High Water Level Alarm

I. Plant Site Pump Station #2 Level Sensor (I-1091):
1. Quantity: One (1)
2. Designed for measuring the liquid level in the Plant Site Pump Station #2 Pump Station wet well as specified here.
3. Level range:
   a. Top 12.0 feet above Bottom (approx. Mounting Elevation)
   b. Normal High Water Level: 8.0 feet above Bottom
   c. Normal Low Water Level: 2.0 feet above Bottom
4. Contractor shall verify with the Manufacturer that proper blanking distance is available based on proposed mounting location and support system.
5. Contractor shall verify that the dimensions of the proposed wet well will not interfere with the Radar Level Sensor at low water level. If additional appurtenances are required the Contractor shall provide them at no additional cost to the Owner.
6. Indicators: Digital level indicator (feet).
7. Pump Control Function:
   a. Low Water Level - All Pumps Off/Alarm
   b. Lead Pump Off
   c. Lag Pump Off
   d. Operating Range - Pump speed will be automatically adjusted to maintain set liquid level
   e. Lead Pump On
   f. Lag Pump On
   g. High Water Level - High Water Level Alarm

J. WAS Aerobic Digester #1 Level Sensor (I-1191):
   1. Quantity: One (1)
   2. Designed for measuring the liquid level in the WAS Aerobic Digesters #2 & #3 as specified here.
   3. Level range:
      a. Top 10.0 feet above Bottom (approx. Mounting Elevation)
      b. Normal High Water Level: 8.0 feet above Bottom
      c. Normal Low Water Level: 6.0 feet above Bottom
   4. Contractor shall verify with the Manufacturer that proper blanking distance is available based on proposed mounting location and support system.
   5. Indicators: Digital level indicator (feet).
   6. Pump Control Function:
      a. Low Water Level - All Pumps Off/Alarm
      b. High Water Level - High Water Level Alarm

K. WAS Aerobic Digester #2 & #3 Level Sensor (I-1291 & 1293):
   1. Quantity: Two (2)
   2. Designed for measuring the liquid level in the WAS Aerobic Digesters #2 & #3 as specified here.
   3. Level range:
      a. Top 11.0 feet above Bottom (approx. Mounting Elevation)
      b. Normal High Water Level: 9.0 feet above Bottom
      c. Normal Low Water Level: 2.0 feet above Bottom
   4. Contractor shall verify with the Manufacturer that proper blanking distance is available based on proposed mounting location and support system.
   5. Indicators: Digital level indicator (feet).
   6. Pump Control Function:
      a. Low Water Level - All Pumps Off/Alarm
      b. High Water Level - High Water Level Alarm

L. Sludge Dewatering Influent Tank Level Sensor (I-1391):
   1. Quantity: One (1)
   2. Designed for measuring the liquid level in the Sludge Dewatering Influent Tank as specified here.
   3. Level range:
      a. Top 6.92 feet above Bottom (approx. Mounting Elevation)
      b. Normal High Water Level: 6.0 feet above Bottom
      c. Normal Low Water Level: 2.0 feet above Bottom
   4. Tank: 10.0 feet diameter, polyethylene or FRP
5. Contractor shall verify with the Manufacturer that proper blanking distance is available based on proposed mounting location and support system. If sufficient blank distance is not provided the Contractor shall provide additional mounting brackets and supports.

6. Indicators: Digital level indicator (feet).

7. The level sensor shall control the pumping rate of the WAS Aerobic Digester #2 & #3 Pump Station and the Screw Press Influent Pump Station

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Submit product data, including Manufacturer's data, for specified products. Include the following:
   1. Manufacturer's wiring diagrams, including field connections.
   2. Mounting Details.
   3. All equipment to be furnished under this Section must be approved prior to being released for manufacturing unless otherwise noted by the Engineer.

C. The manufacturer shall clearly identify any exception to this Section, related sections, or the Drawings. Failure to do this shall be grounds for rejection of the submittal.

D. Certification: The Manufacturer shall provide a certification stating that they have reviewed the Drawings and Specification for this project and have verified that the applicability of the specified equipment to be provided by the Manufacturer for the intended use per the Drawings and Specifications.
   1. The Manufacturer shall provide to the Engineer, as part of the certification, in writing any recommended revisions to the design based upon the Manufacturer's review of the Specifications and Drawings.

1.06 QUALITY ASSURANCE

A. The level sensor(s) covered by this Section are intended to be standard equipment, as modified by this Section, of proven ability, as manufactured by a single manufacturer, having long experience in the production of such sensor(s). The sensor(s) furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and/or specified herein.

B. In the event that equipment which differs from this Section be offered and determined to be equal to that specified, such equipment shall be acceptable only on the basis that any revisions in the design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc. required to accommodate such a substitution shall be made at no cost to the Owner and be as approved by the Engineer.

1.07 DELIVERY, STORAGE, AND PROTECTION

A. In accordance with Section 01 60 00.

1.08 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Siemens
B. Endress-Hauser
C. Rosemount
D. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 TRANSMITTERS

A. The radar level sensor shall be guided wave or non-contacting 2-wire type based on the sensor manufacturer's recommendations per the intended application conditions as shown on the Drawings.
B. Guided Wave Radar Level Transmitter
   1. Guided wave radar level transmitters shall be based on TOR (Time Domain Reflectometry) guided down a probe immersed in process media. Span shall be adjustable over the entire range. Transmitters shall be NEMA 4X weatherproof and corrosion resistant construction with low-copper aluminum body and 316 stainless steel process wetted parts. Accuracy shall be plus or minus 0.2 inch for probes less than 16 feet, plus or minus 0.1 % for greater than 16 feet. Output shall be linear isolated 4-20 milliamperes 24 VDC. Power supply shall be 24 VDC, two-wire design. Each transmitter shall be furnished with a 4-digit LCD indicator capable of displaying engineering units and/or milliamps and mounting hardware as required. Overload capacity shall be rated at a minimum of 25 MPa. Each transmitter shall have a stainless steel tag with calibration data attached to body. Output signal damping shall be provided, with an adjustable time constant of 0-60 seconds. Ambient temperature effect shall be less than 0.01 % of measured distance per degree C. Process Pressure limitations shall be Full Vacuum to 580 psig. Process Temperature limitations shall be -40°F to 302°F.

   2. Where scheduled, guided wave radar level transmitters shall be calibrated in feet of liquid for liquid level service.

C. Non-Contacting 2-Wire Radar Level Transmitter
   1. Non-Contacting 2-wire radar level shall be based on short radar pulses which are transmitted from the antenna at the tank top towards the liquid. Time difference between the transmitted and the reflected pulse is proportional to the distance, from which the level is calculated. Two separate frequencies shall be offered (6Ghz or 26Ghz) to allow the user to choose the best model to fit the application. Span shall be adjustable over the entire range. Transmitters shall be NEMA 4X weatherproof and corrosion resistant construction with low-copper aluminum body and 316 stainless steel process wetted parts. Accuracy shall be plus or minus 0.1 inch for the 26 GHz unit, 0.4 inch for the 6 GHz unit. Output shall be linear isolated 4-20 milliamperes 24 VDC. Power supply shall be 24 VDC, two-wire design. Each transmitter shall be furnished with a 4-digit LCD indicator capable of displaying engineering units and/or milliamps and mounting hardware as required. Overload capacity shall be rated at a minimum of 25 MPa. Each transmitter shall have a stainless steel tag with calibration data attached to body. Output signal damping shall be provided. Temperature effect shall be less than 0.01 % of measured distance per degree C. Process Pressure limitations shall be Full Vacuum to 580 psig (Ansi Class 300 Flange). Process Temperature limitations shall be -40°F to 302°F.

   2. Where scheduled, Non-contacting 2-wire radar level transmitters shall be calibrated in feet of liquid for liquid level service.

PART 3 EXECUTION

3.01 INSTALLATION
   A. Install in accordance with manufacturer's instructions and recommendations in the locations shown on the Drawings and as specified herein.

3.02 FIELD QUALITY CONTROL
   A. Each flow meter shall be tested prior to shipment and the documentation of the test shall be submitted with O & M Manual for the flow meters.

   B. The services of a factory trained representative shall be provided for a total of one (1) day of testing and calibration of the flow meters.

END OF SECTION
SECTION 40 91 34
PRESSURE TRANSMITTER LEVEL SENSOR

PART 1  GENERAL

1.01  SCOPE OF WORK
   A. Furnish all labor, materials, equipment, and incidentals to install and test, complete and ready
      for operation, two (2) Pressure Transducer Level Sensor and Transmitter as shown on the
      Drawings and as specified herein.

1.02  RELATED SECTIONS
   A. Division 26 - Electrical

1.03  SYSTEM DESCRIPTION
   A. The process fluid(s) to be measured will be wastewater contained in the Anaerobic Lagoon.
      The contents of the anaerobic lagoon are corrosive.
   B. The pressure transducer shall be suitable for hydrostatic liquid level measurement.
   C. Fluid temperature will range from 5 degrees C to 35 degrees C

1.04  DESIGN REQUIREMENTS
   A. Anaerobic Lagoon No. 3 Liquid Level Sensor (I-291):
      1. Quantity:    one (1)
      2. Designed for measuring the liquid level in the Anaerobic Lagoon No. 3 liquid level
         standpipe as shown on the drawings.
      3. Fluid To Be Measured:  Industrial Wastewater Anaerobic Lagoon Content
      4. Connection Type:  Submersible
      5. Level range:  3 to 6 feet
      6. Indicators:  Digital level indicator (feet).
      7. Pump Control Function:
         a. Low Water Level:  Pump Off
         b. High Water Level:  High Water Level Alarm
   B. Anaerobic Lagoon No. 3 Underdrain Pump Station (I-292):
      1. Quantity:    one (1)
      2. Designed for measuring the liquid level in the Anaerobic Lagoon No. 3 Underdrain Pump
         Station as shown on the drawings.
      3. Fluid To Be Measured:  Ground Water & Industrial Wastewater Anaerobic
         Lagoon Content
      4. Connection Type:  Submersible
      5. Level range:  3 to 10 feet
      6. Indicators:  Digital level indicator (feet).
      7. Pump Control Function:
         a. Low Water Level:  Pump Off
         b. Operating Range:  Vary Pump Speed to Maintain Set Liquid Level
         c. Pump On Water Level:  Pump On (Alarm)

1.05  SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data:  Submit product data, including Manufacturer's data, for specified products.
      Include the following:
      1. Manufacturer's outline and mounting dimensions for all sensors.
      2. Manufacturer's wiring diagrams, including field connections.
      3. Mounting Details.
      4. All equipment to be furnished under this Section must be approved prior to being released
         for manufacturing unless otherwise noted by the Engineer.
C. Certification: The Manufacturer shall provide a certification stating that they have reviewed the Drawings and Specification for this project and have verified that the applicability of the specified equipment to be provided by the Manufacturer for the intended use per the Drawings and Specifications.
   1. The Manufacturer shall provide to the Engineer, as part of the certification, in writing any recommended revisions to the design based upon the Manufacturer’s review of the Specifications and Drawings.

1.06 QUALITY ASSURANCE
A. The level sensors covered by this Section are intended to be standard equipment, as modified by this Section, of proven ability, as manufactured by a single manufacturer, having long experience in the production of such sensors. The sensors furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and specified herein.
B. In the event that equipment which differs from this Section be offered and determined to be equal to that specified, such equipment shall be acceptable only on the basis that any revisions in the design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc. required to accommodate such a substitution shall be made at no cost to the Owner and be as approved by the Engineer.

1.07 DELIVERY, STORAGE, AND PROTECTION
A. In accordance with Section 01 60 00.

1.08 WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS
2.01 MANUFACTURERS
A. Magnetrol
B. Siemens
C. Endress-Hauser
D. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 COMPONENTS
A. Type:
   1. The transmitter shall measure the liquid level by measuring pressure.
B. Materials of Construction
   1. The housing shall be constructed of 316 stainless steel.
   2. Wetted parts shall be constructed of 316 stainless steel
   3. The diaphragm shall be constructed of aluminum oxide ceramic.
C. Operation/Function:
   1. Process Temperature Range: -20 degrees C to +80 degrees C.
   2. Relative Humidity: 0 to 100%.
   3. Pressure Range: suitable for the liquid levels specified.
   4. Accuracy: + or - 0.075% of span.
   5. Output: 4-20 mA with HART Protocol
   6. Display: LCD scaled to read in feet.
   7. All required device programming interface equipment is to be provided.
D. Enclosure
   1. The enclosure shall be NEMA 4X (IP67)
PART 3 EXECUTION

3.01 INSTALLATION
   A. Install in accordance with manufacturer's instructions and recommendations in the locations shown on the Drawings and as specified herein.

3.02 FIELD QUALITY CONTROL
   A. Perform field inspection and testing in accordance with Section 01 40 00.
   B. Each pressure transmitter shall be tested prior to shipment and the documentation of the test shall be submitted with O & M Manual for the pressure transmitter(s).
   C. The services of a factory trained representative shall be provided for a total of one (1) day of testing and calibration of the pressure transmitter(s).

   END OF SECTION
PART 1 GENERAL
1.01 SCOPE OF WORK
   A. Furnish all labor, materials, equipment, and incidentals to install and test, complete and ready
      for operation, eight (8) Pressure Sensor(s) as shown on the Drawings and as specified herein.

1.02 RELATED SECTIONS
   A. Division 26 - Electrical

1.03 SYSTEM DESCRIPTION
   A. The process fluid(s) to be measured shall be waste activated sludge.
   B. Fluid temperature will range from 5 degrees C to 35 degrees C

1.04 DESIGN REQUIREMENTS
   A. WAS Pump Station Pressure Sensor and Isolation Ring (I-794 & 795):
      1. Quantity: two (2)
      2. Fluid To Be Measured: Waste Activated Sludge
      3. Isolation Ring Connection Type: Flanged
      4. Isolation Ring Size: 4 inch
      5. Pressure Range: 0 to 100 psi
      6. Indicators: Pressure Indicator (psi).
      7. The pressor sensor shall be capable of being used to monitor pump discharge pressure
         and communicate the pressure to the plant PLC.

   B. WAS Aerobic Digester #1 - Pressure Sensor and Isolation Ring (I-1192 & 1193):
      1. Quantity: two (2)
      2. Fluid To Be Measured: Waste Activated Sludge
      3. Isolation Ring Connection Type: Flanged
      4. Isolation Ring Size: 6 inch
      5. Pressure Range: 0 to 100 psi
      6. Indicators: Pressure Indicator (psi).
      7. The pressor sensor shall be capable of being used to monitor pump discharge pressure
         and communicate the pressure to the plant PLC.

   C. WAS Aerobic Digester #2 & #3 - Pressure Sensor and Isolation Ring (I-1295 & 1296):
      1. Quantity: two (2)
      2. Fluid To Be Measured: Waste Activated Sludge
      3. Isolation Ring Connection Type: Flanged
      4. Isolation Ring Size: 6 inch
      5. Pressure Range: 0 to 100 psi
      6. Indicators: Pressure Indicator (psi).
      7. The pressor sensor shall be capable of being used to monitor pump discharge pressure
         and communicate the pressure to the plant PLC.

   D. Screw Press Feed Pumps - Pressure Sensor and Isolation Ring (I-1392 & 1393):
      1. Quantity: two (2)
      2. Fluid To Be Measured: Waste Activated Sludge
      3. Isolation Ring Connection Type: Flanged
      4. Isolation Ring Size: 4 inch
      5. Pressure Range: 0 to 100 psi
      6. Indicators: Pressure Indicator (psi).
      7. The pressor sensor shall be capable of being used to monitor pump discharge pressure
         and communicate the pressure to the plant PLC.
1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Submit product data, including Manufacturer's data, for specified products.
   Include the following:
   1. Manufacturer's outline and mounting dimensions for all sensors.
   2. Manufacturer's wiring diagrams, including field connections.
   3. Mounting Details.
   4. All equipment to be furnished under this Section must be approved prior to being released for manufacturing unless otherwise noted by the Engineer.

1.06 QUALITY ASSURANCE

A. The pressure sensors covered by this Section are intended to be standard equipment, as modified by this Section, of proven ability, as manufactured by a single manufacturer, having a minimum of 10 years’ experience in the production of such sensors. The sensors furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and specified herein.

B. In the event that equipment which differs from this Section be offered and determined to be equal to that specified, such equipment shall be acceptable only on the basis that any revisions in the design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc. required to accommodate such a substitution shall be made at no cost to the Owner and be as approved by the Engineer.

1.07 DELIVERY, STORAGE, AND PROTECTION

A. In accordance with Section 01 60 00.

1.08 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Siemens

B. Endress-Hauser

C. Or Approved Equal
   1. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 PRESSURE SENSOR

A. Type:
   1. The pressure sensor shall measure the internal pipe pressure.

B. Materials of Construction
   1. The housing shall be constructed of powder coated aluminum or 316 stainless steel.
   2. Wetted parts shall be constructed of 316 stainless steel.
   3. The diaphragm shall be constructed of aluminum oxide ceramic.

C. Operation/Function:
   1. Process Temperature Range: -20 degrees C to +80 degrees C.
   2. Relative Humidity: 0 to 100%.
   3. Pressure Range: suitable for the liquid levels specified.
   4. Accuracy: + or - 0.075% of span.
   5. Output: 4-20 mA with HART Protocol
   6. Display: LCD scaled to read in feet.
   7. All required device programming interface equipment is to be provided.

D. Enclosure
   1. The enclosure shall be NEMA 4X (IP67)
E. Isolation Valve
   1. An isolation valve shall be installed between the pressor sensor and the isolation ring.

2.03 ISOLATION RING

A. Function
   1. Line pressure pushes against an elastomer ring inside the isolation ring. The deflection of the ring displaces a fluid fill inside the body of the isolation ring, forcing the fluid into a pressure-measuring device.

B. Isolation Ring
   1. Pressure Isolation Rings are to be of the full flange design, to be retained between standard ANSI B16.1 Class 125/6.5 Class 150 pipeline flanges. Flange bolts shall pass through the ring body and flanges. The outside diameter of the sensor shall match the outside diameter of the mating flange. Face-to-face of the entire ring shall be no longer than specifications MSS-SP67.
   2. Isolation Rings shall be flow through design with flexible elastomer sensing ring around the full circumference. The elastomer sensing ring shall be rigidly clamped between metal end cover flanges, and no part of the elastomeric sensing ring shall be exposed to the external face of the sensor. There shall be no dead ends or crevices and flow passage shall make the sensor self-cleaning.
   3. The pressure sensing ring shall measure pressure for 360° around the full inside circumference of the pipeline. Flexible sensing ring shall have a cavity behind the ring filled with fluid to transfer pressure to the gauge. The Isolation Ring shall be manufactured in the USA.

PART 3 EXECUTION

3.01 INSTALLATION
   A. Install in accordance with manufacturer's instructions and recommendations in the locations shown on the Drawings and as specified herein.

3.02 FIELD QUALITY CONTROL
   A. Perform field inspection and testing in accordance with Section 01 40 00.
   B. Each pressure sensor shall be tested prior to shipment and the documentation of the test shall be submitted with O & M Manual for the pressure transmitter(s).
   C. The services of a factory trained representative shall be provided for a total of one (1) day of testing and calibration of the pressure sensors(s).

END OF SECTION
SECTION 40 91 41
PARSHALL FLUMES

PART 1 GENERAL

1.01 SCOPE OF WORK
A. Furnish all labor, materials, equipment, and incidentals to install and test, ready and complete the Parshall Flume and required accessories as indicated on the Drawings and as specified herein.

1.02 RELATED SECTIONS
A. Section 13 40 40 - Ultrasonic Flow Meters.

1.03 REFERENCES

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. The manufacturer shall clearly identify any exception to this Section, related sections, or the Drawings. Failure to do this shall be grounds for rejection of the submittal.
C. Certification: The Manufacturer shall provide a certification stating that they have reviewed the Drawings and Specification for this project and have verified that the applicability of the specified equipment to be provided by the Manufacturer for the intended use per the Drawings and Specifications.
1. The Manufacturer shall provide to the Engineer, as part of the certification, in writing any recommended revisions to the design based upon the Manufacturers review of the Specifications and Drawings.

1.05 SYSTEM DESCRIPTION
A. The parshall flume shall be suitable for accurately measuring the full flow range specified here.
B. The parshall flume shall be suitable for installation within a concrete channel as shown on the Drawings.

1.06 PERFORMANCE REQUIREMENTS
A. The Parshall Flume shall operate under the following conditions:
1. Maximum Flow Volume: 5.00 MGD
2. Average Flow Volume: 2.50 MGD

PART 2 PRODUCTS

2.01 FLUME TYPE: PROVIDE FLUME/FLUMES OF THE FOLLOWING TYPE/TYPES:
A. Size 9"
B. Single-piece construction.

2.02 MATERIALS
A. One piece, fiberglass reinforced plastic.
B. Gloss inside surfaces, free of irregularities.
C. Minimum 3/16 inch wall thickness.
D. Minimum 30% E-glass by weight.
E. Isophthalic polyester resin.
F. Pultruded fiberglass reinforced plastic bracing at the top of flume (inlet and outlet), T-304 stainless steel hardware.
G. Two inch (minimum) top and end flanges.
H. Molded-in stiffening ribs, maximum 12 inch center to center spacing.
I. 15 mil Isophthalic U.V resistant gel coat on all surfaces.
J. Anchor clips drilled for ¾ inch.
K. Tensile strength (ASTM D 638): 14,000 psi
L. Flexural strength (ASTM D 790): 27,000 psi
M. Flexural modulus (ASTM D 790): 1,000,000 psi
N. Barcol hardness (ASTM D 2583): 50

PART 3 EXECUTION

3.01 INSTALLATION
   A. Install in accordance with manufacturer's instructions.

3.02 FIELD QUALITY CONTROL
   A. Perform field inspection and testing in accordance with Section 01 40 00.

END OF SECTION
SECTION 40 92 15
SLIDE AND WEIR GATES

PART 1 GENERAL

1.01 SCOPE OF WORK
A. Furnish all tools, supplies, materials, equipment, and labor necessary for furnishing, installing, adjusting, and testing of all slide and weir gates and appurtenant work, complete and operable as shown on the Drawings and specified herein.

1.02 REFERENCES
A. ASTM B221
B. ASTM A276
C. ASTM D3935/D707
D. ASTM 8584 C86500
E. AWWA C513-05

1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Shop Drawings: Shop drawings of all gates, seals and channel installation details.

1.04 QUALITY ASSURANCE
A. The Contractor shall demonstrate that each gate installed will operate under field conditions in a manner consistent with the design of the system.
B. The Manufacturer shall have a minimum of five years’ experience in the design and manufacture of equipment of this type.

1.05 DESIGN REQUIREMENTS
A. All gates and frames shall be designed to meet or exceed all design criteria of AWWA Standard C513, defining head and loading calculations, structural strength, deflection requirements, and material specifications.
B. Gates shall be substantially watertight under the design head conditions. Under the design seating, head, the leakage shall be 0.05 gallon per minute per foot of seating perimeter or better. Under the design unseating head, the leakage shall be 0.10 gallon per minute per foot of seating perimeter.
C. The gate shall be design to withstand the maximum head shown on the Drawings.
D. Structural Design Safety Factors (SF):
   1. SF of 4 for ultimate tensile, compressive, and shear strength.
   2. SF of 2 for tensile, compressive, and shear yield strength.

1.06 DELIVERY, STORAGE, AND PROTECTION
A. In accordance with Section 01 60 00.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Orbinox
B. WACO Products, Inc.
C. Rodney Hunt
D. Substitutions: See Section 01 60 00 - Product Requirements
2.02 GENERAL

A. Gates and appurtenances shall have the name of the manufacturer, nominal size, flow directional arrows, working pressure for which they are designed, cast in raised letters or indelibly marked upon some appropriate part of the body.

B. Gates shall be either self-contained or non self-contained of the rising stem configuration as indicated on the gate schedule on the Drawings. All components of the gate shall be designed to withstand the maximum design condition head in the seating and unseating directions and the maximum output of the actuator.

2.03 STAINLESS STEEL GATES

A. FRAME

1. The gate frame shall be constructed of structural members or formed plate welded to form a rigid one-piece frame. The frame shall be suitable for wall mounting or wall thimble mounting (4-sided sealing only).

2. The frame configuration shall allow the replacement of the seals without removing the gate frame from the concrete.

3. The design stress shall not exceed the lesser of 50% of the yield strength or 25% of the ultimate strength of the materials for maximum load conditions.

B. SLIDE

1. The slide shall consist of a flat plate reinforced with formed plates or structural members to limit its deflection to 1/360 of the gate’s span under the design head. The minimum thickness of the slide shall be 1/4”.

2. The design stress shall not exceed the lesser of 50% of the yield strength or 25% of the ultimate strength of the materials for maximum load conditions.

C. GUIDES AND SEALS

1. The guides shall be made of UHMWPE (ultra high molecular weight polyethylene) and shall be of such length as to retain and support at least half (1/2) of the vertical height of the slide in the fully open position (downward).

2. Seals shall be made of EPDM and the design shall be able to obtain the same leakage rate on both seating and unseating head pressure as per the schedule. The seal system shall maintain efficient sealing in any position of the slide and allow the water to flow only through the opened part of the slide.

D. STEM AND COUPLINGS

1. The operating stem shall be of stainless steel designed to transmit in compression at least 2 times the rated output of the operating manual mechanism with a 40 lbs (178 N) effort on the crank or hand wheel.

2. The stem shall have a slenderness ratio less than 200. The threaded portion of the stem shall have machined cut threads of the Acme type or equivalent.

3. Where a hydraulic, pneumatic or electric operator is used, the stem design force shall not be less than 1.25 times the output thrust of the hydraulic or pneumatic cylinder with a pressure equal to the maximum working pressure of the supply, or 1.25 times the output thrust of the electric motor in the stalled condition.

4. The stem extension shall be made of extension tubes and joined to the stem by a solid coupling. The couplings shall be of greater strength than the stem.

5. As a general rule, gates having a width greater than two times their height shall be provided with two lifting mechanism connected by a tandem shaft.

E. STEM COVER

1. Rising stem gates shall be provided with a carbon steel or a clear polycarbonate stem cover. The clear polycarbonate stem cover shall have a cap and condensation vents and a clear position indicating tape. The tape shall be field applied to the stem cover after the gate has been installed and positioned.
F. LIFTING MECHANISM
1. Manual operators of the types listed in the schedule shall be provided by the gate manufacturer.
2. All bearings and gears shall be totally enclosed in a weather tight housing. The pinion shaft of crank operated mechanisms shall be constructed of stainless steel and supported by roller or needle bearings.
3. Each manual operator shall be designed to operate the gate under the maximum specified seating and unseating heads by using a maximum effort of 40 lbs (178 N) on the crank or hand wheel, and shall be able to withstand, without damage, an effort of 80 lbs (356 N).
4. The crank shall be removable and fitted with a corrosion-resistant rotating handle. The maximum crank radius shall be 15 inches (381 mm) and the maximum hand wheel diameter shall be 26 inches (650 mm).

G. YOKE
1. Self-contained gates shall be provided with a yoke made of structural members or formed plates. The maximum deflection of the yoke shall be 1/360 of the gate's span.

H. FASTENERS
1. All necessary attaching bolts, studs, and anchors shall be ASTM A276 Type 304 stainless steel and will be furnished by the slide gate manufacturer.

2.04 ELECTRIC OPERATOR
A. Motor operator shall be a 460-V, 3-phase, 60-Hz motor with precision reduction gearing enclosed in weatherproof housing. The operator shall be designed to raise the gate at a rate of approximately 12 in./min. Integral controls shall include a control power transformer, reversing controller, torque switches, limit switches, space heater to prevent condensation, open-stop-close push-buttons and gate position indicator. The controls shall also include a local-forward, reverse, off, and remote selector switch. Motor reduction helical gear and pinion shall be of heat-treated alloy steel. Final reduction worm shall be of alloy steel and worm gear of machined high-tensile strength bronze. All gearing shall be proportioned for 100% overload condition. Operator shall have a declutch lever and hand wheel for manual operation. Minimum i/o shall include 4-20ma output signal for gate feedback position indication, discrete outputs for fully open, fully closed, and any manufacturer standard recommended protection devices, inputs for valving opening and closing operations.

PART 3 EXECUTION
3.01 INSTALLATION
A. General: All gates, plates, guides, seals, and accessories shall be installed in accordance with the manufacturer’s written instructions and as shown and specified.
B. All gates shall be field tested following installation to demonstrate that the gate operates under field conditions in a manner consistent with the design of the system.

END OF SECTION
SECTION 43 21 15
END SUCTION CENTRIFUGAL PUMPS

PART 1 GENERAL

1.01 SCOPE OF WORK
A. Furnish all labor, materials, equipment, and incidentals to install and test, complete and ready for operation two (2) self-priming centrifugal pumps as shown on the Drawings and as specified herein.

1.02 RELATED SECTIONS
A. Division 26 - Electrical

1.03 SYSTEM DESCRIPTION
A. The pump(s) specified in this section are intended to be standard equipment as produced by the manufacturer. Customized pump material options are not intended. If it is determined that a portion of this specification is not in conformance with the manufacturer's standard offering (i.e. custom), the Engineer shall be notified immediately during the bidding and/or procurement process.
B. The pumps shall be designed for continuous duty under severe operating conditions.
C. Each pumping unit shall be complete with pump, baseplate, direct drive, coupling guard, belts and sheaves, motor, and appurtenances. One manufacturer shall furnish all components.

1.04 DESIGN REQUIREMENTS
A. Nitrate Recycle Pump Station (P-412 & P-413):
   1. Number of Pumps: Two (2)
   2. Configuration: Parallel
   3. Design Point #1 5,600 gpm (ea. pump) at 20 feet TDH
   4. Design Point #2 5,600 gpm (ea. Pump) at 10 feet TDH
   5. Maximum Solids Size: 3 inches
   6. Motor Horsepower: 40 HP
   7. Motor Type: TEFC Severe Duty
   8. Motor Configuration: Overhead V-Belt Drive
   9. Pump Influent Size: 16-inch
   10. Pump Effluent Size: 16-inch
   11. The pump(s) shall be capable of operating on a variable speed drive for automatic control of pump speed and pumped flow rate to maintain a set discharge flow rate.

1.05 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Submit product data, including Manufacturer's data, for specified products.
   1. System Description: Include the following:
      a. Manufacturer's data, order sheet, or equivalent for each major piece of equipment, component, instrument or device being supplied.
      b. Manufacturer's outline and mounting dimensions for all field mounted components, including, but not limited to, drives, motors, pumps and etc..
      c. Manufacturer's wiring diagrams for instrumentation and control system, including necessary field connections (if required).
      d. Manufacturer's Dimensions and Field Fabrication Details for all mechanical equipment.
      e. Installation Details.
      f. The Manufacturer shall clearly identify any exception to the specification or drawings. Failure to do this shall be grounds for rejection of the submittal.
      g. All equipment to be furnished under this Section must be approved prior to being released for manufacturing unless otherwise noted by the Engineer.
C. Operation and Maintenance Data: Operation and Maintenance data for each piece of equipment supplied.
D. Certificates: Certify that products of this section meet or exceed specified requirements.
E. Manufacturer's Field Reports: Provide copies of the manufacturer's field reports from inspection and system start-up services.
F. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
G. Certification: The Manufacturer shall provide a certification stating that they have reviewed the Drawings and Specification for this project and have verified that the applicability of the specified equipment to be provided by the Manufacturer for the intended use per the Drawings and Specifications.
   1. The Manufacturer shall provide to the Engineer, as part of the certification, in writing any recommended revisions to the design based upon the Manufacturer's review of the Specifications and Drawings.
H. The manufacturer shall clearly identify any exception to this Section, related sections, or the Drawings. Failure to do this shall be grounds for rejection of the submittal.

1.06 QUALITY ASSURANCE
A. The equipment covered by this Section is intended to be standard equipment, as modified by this Section, of proven ability, as supplied by a single manufacturer, having long experience in the production of such equipment. The equipment furnished shall be designed, constructed and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and as specified herein.
B. In the event that equipment which differs from this Section be offered and determined to be equal to that specified, such equipment shall be acceptable only on the basis that any revisions in the design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc. required to accommodate such a substitution shall be made at no cost to the Owner and be as approved by the Engineer.
C. The rated horsepower of the drive units shall be such that the units will not be overloaded nor the service factor reduced when the unit is operated at any point on the curve. If, due to the slope of the performance curve, a drive unit of greater horsepower than specified is required to meet this condition, the drive unit will be considered for approval only if any and all changes in electrical work, etc. required by such a change will be provided at no additional cost to the Owner and be to the satisfaction of the Engineer.

1.07 DELIVERY, STORAGE, AND PROTECTION
A. In accordance with Section 01 60 00.

1.08 WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Sulzer
B. Substitutions: Not permitted.

2.02 MATERIALS FOR PUMPS
A. General:
   1. Stainless steel nameplates giving the name of manufacturer, the rated capacity, head, speed, and other pertinent data shall be attached to each pump.
   2. The manufacturer shall supply complete factory mounted equipment.
   3. All electrical materials and equipment shall be UL listed or Factory Mutual approved and NEMA rated.
4. Control panels shall be factory wired, such that field wiring connections shall require connection of power and control wiring to the control panel and to the pumps and alarm wiring to the control panel and the pump failure alarm light. Field wiring connections shall be to numbered terminal strips.
5. The entire control system shall be factory tested prior to shipment.

B. Casing:
1. The casing shall be of ASTM A 48 cast iron construction and shall be end suction with top centerline, self-venting discharge and 125# or 150# ANSI flanges.
2. The casing shall be of a back-pull-out design to allow complete disassembly without disturbing the piping or driver.
3. The casing shall be supported by rigid integral cast feet for maximum resistance and distribution of unanticipated loads.
4. The casing shall be radially split and rabbeted to the stuffing box cover and adapter to assure proper alignment.
5. The shall be sealed by use of a confined gasket between the casing and cover.

C. Impeller:
1. The impeller shall be of ASTM A743 CF8M (316 stainless steel) or ASTM A 890 Grade 3A duplex stainless steel and be of open design, statically and dynamically balanced to ISO 1940 G6.3.
2. The impeller shall be mounted to the shaft by means of an integral spiral cut shaft key or via acme thread cut on the shaft.
3. The impeller shall be locked in place with an impeller bolt with integral locking washer or by an impeller nut.

D. Side Plate:
1. A wear plate of ASTM A743 CF8M (316 stainless steel) or ASTM A 890 Grade 3A duplex stainless steel shall be standard with open impellers.
2. The wear plate shall protect the casing against wear and maintain pump efficiency at the highest levels.

E. Shaft:
1. The shaft shall be of heavy-duty SS 2324 duplex stainless steel with a minimal overhang to the centerline of impeller.
2. The maximum shaft deflection shall be less than 0.002” at the face of the seal box.
3. The shaft and sleeve shall be sealed from the pumped liquid by use of impeller and sleeve o-rings.

F. Dynamic Seal:
1. The dynamic seal assembly shall be of ASTM A743 CF8M (316 stainless steel) or ASTM A 890 Grade 3A duplex stainless steel and must include flow interrupters to prevent solids and fibrous material build-up.
2. The static seal should not contact the shaft during operation and automatically close when the pump is not in operation.

G. Adapter:
1. The adapter shall be rabbet fitted to the bearing unit, back cover and casing to provide exact alignment of the rotating components.

H. Bearing Unit:
1. The bearing unit shall be sealed by use of non-contacting labyrinth isolators to protect the bearings and lubricating oil from external contamination.
2. A bullseye sight glass shall be provided to monitor the oil level.
3. The bearing housing shall be drilled on both sides to allow installation of an optional oiler.
4. The bearings shall be shoulder mounted to the shaft and fixed in the bearing housing to eliminate any axial shaft movement.
I. Bearings:
1. The radial bearing (inboard) is to be a cylindrical roller design with a minimum L-10 life of 100,000 hours.
2. The axial (thrust) bearing shall consist of two 40 degree angular contact bearings mounted back-to-back to provide a minimum L-10 life of 100,000 hours.

J. Lubrication:
1. Bearing lubrication shall be an oil bath.

PART 3 EXECUTION

3.01 INSTALLATION
A. Install in accordance with manufacturer's instructions and recommendations in the locations shown on the Drawings. Installation shall include furnishing the required oil and grease for initial operation. The grades of oil and grease shall be in accordance with the manufacturer's recommendations. Anchor bolts shall be set in accordance with the manufacturer's instructions and recommendations.

3.02 FIELD QUALITY CONTROL
A. Perform field inspection and testing in accordance with Section 01 40 00.
B. After Contractor and Engineer have mutually agreed that the equipment installation is complete and ready for continuous operation, Contractor and a qualified field service representative of the manufacturer shall conduct an operating test of the equipment and the controls in the presence of Engineer to demonstrate that the pumps will function correctly to the satisfaction of the Owner and if required the Engineer.

3.03 MANUFACTURER'S FIELD SERVICES
A. The services of a factory trained representative of the manufacturer shall be provided to inspect the installation of the equipment, make any necessary adjustments (before initial start-up), place it in initial trouble-free operation, and instruct the operating personnel in its operation and maintenance.
B. The factory trained representative shall be provided for two (1) trip and a total of two (2) days on-site for:
   1. Installation inspection of the pumps
   2. Start-up and operating instructions for the pumps.

END OF SECTION
SECTION 43 21 22
SELF-PRIMING CENTRIFUGAL PUMPS

PART 1 GENERAL

1.01 SCOPE OF WORK
A. Furnish all labor, materials, equipment, and incidentals to install and test, complete and ready for operation twelve (12) self-priming centrifugal pumps as shown on the Drawings and as specified herein.

1.02 RELATED SECTIONS
A. Division 26 - Electrical

1.03 SYSTEM DESCRIPTION
A. The pump(s) specified in this section are intended to be standard equipment as produced by the manufacturer. Customized pump material options are not intended. If it is determined that a portion of this specification is not in conformance with the manufacturer's standard offering (i.e. custom), the Engineer shall be notified immediately during the bidding and/or procurement process.
B. The pumps shall be designed with an open impeller to be used for pumping liquids containing solid particles and abrasives.
C. The pump(s) shall be equipped with a solids management system designed for management of sanitary wipes, plastic bags, feathers, hair, sludge, and all other types of stringy solids.
D. The pumps shall have an unobstructive flow into the suction and a large smooth flow channel to the casing and impeller which shall prevent clogging.
E. The pumps shall be designed for continuous duty under severe operating conditions.
F. Each pumping unit shall be complete with pump, baseplate, overhead v-belt drive, belt guard, belts and sheaves, motor, and appurtenances. One manufacturer shall furnish all components.

1.04 DESIGN REQUIREMENTS
A. Anaerobic Lagoon #3 Eff. Pump Station (P-210, 211 & 212):
1. Number of Pumps: Three (3)
2. Configuration: Parallel
3. Design Point #1 (One Pump On)
   a. Flow: 1,750 gpm
   b. Total Dynamic Head: 27 feet
   c. Suction Lift: 7 feet (WS to Pump Center Line)
   d. Suction Friction Loss: 5.3 feet
4. Design Point #2 (One Pump On)
   a. Flow: 1,750 gpm (ea. pump)
   b. Total Dynamic Head: 40 feet
   c. Suction Lift: 11 feet (WS to Pump Center Line)
   d. Suction Friction Loss: 5.3 feet
5. Maximum Solids Size: 3 inches
6. Motor Horsepower: 40 HP
7. Motor Type: TEFC Severe Duty
8. Motor Configuration: Overhead V-Belt Drive
9. Pump Influent Size: 8-inch
10. Pump Effluent Size: 8-inch
11. Casing Heater Required: No
12. The pump(s) shall be capable of operating on a variable speed drive for automatic control of pump speed and pumped flow rate to maintain a set discharge flow rate.
B. Return Activated Sludge Pump Station (P-710, 711, 712, & 713):
1. Number of Pumps: Four (4)
2. Configuration: Parallel

3. Design Point #1 (Two Pumps On)
   a. Flow: 1,050 gpm (ea. pump)
   b. Total Dynamic Head: 31 feet
   c. Suction Lift: Flooded Suction
   d. Suction Friction Loss: 5 feet

4. Design Point #2 (Four Pumps On)
   a. Flow: 1,400 gpm
   b. Total Dynamic Head: 57 feet
   c. Suction Lift: Flooded Suction
   d. Suction Friction Loss: 8 feet

5. Maximum Solids Size: 3 inches

6. Motor Horsepower: 50 HP

7. Motor Type: TEFC Severe Duty

8. Motor Configuration: Overhead V-Belt Drive

9. Pump Influent Size: 8-inch

10. Pump Effluent Size: 8-inch

11. Casing Heater Required: No

12. The pump(s) shall be capable of operating on a variable speed drive for automatic control of pump speed and pumped flow rate to maintain a set discharge flow rate.

C. Filter Influent Pump Station (P-716, 717 & 718):

1. Number of Pumps: Three (3)

2. Configuration: Parallel

3. Design Point #1 (One Pump On)
   a. Flow: 1,750 gpm
   b. Total Dynamic Head: 35 feet
   c. Suction Lift: 7.5 feet (WS to Pump Center Line)
   d. Suction Friction Loss: 0.8 feet

4. Design Point #2 (Two Pumps On)
   a. Flow: 1,750 gpm (ea. pump)
   b. Total Dynamic Head: 40 feet
   c. Suction Lift: 7.5 feet (WS to Pump Center Line)
   d. Suction Friction Loss: 0.8 feet

5. Maximum Solids Size: 3 inches

6. Motor Horsepower: 40 HP

7. Motor Type: TEFC Severe Duty

8. Motor Configuration: Overhead V-Belt Drive

9. Pump Influent Size: 8-inch

10. Pump Effluent Size: 8-inch

11. Casing Heater Required: No

12. The pump(s) shall be capable of operating on a variable speed drive for automatic control of pump speed and pumped flow rate to maintain a set liquid level in the wet well.

D. Plant Site Pump Station #2 (P-1010 & 1011):

1. Number of Pumps: Two (2)

2. Configuration: Parallel

3. Design Point #1 (One Pump On)
   a. Flow: 600 gpm
   b. Total Dynamic Head: 35 feet
   c. Suction Lift: 13 feet (WS to Pump Center Line)
   d. Suction Friction Loss: 1.65 feet

4. Motor Horsepower: 15 HP

5. Motor Type: TEFC Severe Duty

6. Motor Configuration: Overhead V-Belt Drive
7. Pump Influent Size: 4-inch  
8. Pump Effluent Size: 4-inch  
9. Casing Heater Required: No  
10. The pump(s) shall be capable of operating on a variable speed drive for automatic control of pump speed and pumped flow rate to maintain a set liquid level in the wet well.

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data shall include at least the following:
   1. Certified shop and erection drawings showing all important details of construction and dimensions.
   2. Descriptive literature, bulletins, and/or catalogs of the equipment.
   3. Data on the characteristics and performance of the pumps. Data shall include certified performance curves, based on actual shop tests of duplicate units, which show that they meet the specified requirements for head, capacity, efficiency, allowable NPSH, allowable suction lift and horsepower. Curves shall be submitted on 8-1/2 inch x 11-inch sheets.
   4. The total weight of the equipment including weight of the single largest item.
   5. A complete total bill of materials for all equipment.
   6. A list of manufacturer's recommended spare parts.
   7. Complete data on motors.
   8. Manufacturer's wiring diagrams for instrumentation and control system, including necessary field connections (if required).

C. Operating and Maintenance Manuals (O&M Manuals): Submit two (2) hard copies in a three ring binder and one (1) electronic copy in pdf format of operating and equipment maintenance instructions and detailed drawings.

D. The manufacturer shall clearly identify any exception to this Section, related sections, or the Drawings. Failure to do this shall be grounds for rejection of the submittal.

E. Certification: The Manufacturer shall provide a certification stating that they have reviewed the Drawings and Specification for this project and have verified that the applicability of the specified equipment to be provided by the Manufacturer for the intended use per the Drawings and Specifications.

   1. The Manufacturer shall provide to the Engineer, as part of the certification, in writing any recommended revisions to the design based upon the Manufacturer's review of the Specifications and Drawings.

1.06 QUALITY ASSURANCE

A. The pumps covered by this Section are intended to be standard pumping equipment, as modified by this Section, of proven ability, as manufactured by a single manufacturer, having long experience in the production of such pumps. The pumps furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and specified herein.

B. In the event that equipment which differs from this Section be offered and determined to be equal to that specified, such equipment shall be acceptable only on the basis that any revisions in the design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc. required to accommodate such a substitution shall be made at no cost to the Owner and be as approved by the Engineer.

C. The rated horsepower of the drive unit shall be such that the unit will not be overloaded nor the service factor reduced when the pump is operated at any point on the pump's capacity curve. If, due to the slope of the pump's performance curve, a drive unit of greater horsepower than specified is required to meet this condition, the pump will be considered for approval only if any and all changes in electrical work, etc. required by such a change will be provided at no additional cost to the Owner and be to the satisfaction of the Engineer.
1.07 DELIVERY, STORAGE, AND PROTECTION
   A. In accordance with Section 01 6000.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Gorman Rupp
   B. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 PUMP DESIGN
   A. Pumps shall be horizontal, self-priming centrifugal type, designed specifically for handling raw, unscreened, domestic sanitary sewage. Pump solids handling capability and performance criteria shall be in accordance with requirements listed under PART 1.04 - Design Requirements of this section.

2.03 MATERIALS AND CONSTRUCTION FEATURES
   A. Pump casing:
      1. Casing shall be cast iron Class 30 with integral volute scroll.
      2. Casing shall incorporate the following features:
         a. Mounting feet sized to prevent tipping or binding when pump is completely disassembled for maintenance.
         b. Fill port coverplate, 3 1/2" diameter, shall be opened after loosening a hand nut/clamp bar assembly. In consideration for safety, hand nut threads must provide slow release of pressure, and the clamp bar shall be retained by detente lugs. A Teflon gasket shall prevent adhesion of the fill port cover to the casing.
         c. Casing drain plug shall be at least 1 1/4" NPT to insure complete and rapid draining.
   B. Coverplate:
      1. Coverplate shall be cast iron Class 30.
      2. Design must incorporate the following maintenance features:
         a. A lightweight inspection coverplate, retained by acorn nuts, for access to pump interior for removal of stoppages. Designs that require removal of complete coverplate assembly for access to the impeller will not be accepted.
         b. Retained by acorn nuts for complete access to pump interior. Back coverplate removal must allow service to the impeller, seal, wear plate or check valve without removing suction or discharge piping. Back coverplate shall incorporate an obstruction free flow path by combining four support posts into a two-point “webbed” plate design for increased durability, reduced clogging, and increased operational efficiency.
         c. The replaceable wear plate shall be hard iron.
         d. Aggressive Self-Cleaning Wear Plate
            1) A replaceable wear plate secured to the back cover plate by studs and nuts. Wear plate shall be self-cleaning design ensuring that debris is cleared away and does not collect on the impeller vanes.
            2) The nature of the conveyed medium poses significant challenges to the continuous operation of the pump. Of particular concern is the clogging of the impeller by debris in the pumped medium including but not limited to long rags, fibers, and like debris which are able to wrap around the impeller vanes, stick to the center of the vanes or hub, or lodge within the spaces between the impeller and the housing.
            3) The aggressive self-cleaning wear plate shall have integral laser cut notches and grooves in combination with a “tooth” designed to disturb and dislodge any solids which might otherwise remain on the impeller in dynamic operation. Wear plate is designed to constantly and effectively clear the eye of the impeller without the use of blades or cutters.
e. In consideration for safety, a pressure relief valve shall be supplied in the inspection coverplate. Relief valve shall open at 75-200 PSI.

f. One O-ring of Buna-N material shall seal inspection coverplate to back coverplate.

g. Two O-rings of Buna-N material shall seal back coverplate to pump casing.

h. Pusher bolt capability to assist in removal of inspection coverplate or back coverplate. Pusher bolt threaded holes shall be sized to accept same retaining cap screws as used in rotating assembly.

i. Easy-grip handle shall be mounted to face of inspection coverplate.

C. Rotating Assembly:

1. A rotating assembly, which includes impeller, shaft, mechanical shaft seal, lip seals, bearing, seal plate and bearing housing must be removable as a single unit without disturbing the pump casing or piping.

2. Design shall incorporate the following features:

a. Seal plate and bearing housing shall be hard iron. Separate oil filled cavities, vented to atmosphere, shall be provided for shaft seal and bearings. Cavities must be cooled by liquid pumped and lip seals will prevent leakage of oil.

   1) The bearing cavity shall have an oil level sight gauge and fill plug check valve. The clear sight gauge shall provide easy monitoring of the bearing cavity oil level and condition of oil without removal of the fill plug check valve. The check valve shall vent the cavity but prevent introduction of moist air to the bearings.

   2) The seal cavity shall have an oil level sight gauge and fill/vent plug. The clear sight gauge shall provide easy monitoring of the seal cavity oil level and condition of oil without removal of the fill/vent plug.

   3) Double lip seal shall provide an atmospheric path providing positive protection of bearings, with capability for external drainage monitoring.

b. Impeller shall be hard iron, two-vane, semi-open, non-clog, with integral pump out vanes on the back shroud. Impeller shall thread onto the pump shaft and be secured with a lock screw and conical washer.

c. Shaft shall be AISI 4140 alloy steel.

d. Bearings shall be anti-friction ball or tapered roller type of proper size and design to withstand all radial and thrust loads expected during normal operation. Bearings shall be oil lubricated from a dedicated reservoir. Pump designs which use the same oil to lubricate the bearings and shaft seal shall not be acceptable.

e. Shaft seal shall be oil lubricated mechanical type. The stationary and rotating seal faces shall be tungsten titanium carbide alloy. Each mating surface shall be lapped to within three light band flatness (35 millionths of an inch), as measured by an optical flat under monochromatic light. The stationary seal seat shall be double floating by virtue of a dual O-ring design; an external O-ring secures the stationary seat to the seal plate, and an internal O-ring holds the faces in alignment during periods of mechanical or hydraulic shock (loads which cause shaft deflection, vibration, and axial/radial movement). Elastomers shall be viton. Cage and spring to be AISI 316 stainless steel. Seal shall be oil lubricated from a dedicated reservoir. The same oil shall not lubricate both shaft seal and shaft bearings.

f. Pusher bolt capability to assist in removal of rotating assembly. Pusher bolt threaded holes shall be sized to accept same capscrews as used for retaining rotating assembly.

D. Adjustment of the impeller face clearance (distance between impeller and wear plate) shall be accomplished by external means.

1. Clearances shall be maintained by a four point external shimless coverplate adjustment system, utilizing a four collar and four adjusting screw design allowing for incremental adjustment of clearances by hand as required. Each of the four points shall be lockable to prevent inadvertent clearance increases or decreases due to equipment vibration or accidental operator contact. The four point system also allows for equal clearance gaps at all points between the impeller and wear plate. Requirement of realignment of belts,
couplings, etc., shall not be acceptable. Coverplate shall be capable of being removed without disturbing clearance settings. Clearance adjustment systems that utilize less than four points will not be considered.

2. There shall be provisions for additional clearance adjustment in the event that adjustment tolerances have been depleted from the coverplate side of the pump. The removal of stainless steel shims from the rotating assembly side of the pump shall allow for further adjustment as described above.

3. Clearance adjustment which requires movement of the shaft only, thereby adversely affecting seal working length or impeller back clearance, shall not be acceptable.

E. Suction check valve shall be molded Neoprene with integral steel and nylon reinforcement. A blow-out center shall protect pump casing from hydraulic shock or excessive pressure. Removal or installation of the check valve must be accomplished through the coverplate opening, without disturbing the suction piping. Sole function of check valve shall be to save energy by eliminating need to reprime after each pumping cycle. Pumps requiring a suction check valve to assist reprime will not be acceptable.

F. Spool flanges shall be one-piece cast iron, class 30 fitted to suction and/or discharge ports. Each spool shall have one 1 1/4" NPT and on 1/4" NPT tapped hole with pipe plugs for mounting gauges or other equipment.

G. Volute Casing Heater:
   1. Pump shall be provided with a thermostat mounted to the exterior of the volute casing, and a 115 volt electric heater inserted into the interior of the volute by means of a dedicated port. The heater shall be energized at 43+/-3 degrees F to provide heat to the casing and eliminate the possibility of freezing. Heater probes that must be installed through a pump drain port shall not be acceptable.

2.04 MOTORS

A. Motors shall be squirrel cage induction type meeting as a minimum NEMA design B speed torque class. Breakdown torque shall be 200% or more of the maximum torque load placed on the motor shaft.

B. Motors shall have ball bearings and shall have an AFBMA B-10 bearing life of 100,000 hours minimum. Bearings shall be regreasable.

C. All insulated windings shall have Class F non-hygroscopic insulation systems rated for temperature rise and ambient temperature in accordance with NEMA MG-1 Standards for the insulation class specified, except the motors shall be designed for Class B temperature rise.

D. Motor shall be high efficiency type. Motor shall be wound with copper wire.

E. Motors shall be horizontal solid shaft, 480 volts, 3 phase, 60 Hertz. Each motor shall have a minimum 1.15 service factor. Where a 1.15 service factor is required on an inverter duty motor, provide next largest size motor and a 1.0 service factor.

F. Motors shall be rated for use with a variable frequency drive (VFD). Coordinate with VFD supplier to match drive and motor.

G. Motors shall be TEFC and shall have cast iron frames, end bells, bearing brackets, oversized terminal box, and guards. Motors shall have a stainless steel breathers/drains. Motor shall be server duty rated for an indoor environment.

H. Each motor shall be furnished with three hermetically sealed thermal switches imbedded in the windings. The thermal switches shall be connected in series and shall be wired to the motor starter. Each switch shall open when an excessive heat rise occurs in the motor.

2.05 SERVICEABILITY

A. The pump manufacturer shall demonstrate to the engineer's satisfaction that consideration has been given to reducing maintenance costs by incorporating the following features.

B. No special tools shall be required for replacement of any components within the pump.
2.06 ACCESSORIES
   A. A Standard Suction and Discharge Gauge Panel Kit shall be provided for each pump.
   B. A 1-inch x 1-inch Automatic Air Release Valve shall be provided for each pump.

PART 3 EXECUTION
3.01 EXAMINATION
   A. Contractor shall off-load equipment at installation site using equipment of sufficient size and
      design to prevent injury or damage. Immediately after off-loading, contractor shall inspect
      complete pump and appurtenances for shipping damage or missing parts. Any damage or
      discrepancy shall be noted in written claim with shipper prior to accepting delivery. Validate all
      pump serial numbers and parts lists with shipping documentation. Notify the manufacturer’s
      representative of any unacceptable conditions noted with shipper.

3.02 INSTALLATION
   A. Install, level, align, and lubricate pump(s) as required. Installation must be in accordance with
      written instructions supplied by the manufacturer at time of delivery.
   B. Prior to applying electrical power to any motors or control equipment, check all wiring for tight
      connection. Verify that protective devices (fuses and circuit breakers) conform to project design
      documents. Manually operate circuit breakers and switches to ensure operation without
      binding. Open all circuit breakers and disconnects before connecting utility power. Verify line
      voltage, phase sequence and ground before actual start-up.
   C. After all anchor bolts, piping and control connections are installed, completely fill the grout dam
      in the pump station base with non-shrink grout.

3.03 MANUFACTURER’S FIELD SERVICES
   A. A factory-authorized service representative shall perform the following:
      1. Eight (8) labor hours, on-site time for functional and performance testing and training.
   B. Operational Test
      1. Prior to acceptance by owner, an operational test of all pumps, drives, and control
         systems shall be conducted to determine if the installed equipment meets the purpose and
         intent of the specifications. Tests shall demonstrate that all equipment is electrically, mechanical, structurally, and otherwise acceptable; it is safe and in optimum working
         condition; and conforms to the specified operating characteristics.
      2. After construction debris and foreign material has been removed from the wet well, 
         contractor shall supply clear water volume adequate to operate station through several
         pumping cycles. Observe and record operation of pumps, suction and discharge gage
         readings, ampere draw, pump controls, and liquid level controls. Check calibration of all
         instrumentation equipment, test manual control devices, and automatic control systems.
         Be alert to any undue noise, vibration or other operational problems.

END OF SECTION
SECTION 43 21 23
SELF-PRIMING CENTRIFUGAL CHOPPER PUMPS

PART 1 GENERAL

1.01 SCOPE OF WORK
A. Furnish all labor, materials, equipment, and incidentals to install and test, complete and ready for operation three (3) self-priming centrifugal chopper pumps as shown on the Drawings and as specified herein.

1.02 SYSTEM DESCRIPTION
A. The pump shall be specifically designed to chop and pump waste solids at heavy consistencies. Materials shall be macerated and conditioned by the pump as an integral part of the pumping action. The pump must have demonstrated the ability to chop through and pump high concentrations of solids such as plastics, heavy rags, grease and hair balls, wood, paper products and stringy materials without plugging, both in tests and field applications. The pump shall be designed to retain adequate liquid in the casing to insure repriming without suction and discharge check valves and with a dry suction pipe.
B. The pumps shall be designed for continuous duty under severe operating conditions.
C. Each pumping unit shall be complete with pump, baseplate and coupling guard, overhead v-belt drive, belts and sheaves, motor, and appurtenances. One manufacturer shall furnish all components.

1.03 DESIGN REQUIREMENTS
A. Short Circuit Pump Station Pump Station (P-100):
   1. Number of Pumps: One (1)
   2. Design Point #1 (One Pump On)
      a. Flow: 500 gpm
      b. Total Dynamic Head: 37 feet
      c. Suction Lift: 9 feet (WS to Pump Center Line)
      d. Suction Friction Loss: 0.25 feet
   3. Design Point #2 (One Pump On)
      a. Flow: 900 gpm
      b. Total Dynamic Head: 49 feet
      c. Suction Lift: 9 feet (WS to Pump Center Line)
      d. Suction Friction Loss: 0.75 feet
   4. Design Point #3 (One Pump On)
      a. Flow: 1,200 gpm
      b. Total Dynamic Head: 62 feet
      c. Suction Lift: 9 feet (WS to Pump Center Line)
      d. Suction Friction Loss: 1.5 feet
   5. Design Point #4 (Two Pumps On)
      a. Flow: 1,750 gpm (ea. pump)
      b. Total Dynamic Head: 50 feet
      c. Suction Lift: 9 feet (WS to Pump Center Line)
      d. Suction Friction Loss: 2.6 feet
      e. Design Point #4 occurs when the Short Circuit Pump is operated in parallel with one of the Anaerobic Lagoon #1 & #2 Effluent Pump Station pumps to pump to the Anoxic Reactor #1 via the alternative by-pass force main.
   6. Maximum Solids Size: 3 inches
   7. Motor Horsepower: 50 HP
   8. Motor Type: TEFC Severe Duty
   9. Motor Configuration: Overhead V-Belt Drive
   10. Pump Influent Size: 8-inch
11. Pump Effluent Size: 8-inch
12. Casing Heater Required: Yes
13. Pump(s) are to be installed outside and shall be provided with all recommended appurtenances to protect against freezing.
14. The pump(s) shall be capable of operating on a variable speed drive for automatic control of pump speed and pumped flow rate to maintain a set discharge flow rate.

B. Anaerobic Lagoon #1 & #2 Eff. Pump Station (P-111 & 112):
   1. Number of Pumps: Two (2)
   2. Configuration: Parallel
   3. Design Point #1 (One Pump On)
      a. Flow: 1,750 gpm
      b. Total Dynamic Head: 17 feet
      c. Suction Lift: 4 feet (WS to Pump Center Line)
      d. Suction Friction Loss: 2.6 feet
   4. Design Point #2 (Two Pumps On)
      a. Flow: 1,750 gpm (ea. pump)
      b. Total Dynamic Head: 50 feet
      c. Suction Lift: 9 feet (WS to Pump Center Line)
      d. Suction Friction Loss: 2.6 feet
   5. Maximum Solids Size: 3 inches
   6. Motor Horsepower: 50 HP
   7. Motor Type: TEFC Severe Duty
   8. Motor Configuration: Overhead V-Belt Drive
   9. Pump Influent Size: 8-inch
  10. Pump Effluent Size: 8-inch
  11. Casing Heater Required: Yes
  12. Pump(s) are to be installed outside and shall be provided with all recommended appurtenances to protect against freezing.
  13. The pump(s) shall be capable of operating on a variable speed drive for automatic control of pump speed and pumped flow rate to maintain a set liquid level in the wet well.

1.04 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data shall include at least the following:
      1. Certified shop and erection drawings showing all important details of construction and dimensions.
      2. Descriptive literature, bulletins, and/or catalogs of the equipment.
      3. Data on the characteristics and performance of the pumps. Data shall include certified performance curves, based on actual shop tests of duplicate units, which show that they meet the specified requirements for head, capacity, efficiency, allowable NPSH, allowable suction lift and horsepower. Curves shall be submitted on 8-1/2 inch x 11-inch sheets.
      4. The total weight of the equipment including weight of the single largest item.
      5. A complete total bill of materials for all equipment.
      6. A list of manufacturer's recommended spare parts.
      7. Complete data on motors.
      8. Manufacturer's wiring diagrams for instrumentation and control system, including necessary field connections (if required).
   C. The manufacturer shall clearly identify any exception to this Section, related sections, or the Drawings. Failure to do this shall be grounds for rejection of the submittal.
D. Certification: The Manufacturer shall provide a certification stating that they have reviewed the Drawings and Specification for this project and have verified that the applicability of the specified equipment to be provided by the Manufacturer for the intended use per the Drawings and Specifications.

1. The Manufacturer shall provide to the Engineer, as part of the certification, in writing any recommended revisions to the design based upon the Manufacturer's review of the Specifications and Drawings.

1.05 QUALITY ASSURANCE

A. The contractor shall submit manufacturer's standard warranty and a performance affidavit for equipment to be furnished in accordance with this section. The warranty for workmanship and materials shall be manufacturer's standard for 1 year from startup, not to exceed 18 months from factory shipment. In the performance affidavit, the manufacturer must certify to the Contractor and the Owner, that the Contract Documents have been examined, and that the equipment will meet in every way the performance requirements set forth in the Contract Documents for the application specified. Shop drawings will not be reviewed prior to the receipt by the Engineer of an acceptable performance affidavit. The performance affidavit must be signed by an officer of the company manufacturing the equipment, and witnessed by a notary public. The performance affidavit must include a statement that the equipment will not clog or bind on solids typically found in the application set forth.

B. The pumps covered by this Section are intended to be standard pumping equipment, as modified by this Section, of proven ability, as manufactured by a single manufacturer, having long experience in the production of such pumps. The pumps furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and specified herein.

C. In the event that equipment which differs from this Section be offered and determined to be equal to that specified, such equipment shall be acceptable only on the basis that any revisions in the design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc. required to accommodate such a substitution shall be made at no cost to the Owner and be as approved by the Engineer.

D. The rated horsepower of the drive unit shall be such that the unit will not be overloaded nor the service factor reduced when the pump is operated at any point on the pump's capacity curve. If, due to the slope of the pump's performance curve, a drive unit of greater horsepower than specified is required to meet this condition, the pump will be considered for approval only if any and all changes in electrical work, etc. required by such a change will be provided at no additional cost to the Owner and be to the satisfaction of the Engineer.

1.06 DELIVERY, STORAGE, AND PROTECTION

A. In accordance with Section 01 60 00.

1.07 EXTRA MATERIALS

A. See Section 01 60 00 - Product Requirements, for additional provisions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Vaughan Co., Inc.

2.02 PUMP DESIGN

A. Pumps shall be horizontal, self-priming centrifugal type, designed specifically for handling raw, unscreened, domestic sanitary sewage. Pump solids handling capability and performance criteria shall be in accordance with requirements listed under PART 1.04 - Design Requirements of this section.
2.03 MATERIALS AND PUMP CONSTRUCTION

A. Housing: Shall include 150 lb. flanged inlet and discharge flanges, an oversized cleanout and mounting feet. The housing shall be ductile cast iron with all water passages to be smooth, and free of blowholes and imperfections for good flow characteristics.

B. Casing: Shall be ductile cast iron Class 30 with all water passages to be smooth, and free of blowholes and imperfections for good flow characteristics. Casing shall be a separate parts component of the housing.

C. Impeller: Shall be semi-open type with pump out vanes to reduce seal area pressure. Chopping/maceration of materials shall be accomplished by the action of the cupped and sharpened leading edges of the impeller blades moving across the cutter bar at the intake openings, with a maximum set clearance between the impeller and cutter bar of .015". Impeller shall be cast steel and heat treated to minimum 60 Rockwell C Hardness and dynamically balanced. The impeller shall be threaded to the shaft and shall have no axial adjustments and no set screws.

D. Cutter Bar: Shall be recessed into the pump bowl, and shall extend diametrically across entire pump suction opening. Cutter bar shall be plate steel and heat treated to minimum 60 Rockwell C Hardness.

E. Upper Cutter: Shall be threaded into the backplate behind the impeller, designed to cut against the pump-out vanes and the impeller hub, reducing and removing stringy materials from the mechanical seal area. Upper cutter shall be cast steel and heat treated to minimum 60 Rockwell C Hardness.

F. Pump Shafting: Shall be heat treated.

G. Bearings: Shall be oil bath lubricated with ISO Gr. 46 turbine oil and site glass indication. Shaft thrust in both directions shall be taken up by a double-row angular contact ball bearing. A single-row radial bearing shall also be provided. B10 bearing life shall be minimum 100,000 hours.

H. Back Pull-Out Bearing Housing: Shall be ductile cast iron, and machined with piloted bearing fits for concentricity of all components. Back pull-out design shall incorporate jacking bolts for accurate adjustment of impeller-to-cutter bar and impeller-to-upper cutter clearances, and shall allow removal of pump components without requiring disconnection of housing from inlet or discharge piping. Viton double lip seals riding on a stainless steel shaft sleeve shall provide sealing at the drive end of the bearing housing.

I. Mechanical Seal: Mechanical seal shall be cartridge type with silicon carbide faces. Seal shall be positively driven by set screws. Elastomers shall be Viton.

J. Shaft Coupling: Bearing housing and motor stool design is to provide accurate, self-aligning mounting for a C-flanged electric motor. Pump and motor coupling shall be T.B. Woods Sureflex elastomeric type.

K. Belt Drive: Adjustable brackets shall be used to support a side-mounted motor. Sheaves and belts shall be properly sized for horsepower ratings, and all guards are to be supplied with the belt drive system.

L. Stainless Steel Nameplates: Shall be attached to the pump and drive motor giving the manufacturer's model and serial number, rated capacity, head, speed and all pertinent data.

M. Flap Valve: The function of the flap valve is to minimize re-priming time at the start of each pumping cycle. Pumps requiring flap valves or suction check valves to prime or re-prime will not be acceptable.

N. Reprime Performance: The pump shall be capable of a reprime lift of 5 feet while operating at a selected speed or selected impeller trim. The reprime lift shall be defined as the vertical height from the centerline of the pump suction to the top of the liquid from which the pump will prime. Repriming of the pump shall be accomplished within 5 minutes.
2.04 MOTORS

A. Motors shall be squirrel cage induction type meeting as a minimum NEMA design B speed torque class. Breakdown torque shall be 200% or more of the maximum torque load placed on the motor shaft.

B. Motors shall have ball bearings and shall have an AFBMA B-10 bearing life of 100,000 hours minimum. Bearings shall be regreasable.

C. All insulated windings shall have Class F non-hygroscopic insulation systems rated for temperature rise and ambient temperature in accordance with NEMA MG-1 Standards for the insulation class specified, except the motors shall be designed for Class B temperature rise.

D. Motor shall be high efficiency type. Motor shall be wound with copper wire.

E. Motors shall be horizontal solid shaft, 480 volts, 3 phase, 60 Hertz. Each motor shall have a minimum 1.15 service factor. Where a 1.15 service factor is required on an inverter duty motor, provide next largest size motor and a 1.0 service factor.

F. Motors shall be rated for use with a variable frequency drive (VFD). Coordinate with VFD supplier to match drive and motor.

G. Motors shall be TEFC and shall have cast iron frames, end bells, bearing brackets, oversized terminal box, and guards. Motors shall have a stainless steel breathers/drains. Motor shall be server duty rated for an indoor environment.

H. Each motor shall be furnished with three hermetically sealed thermal switches imbedded in the windings. The thermal switches shall be connected in series and shall be wired to the motor starter. Each switch shall open when an excessive heat rise occurs in the motor.

2.05 SERVICEABILITY

A. The pump manufacturer shall demonstrate to the engineer's satisfaction that consideration has been given to reducing maintenance costs by incorporating the following features.

PART 3 EXECUTION

3.01 EXAMINATION

A. Contractor shall off-load equipment at installation site using equipment of sufficient size and design to prevent injury or damage. Immediately after off-loading, contractor shall inspect complete pump and appurtenances for shipping damage or missing parts. Any damage or discrepancy shall be noted in written claim with shipper prior to accepting delivery. Validate all pump serial numbers and parts lists with shipping documentation. Notify the manufacturer's representative of any unacceptable conditions noted with shipper.

3.02 INSTALLATION

A. Install, level, align, and lubricate pump(s) as required. Installation must be in accordance with written instructions supplied by the manufacturer at time of delivery.

B. Prior to applying electrical power to any motors or control equipment, check all wiring for tight connection. Verify that protective devices (fuses and circuit breakers) conform to project design documents. Manually operate circuit breakers and switches to ensure operation without binding. Open all circuit breakers and disconnects before connecting utility power. Verify line voltage, phase sequence and ground before actual start-up.

C. After all anchor bolts, piping and control connections are installed, completely fill the grout dam in the pump station base with non-shrink grout.
3.03 MANUFACTURER’S FIELD SERVICES

A. A factory-authorized service representative shall perform the following:
   1. Eight (8) labor hours, on-site time for functional and performance testing and training.

B. Operational Test
   1. Prior to acceptance by owner, an operational test of all pumps, drives, and control systems shall be conducted to determine if the installed equipment meets the purpose and intent of the specifications. Tests shall demonstrate that all equipment is electrically, mechanically, structurally, and otherwise acceptable; it is safe and in optimum working condition; and conforms to the specified operating characteristics.
   2. After construction debris and foreign material has been removed from the wet well, contractor shall supply clear water volume adequate to operate station through several pumping cycles. Observe and record operation of pumps, suction and discharge gage readings, ampere draw, pump controls, and liquid level controls. Check calibration of all instrumentation equipment, test manual control devices, and automatic control systems. Be alert to any undue noise, vibration or other operational problems.

END OF SECTION
SECTION 43 21 35
ROTARY LOBE PUMPS

PART 1 GENERAL

1.01 SCOPE OF WORK
A. Furnish all labor, materials, equipment, and incidentals to install and test, complete and ready for operation, six (6) positive displacement rotary convoluted lobe pumps as shown on the Drawings and as specified herein.

1.02 SYSTEM DESCRIPTION
A. Each pumping unit shall be complete with rotary convoluted lobe pump, gear reducer, baseplate and coupling guard, overhead z-belt drive, belts and sheaves, and all necessary appurtenances for a complete installation. One manufacturer shall furnish all components of the pumping units.
B. The pumps shall be designed for continuous duty under severe operating conditions.
C. Each pumping unit shall be complete with rotary convoluted lobe pump, gear reducer, baseplate and coupling guard, overhead v-belt drive, belts and sheaves, and appurtenances. One manufacturer shall furnish all components of the pumping units.

1.03 DESIGN REQUIREMENTS
A. Waste Activated Sludge Pump Station (P-714 & 715):
   1. Number of Pumps: Two (2)
   2. Configuration: Parallel
   3. Design Flow Capacity: 200 gpm
   4. Total Dynamic Head at Design Flow: 70 feet
   5. Maximum Solids Size: 2 inches
   6. Motor Horsepower: 10 HP
   7. Motor Type: TEFC Severe Duty
   8. Motor Configuration: Overhead Z-Belt Drive
   9. Pump Influent Size: 4-inch
   10. Pump Effluent Size: 4-inch
B. Waste Activated Sludge Aerobic Digester #1 Pump Station (P-1110 & 1111):
   1. Number of Pumps: Two (2)
   2. Configuration: Parallel
   3. Design Flow Capacity: 400 gpm
   4. Total Dynamic Head at Design Flow: 105 feet
   5. Maximum Solids Size: 2 inches
   6. Motor Horsepower: 25 HP
   7. Motor Type: TEFC Severe Duty
   8. Motor Configuration: Overhead Z-Belt Drive
   9. Pump Influent Size: 6-inch
   10. Pump Effluent Size: 6-inch
   11. Pump shall be suitable for suction lift operation.
C. Waste Activated Sludge Aerobic Digester #2 & #3 Pump Station (P-1210 & 1211):
   1. Number of Pumps: Two (2)
   2. Configuration: Parallel
   3. Design Flow Capacity: 300 gpm
   4. Total Dynamic Head at Design Flow: 70 feet
   5. Maximum Solids Size: 2 inches
   6. Motor Horsepower: 15 HP
   7. Motor Type: TEFC Severe Duty
   8. Motor Configuration: Overhead Z-Belt Drive
   9. Pump Influent Size: 6-inch
10. Pump Effluent Size: 6-inch
11. Pump shall be suitable for suction lift operation.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data shall include at least the following:
   1. Certified shop and erection drawings showing all important details of construction and dimensions.
   2. Descriptive literature, bulletins, and/or catalogs of the equipment.
   3. Data on the characteristics and performance of the pumps. Data shall include certified performance curves, based on actual shop tests of duplicate units, which show that they meet the specified requirements for head, capacity, efficiency, allowable NPSH, allowable suction lift and horsepower. Curves shall be submitted on 8-1/2 inch x 11-inch sheets.
   4. The total weight of the equipment including weight of the single largest item.
   5. A complete total bill of materials for all equipment.
   6. A list of manufacturer's recommended spare parts.
   7. Complete data on motors.
   8. Manufacturer's wiring diagrams for instrumentation and control system, including necessary field connections (if required).

C. The manufacturer shall clearly identify any exception to this Section, related sections, or the Drawings. Failure to do this shall be grounds for rejection of the submittal.

D. Certification: The Manufacturer shall provide a certification stating that they have reviewed the Drawings and Specification for this project and have verified that the applicability of the specified equipment to be provided by the Manufacturer for the intended use per the Drawings and Specifications.
   1. The Manufacturer shall provide to the Engineer, as part of the certification, in writing any recommended revisions to the design based upon the Manufacturer's review of the Specifications and Drawings.

1.05 QUALITY ASSURANCE

A. The pumps covered by this Section are intended to be standard pumping equipment, as modified by this Section, of proven ability, as manufactured by a single manufacturer, having long experience in the production of such pumps. The pumps furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and specified herein.

B. In the event that equipment which differs from this Section be offered and determined to be equal to that specified, such equipment shall be acceptable only on the basis that any revisions in the design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc. required to accommodate such a substitution shall be made at no cost to the Owner and be as approved by the Engineer.

C. The rated horsepower of the drive unit shall be such that the unit will not be overloaded nor the service factor reduced when the pump is operated at any point on the pump's capacity curve. If, due to the slope of the pump's performance curve, a drive unit of greater horsepower than specified is required to meet this condition, the pump will be considered for approval only if any and all changes in electrical work, etc. required by such a change will be provided at no additional cost to the Owner and be to the satisfaction of the Engineer.

1.06 DELIVERY, STORAGE, AND PROTECTION

A. In accordance with Section 01 60 00.

1.07 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Provide two year 100% parts and labor manufacturer warranty, including wear and tear to the pump. The warranty shall include, but not be limited to, mechanical seals, wear plates, housing segments, and lobes.

1.08 EXTRA MATERIALS
A. See Section 01 60 00 - Product Requirements, for additional provisions.
B. Supply two sets of belts for Owner's use in maintenance of equipment.
C. Supply any of the manufacturer's special tools for proper operation and maintenance of the pumps.

PART 2 PRODUCTS
2.01 MANUFACTURERS
A. Vogelsang USA - Twinsburg, Ohio
B. Boerger Pumps
C. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 ROTARY LOBE POSITIVE DISPLACEMENT PUMP
A. Each pump shall be of heavy duty, positive displacement rotary lobe design with gray cast iron casing and smooth end cover, of 230 - 260 Brinell hardness.
B. The pump shall utilize two tri-lobe rotors, which are driven through positive timing gears running in oil. Solid gray cast iron cores shall be covered with a layer of Buna-N Durometer hardness 65-72. The geometry of the rotor core shall be the same as that of the finished rotor. Rotor vane geometry shall be convoluted to provide pressure-pulse free operation. The convoluted rotor shall be specifically designed for pumping secondary sludge containing organic solids, small inorganic particles and grit. Rotors shall be positioned to the shaft by replaceable hardened key ways, and secured to the shaft by internal/external expansion clamp sleeves and flush discs requiring no recesses in the end cover.
C. The front cover shall be constructed of gray cast iron, with a minimum Brinell hardness of 230-260, and permit removal of the rotors without disturbing piping, bearings, and mechanical seals. It shall also be machined to accept a reversible wear plate, constructed of Hardox 500 material or equal, with a minimum Brinell hardness of 550, and a finished hardened reversible surface of 700 Brinell. Each pump shall be of heavy duty, positive displacement rotary lube design with ductile iron ASTM A536 casting and end cover, of 140 to 190 Brinell hardness.
D. The shafts shall be of carbon steel ASTM A293 fitting with replaceable ceramic coated stainless steel sleeves where passing through the seal area. They 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.
E. Split mechanical seals shall be provided for each positive displacement pump. A blocking chamber located behind the mechanical seal, and in front of the bearing housing lip seal shall be molded into the casting of the pump. This chamber shall be suitable for fill, from the side of the pump, through nipples, and have an external sight glass to review the status of the mechanical seals operation, mounted on the opposite side of the pump, located in easy view of the operator.
F. Port connections shall be ANSI Class 150 flanges; size specified on Drawings. They shall be hot dipped galvanized, for long life, and abrasion resistance.
G. The removable end cover shall be flush with no recesses or dead pockets where solids can accumulate. The cover shall be sealed with Buna "N" O-ring and provide complete access to the pump chamber without disconnecting pipe work glands or bearings. The removable front cover is to be mounted to the pump with 4 individual bolts, to provide unhindered access to the rotors to facilitate ease of maintenance and operator safety.
H. The manufacturer of the pumps shall measure all critical clearances upon reassemble of the coated parts and reaffirm all warranties on the pumps.
I. The pump, gear reducer and motor shall be mounted on a steel baseplate complete with necessary couplings, guards, and mounting hardware. Mounting of the pump shall be such that the oil drain on the bottom of the gear casing shall be easily accessible to allow

J. Miscellaneous: Nameplates and other data plates shall be stainless steel, suitably secured to the pump.
1. Parts shall be completely identified with a numerical system to facilitate parts inventory control. Each part shall be properly identified by a separate number, and those parts which are identical shall have the same number to effect minimum spare parts inventory.

K. Appurtenances: All bolts, nuts, washers, and gaskets necessary for field installation shall be furnished by the manufacturer.

L. Vibration: Pumps and motors shall operate at any point within their operating range without undue noise and vibration. Vibration at any point in the operating range shall not exceed the limits allowed by the Hydraulic Institute.

M. The top and bottom housing segments of the pump shall be constructed of gray cast iron, hardened to a minimum of 700 Brinell hardness, and be adjustable based on wear. The adjustment shall be accomplished by simply moving stainless steel shims from one hole to the next in the pump housing, allowing for the closing of tolerance around the rotors. This adjustment must be available a minimum of two times from factory tolerance.

2.03 MOTORS
A. Motors shall be squirrel cage induction type meeting as a minimum NEMA design B speed torque class. Breakdown torque shall be 200% or more of the maximum torque load placed on the motor shaft.
B. Motors shall have ball bearings and shall have an AFBMA B-10 bearing life of 100,000 hours minimum. Bearings shall be regreasable.
C. All insulated windings shall have Class F non-hygroscopic insulation systems rated for temperature rise and ambient temperature in accordance with NEMA MG-1 Standards for the insulation class specified, except the motors shall be designed for Class B temperature rise.
D. Motor shall be high efficiency type. Motor shall be wound with copper wire.
E. Motors shall be horizontal solid shaft, 480 volts, 3 phase, 60 Hertz. Each motor shall have a minimum 1.15 service factor. Where a 1.15 service factor is required on an inverter duty motor, provide next largest size motor and a 1.0 service factor.
F. Motors shall be rated for use with a variable frequency drive (VFD). Coordinate with VFD supplier to match drive and motor.
G. Motors shall be TEFC and shall have cast iron frames, end bells, bearing brackets, oversized terminal box, and guards. Motors shall have a stainless steel breathers/drains. Motor shall be server duty rated for an indoor environment.
H. Each motor shall be furnished with three hermetically sealed thermal switches imbedded in the windings. The thermal switches shall be connected in series and shall be wired to the motor starter. Each switch shall open when an excessive heat rise occurs in the motor.

2.04 CLEANING AND PACKING
A. Thoroughly clean all equipment, components, and subassemblies of all water, sand, grit, weld splatter, grease, oil, and other foreign materials before preparation for shipment. Protect all machined surfaces against physical damage and exposure during shipment. Handling, storage, and installation.
B. Pack pump to provide ample protection from damage during shipment, handling, and storage. Cap and seal all openings.
PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions and recommendations in the locations shown on the Drawings. Installation shall include furnishing the required oil and grease for initial operation. The grades of oil and grease shall be in accordance with the manufacturer's recommendations. Anchor bolts shall be set in accordance with the manufacturer's recommendations.

3.02 CLEANING

A. Clean grease, oil, or any other debris from the exterior surfaces of the pumps and motors.

3.03 FIELD QUALITY CONTROL

A. Controls shall be factory tested and documentation of the test shall be submitted to the Engineer and shall be included in the O&M manual.

B. After the pumps have been completely installed, conduct such tests as are necessary to indicate that pump efficiency and discharge conform to the Specifications. Field tests shall be performed on all pumps furnished under this Section. Supply all electric power, labor and water or wastewater and auxiliary equipment required to complete the field tests.

C. If the pump performance does not meet the Specifications, corrective measures shall be taken, or pumps shall be removed and replaced with pumps which satisfy the conditions specified. A twelve (12) hour operating period of the pumps will be required before acceptance.

D. Any component parts which are damaged as a result of testing or which fail to meet the requirements of these Specifications shall be replaced, reinstalled and retested at the Contractor's expense.

END OF SECTION
SECTION 43 21 39
SUBMERSIBLE PUMPS

PART 1 GENERAL
1.01 SCOPE OF WORK
A. Furnish all labor, materials, equipment, and incidentals to install and test, complete and ready for operation, two (2) pumps as shown on the Drawings and as specified herein.

1.02 REFERENCES
B. AGBMA Standard 11-78 - Load and Fatigue Life for Roller Bearings.
C. ASTM A48 - Gray Iron Castings

1.03 SYSTEM DESCRIPTION
A. The submersible pumps specified herein are intended to be standard for submersible use in industrial wastewater handling.
B. The pumps shall be located as indicated on the Drawings.
C. Each pump shall be wet pit type submersible pumps with all materials in contact with the pumped fluid. Pumps shall be non-clog sewage pumps.
D. Pump performance shall be stable and free from cavitation and noise throughout the specified operating head range at minimum suction submergence.
E. Each pumping unit shall be designed so that reverse rotation at rated head will not cause damage to any component.
F. Pumps shall be capable of operating continuously without being fully submerged.
G. Pump motors shall be non-overloading across the entire pump curve or as indicated by pump head ranges shown and minimum pump operating head indicated.

1.04 DESIGN REQUIREMENTS
A. Plant Site Pump Station #1 (P-910 & 911):
   1. Number of Pumps: Two (2)
   2. Configuration: Parallel
   3. Design Flow Capacity: 400 gpm
   4. Total Dynamic Head at Design Flow: 40 feet
   5. Motor Horsepower: 7.5 HP
   6. Minimum Discharge Nozzle Size: 4-inch
   7. Motor Voltage: 480 Volt/3 Phase/60 Hz
   8. Motor Type: Submersible
   9. The pump(s) shall be capable of operating on a variable speed drive for automatic control of pump speed and pumped flow rate to maintain a set liquid level in the wet well.

1.05 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data shall include at least the following:
   1. Certified shop and erection drawings showing all important details of construction and dimensions.
   2. Descriptive literature, bulletins, and/or catalogs of the equipment.
   3. Data on the characteristics and performance of the pumps. Data shall include certified performance curves, based on actual shop tests of duplicate units, which show that they meet the specified requirements for head, capacity, efficiency, allowable NPSH, and horsepower. Curves shall be submitted on 8-1/2 inch x 11-inch sheets.
   4. The total weight of the equipment including weight of the single largest item.
   5. A complete total bill of materials for all equipment.
6. A list of manufacturer's recommended spare parts.
7. Complete data on motors.
8. Manufacturer's wiring diagrams for instrumentation and control system, including necessary field connections (if required).

C. The manufacturer shall clearly identify any exception to this Section, related sections, or the Drawings. Failure to do this shall be grounds for rejection of the submittal.

D. Certification: The Manufacturer shall provide a certification stating that they have reviewed the Drawings and Specification for this project and have verified that the applicability of the specified equipment to be provided by the Manufacturer for the intended use per the Drawings and Specifications.

1. The Manufacturer shall provide to the Engineer, as part of the certification, in writing any recommended revisions to the design based upon the Manufacturer's review of the Specifications and Drawings.

1.06 QUALITY ASSURANCE

A. The pumps covered by this Section are intended to be standard pumping equipment, as modified by this Section, of proven ability, as manufactured by a single manufacturer, having long experience in the production of such pumps. The pumps furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and specified herein.

B. In the event that equipment which differs from this Section be offered and determined to be equal to that specified, such equipment shall be acceptable only on the basis that any revisions in the design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc. required to accommodate such a substitution shall be made at no cost to the Owner and be as approved by the Engineer.

C. The rated horsepower of the drive unit shall be such that the unit will not be overloaded nor the service factor reduced when the pump is operated at any point on the pump's capacity curve. If, due to the slope of the pump's performance curve, a drive unit of greater horsepower than specified is required to meet this condition, the pump will be considered for approval only if any and all changes in electrical work, etc. required by such a change will be provided at no additional cost to the Owner and be to the satisfaction of the Engineer.

1.07 DELIVERY, STORAGE, AND PROTECTION

A. In accordance with Section 01 60 00.

1.08 EXTRA MATERIALS

A. One set of all special tools required for normal operation and maintenance shall be provided.

B. The following spare parts shall be provided:
   1. One extra set of mechanical seals for each pump.
   2. Two complete set of gaskets, O-rings, etc. for each pump.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Flygt Pumps
B. KSB
C. Gorman Rupp Company
D. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 MATERIALS

A. Volute, Impeller and Motor Casing shall be Cast Iron, ASTM A48, Class 35B.
B. The impeller Wear Ring for non-clog impellers shall be a stainless steel impeller wear ring heat-shrink fitted onto the suction inlet of the impeller.
C. The Volute Wearing Ring for non-clog impellers shall be a Nitrile rubber coated steel ring insert or shall be a stainless steel ring with a 450 Brinell hardness insert that is drive-fitted to the volute inlet.

D. Discharge elbow shall be Cast iron, ASTM, Class 35B.

E. Guide Rails shall be stainless steel, Type 304.

2.03 GENERAL CONSTRUCTION

A. The pump(s) shall be automatically and firmly connected to the discharge connection, guided by no less than two guide bars extending from the top of the station to the discharge connection. Single guide rail or cabling systems shall not be acceptable. There shall be no need for personnel to enter the wet-well. Sealing of the pumping unit to the discharge connection shall be accomplished by a machined metal-to-metal watertight contact. Sealing of the discharge interface with a diaphragm, O-ring or profile gasket will not be acceptable. No portion of the pump shall bear directly on the sump floor.

B. Major pump components shall be of gray cast iron, ASTM A-48, Class 35B, with smooth surfaces devoid of blow holes or other irregularities. All exposed nuts or bolts shall be AISI type 304 stainless steel construction. All metal surfaces coming in contact with the pumpage, 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.

1. Sealing design shall incorporate metal-to-metal contact between machined surfaces. Critical mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile or Viton rubber O-rings. Fittings will be the result of controlled compression of rubber O-rings in two planes and O-ring contact of four sides without the requirements of a specific torque limit. Rectangular cross-sectioned gaskets requiring specific torque limits to achieve compression shall not be considered as adequate or equal. No secondary sealing compounds, elliptical O-rings, grease or other devices shall be used.

C. Bearings: The pump shaft shall rotate on two bearings. Motor bearings shall be permanently grease lubricated. The upper bearing shall be a single roller bearing. The lower bearing shall be a two row angular contact bearing. Excessive shaft overhang and single row lower bearings are not acceptable. The minimum L10 bearing life shall be 50,000 hours along the usable portion of the pump curve at maximum product speed.

D. Pump Shaft: Pump and motor shaft shall be the same unit. The pump shaft is an extension of the motor shaft. Couplings shall not be acceptable. The pump shaft shall be of carbon steel C-1035 and shall be completely isolated from the pumped liquid. If the pump shaft is not isolated from the pumped liquid, the shaft shall be stainless steel, ANSI 431 with a shaft sleeve. The shaft deflection ratio, L^3/d^4, shall have a maximum ratio of 50 to insure minimal deflection and low vibration levels. The length (L) of the shaft overhang shall be measured from the center of the inboard radial bearing to the end of the shaft. The diameter (d) represents the diameter of the shaft.

E. Cooling System: Each unit shall be provided with an adequately designed cooling system. A water jacket shall be provided for motors greater than 18 Hp. The motor water jacket shall encircle the stator housing and shall be of cast iron, ASTM A-48, Class 35B or Type 316 stainless steel. The water jacket shall thus provide heat dissipation for the motor regardless of whether the motor unit is submerged in the pumped media or surrounded by air. The water jacket shall encircle the stator housing; thus, providing heat dissipation for the motor regardless of the type of installation. Impeller back vanes shall provide the necessary circulation of the cooling liquid through the water jacket. The cooling media channels and ports shall be non-clogging by virtue of their dimensions. The cooling system shall provide for continuous pump operation in liquid temperature up to 104 DEGREES F. Restrictions below this temperature are not acceptable. Carbon steel cooling jackets are not acceptable.

F. Sealing System: Each pump shall be provided with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies. The seals shall operate in a lubricant reservoir that hydrodynamically lubricates the lapped seal faces at a constant rate. The lower,
primary seal unit, located between the pump and the lubricant chamber, shall contain one stationary and one positively driven rotating tungsten-carbide ring. The upper, secondary seal unit, located between the lubricant chamber and the motor housing, shall contain one stationary tungsten-carbide seal ring and one positively driven rotating tungsten-carbide seal ring. The tungsten-carbide seals shall use nickel binder for corrosion resistance. Seals containing silicon carbide, ceramic, or carbon or tool steel elements will not be considered equal to tungsten carbide. Each seal interface shall be held in contact by its own spring system. The seals shall require neither maintenance nor adjustment nor depend on direction of rotation for sealing.

1. The following seal types shall not be considered acceptable nor equal to the dual independent seal specified: shaft seals without positively driven rotating members, or conventional double mechanical seals containing either a common single or double spring acting between the upper and lower seal faces, or seals using external exposed springs. No system requiring a pressure differential to offset pressure and to effect sealing shall be used.

2. 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. Seal lubricant shall be FDA Approved, nontoxic. 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.

3. The motor shall be able to operate dry without damage while pumping under load.

G. The seal chamber shall incorporate a spiral track in the seal chamber wall. This spiral track or “spin-out” creates a “flushing” action, forcing abrasive particles away, to reduce wear and extend seal life. In lieu of a spiral-track, provide an additional lower mechanical seal for each pump in addition to the spare parts indicated.

H. Seal Failure and Thermal Sensors: A leakage sensor shall be available to detect water and oil in the stator chamber. The Float Leakage Sensor is a small float switch used to detect the presence of water or oil in the stator chamber. When activated, the sensor will stop the motor and send an alarm the control panel in both local and remote modes. A capacitance sensor in the oil chamber shall be acceptable. USE OF VOLTAGE SENSITIVE SOLID STATE SENSORS AND TRIP TEMPERATURE ABOVE 125°C (260°F) SHALL NOT BE ALLOWED.

1. The motor stators shall incorporate thermal switches in series to monitor the temperature of each phase winding. At 125°C (260°F) the thermal switches shall open, stop the motor and activate an alarm.

2. The thermal switches and leakage sensor shall be connected to a control and status monitoring unit that is mounted in any control panel.

I. The pump manufacturer shall provide a Submeg, an automatic meggering device with a minimum testing voltage of 500 V at a current of less than 0.25 mA. A device with testing voltage less than 500 V is unacceptable. This device shall be a 12-pin plug-in module and have sunlight visible LED indicators: "Power On", "500VDC On" and "Low Meg". A "Motor Reset" push-button and "Emergency Bypass" switch shall be mounted on the Submeg module so that the pump may be run in emergency situations. The monitoring device shall have a manual "Meg Test" button, which tests the internal circuitry of the module. The device shall test the motor insulation for 10 seconds prior to starting. The device shall prevent the motor from starting if it detects a resistance of 1 Megohm or less. The device will test motor before starting after power failure and provide an early warning system to prevent motor burn-outs due to moisture. The function of this device shall allow repairs to be scheduled, monitors repaired submersible motors, and monitors cable entry leakage.

J. The pump motor shall be induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber, NEMA B type. The motor shall be inverter duty/VFD rated in accordance with NEMA MG1 standards. The stator windings and stator leads shall be insulated with moisture resistant Class H insulation rated for 180°C. The stator shall have Class H insulation and shall be heat-shrink fitted into the stator housing and shall be applied by the trickle impregnation process monomer-free polyester resin resulting in a winding fill factor of at least 95% of the winding voids. The use of multiple step dip and bake-type stator insulation
process is not acceptable. The use of bolts, pins or other fastening devices requiring penetration of the stator housing is not acceptable. The motor shall be designed for continuous duty handling pumped media of 40°C (104°F) and capable of up to 15 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of cast aluminum. Thermal switches set to open at 125°C (260°F) shall be embedded in the stator lead coils to monitor the temperature of each phase winding. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection and shall be connected to the control panel. The junction chamber containing the terminal board, shall be hermetically sealed from the motor by an elastomer O-ring seal. Connection between the cable conductors and stator leads shall be made with threaded compression type binding posts permanently affixed to a terminal board. Wire nuts or crimping type connection devices are not acceptable. The motor and pump shall be assembled by the same manufacturer and provide a written guaranty for parts replacement and availability for 15 years.

K. The combined service factor (combined effect of voltage, frequency and specific gravity) shall be a minimum of 1.15. The motor shall have a voltage tolerance of plus or minus 10%. The motor shall be designed for operation up to 40°C (104°F) ambient and with a temperature rise not to exceed 80°C. A performance chart shall be provided upon request showing curves for torque, current, power factor, input/output kW and efficiency. This chart shall also include data on starting current and torque.

L. The power cable shall be sized according to the NEC and ICEA standards and shall be of sufficient length to reach the junction box without the need of any splices. The outer jacket of the cable shall be oil resistant chloroprene rubber. The motor and cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet.

M. The motor horsepower shall be adequate so that the pump is non-overloading throughout the entire pump performance curve from shut-off through operating flows and head ranges shown for each station.

N. The cable entry seal design shall preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall consist of a single cylindrical elastomer grommet, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the body containing a strain relief function, separate from the function of sealing the cable. The assembly shall provide ease of changing the cable when necessary using the same entry seal. The cable entry junction chamber and motor shall be separated by terminal board, which shall isolate the interior from foreign material gaining access through the pump top. Cable entry seals shall be standard design of manufacturer. If epoxy or silicone sealing systems are used, a ground conductor, relay and pilot cable shall be provided. The pump's ground conductor(s) and associated ground terminals shall be continuously monitored for open circuits, corrosion and loose connections. This monitoring of ground check and shall take place in the pump control panel and shall not require the addition of any electrical/ electronic circuitry within the pump. The standard pump cable shall be provided with a yellow ground check conductor in addition to the green ground conductor(s), to provide a continuous ground loop for monitoring. A solid state plug-in relay shall be provided to monitor the continuity of the ground loop and to measure the ground connections for a resistance of less than 500 ohms. LED pilot lights shall provide an indication of a faulty ground condition and in the event of an alarm, the relay shall shut down the motor. A manual reset shall be provided to reset the alarm condition. A test push-button shall simulate an open ground wire and shall check the relay for proper operation.

O. Volute: Single-piece minimum ASTM A48, Class 35B gray cast iron, non-concentric design with smooth passages large enough to pass any solids that may enter the impeller. An impeller Volute must be equipped with a centerline discharge.

P. The impeller(s) shall be of gray cast iron, Class 35B, dynamically balanced, double shrouded non-clogging design or a semi-open design as described herein. The impeller shall have a long throughlet without acute turns. The impeller(s) shall be capable of handling solids, fibrous materials, heavy sludge and other matter found in wastewater. Mass moment of inertia
calculations shall be provided by the pump manufacturer upon request. Impeller(s) shall be keyed to the shaft, retained with an expansion ring and shall be capable of passing a minimum 3 inch diameter solid. All impellers shall be coated with an acrylic dispersion zinc phosphate primer.

2.04 PROTECTIVE COATING

A. All metal surfaces coming into 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. Provide field touch-up kit.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions and recommendations in the locations shown on the Drawings. Installation shall include furnishing the required oil and grease for initial operation. The grades of oil and grease shall be in accordance with the manufacturer's recommendations. Anchor bolts shall be set in accordance with the manufacturer's recommendations.

3.02 FIELD QUALITY CONTROL

A. Controls shall be factory tested and documentation of the test shall be submitted to the Engineer and shall be included in the O&M manual.

B. After the pumps have been completely installed, conduct such tests as are necessary to indicate that pump efficiency and discharge conform to the Specifications. Field tests shall be performed on all pumps furnished under this Section. Supply all electric power, labor and water or wastewater and auxiliary equipment required to complete the field tests.

C. If the pump performance does not meet the Specifications, corrective measures shall be taken, or pumps shall be removed and replaced with pumps which satisfy the conditions specified.

D. Any component parts which are damaged as a result of testing or which fail to meet the requirements of these Specifications shall be replaced, reinstalled and retested at the Contractor's expense.

3.03 MANUFACTURER'S FIELD SERVICES

A. A factory-authorized service representative shall perform the following:
   1. Eight (8) labor hours, on-site time for installation assistance and inspection.
   2. Eight (8) labor hours, on-site time for functional and performance testing and training.

B. Site Test: Conduct a functional test on each pump prior to substantial completion of the project:
   1. Start-up - Start-Up of pumps, operation of control system, and demonstration of guide rail lift out operation.
   2. Alignment - Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.
   3. Operating Temperatures - Monitor bearing areas on pump and motor for abnormally high temperatures.
   4. Verify that under actual operating conditions that the motor stator temperature windings analog readouts do not exceed a 176 degree F (80 degree C) temperature rise over ambient conditions.
   5. Inspect the field assembly of components and installation of equipment including electrical connections. Prepare a written report on findings and any recommended corrective actions.

END OF SECTION
SECTION 43 21 47
SUBMERSIBLE SUMP PUMPS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidentals to install and test, complete and ready for operation, one (1) submersible sump pump(s) as shown on the Drawings and as specified herein.

1.02 SYSTEM DESCRIPTION

A. The submersible sump pump(s) specified herein are intended to be standard for submersible use in wastewater applications for dewatering drainage sumps.

B. The pumps shall be located as indicated on the Drawings.

C. Each pump shall be wet pit type submersible pumps with all materials in contact with the pumped fluid.

1.03 DESIGN REQUIREMENTS

A. WAS Aerobic Digester No. 2 & 3 Pump Station Sump Pump Station:
   1. Number of Pumps: One (1)
   2. Design Flow Capacity: 10 gpm
   3. Total Dynamic Head at Design Flow: 15 feet
   4. Level Control: Integral to Pump
   5. Motor Type: Submersible
   6. The pumps shall be equipped with a liquid level control system on the pump that turns the pump on and off based on the liquid level in the sump.
   7. The Contractor shall coordinate the electrical requirements of the sump pump with the electrical design.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data shall include at least the following:
   1. Certified shop and erection drawings showing all important details of construction and dimensions.
   2. Descriptive literature, bulletins, and/or catalogs of the equipment.
   3. Data on the characteristics and performance of the pumps.
   4. The total weight of the equipment including weight of the single largest item.
   5. A complete total bill of materials for all equipment.
   6. A list of manufacturer’s recommended spare parts.
   7. Complete data on motors.
   8. Manufacturer's wiring diagrams for instrumentation and control system, including necessary field connections (if required).

C. The manufacturer shall clearly identify any exception to this Section, related sections, or the Drawings. Failure to do this shall be grounds for rejection of the submittal.

D. Certification: The Manufacturer shall provide a certification stating that they have reviewed the Drawings and Specification for this project and have verified that the applicability of the specified equipment to be provided by the Manufacturer for the intended use per the Drawings and Specifications.
   1. The Manufacturer shall provide to the Engineer, as part of the certification, in writing any recommended revisions to the design based upon the Manufacturers review of the Specifications and Drawings.
1.05 QUALITY ASSURANCE

A. The pumps covered by this Section are intended to be standard pumping equipment, as modified by this Section, of proven ability, as manufactured by a single manufacturer, having long experience in the production of such pumps. The pumps furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and specified herein.

B. In the event that equipment which differs from this Section be offered and determined to be equal to that specified, such equipment shall be acceptable only on the basis that any revisions in the design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc. required to accommodate such a substitution shall be made at no cost to the Owner and be as approved by the Engineer.

C. The rated horsepower of the drive unit shall be such that the unit will not be overloaded nor the service factor reduced when the pump is operated at any point on the pump's capacity curve. If, due to the slope of the pump's performance curve, a drive unit of greater horsepower than specified is required to meet this condition, the pump will be considered for approval only if any and all changes in electrical work, etc. required by such a change will be provided at no additional cost to the Owner and be to the satisfaction of the Engineer.

1.06 DELIVERY, STORAGE, AND PROTECTION

A. In accordance with Section 01 60 00.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Goulds
B. Zoeller
C. ABS
D. Barnes
E. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 MATERIALS

A. Casing: Cast iron.
B. Shaft: Stainless steel
C. Impeller: Cast Iron
D. Power Cable: Severe duty rated, oil and water resistant.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions and recommendations in the locations shown on the Drawings.

3.02 FIELD QUALITY CONTROL

A. Controls shall be factory tested and documentation of the test shall be submitted to the Engineer and shall be included in the O&M manual.

B. After the pumps have been completely installed, conduct such tests as are necessary to indicate that pump efficiency and discharge conform to the Specifications. Field tests shall be performed on all pumps furnished under this Section. Supply all electric power, labor and water or wastewater and auxiliary equipment required to complete the field tests.

C. If the pump performance does not meet the Specifications, corrective measures shall be taken, or pumps shall be removed and replaced with pumps which satisfy the conditions specified.
D. Any component parts which are damaged as a result of testing or which fail to meet the requirements of these Specifications shall be replaced, reinstalled and retested at the Contractor's expense.

END OF SECTION
SECTION 43 41 43
HIGH DENSITY CROSS-LINKED POLYETHYLENE STORAGE TANKS

PART 1 GENERAL

1.01 SCOPE OF WORK
A. Furnish all labor, materials, equipment, and incidentals required to install, field test, complete and make ready for service five (5) vertical, flat bottom, seamless, high density crosslinked polyethylene storage tanks with double wall containment (as required) as indicated on the Drawings and as specified herein.

1.02 REFERENCES
A. ANSI B16.5 - Pipe Flanges and Flanged Fittings.
D. ASTM D746 - Brittleness Temperature of Plastics and Elastomers by Impact.
F. ASTM D883 - Standard Definitions of Terms Relating to Plastics
G. ASTM D1505 - Density of Plastics by the Density-Gradient Technique.
H. ASTM D1525 - Vicat Softening Temperature of Plastics.
J. ASTM D1998 - Standard Specification for Polyethylene Upright Storage Tank: Section 11.3: Low Temperature Impact Test and Section 11.4: Oxylene-Insoluble Fraction (Gel Test).

1.03 SYSTEM DESCRIPTION
A. General:
1. It is the intent of this Specification and Drawings to afford the fabricator as much design latitude as possible insomuch as the design is consistent with the basic requirements. Therefore, it is intended that the fabricator will have ample opportunity to utilize his particular "know how" in the design and details of tank fabrication in order to produce equipment which will be adequate for the intended purpose.
2. The fabricator shall submit a design based on the information given which will meet the requirements of the job regarding strength, corrosion resistance, and work ability.
3. Double Wall Tanks:
   a. The tank shall be a double wall tank consisting of two bottoms and two shells with a single dish top.
   b. The interior and exterior tank shall be designed to be self-sustaining.
   c. The exterior tank shall be designed to 110% of the interior tank capacity.

B. Carbon Source Storage Tank:
1. Quantity: Two (2)
2. Fluid: Non-flammable carbon source solution
3. Nominal Volume: 6,650 gallons
4. Tank Design: Double Wall Tank
5. Nominal Outside Diameter: 10 feet 2 inches
6. Nominal Height: 14 feet 3 inches
7. Tank dimensions are for reference only. Manufacturers standard tank dimensions will be satisfactory so long as the supplied tank will fit in the area and location provided.

C. Sludge Dewatering Influent Tank:
1. Quantity: One (1)
2. Fluid: Digested Waste Activated Sludge
3. Nominal Volume: 4,000 gallons
4. Tank Design: Single Wall, Open Top Tank
5. Nominal Diameter: 10 feet 0 inches
6. Nominal Height: 6 feet 11 inches
7. The tank shall be equipped with internal baffled for mixing.
8. A mixer support bridge shall be provided. The Contractor shall coordinate mixer support requirements.
9. Tank dimensions are for reference only. Manufacturers standard tank dimensions will be satisfactory so long as the supplied tank will fit in the area and location provided.

D. Polymer Mix Tank:
1. Quantity: Two (2)
2. Fluid: 2% Cationic Polymer Solution
3. Nominal Volume: 4,000 gallons
4. Tank Design: Single Wall, Open Top Tank
5. Nominal Diameter: 10 feet 0 inches
6. Nominal Height: 6 feet 11 inches
7. The tank shall be equipped with internal baffled for mixing.
8. A mixer support bridge shall be provided. The Contractor shall coordinate mixer support requirements.
9. Tank dimensions are for reference only. Manufacturers standard tank dimensions will be satisfactory so long as the supplied tank will fit in the area and location provided.

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Submit product data, including Manufacturer's data for specified equipment. Include the following:
   1. Manufacturer's data, order sheet, or equivalent for each major item being supplied.
   2. Dimensions of tank, fittings, and attachments, with bolt and gasket material.
   3. Wall thickness calculations per ASTM D 1998-97 using 600-psi design hoop stress at 100 degrees F.
   4. Locations of fittings and attachments and size of manway openings.
   5. Resin used and a complete manufacturer specification of the resin used.
   6. Weight of tanks.
   7. Statement that fabrication is in accordance with these Specifications.
   8. Certificate of Compliance from the tank manufacturer stating:
      a. All fittings, heat tracing, insulation, etc. have been installed by the tank manufacturer.
      b. Hydrostatic tests have been performed by the manufacturer and all fittings were installed prior to the tests.
   9. Details on packaging.
   10. Instructions for handling, storage and installation of tanks.
   11. Statement that materials and resin used are suitable for intended service.
   12. The manufacturer shall clearly identify any exception to the specification or Drawings. Failure to do this shall be grounds for rejection of the submittal.
C. Shop drawings shall be approved by the Engineer prior to any manufacturing of tanks, fittings, etc. Approval of drawings by the Engineer shall not release the Contractor of responsibility of compliance with these specifications.
D. Submit a list of previous five similar use site installations in the past 36 months or provide a list of three or more customers using tanks for the same chemical applications and similar weather conditions for at least ten years.
E. Certification: The Manufacturer shall provide a certification stating that they have reviewed the Drawings and Specification for this project and have verified that the applicability of the specified equipment to be provided by the Manufacturer for the intended use per the Drawings and Specifications.
   1. The Manufacturer shall provide to the Engineer, as part of the certification, in writing any recommended revisions to the design based upon the Manufacturer's review of the Specifications and Drawings.

F. Submit supporting information of UL tank manufacturing capabilities.

1.05 QUALITY ASSURANCE
   A. The tanks covered by this Section are intended to be standard equipment, as modified by this Section, of proven ability, as supplied by a single manufacturer, having long experience in the fabrication of such tanks. The tanks furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and as specified herein.

   B. In the event that a tank which differs from this Section be offered and determined to be equal to that specified, such tanks shall be acceptable only on the basis that any revisions in the design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc. required to accommodate such a substitution shall be made at no cost to the Owner and be as approved by the Engineer.

1.06 DELIVERY, STORAGE, AND PROTECTION
   A. In accordance with Section 01 60 00.
   B. Tanks which are shipped in the horizontal position shall be mounted on padded cradles. All tank end blocking used to prevent shifting of tanks must be padded and bare only upon the knuckle radius of the tank bottom.

   C. Tanks shall be secured to the cradles or skids to prevent rotation or other movement. In turn, the cradles or skids shall be fastened securely to the truck bed.

   D. All tie-down straps shall give provision for thermal expansion and shall be padded where in contact with the equipment.

   E. Flange faces shall be protected from damage by covering with suitable plywood or hardboard and securely fastened.

   F. Tanks shall be positively vented at all times.

PART 2 PRODUCTS
2.01 MANUFACTURER
   A. Poly Processing Company
   B. Substitutions - In accordance with Section 01 60 00 - Product Requirements

2.02 MATERIALS
   A. Plastic
      1. The tanks shall be molded from high density crosslinked polyethylene. The resin used shall be Marlex CL-200 YJN as manufactured by Phillips Petroleum Company, Plastics Division or Paxon 7004 as manufactured by Paxon, Inc. or of resins of equal physical and chemical properties.

   B. Fillers and Pigments
      1. The plastic shall not contain any fillers. All plastic shall contain a minimum of 0.25 percent U.V. stabilizer and maximum of 0.60 percent. Pigments may be added as desired by the OWNER or as designated by the manufacturer, not to exceed 0.5 percent of dry blended or 2 percent if melt compound of the total weight of the tank.
2.03 HIGH DENSITY CROSSLINKED POLYETHYLENE TANKS
A. The high density crosslinked polyethylene tanks shall be constructed by the rotational molding process.
B. The high density crosslinked polyethylene tanks shall be capable of storing the above specified chemicals at temperatures up to 130 degrees F.
C. The nominal properties of the material are as follows based on molded parts:
   1. Density (ASTM D1505): 0.940 to 0.945 g/cc
   2. ESCR Spec. Thickness 0.125" F50 10% Igepal (ASTM D1693):>1,000 hours
   3. Tensile Strength Ultimate 2 in/min (ASTM D638 Type IV Spec):2,600 psi
   4. Elongation at Break 2 in/min (ASTM D638):400 percent
   5. Vicat Softening Temperature (ASTM D1525):240 degrees F
   6. Britteness Temperature (ASTM D746):-130 degrees F
   7. Flexural Modulus (ASTM D790):100,000 to 110,000 psi

2.04 SAFE TANKS/CONTAINMENT SYSTEMS
A. Tanks shall consist of a crosslinked polyethylene primary tank with a secondary containment tank. The primary tank shall be vertical, cylindrical, flat bottom, dome top, and seamless construction. The secondary containment tank, outer tank, shall be a crosslinked polyethylene, open top, vertical, cylindrical, flat bottom, and seamless in construction.
B. The tank diameter shall be measured externally. Tolerance on the outside diameter including out of roundness shall be plus or minus two percent. Measurement shall be taken in a horizontal position. The knuckle radius at bottom to wall shall be a minimum of one inch.
C. The minimum wall thickness shall be 1/4 inch in all places.
D. All edges cut out, such as entrance manway, shall be trimmed to have smooth edges.

2.05 ACCESSORIES
A. Manways
   1. The manway openings for the double wall containment tanks shall be a minimum of 24" diameter. The manway cover shall be a bolt on type or screw on type lid manufactured from cross-linked polyethylene. Bolts used on the bolt on type lid shall be polyethylene, nylon or a compatible plastic material.
B. Integrally Molded Flanged Outlets
   1. The integrally molded flanged outlets shall be located at the bottom of the sidewall and allow the tank to be fully drained. The integrally molded flanged outlets shall be integrally molded into the tank during the rotational molding process. The integrally molded flanged outlets shall be seamless, flanged, and manufactured from the same material as the tank. Inserts are not acceptable. A PVC companion flange assembly with a split backing ring, stainless steel bolts and EPDM gasket shall be provided.
C. The Polymer Mix Tank shall be provided with the following:
   1. One 4-inch integrally molded flange outlet shall be located at bottom of tank.
   2. Center mounted mixer designed to mix 4,000 gallons of 30,000 mg/L digested waste activated sludge.
   3. The mixer shall have a minimum horsepower of 5 HP.
D. The Polymer Mix Tank shall be provided with the following:
   1. One 4-inch integrally molded flange outlet shall be located at bottom of tank.
   2. Center mounted mixer designed to mix 4,000 gallons of 2% polymer solution.
   3. The mixer shall have a minimum horsepower of 2 HP.
E. The Double Wall Storage Tanks shall be provided with the following:
   1. Vent - one per tank.
   2. One 3-inch integrally molded flange outlet filling port shall be provided at the top of the tank.
3. One 3-inch integrally molded flange outlet discharge port shall be provided at the bottom of the tank.
4. One 3-inch integrally molded flange outlet overflow port shall be provided 6 inches below top of shell.
5. Liquid Level Indicator - One reverse float level gauge with gradation markings for measuring liquid level in the bulk storage tank.
6. Necessary corrosion resistant hardware for installation of tank accessories.

F. Tie Down Systems
1. A tie down system shall be provided for each Double Wall Storage Tank. 316 Stainless Steel clips, bolts, and accessories shall be provided to securely anchor the tank to the cylindrical tank concrete pad. Anchor bolts shall be supplied by the Contractor.

PART 3 EXECUTION

3.01 INSTALLATION
A. Install in accordance with the Drawings and manufacturer's instructions.
B. Tanks shall be installed on five layers of 30-lb roofing felt, or other resilient support as recommended by the manufacturer to provide for an even bearing on the concrete pad.
C. Make all pipe connections to tanks as shown on the Drawings.
D. Tanks and support members shall be anchored in their final position according to the manufacturer's recommendations.

END OF SECTION
SECTION 43 41 64
PRECAST POST TENSIONED CONCRETE TANKS

PART 1 GENERAL

1.01 SCOPE OF WORK
A. The Contractor may provide either Precast Post Tensioned Concrete Tanks or Prestressed Concrete Tanks. This section specifies the requirements for Precast Post Tensioned Tanks. Refer to section 43 41 65 for the requirements for Prestressed Concrete Tanks.
B. Furnish all labor, materials, equipment and incidentals to design and erect the precast post tensioned concrete tanks, including foundation, drilled concrete piers, tank structure, and tank appurtenances as shown on the Drawings and as specified herein.

1.02 RELATED SECTIONS
A. Section 00 30 00 - Information Available to Bidders
B. Section 31 23 16 - Excavation
C. Section 31 23 23 - Fill and Backfill: Backfilling at building and foundations.
D. Section 03 20 00 - Concrete Reinforcement
E. Section 03 30 00 - Cast-in-Place Concrete: Concrete for concrete components.

1.03 ALTERNATIVES
A. See Section 01 23 00 - Alternatives, for product alternatives affecting this section.
B. This section describes an alternative product; refer to Section 13 20 40 for the base bid product.

1.04 REFERENCES
A. General: The work shall comply with the most recent standards or tentative standards as published at the date of the contract and as listed in this specification using the abbreviation shown.
B. American Concrete Institute (ACI):
   1. ACI 301 - Specifications for Structural Concrete for Buildings
   2. ACI 302 - Recommended Practice for Concrete Floor and Slab Construction
   3. ACI 304 - Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete
   4. ACI 305R - Hot Weather Concreting
   5. ACI 306R - Cold Weather Concreting
   6. ACI 308 - Recommended Practice for Curing Concrete (Reaffirmed 1978)
   7. ACI 309 - Recommended Practice for Consolidation of Concrete (Reaffirmed 1978)
   8. ACI 311 - Recommended Practice for Concrete Inspection
   9. ACI 318 - Building Code Requirements for Reinforced Concrete
   10. ACI 318-77 - Appendix B Alternate Design Method
   11. ACI 344R - Design and Construction of Circular Prestressed Concrete Structures (Reported by ACI Committee 344)
   12. ACI 347 - Recommended Practice for Concrete Formwork
   13. ACI 350R - Concrete Sanitary Engineering Structures
   14. ACI SP-2 - ACI Manual of Concrete Inspection
   15. ACI 533-3R - Fabrication, Handling and Erection of Precast Concrete Wall Panels
C. American Waterworks Association (AWWA) Publications
   1. AWWA D115 - AWWA Standard for Circular Prestressed Concrete Water Tanks With Circumferential Tendons
   2. AWWA C652-92 - AWWA Standard for Disinfection of Water Storage Facilities
D. American Society of Civil Engineers:
   1. ASCE - 7 - Loads for Buildings and Structures
E. American Society for Testing and Materials (ASTM):
   1. ASTM A416 - Steel Strand, Uncoated Seven-Wire Stress Relieved for Prestressed Concrete
   2. ASTM A615 - Specification for Deformed and Plain Billet Steel Bars for Concrete Reinforcement
   3. ASTM C150 - Specification for Portland Cement
   4. ASTM D395 - Standard Test Methods for Rubber Property Compression Set
   5. ASTM D412 - Standard Test Methods for Rubber Properties in Tension
   6. ASTM D566 - Standard Test Method for Dropping Point of Lubricating Grease
   7. ASTM D1743 - Corrosion Inhibitor
   8. ASTM D2000 - Standard Classification System for Rubber Products in Automotive Applications
   10. ASTM D30331 - Specification for Standard Type PSP Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
   11. ASTM D3350 - Specification for Polyethylene Plastics Pipe and Fittings Materials

1.05 SYSTEM DESCRIPTION
A. This section consists of designing precast post-tensioned concrete and the furnishing of all materials, equipment and labor, for performing all operations for the construction of precast post-tensioned concrete tanks as indicated on the drawings.
B. The tank shall meet the design requirements for a post-tensioned concrete structure as recommended in ACI 350, AWWA D115, and the Post-Tensioning Institute Design Manual.
C. The prestressed concrete tanks shall also be designed and constructed in accordance with the AWWA D-115 specifications for Precast Post-Tensioned Tanks with Internal Tendons.

1.06 DESIGN REQUIREMENTS
A. Tank: Anoxic Reactor #1 Tank shall be designed and constructed as shown on the Drawings.
   1. Anoxic Reactor #1 Tank
      a. Nominal Diameter: 140 feet
      b. Required Capacity: 3,200,000 gallons
      c. High Water Level: 28.0 feet from top of slab.
      d. Sidewall Height: 30.0 feet from top of slab.
   2. Structurally designed to comply with applicable building codes including:
      a. Wind Loads
      b. Seismic Loads
   3. The tank shall be designed for a maximum liquid level inside the tank equal to the tank wall height.
   4. The tank shall include the internal launders, flow channels, troughs, and drops as shown on the drawings.
   5. The tank shall include manhole rungs or a corrosion resistant ladder for emergency egress from the tank in the event of an accident resulting in personnel falling into the tank.
B. Tank: Nitrification Reactor #2 Tank shall be designed and constructed as shown on the Drawings.
   1. Nitrification Reactor #2 Tank
      a. Nominal Diameter: 152 feet
      b. Required Capacity: 3,500,000 gallons at the High Water Level.
      c. High Water Level: 26.0 feet from top of slab.
      d. Sidewall Height: 28.0 feet from top of slab.
   2. Structurally designed to comply with applicable building codes including:
      a. Wind Loads
      b. Seismic Loads
   3. The tank shall be designed for a maximum liquid level inside the tank equal to the tank wall height.
4. The tank shall include the internal launders, flow channels, troughs, and drops as shown on the drawings.
5. The tank shall include manhole rungs or corrosion ladder for emergency egress from the tank in the event of an accident resulting in personnel falling into the tank.

1.07 NOTATION

- **b** - Unit width (linear)
- **d** - Distance from face of support (linear)
- **Ec** - 57,000 (f′) short term modulus of elasticity of concrete
- **f′c** - 28-day compressive cylinder strength of concrete (force per unit area)
- **fc** - Permissible compressive concrete stress (force per unit area)
- **fpu** - Specified tensile strength of steel prestressing wire strand, (force per unit area)
- **fse** - Effective steel prestress after losses (force per unit area)
- **fsi** - Allowable steel prestress before losses (force per unit area)
- **ld** - Length for bond development
- **H** - Depth of fluid (linear)
- **Pfw** - Final prestressing force for water load (force)
- **R** - Inside radius of tank (linear)
- **tc** - Core wall thickness (linear)

1.08 DESIGN METHOD

A. Base tank design on elastic analysis methods and take into account effects of all loads and prestressing forces during and after tensioning, and conditions of edge restraint at wall junctions with floor.
B. Stresses shall not exceed allowable stresses in paragraph E.
C. Consideration shall be given to the effects of all loads and load combinations including stresses induced by temperature and moisture gradients.
D. The recommendations herein pertain to service load conditions and serviceability requirements.
E. The design must meet the strength requirements of ACI 350. All applicable sections of the latest edition of ACI 350, including supplements and the precast and prestressed concrete chapters, shall be allowed except when supplemented or modified by provisions of this specification.

1.09 DESIGN LOADS

A. Loads indicated in this section shall be included in the design. Loadings, including post-tensioning forces shall follow governing codes.
B. The manufacturer shall refer to the provided geotechnical report for critical design values.

1.10 FOUNDATION AND FLOOR DESIGN

A. Dead Loads.
B. Water Loads.
C. Uplift due to ground water and/or flood water.
D. Radial forces from base to tank wall.
E. When tanks are to be installed in locations susceptible to frost, the foundations shall extend below grade to the maximum frost depth for the area.
F. Minimum thickness of the slab shall be 8 inches. Floors shall be placed continuously in sections as large as practicable to decrease the length of construction joints and their related problems. Precautions shall be taken with large floor sections to limit long-term shrinkage by using low-slump concrete, adequate reinforcement, and proper curing conditions. Hydrostatic
uplift when the tank is empty, or when the tank water level is lowered rapidly, shall be precluded by adequate surface drainage and underdrainage, if necessary.

1. The slab shall be thickened as necessary in areas where equipment is to be anchored to the slab. The thickened slab shall extend into the subgrade. Slab thickening into the tank shall not be accepted.

G. Where joints are provided, suitable methods and/or devices will be employed to prevent leakage. For crack control in the floor, the minimum reinforcement in each of the two perpendicular directions in the horizontal plan shall be 0.0015 times the cross sectional area of the concrete area for prestressed floors or 0.005 times the cross sectional area for non-prestressed floors. Where the wall base shear is transferred into radial tension in the slab, additional reinforcement shall be as required. A minimum of 2 in. of concrete protection shall be provided for all reinforcing steel on the sides of the walls in contact with the liquid contents of the tanks.

1.11 FOOTING

A. Wall Footings:
   1. A continuously reinforced concrete footing, either as a thickened floor edge region or one separated from the floor, shall be provided to distribute the vertical loads at the base of the wall to the underlying foundation material. Foundation for membrane floors and footings shall be of uniform compaction and bearing value to support the structure without differential settlement that may damage the structure. Foundation for footings shall likewise provide uniform support to limit differential settlement.

1.12 WALL DESIGN LOADS

A. Internal Pressure: The pressure from maximum water level to the top of the wall.
B. Backfill Loading: The lateral pressure from earth backfill, symmetrical or asymmetrical. Net lateral loads, including those due to unequal backfill, shall be determined by rational methods of soil mechanics based on foundation and soils investigations. Surcharge loads on backfill surfaces shall be considered. Backfill pressure shall not be used to reduce the amount of post-tensioning force required for resisting internal water pressure. The assumed internal friction angle of the soil shall be no more than 20 degrees for unit soil density of 125 pounds per cubic feet. Refer to the geotechnical report for additional information. Hydrostatic pressure shall be considered unless the design ground water elevation is below the bottom of the tank foundation per the Geotech report.
C. Consider all effects of construction including loads resulting from equipment, materials, and construction methods to be used.
D. Appurtenance loads.
E. Operating loads and system surges.
F. Compressive stresses and bending moments in the wall due to application and post-tensioning forces.
G. Temperature gradient through the wall.
H. Moisture gradient through the wall.
I. Seismic loads- shall be as required by ASCE 7
J. Wind loads- shall be as required by ASCE 7
K. Consider compressive stresses and bending moments in the wall due to unequal distribution of post-tension cables such as banding above and below all openings.

1.13 VERTICAL STRESSES AND REINFORCEMENT

A. Maximum tensile stress for regular mild steel reinforcement used to resist vertical bending stresses shall be 18,000 psi for Grade 60. Bar size shall be no greater than #8 and bar spacing shall not exceed 12 inches.
B. Shear Forces: Reinforcement of joints must be sufficient to resist the following loads and any combination thereof:
   1. Water
   2. Backfill
   3. Prestressing
   4. Other conditions specific to the site
   5. Reinforcing steel should not be credited with resisting any portion of primary circumferential tension resulting from radial design pressure.
   6. Mild steel reinforcement shall not be used to resist any portion of circumferential tension.

1.14 POST-TENSIONING STEEL
A. Maximum permissible initial stress f in any wire on the wall shall not exceed 0.75fpu.
B. Allowance for stress losses in steel, and for maintaining residual compression in the concrete if not calculated by more precise means, should assumed as 32,000 psi. This figure includes consideration of losses due to shrinkage, plastic and elastic shortening of concrete, and relaxation of steel. A greater allowance for stress losses may be required for structures subjected to unusual creep, shrinkage, or temperatures, or where the radial design pressure is not applied for a long time after completion of construction.
C. Friction losses should be computed in accordance with ACI 318 and should be added to other computed losses.
D. Maximum design stress in prestressing wire, for structures subject to full design load, after deduction of the above allowances for stress losses, shall not exceed 0.60 fpu.

1.15 NONSTRESSED REINFORCEMENT
A. Reinforcing steel shall be designed in accordance with the requirements of ACI 318. Maximum crack control quantity for deformed bars provided in ACI 350 shall not be exceeded.
B. Reinforcing may consist of bars or welded wire fabric to effectively control cracking due to bending moments in the wall.
C. Reinforcing steel should not be credited with resisting any portion of primary circumferential tension resulting from radial design pressure.
D. Mild steel reinforcement shall not be used to resist any portion of circumferential tension.

1.16 ALLOWABLE STRESSES IN CONCRETE
A. The stresses for concrete shall not exceed the values indicated below:
B. COMPRESSION: Extreme fiber
   1. fc
      a. 0.55 fc initial
      b. 0.45 fc at service loads
C. TENSION: In zones with auxiliary reinforcement and diaphragm
D. SHEAR: As a measure of diagonal tension at a distance d from the face of the support, psi.
   1. Shear strength of the tank walls shall be provided in accordance with ACI 318, Sec. 11.10, Special provision for walls.
E. BOND: Development length and bonding reinforcements: Deformed bars and welded wire fabric.
   1. ld
      a. Development length, l shall be computed as a measure of bond resistance in accordance with recommendations of ACI Committee 318.
F. Note: coefficients shown are for values of fc expressed in psi.

1.17 WALL THICKNESS
A. The thickness of the concrete wall shall be such that membrane shell stresses are within the allowable stresses but not less than 9-in. thick.
1.18 WALL JOINT DETAILS
   A. Rotation and translation under circumferential prestressing and lateral wall loads.
   B. The designer shall consider wall boundary conditions resulting from the construction joint
details to be used at the top and bottom of the wall.
   C. The base of the wall shall be supported on plastic shims to allow wall movement during
tensioning of horizontal tendons.

1.19 WALL DESIGN
   A. Design Method: Wall design shall be based on elastic cylindrical shell analysis for stresses and
deformations due to loads outlined herein. Effects of shrinkage, temperature change,
temperature gradient, and creep should be taken in account.
   B. Circumferential Post-Tensioning Force: Circumferential post-tensioning steel shall be furnished
to resist all forces due to internal loads, after accounting for all stress losses and for residual
compression.

1.20 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Shop Drawings and Product Data:
      1. Furnish detailed design drawings, design calculations and detailed field construction
         procedures for review and approval by the Engineer.
      2. Design drawings and calculations shall be sealed by a Registered Professional Engineer
         licensed to practice in the State of the State in which the Project is located.
      3. The Engineer's approval does not relieve the Contractor of his design responsibility.

1.21 QUALITY ASSURANCE
   A. Tank Supplier Qualifications: A firm that complies with the following requirements and is
      experienced in producing circular precast, post-tensioned, concrete tanks that have a record of
      successful in-service performance and no tank failures.
      1. Assumes responsibility for engineering circular precast, post-tensioned, concrete tanks to
         comply with performance requirements. This responsibility includes preparation of Shop
         Drawings and comprehensive engineering analysis by a qualified professional engineer
         employed directly for the Tank designer/builder.
      2. Precast Tank Engineer Qualifications: A professional engineer licensed in jurisdiction
         where Project is located and who has no less than 5 years’ experience in providing
         engineering services of the kind indicated. Engineering services are defined as those
         performed for designs and installations of circular precast, post-tensioned, concrete tanks.
      3. Participates in PCI’s Plant Certification program and is designated a PCI-certified plant for
         Group C, Category C3 at the time of bid.
         a. Certification shall be maintained throughout the production of the precast concrete
            units. Production shall immediately stop if at any time the fabricator’s certification is
            revoked, regardless of the status of completion of contracted work. Production will
            not be allowed to re-start until the necessary corrections are made and certification
            has been re-established. In the event certification cannot be re-established in a
            timely manner to avoid project delays, the fabricator, at no additional cost, will
            contract out the remainder of the units to be manufactured at a PCI certified plant.
      4. Has sufficient production capacity to produce required members to meet the project
         schedule.
   B. Tank Supplier: Subject to compliance with requirements, provide circular precast, post-
tensioned, concrete tanks by Dutchland, Inc. located in Gap, Pennsylvania, or pre-approved
equal.
C. Alternate Tank Supplier Pre-approval Qualifications: Alternate Tank Suppliers wishing to become pre-approved shall comply with the Tank Supplier Qualifications listed above, and the following requirements.
   1. The firm shall have a minimum of 15 consecutive years in designing, producing and installing tanks of similar arrangement, size and complexity using the precast, post-tensioned system.
   2. The firm shall document the successful installation and performance of a minimum of ten similar facilities, and certify compliance of those structures will all applicable provisions of AWWA D115 for a precast, post-tensioned structure.
   3. The firm shall employ a full-time engineer on staff who meets the Precast Tank Engineer Qualifications listed above and who has served as the engineer in responsible charge of at least ten similar structures.
   4. The firm shall submit with its bid a summary sheet documenting compliance with these qualifications.
   5. The firm shall submit with its bid a reference sheet listing contact names and telephone numbers of at least five similar structures built by the firm.

D. Post-Tensioning Installer Qualifications: A qualified installer whose full-time Project superintendent has successfully completed PTI's Level 1 Bonded PT - Field Installation course.
   1. Superintendent must receive training from post-tensioning supplier in the operation of stressing equipment to be used on Project.

E. Post-Tensioning Inspector Qualifications: Personnel performing field inspections and measuring elongations shall have successfully completed PTI's Level 1 Bonded PT - Field Installation course.

1.22 PRE-INSTALLATION MEETING
A. Convene one week before starting work of this section.

1.23 WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. The Manufacturer shall provide a 5-year structural warranty to the Owner. The Manufacturer shall warrant that all items provided by the Manufacturer including the base, walls, roof, support columns, etc. shall be free from material defect due to faulty equipment design, workmanship, or materials which appear, are discovered, and are reported in writing to the Manufacturer within 5 years of the installation date. This warranty shall also extend to coatings, liners, and sealants recommended, provided and installed by the Manufacturer to provide a watertight structure. If material defects due to faulty equipment design, workmanship, or materials are reported to the Manufacturer within a 5 year period, the Manufacturer shall furnish without charge to the Owner all necessary labor and materials required to repair all defects subject to this warranty.
C. The Owner's or the Engineer's approval of the Contractor's design, or the Owner's acceptance and final payment for the work shall not relieve the Contractor of design responsibility.

PART 2 PRODUCTS
2.01 MANUFACTURERS

2.02 MATERIALS
A. Concrete
   1. Conforming to recommendations of ACI 350, as modified herein. Submit mix proportions for approval by the Engineer meeting the following strength requirements:
      a. Strength: 5,000 psi minimum 28 days compressive strength.
      b. Slump: 4-inch maximum, unless HRWR admixtures are used.
      c. Cement: Type II or Type I/II conforming to ASTM C 150.
      d. Mixing Water: Conforming to ACI 318.
e. Admixtures: Comply with requirements of ACI 301.
  f. Admixtures containing chlorides, fluorides, or sulfides are not permitted.

2. Perform compression tests in accordance with ACI 301.
3. Non-prestress reinforcement shall conform to requirements of ACI 318 or ASTM A 615, Grade 60.

2.03 POST TENSIONED TENDONS
A. Post-tensioned tank walls and floors shall be designed in accordance with ACI 318, and the Post-Tensioning Institute except when supplemented or modified by provisions of this specification.
B. Post-tensioning shall be as follows:
  1. Horizontal prestress reinforcement shall use a bonded or un-bonded seven wire tendon system.
  2. Vertical wall tendons, floor tendons, and roof tendons shall be either bonded or unbonded, encapsulated seven wire tendons.
  3. Tendons shall be seven wire, stress relieved low relaxation strand conforming to ASTM-416-A "Specifications for uncoated seven-wire stress relieved low relaxation strand for prestressed Concrete". Mill test reports for each pack of strand shall be furnished to the Engineer upon request.
C. Corrosion Protection of Bonded Tendons:
   a. Plastic ducts for horizontal circumferential tendons should be either corrugated or smooth, minimum 40 mil thickness. The horizontal ducts should be made continuous in the vertical joint between wall panels. Plastic ducts should be chemical inert.
   b. Tendons are grouted in the ducts with Portland cement grout, in accordance with Chapter 18 of ACI 318.
D. Corrosion Protection of Unbonded Tendons:
   a. Corrosion protection of unbonded tendons shall consist of two layers with one layer of corrosion inhibitor on the steel strand, then a seamless layer of polypropylene. Polypropylene shall be hot melt extruded over the corrosion inhibitor with a thickness averaging 0.020-inch with no areas of coating less than 0.018-inch thick. Corrosion inhibitor shall provide a thickness over the bare strand of at least 0.003-inch.
   b. Unbonded strands shall be in conformance with PTI "Specifications for Unbonded Single Strand Tendons" for a corrosive environment.

2.04 ELASTOMERIC MATERIALS
A. Bearing Pads: Neoprene containing virgin polymer with physical properties complying with ASTM D2000.
   1. Ultimate Tensile Strength: 1,500 psi.
   5. The method of securing sponge filler pads shall be the same as for elastomeric pads. All voids shall be caulked with an approved nontoxic sealant that bonds securely to all surfaces of pad, filler waterstop. Particular attention shall be paid to the filling and sealing of the joint between bearing pad and waterstop.

2.05 APPURTENANCES
A. Flanges: Provide Cast-In-Place wall flanges and Openings as indicated on the Drawings:
B. Access Manway: A bolted 18" x 24" elliptical galvanized steel access manway shall be provided in the side wall of each above ground tank. The manhole frame shall have a waterstop flange attached with a continuous weld. The manway door shall be hinged to the tank wall and shall include a 40 durometer, full faced neoprene rubber gasket to provide a water tight seal.
PART 3  EXECUTION

3.01  CONCRETE PLACEMENT

A. Unless specifically authorized in writing, concrete shall not be placed during cold weather when the ambient temperature is below 35 degrees F and rising, or below 40 degrees F and falling, when the concrete is likely to be subjected to freezing temperature before final set has occurred and the concrete strength has reached 500 psi. Most well-proportioned concrete will reach this strength when the temperature has been maintained at 50 degrees F into the second day after placement. The materials shall be heated so that the temperature of the concrete when deposited shall be not less than 50 degrees F, or as otherwise specified in ACI 306, or more than 90 degrees F. If required, all methods and equipment for heating and protecting concrete-in-place shall be subject to approval.

B. For concrete placed during extremely hot weather, the aggregate shall be cooled by frequent spraying in such a manner as to utilize the cooling effect of evaporation. During such periods, the placement schedule shall be arranged, as approved, in such manner as to provide time for the temperature of the previously placed course to recede. The mixing water shall be the coolest available at the site, insofar as is practicable and shall conform to ACI 305.

C. Placement of concrete during periods of low humidity shall be avoided when feasible and economically possible, particularly when large surface areas are to be finished. In any event, surfaces exposed to drying wind shall be covered with polyethylene sheets immediately after finishing and shall be water cured continuously from the time the concrete has taken initial set. Curing compounds may be used in conjunction with water curing.

D. Concrete for each precast panel shall be placed in one continuous operation.

E. Precast tank supplier shall provide for all penetrations and openings in the tank walls, as indicated on the Drawings, and subject to Engineer's approval.

3.02  ERECTION

A. The precast panels shall be erected to the correct vertical and circumferential alignment. The edges of adjoining panels shall not vary inwardly or outwardly from one another by more than 3/8 inch (9.5 mm) and shall be placed to the tank radius, within the same tolerance. Tank wall penetrations and openings shall be in proper alignment and location.

B. The vertical slots between panels shall be filled with cast-in-place concrete, compatible with the details of the joint. The strength of the concrete grout shall be at least equal to that specified for concrete in the wall panels.

C. The steel reinforcement shall be placed in conformance with ACI 301. The minimum cover over steel and welded wire fabric reinforcement shall be as specified.

D. Set restraint blocks to the correct radially and tangential position. Mark the center of the joint on each block. Use this to determine edge of panel location on blocks and mark within 1/8 in.

E. Set braces with red head type inserts into the tank bottom at the correct radial position.

F. Erect panels on low friction shim stacks, remove the lifting attachments and plumb the panel.

G. Threading the circumferential tendons should begin after all panels are erected and plumbed. Pointing the strand ends with a grinder and/or use of lubricant between the strand and chases may be necessary if misalignment exists.

H. Vertical joints must be formed and air entrained concrete placed in them. Concrete must be without voids. Aggregate segregation must not occur. Test cylinders must be made, cured under job site conditions, and broken to determine when circumferential post-tensioning may proceed.

I. After post-tensioning is complete and the elongations are checked by the Engineer, the excess strand length may be removed and the anchorage hardware and exposed wire strands shall be completely coated with epoxy or encapsulated in plastic. The anchorage-coupler area shall then be covered with the required concrete cover (as per manufacturer's design) and the void inside the cover shall be grouted solid with concrete grout.
J. Grouting of tendon ducts should be carried out as promptly as possible after tensioning. The total time the prestressing steel is exposed to other than a controlled environment prior to grouting shall not exceed 10 days, nor 7 days after tensioning, whichever is less, unless special precautions, such as use of a vapor phase corrosive inhibitor, are taken to protect the prestressing steel. The methods or products used shall not jeopardize the effectiveness of the grout as a corrosion inhibitor, nor the bond between the prestressed reinforcement and grout. Vapor phase corrosion inhibitors should be used in strict accordance with the manufacturer's recommendations. Additional restrictions may be appropriate for potentially corrosive environments.

K. Grouting equipment shall be capable of grouting at a pressure of 200 psi (1.4 MPa). However the tendon ducts should not be over pressurized during injection if blockage exists. Instead the grout should be washed out and the blockage removed. Ducts may be flushed with clean water (not air) prior to grouting to assure there are no blockages.

L. Horizontal grouted tendons shall have air release valves which will also act as standpipes at intentionally high points and drains at intentionally low points such as when tendons are deflected around penetrations. These vents and drains, and a vent at the opposite end of the tendon from the point of injection, should be closed when a steady stream of pure grout is ejecting. After all vents and drains are closed, the pressure in the duct can be increased to 100 psi (0.7 MPa) and a valve at the injection end closed to lock off the grout under pressure. After grout has set, but not less than 24 h after grouting, cut off any vents or stand pipes and seal.

M. Grout injections in vertical tendons shall always be from the lowest point in the tendon to avoid entrapping air.

N. Provide admixtures to prevent bleeding and grout settlement. Material shall be added to the mix on-site. Acceptable products are Sika Interplast-N, or equal.

O. All cement grout should pass through a screen with 0.125 in. (3 mm) maximum clear openings prior to being introduced into the grout pump.

P. When quick setting can occur due to hot weather, the grout should be cooled by acceptable methods such as cooling the mixing water to prevent blockages during pumping operations. When freezing weather conditions prevail during and following the placement of grout, adequate means, such as keeping the wall temperature up by heaters or blankets, shall be provided to protect the grout in the ducts from freezing until the grout attains a minimum strength of 1000 psi (6.9 MPa).

Q. The seal between the walls and tank bottom is then installed. The concrete must be dry for seal installation. Temperature must be per the sealant manufacturer’s recommendations. After the seal is installed and cured, the tank should be hydrotested.

3.03 WALL TOLERANCES
A. The maximum out-of-round tolerance for precast concrete panel walls shall be based on the ratio of +/- 1/2 in. per 100 feet diameter circle and the circumference shall be a smooth curve. Tolerance in wall thickness shall be + 1/4 inch concrete wall thickness and shall not be less than specified. All transitions shall be gradual and smooth. Walls shall be plumb within a tolerance not exceeding 3/8 in. per 10 ft. of vertical dimensions.

3.04 ELASTOMERIC BEARING PADS
A. Where bearing pads are used, the tank wall shall be free of all obstruction that would prevent free movement of the joint. All bearing pads shall be placed at a minimum of 12 inches from panel's vertical edges toward panel center line.

3.05 SPONGE FILLERS
A. The method of securing sponge filler pads shall be the same as for elastomeric pads. All voids shall be caulked with an approved nontoxic sealant that bonds securely to all surfaces of pad, filler waterstop. Particular attention shall be paid to the filling and sealing of the joint between bearing pad and waterstop.
3.06 TESTING

A. Upon completion of wall construction of the tank, it shall be filled to overflowing with water furnished by the Owner. The tank shall remain filled for a period of at least 24 hours to allow for absorption. After the initial period, makeup water shall be added as required and the water level recorded and measured at the end of the 48 hour period.

B. There shall be no flowing water allowed through the tank walls or slab. Damp spots which glisten on the surface of the tank and spots where moisture can be picked up on a dry hand will not be allowed. Maximum allowable liquid-volume loss by measurement shall not have exceeded 1/10th of one percent of the tank capacity per 24 hours. If the loss exceeds this amount, the Engineer shall require the tank to be repaired and retested.

3.07 TANK BACKFILL

A. When backfill is required, it shall be initiated only after the tank has been satisfactorily tested and filled.

3.08 CLEAN UP

A. The premises shall be kept clean and orderly at all times during the work, and upon completion of construction, the Contractor shall remove or otherwise dispose of all rubbish and other unsightly material caused by the construction operations. The Contractor shall leave the premises in as good a condition as was found.

END OF SECTION
SECTION 43 41 65
PRESTRESSED CONCRETE TANKS

PART 1 GENERAL

1.01 SCOPE OF WORK
A. The Contractor may provide either Precast Post Tensioned Concrete Tanks or Prestressed Concrete Tanks. This section specifies the requirements for Prestressed Concrete Tanks. Refer to section 43 41 64 for the requirements for Precast Post Tensioned Tanks.
B. Furnish all labor, materials, equipment and incidentals to erect the prestressed concrete storage tanks, including foundation, tank structures, and tank appurtenances as shown on the Drawings and as specified herein.

1.02 REFERENCES
B. AWWA D110-04 - Wire- and Strand-Wound, Circular, Prestressed Concrete Water Tanks.
E. ASTM A 1008/A 1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy With Improved Formability.

1.03 SUBMITTALS
A. Shop Drawings: Provide complete plan, elevation, and sectional views showing critical dimensions including:
   1. Size, location and number of all reinforcing bars.
   2. Thickness of all parts of the tank structure including floor, core wall, and covercoat.
   3. Prestressing schedule including number and placement of prestressing wires on the tank wall and total applied force per foot of wall height.
   4. Location and details of all accessories required.
   5. Minimum size of shop drawings shall be 18” by 24”.
B. Product Data: Submit concrete design mixes including ingredient proportions, minimum cementitious content, and water/cementitious ratio in accordance with these specifications.
C. Design Data: Submit structural calculations for the tank, signed and sealed by a professional engineer in accordance with Section 1.05 A.3 of these specifications.
D. Test Reports: Submit concrete strength reports for 7-day and 28-day breaks.
E. Warranty Document: Submit warranty document in Owner’s name in accordance with Section 1.07 A of these specifications.
F. Project Record Documents: Record actual location layout and final configuration of tank and accessories on shop drawings and submit to engineer after construction of the tank is complete.

1.04 QUALITY ASSURANCE
A. Qualifications and Experience:
   1. Tank Construction Company: Shall be a firm with ten years of experience in the design and construction of wire-wound, circular prestressed composite tanks with satisfactory evidence that it has the skill, reliability, and financial stability to build and guarantee the tank in accordance with the quality required by these specifications. The company
constructing the tank shall have built completely in its own name in the past five years, and be presently responsible for, a minimum of ten (10) prestressed composite tanks of equal or greater size than that required for this project which meet these specifications and are now providing satisfactory service.

2. Construction: The entire tank, including all portions of the floor and wall shall be built by the tank construction company, using its own trained personnel and equipment.

3. Design: All design work for the tank shall be performed by a professional engineer with no less than five years of experience in the design and construction of circular prestressed composite tanks. The professional engineer shall be a full-time staff member of the tank construction company and shall be licensed to work in the state where the project is located.

4. The steel shell design and epoxy injection procedure (covered by U.S. Patent 5,150,551) shall have been used in the ten tanks required in the tank construction company's experience record.

B. Prequalification:

1. Crom, LLC is the prequalified tank construction company for the prestressed concrete tank.

2. Additional tank construction companies wanting to be prequalified and meeting the criteria as stated in Section 1.05 Qualifications and Experience shall make a complete submittal to the Engineer for review fourteen (14) days prior to the date set for receipt of the bids.

3. Prequalification submittal by tank construction companies who are not previously prequalified shall include the following items:
   a. Preliminary design drawings and calculations showing the dimensions of the tank, details of the type of construction, wire wound prestressing methods and principal sizes and thicknesses of structural members.
   b. Complete experience record for the tanks that have been designed and built in the tank construction company's own name. The record should also include the size of the tank, name and address of the Owner, the year of construction and the name of the Engineer for the project.
   c. The name of the tank designer and his/her experience as the designer of record for prestressed concrete tanks.
   d. (Other items for prequalification submittal i.e. Schedules, Resumes for Design and Construction Personnel)

1.05 DESIGN REQUIREMENTS

A. Anoxic Reactor #1 shall be designed and constructed as shown on the Drawings.

1. Anoxic Reactor #1
   a. Nominal Diameter: 140 feet
   b. Required Capacity: 3,200,000 gallons at the High Water Level.
   c. High Water Level: 28.0 feet from top of slab.
   d. Sidewall Height: 30.0 feet from top of slab.

2. Structurally designed to comply with applicable building codes including:
   a. Wind Loads
   b. Seismic Loads

3. The tank shall be designed for a maximum liquid level inside the tank equal to the tank wall height.

4. The tank shall include the internal launders, flow channels, troughs, and drops as shown on the drawings.

5. The tank shall include manhole rungs or a corrosion resistant ladder for emergency egress from the tank in the event of an accident resulting in personnel falling into the tank.

B. Nitrification Reactor #2 shall be designed and constructed as shown on the Drawings.

1. Nitrification Reactor #2
   a. Nominal Diameter: 152 feet
   b. Required Capacity: 3,500,000 gallons at the High Water Level.
c. High Water Level: 26.0 feet from top of slab.
d. Sidewall Height: 28.0 feet from top of slab.

2. Structurally designed to comply with applicable building codes including:
   a. Wind Loads
   b. Seismic Loads

3. The tank shall be designed for a maximum liquid level inside the tank equal to the tank wall height.

4. The tank shall include the internal launders, flow channels, troughs, and drops as shown on the drawings.

5. The tank shall include manhole rungs or a corrosion resistant ladder for emergency egress from the tank in the event of an accident resulting in personnel falling into the tank.

1.06 WARRANTY
A. Provide warranty for workmanship and materials on the complete structural portion of the tank for a five-year period from date of acceptance of the work. In case leakage or other defects appear within the five-year period, the tank construction company shall promptly repair the tank at its own expense upon written notice by the Owner that such defects have been found. Leakage is defined as a stream flow of liquid appearing on the exterior of the tank, the source of which is from the inside of the tank. The tank construction company shall not be responsible for, nor liable for, any subsurface condition. This warranty shall not apply to any accessory, equipment or product that is not a structural part of the tank and is manufactured by a company other than the tank construction company.

PART 2 PRODUCTS
2.01 MANUFACTURER
A. Crom, LLC - Gainesville, Florida - (352) 372-3436
B. Substitutions - See Section 01 60 00 - Product Requirements for Substitution Procedures.

2.02 PERFORMANCE
A. The design shall be in conformance with applicable portions of American Concrete Institute (ACI) 372R-03 Design and Construction of Circular Wire- and Strand-Wrapped Prestressed Concrete Structures, AWWA D110-04 Wire- and Strand-Wound, Circular, Prestressed Concrete Water Tanks, and currently accepted engineering principles and practices for the design of such structures.

B. Earthquake Design: Fixed percentage method as specified in AWWA D110, Section 4.1.

C. The thickness of the core wall shall be calculated so as to accept the initial compressive forces applied by prestressing, hydrostatic stresses induced by contents, and other applicable loads such as soil backfill and wind.

D. Backfill loads shall not be used in the design of the core wall to counteract hydraulic loads or provide residual compression in the wall.

E. Concrete: See Section 03 30 00 - Cast-In-Place Concrete.

F. Shotcrete:
   1. Use Type I cement.
   2. A maximum of 20% of cementitious material may be fly ash for all concrete mixes.
   3. Core Wall Shotcrete: Minimum 4000 psi compressive strength at 28 days, 4” +/-1” slump.
   4. Covercoat Shotcrete: Minimum 3500 psi compressive strength at 28 days, 4” +/-1” slump.
   5. Allowable compressive stress due to final prestressing force, fg:
      a. 1250 psi + 75t psi/in. with 0.45 fg maximum (where fg is defined as compressive strength required for final prestressing force and t is the thickness of the core wall in inches).
   6. Allowable compressive stress due to initial prestressing force, fgi:
a. 1250 psi + 75 t psi/in. with 0.5 f'gi maximum or less (where f'gi is defined as compressive strength at time initial prestressing force is applied and t is the thickness of the core wall in inches).

b. Maximum of 2250 psi.

G. Prestressing Wire:
1. The prestressing wire shall conform to the requirements of ASTM A821, Type B.
2. Wire size shall be 0.162" (8 gauge), 0.192" (6 gauge) or larger, but no larger than 0.250".
3. Working stress for the tank wall, fs shall be a maximum of 115,000 psi.
4. Allowable design tensile stress before losses, fsi shall be 145,600 psi or no greater than 0.63 fu.
5. Ultimate tensile strength, fu shall be, 231,000 psi or greater for 8 gauge wire, 222,000 psi or greater for 6 gauge.

H. Non-prestressed Mild Reinforcing Steel:
1. Allowable design tensile stress, fs shall be a maximum of 18,000 psi.
2. Yield strength of reinforcing steel, fy shall be 60,000 psi.

2.03 FLOOR

A. When tanks are to be installed in locations susceptible to frost, the foundations shall extend below grade to the maximum frost depth for the area.

B. A minimum percentage of 0.60% reinforcing steel (wire mesh or fiber mesh not allowed) shall be used in the membrane floor. The minimum percentage shall apply to all thickened sections and shall extend a minimum of 2' into the adjacent membrane floor. Provide a minimum slab thickness of 8".

1. The slab shall be thickened as necessary in areas where equipment is to be anchored to the slab. The thickened slab shall extend into the subgrade. Slab thickening into the tank shall not be accepted.

2.04 CORE WALL

A. The core wall shall be constructed of shotcrete, encasing a steel diaphragm continuous the full wall height without horizontal splices.

B. The thickness of the core wall shall be calculated so as to accept the initial compressive forces applied by prestressing, backfill, and other applicable loads, but in no case be less than 3½” thick.

C. Horizontal sections of the wall shall form true circles without flat areas, excessive bumps or hollows.

D. Interior and exterior surfaces of the core wall shall be water cured for a minimum of 7 days or until prestressing begins.

E. To compensate for bending moments, shrinkage, differential drying, and temperature stresses, the following reinforcing steel shall be incorporated in the core wall.

1. The top 2' of core wall shall have not less than 1% circumferential reinforcing.
2. The bottom 3' of core wall shall have not less than 1% circumferential reinforcing.
3. Inside Face:
   a. 26 gauge steel shell diaphragm continuous the full wall height without horizontal splices.
   b. Additional vertical and horizontal reinforcing steel bars as required by design computations.
4. Outside Face:
   a. Vertical reinforcing steel: Minimum of #4 bars at 12" center to center.
   b. Additional vertical and horizontal reinforcing steel bars as required by design computations.
2.05 STEEL SHELL DIAPHRAGM

A. A 26 gauge steel tank shell, complying with ASTM A 1008, shall be used throughout the core wall, providing a waterstop. The steel shell diaphragm shall be encased and protected with shotcrete no less than 1" thick at all places.

B. The steel shell is to be formed and erected so that a mechanical key is created between the shotcrete and diaphragm.

C. The sheets of steel diaphragm shall be continuous from top to bottom of wall; horizontal joints or splices will not be permitted.

D. All vertical joints in the diaphragm shall be sealed watertight by epoxy injection in accordance with U.S. Patent No. 5,150,551.

E. Epoxy injection shall be carried out from bottom to top of wall, using a pressure pumping procedure, after the steel shell has been fully encased, inside and outside, with shotcrete.

F. The sealant shall conform to the requirements of ASTM C881, Type III, Grade 1, and shall be 100% solids, moisture insensitive, low modulus epoxy system. When pumped, maximum viscosity of the epoxy shall be 10 poises at 77°F.

G. The epoxy sealant shall be suitable for bonding to concrete, shotcrete, and steel.

H. In all tanks designed to use a waterstop at the floor/wall joint, the steel shell diaphragm shall be epoxy bonded to this waterstop.

2.06 SHOTCRETE

A. All shotcrete shall be applied by or under direct supervision of experienced nozzlemen certified by the American Concrete Institute (ACI) as outlined in ACI certification publication CP-60.

B. Shotcrete mixes shall have a minimum of 1 part cementitious material to 3 parts of sand.

C. Each shotcrete layer shall be broomed prior to final set to effect satisfactory bonding of the following layer.

D. No shotcrete shall be applied to reinforcing steel or diaphragm that is encrusted with overspray.

E. No less than ?" thick shotcrete shall separate reinforcing steel and prestressing wire.

2.07 HORIZONTAL PRESTRESSING

A. Circumferential prestressing of the tank shall be achieved by the application of cold-drawn, high-carbon steel wire complying with ASTM 821 Type B, placed under high tension. A substantial allowance shall be made for prestressing losses due to shrinkage and plastic flow in the shotcrete and due to relaxation in the prestressing steel.

B. Placement of the prestressing steel wire shall be in a continuous and uniform helix of such pitch as to provide in each lineal foot of core wall height an initial force and unit compressive stress equal to that shown on the design drawings. Splicing of the wire shall be permitted only when completing the application of a full coil of wire or when removing a defective section of wire.

C. Areas to be prestressed will contain not less than 10 wires per foot of wall for 8 gauge and 8 wires per foot of wall for 6 gauge. A maximum of 24 wires per layer per foot for 8 gauge and 20 wires per layer per foot for 6 gauge will be allowed. Shotcrete shall be used to completely encase each individual wire and to protect it from corrosion. To facilitate this encasement, the clear space between adjacent wires is to be no less than one wire diameter.

D. Prestressing shall be accomplished by a machine capable of continuously inducing a uniform initial tension in the wire before it is positioned on the tank wall. Tension in the wire shall be generated by methods not dependent on cold working or re-drawing of the wire. In determining compliance with design requirements, the aggregate force of all tensioned wires per foot of wall shall be considered rather than the force per individual wire, and such aggregate force shall be no less than that required by the drawings.
E. The tank construction company shall supply equipment at the construction site to measure
tension in the wire after it is positioned on the tank wall. The stress measuring equipment shall
include: electronic direct reading stressometer accurate to within 2%, calibrated dynamometers
and a test stand to verify the accuracy of the equipment.

F. After circumferential prestressing wires have been placed, they shall be protected by
encasement in shotcrete. This encasement shall completely encapsulate each wire and
permanently bond the wire to the tank wall.

G. When multiple layers of wire are required, shotcrete cover between layers shall be no less than
1/8-inch thick.

H. After all circumferential prestressing wires have been placed, a shotcrete cover having a
thickness of no less than 1” shall be placed over the prestressing wires.

2.08 WALL OPENINGS

A. When it is necessary for a pipe to pass through the tank wall, the invert of such pipe or sleeve
shall be no less than 18” above the floor slab, and the prestressing wires required at the pipe
elevation shall be distributed above and below the opening leaving an unbanded strip around
the entire tank.

B. Unbanded strips shall have a vertical dimension of no more than 36” unless an axi-symmetric
shell analysis is performed to account for shear and moments caused by displacement of the
prestressing wires into adjacent bands.

C. All wall pipes and sleeves passing through the wall shall be sealed to the steel shell diaphragm
by epoxy injection.

2.09 TANK ACCESSORIES

A. The tank construction company shall furnish and install the tank accessories.

B. Flanges: Provide Cast-In-Place wall flanges and Openings as indicated on the Drawings:

C. Access Manway: A bolted 18" x 24" elliptical galvanized steel access manway shall be provided
in the side wall of each above ground tank. The manhole frame shall have a waterstop flange
attached with a continuous weld. The manway door shall be hinged to the tank wall and shall
include a 40 durometer, full faced neoprene rubber gasket to provide a water tight seal.

2.10 PAINTING

A. Shall match existing Crom Tank.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify elevations, placement and grading for tank prior to starting tank construction.

3.02 INSTALLATION

A. Tank Floor:
1. The floor shall be vibratory screened to effect consolidation of concrete and proper
encasement of floor reinforcing steel.
2. The floor shall be continuously water cured until tank construction is completed.

B. Tank Wall:
1. The wall shall be constructed in a predesigned manner utilizing steel shell diaphragm,
layers of shotcrete and prestressing wire.
2. The diaphragm shall be protected against damage before, during, and after erection. Nail
or other holes shall not be made in the steel shell for erection or other purposes except for
inserting wall pipes or sleeves, reinforcing steel, bolts, or other special appurtenances.
Such penetrations shall be sealed with an approved epoxy sealant.
3. Interior and exterior portions of the shotcrete wall shall be water cured for a minimum of 7
days or until prestressing is started.
C. Prestressing: The initial tension in each wire shall be read and recorded to verify that the total aggregate force is no less than that required by the design. Averaging or estimating the force of the wire on the wall shall not be considered satisfactory evidence of correct placement of prestressing wires.

3.03 FIELD QUALITY CONTROL

A. Inspection and Testing:
1. Hydrostatic Testing: Test completed tank for liquid tightness by filling tank to its overflow elevation with water provided by Owner.
2. Concrete and Shotcrete Testing: Test all concrete and shotcrete used in the tank structure in accordance with Section 03 30 00.

3.04 CLEANING AND DISINFECTION

A. Clean interior and exterior of tank to remove debris, construction items, and equipment.

END OF SECTION
SECTION 46 09 03
PROCESS CONTROL SYSTEM

PART 1  GENERAL

1.01  SECTION INCLUDES

A. The wastewater treatment process control system consists of the following, some of which are specified in other sections:
   1. Sensors, transmitters, and actuators.
   2. Controllers that communicate with each other, and their control panels and control panel devices, and controller configuration and programming.
   3. Process control network connecting controllers to each other and to sensors, actuators, and other devices and to external networks.
   4. Process control network wiring, routers, repeaters, and other network hardware.

B. This section also includes:
   1. Interoperability requirements for instrumentation specified in other sections.

C. PLC programming shall be provided by the Contractor.

D. Contractor shall install the PLC based control panels as shown on the drawings.

1.02  RELATED REQUIREMENTS

A. Drawings provided by the Engineer are schematic in nature. Contractor shall verify all information by coordinating exact requirements with the equipment suppliers for all equipment being connected to the control system.

1.03  REFERENCE STANDARDS


B. IEEE C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits; 2002 (Cor 1, 2012).

C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

D. UL 5085-3 - Low Voltage Transformers - Part 3: Class 2 and Class 3 Transformers; Current Edition, Including All Revisions.

1.04  SUBMITTALS

A. Make submittals in following order, prior to Startup:
   1. Shop Drawings and Product Data, as a single submittal package.
   3. Field Quality Control Plan.
   5. Startup Plan.
   6. Pre-Functional Inspection Checklists.

B. After Startup, make submittals in following order:
   1. Functional Test Reports.
   2. Revised Project Record Documents.

C. Product Data: For each product to be installed, submit manufacturer's technical data, including description of product, model names/numbers, and installation instructions.

D. Software Product Data: For each different software package to be installed or used during installation, submit manufacturer's technical data, including feature description, licensing requirements, and user manual.

E. Shop Drawings: See below under "SHOP DRAWINGS".
F. Field Quality Control Plans: Prepare detailed plans for inspecting and testing the process control system prior to Startup and after Startup.
   1. Explain, step-by-step, the actions and expected results that will demonstrate that the control system performs in accordance with requirements.
   2. Organize plan to verify each unit process in flow sequence or reverse flow sequence, whichever is most appropriate, and with overall system operation verified last.
   3. Coordinate plan with Startup Plan and with overall system functional testing.
   4. Include details on equipment needed, including manufacturer name, model number, equipment function, date of the latest calibration, and results of latest calibration.

G. Operation and Maintenance Data: See Section 46 01 06 for requirements.

1.05 SHOP DRAWINGS

A. General Requirements for Shop Drawing Submittals:
   1. Information in Contract Documents: To the extent that any of the specified submittal information is already indicated in the contract documents, include that data in submittals; if any specific layout is shown on the contract drawings, model submittals on that layout unless there is a good reason to use a different layout.
   2. Deviations from Contract Documents: Clearly identify all deviations from the contract documents, for approval; unacceptable deviations discovered after approval of submittal will be cause for rejection of the work.
   3. O&M Data in Shop Drawings: Shop drawings are intended to become as-built drawings and be incorporated into O&M Manual; provide all information specified for O&M data in the relevant submittal.

B. Provide a summary of the proposed control functions and a theory of operation for the control system.

C. Process Control System Layouts: For each unit process, show schematic layout of network, control devices, and controlled equipment, with additional information necessary to identify all components; layout that approximates physical layout is preferred.

D. Unit Process Control Sequences: For each unit process, provide narrative of control sequence and diagram of control logic; clearly identify all deviations from the contract documents.

E. Process Control Network Riser Diagrams: For each unit process, show all network devices, controllers, transmitters, and network terminators; schematic or tabular format may be used; for each item, show:
   1. Descriptive name.
   2. Physical sequential order; i.e. previous and next device on network.
   3. Room identifier and location within room.

F. Points Schedule: For each unit process, show all input, output, calculated, virtual, and other points; for each point show at least:
   1. Device address and NodeID.
   2. General description.
   3. Hardware I/O, including Type (analog input, analog output, binary input, binary output, pulse accumulator).
   5. Overrides.

G. Equipment Schedule: For each unit process, list each control device, instrument, and item of controlled equipment, with:
   1. Project unique identifier.
   2. Device or equipment description.
   3. Manufacturer, model number, part number.
   4. List of other submittals related to this item, by submittal number.
H. Wiring Diagrams: For each unit process, prepare functional wiring diagrams showing interconnection of conductors and cables to controllers and to terminals of input and output devices, starters, and controlled equipment.
   1. Show each power supply and transformer not integral to a controller, starter, or equipment item.
   2. Identify sources of power back to panel board circuit breaker number, controller enclosures, magnetic starter, or equipment control circuit.
   3. Show necessary jumpers and ground connections.
   4. Show connected volt-ampere load and power supply volt-ampere rating.
   5. Show labels of conductors.

I. Provide screen shots of the user interface screens and all other applicable screens.

1.06 PROJECT RECORD DOCUMENTS

A. Product Data Submittals: Update product data submittals to show products actually installed.
B. Shop Drawing Submittals: Update all shop drawing submittals to show "as-built" conditions; identify changes clearly.
C. Copies of Installed Controller Programming and Software:
   1. Include:
      a. Complete source code necessary for controller to function correctly if installed on a replacement controller of same type.
      b. Each different controller programming application (LNS Plug-in).
   2. Submit on optical disk, clearly marked with project identification, description of contents, and date of latest revision.
   3. Include a list or table of contents organized by controller, clearly indicating which program or file is associated with which device(s).

PART 2 PRODUCTS

2.01 OPERATIONAL REQUIREMENTS

A. Data from other sources (user inputs, recipes, tunable parameters, intelligent devices, etc.) are combined with process data into a single logical database that defines, in real time, the known state of the process. Control strategy algorithms produce process control outputs that are also combined into the logical database to complete the process state definition.

2.02 GENERAL EQUIPMENT REQUIREMENTS

A. Operating Environment: Unless otherwise specified, provide products rated for continuous operation under following conditions:
   1. Products Installed Indoors: Ambient temperatures in range of 32 to 122 degrees F (0 to 50 degrees C).
   2. Products Installed Outdoors or in Unconditioned Indoor Spaces: Ambient temperatures in range of minus 35 to plus 151 degrees F (minus 37 to 66 degrees C).
   3. Air Pressure: Conditions normally encountered in installed location.
   4. Vibration: Conditions normally encountered in the installed location.
   5. Humidity: 10 to 95 percent relative humidity, noncondensing.

B. Surge Protection:
   1. Equipment Connected to AC Circuits: Provide equipment that is internally protected against power-line surges or provide separate protection against power-line surges; provide protection meeting requirements of IEEE C62.41.2; do not use fuses.
   2. Equipment Connected to Transmitter and Control Wiring That is Installed Outdoors: Provide equipment that is internally protected against induced waveform surges or provide separate protection against waveform surges as follows:
      a. A waveform with 10-microsecond rise time, 1,000-microsecond decay time and peak current of 60 amps.
      b. A waveform with 8-microsecond rise time, 20-microsecond decay time and peak current of 500 amperes.
2.03 SYSTEM DESCRIPTION

A. Process Control System: Provide a system that monitors and automatically controls operation of process equipment and instrumentation using programmable controllers.

1. Provide a control system in which control sequence logic resides in the local controllers and which is not dependent on any supervisory control software or centralized functionality.
2. Provide end-to-end process control loop accuracy from sensor to display and final control element.
3. Use sequences of operation, setpoints, settings, and alarm limits as indicated.
4. Provide a transmitter for each sensor, unless indicated for local readout/display only.
5. Provide a transmitter/controller for each actuator and actuated device.
6. Provide a controller for each device having alarm states.
7. Provide for operator interaction, process equipment control, and monitoring.
8. Include all necessary sensors, field preamplifiers, signal conditioners, offset and span adjustments, amplifiers, transducers, transmitters, control devices, and engineering unit conversions and algorithms for applications.
9. Provide network and control hardware that can be replaced by similar control equipment from other equipment manufacturers without loss of system functionality.

B. Operation and Maintenance Documentation: Provide sufficient documentation and data, including rights thereto, such that repair, replacement, upgrades, and expansions of the system and individual devices can be accomplished without subsequent or future dependence on original installer.

2.04 PROCESS CONTROL NETWORK

A. Network Design: As required to connect all process control devices and points, with following limitations:

1. No more than two routers between any controller and the backbone.

B. Control Network Wiring:

1. For Binary and Analog Signals: 18 AWG, copper, single- or multiple-twisted, minimum 2 inch (50 mm) lay of twist, 100 percent shielded pairs, with 300-volt insulation, unless otherwise shown.
   a. Each Pair: 20 AWG tinned-copper drain wire and individual overall pair insulation.
   b. Cables: Overall aluminum-polyester or tinned-copper cable-shield tape, overall 20 AWG tinned-copper cable drain wire, and overall cable insulation.
2. For 120-volt Control Circuits: 18 AWG or thicker stranded copper rated for 600-volt service.

C. Terminal Blocks: Where not integral to equipment, provide terminal blocks that are insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism; suitable for rail mounting, with end plates and partition plates for separation or with enclosed sides.

D. Transformers: UL 5085-3; sized so that connected load is no greater than 80 percent of transformer rated capacity.

2.05 CONTROLLER INPUT-OUTPUT (I/O) FUNCTIONS

A. Input Measurement Accuracy: Maximum error of measured value at SNVT output less than 105 percent of maximum allowable error specified for sensor or instrument.

B. Analog Inputs:

1. Analog to digital (A-to-D) conversion with minimum resolution of 8 bits plus sign or better as needed to meet accuracy requirements.
2. Provide signal conditioning including transient rejection for each analog input.
3. Capable of being individually calibrated for zero and span.
4. Common mode noise rejection of at least 50 dB from 0 to 100 Hz for differential inputs, and normal mode noise rejection of at least 20 dB at 60 Hz from source impedance of 10,000 ohms.

C. Analog Outputs:
1. Digital to analog (D-to-A) conversion with minimum resolution of 8 bits plus sign, and output signal with range of 4 to 20 mA DC or 0-10 volts DC.
2. Capable of being individually calibrated for zero and span.
3. On outputs with Hand-Off-Auto (H-O-A) switches, provide for overriding output to 0 percent and to 100 percent.

D. Binary Inputs:
1. Accept contact closures and ignore transients of less than 5 millisecond duration.
2. Provide isolation and protection against applied steady-state voltage up to 180 volts AC peak.

E. Binary Outputs:
1. Provide relay contact closures or triac outputs for momentary and maintained operation of output devices.
2. Relay Contact Closures:
   a. Minimum duration of 0.1 second.
   b. At least 180 volts of isolation.
   c. Electromagnetic interference suppression on all output lines to limit transients to non-damaging levels.
   d. Minimum contact rating of one ampere at 24 volts AC.
3. Triac Outputs: At least 180 volts of isolation, with minimum contact rating of one ampere at 24 volts AC.
4. On outputs with H-O-A switches, provide for overriding the output open or closed.

F. Pulse Accumulators: Same characteristics as binary inputs, and:
1. Buffer to totalize pulses.
2. Accept rates of at least 20 pulses per second.
3. Totalized value reset to zero upon operator's command.

2.06 PROCESS MONITORING

A. Common Display Features
1. The following display elements must be included on all full-screen PCS process monitoring displays in a consistent location or screen area:
   a. PCS Identification,
   b. Display title,
   c. Display filename or other Display Identification (if appropriate),
   d. Current Date (DD-MMM-YY format),
   e. Current Time (HH:MM:SS format, 24 hour military time, local time zone),
   f. Indications (preferably counts) of active and unacknowledged alarms,
   g. Indication of active simulation or similar unusual system mode(s),
   h. Common navigation and control features (e.g., “home” button, “back” button, “print” button, pull-down menus)

B. Process Overview Displays
1. Process overview displays provide discrete icons or symbols for each process unit or ancillary system subordinate to the overview. Every process unit and ancillary system within the scope of the PCS should be included on one and only one overview display. Where multiple process overview displays are required to represent the entire scope of the PCS, process overview displays should be linked by a “rapid navigation” capability.
2. Process overview displays should be logically organized and, if necessary, logically subdivided. Organization may be based on product flow path, physical equipment layout, operating areas, functional classes, or some combination of the above.
3. The following are display elements typically included on process overview displays:
   a. Common process monitoring display features, as previously identified,
   b. Process unit and ancillary system icons or symbols,
   c. “Rapid navigation” capability to each subordinate process unit and ancillary system display,
   d. Representation of primary product flow path,
   e. Graphical and/or text representation of key instrument readings (e.g., level, flow, temperature, etc.), and
   f. Graphical and/or text representation of key resource attributes (e.g., process unit states, assigned batch IDs, operational modes, etc.).

C. Process Unit Displays
   1. Process unit displays are typically associated with a single process unit or ancillary system (e.g., headers, bulk material systems, shared equipment, etc.). These displays provide discrete dynamic icons, symbols, and/or text representations for each subordinate equipment module, control module, and other key dynamic process attributes.
   2. Every equipment module, control module, and key dynamic process attribute within the scope of the PCS should be included on a process unit display. With the possible exception of shared modules, every equipment module, control module, and key dynamic process attribute within the scope of the PCS should be included on only one process unit display.
   3. Where multiple process unit displays are required to represent a single process unit or ancillary system, the displays should be linked by a “rapid navigation” capability. A “rapid navigation” capability should also be provided to the following:
      a. Related process unit displays (e.g., upstream units, downstream units, and supporting utilities),
      b. Encompassing process overview display, and
      c. Subordinate process detail displays.
   4. Process unit displays should be logically organized and, if necessary, logically subdivided. Organization may be based on product flow path, physical equipment layout, operating responsibilities or some combination of the above.

D. Process Detail Displays
   1. Process detail displays are typically associated with a single module or object (e.g., specific valve, specific controller, specific equipment phase, etc.). This type of display is sometimes referred to as “faceplates” or “device pop-ups”. They provide dynamic icons, symbols, and/or text representations for every important aspect of the subject equipment module, control module, or other dynamic process resource.
   2. Every equipment module, control module, and dynamic process resource within the scope of the PCS should be accessible through a process detail display. These displays may “float” over other process displays in a movable window, occupy a configurable portion of another process display, or be part of a dedicated whole-screen display of process details.
   3. Access to a process detail display is typically provided through a “rapid navigation” link on a process unit display (e.g., clicking a valve symbol shows the process detail display for the specific valve that was clicked). If practicable, a dropdown list or other menu system should be provided in the process detail display to allow changing the subject module.
   4. All process detail displays should include the following:
      a. Object Name,
      b. Object Descriptor,
      c. Alarm Indication(s),
      d. Interlock Indication(s), and
      e. Appropriate navigation features (e.g., Close/Exit button, Trend display button, Interlock detail display, tuning display, etc.),
2.07 BASIC DATA PROCESSING
   A. All data monitored by the Process Control System (PCS) shall be immediately converted to
      standard engineering units prior to use in any comparison or control logic. This conversion
      should also include normalization of discrete data values (e.g., so that “1” always represents
      the “alarm” state for a discrete input alarm and the “open” state for a valve). Process control
      outputs should undergo similar conversions immediately prior to transmittal.

2.08 SHUTDOWN
   A. System documentation shall include a detailed procedure for performing a controlled and
      complete shutdown of the PCS. PCS shutdown shall cause controlled process equipment to
      revert to a pre-defined safe (typically de-energized) state.
   B. The ability to shutdown the PCS shall be restricted to Supervisors, System Administrators,
      Engineering, and Maintenance personnel. PCS event log(s) and/or alarm log(s) shall indicate
      the normal shutdown of any PCS component. Where possible, PCS event log(s) and/or alarm
      log(s) shall indicate abnormal PCS component shutdowns (e.g., power interruptions).

2.09 NORMAL OPERATION
   A. On PCS restart according to the PCS startup procedure(s), normal operation shall be enabled.
      System documentation shall include detailed procedures for normal PCS operation (e.g.,
      display elements and navigation, starting batches, using control modules, etc.). The ability to
      perform normal PCS operations shall be based on privileges associated with the user’s
      account.

2.10 DISASTER RECOVERY
   A. System documentation shall include detailed procedures for a complete re-install of software on
      each PCS component. These procedures shall include sufficient detail to completely re-build
      the PCS from purchased hardware and archived software. Independent electronic copies of all
      software required to re-build the PCS shall be supplied with the PCS.

2.11 PROCESS ALARM DETECTION
   A. Process alarm detection functionality compares data values against range and alarm limits.
      Range errors and alarms should be propagated, as appropriate, to subsequent data processing
      logic. All non-discrete dynamic system inputs automatically monitored by the PCS should be
      subjected to both range checking and appropriate alarm checking
   B. All non-discrete manual system inputs should also be subjected to range checking. Out-of-
      range manual data entries should be rejected (with an appropriate message explaining why the
      value was rejected) and/or treated as a process alarm (i.e., annunciated and subjected to alarm
      management functions), as appropriate. All manual entries, including rejected entries, should
      be recorded in PCS event logs, if practicable.

2.12 ALARM MANAGEMENT
   A. The PCS must provide for configuration of alarms to detect unexpected process excursions for
      operator notification and /or response. Two basic types of alarms must be supported by the
      PCS, process alarms and equipment alarms. Process alarms differ from equipment alarms in
      that their parameters such as, setpoint, time delay, deadband, etc must be modifiable during
      progression of a batch process on a per step basis from the phase logic. Equipment alarm
      parameters are tuned to meet the specific equipment requirements and once set, are only
      modified if physical changes occur to the equipment. Both types are subjected to the alarm
      management requirements described in this section.
   B. The system shall provide for process alarm priorities, a minimum of five levels, which are
      selectable during configuration. At least one of the priority levels will represent alarms that
      affect the quality of the batch. Other alarm priorities will be assigned to equipment protection,
      personnel safety and operator information.
C. Alarm Display:
   1. All system alarms shall be presented to the operator on a priority basis defined as ‘oldest, highest priority, non-acknowledge alarm’ first. All alarms shall be displayed in an alarm list/banner and on a relevant graphic, in the specified colors. Alarm display characteristics are determined according to their state and their priority. The display and annunciation of an alarm is activated by a change in state of the alarm. The system shall support configuration of dynamic color change of foreground and background text based on current alarm state at a given priority level. The system shall also support configuration of an internal audible signal as well as an output to external light or audible signal based on current alarm state at a given priority level. Alarm states are defined as:
   a. Normal - No alarm condition exists
   b. Active - process measurement is outside of prescribed alarm setpoint value.
   c. Active Acknowledged - Alarm is and has been acknowledged by the operator
   d. Active Unacknowledged - Alarm is active but not acknowledged by the operator
   e. Cleared Unacknowledged – Alarm condition has returned to normal state without operator acknowledgement.

D. Alarm Summary Display Information
   1. The alarm summary shall display to the operator a list of all alarms that are currently:
      a. Active-Unacknowledged
      b. Active-Acknowledged
      c. Cleared-Unacknowledged
   2. The alarm summary shall provide the following real-time information for each alarm:
      a. Alarm tag
      b. Value of the alarm setting being transgressed
      c. Time and date of last alarm activation
      d. Alarm severity
      e. Critical alarm category
      f. Area / Cell / Unit in which the alarm was generated
      g. Alarm state and severity
      h. Critical alarm category
      i. Process Area / Cell / Unit
   3. As a default, all system alarms should be presented to the operator on a priority basis defined as ‘oldest, highest priority, non-acknowledge alarm’ first. The PCS shall provide for filtering and display of the alarm list in the following ways:
      a. Alarm severity
      b. Critical alarm category
      c. Process Area / Cell / Unit

E. Alarm Log
   1. A journal of alarms will be maintained on the PCS. GMP alarms will also be captured for inclusion in the batch record. The PCS shall provide the following alarm logging capability. Note that all logging shall conform to 21 CFR Part 11 requirements. All pertinent data including tag number, batch ID (if applicable) time of alarm, value of alarm and maximum and minimum deviations are recorded to the alarm database with each alarm event. The system shall also calculate and record the duration of an alarm when the alarm clearance event is detected.
   2. System alarm logging shall be triggered by the following alarm status changes:
      a. Activation (and re-activation)
      b. Clearance
      c. Acknowledgement
      d. Disable / Enable
   3. Upon alarm activation the system shall log the following formation:
      a. Alarm tag
      b. Value of the alarm setting being transgressed
c. Time and date of alarm activation
d. Critical alarm category
e. Area / Cell / Unit in which the alarm was generated
f. Alarm state and severity

4. Upon acknowledgement of an alarm the system shall append the following information to
   the log created upon activation of that alarm:
   a. Operator electronic signature
   b. Time and date of alarm acknowledgement

5. Upon clearance of an alarm the system shall calculate and append the following
   information to the log created upon activation of that alarm:
   a. Value of the alarmed process variable
   b. Time and date of alarm clearance
   c. Minimum and maximum deviation values while in alarm
   d. Duration of alarm

2.13 ALARM ACKNOWLEDGEMENT
A. Operators must be logged on to the PCS and have the proper authority as enforced by PCS
   security to acknowledge alarms. The PCS shall record in the operator action log all
   acknowledgement activities. The operator’s electronic signature, the action taken, date and
   time must be recorded with each acknowledgement. The PCS shall support two means for
   operators to acknowledge alarms, on an individual basis, and on a group basis. The group
   shall be all current unacknowledged alarms displayed on the alarm list. Note that group
   acknowledgement shall result in an entry in the operator action log for each individual alarm.

2.14 ALARM OUTPUT DEVICES
A. The system shall support the following output devices. System configuration shall allow for
   changes in alarm states to activate any combination of the devices:
   1. Console screen (visual)
   2. Console screen (audible)
   3. Exterior building mounted, control room or plant floor flashing light and/or horn.

2.15 SECURITY
A. All PCS components and networks shall be designed to protect against deliberate and/or
   accidental activities that could potentially compromise personnel, product, equipment, and
   electronic records. Physical controls should include protection of all PCS components (through
   locking individual enclosures and/or through isolation in protected areas such as locked rooms)
   from reasonable attempts to disrupt or modify the component. Logical controls should include
   user authentication for any process control or PCS modification activity.

B. Access level assigned to an individual will dictate which HMIs and displays a user has access
   to, and which operations the user can perform. Where feasible, user access administration
   should leverage existing site computer security policies and procedures (including security
   administration servers and existing user accounts).

C. Users may be allowed to view and navigate operating displays without login. However, a login
   is required to perform any activity that changes any process attribute (e.g., module modes and
   states, setpoints, and parameter values) or in any way modifies the Process Control System
   (e.g., configuration changes, node startup/shutdown, and code changes).

D. Records of operator actions should include the operator’s identity, as confirmed by user
   account login information. All PCS access attempts and results must be recorded and
   accessible for review and/or reporting.

2.16 SAFETY
A. The PCS must be designed to both mitigate process hazards and to prevent introduction of any
   new hazards related to the PCS components.
2.17 RESPONSE TO FAILURES
   A. PCS components should include self-diagnostic capabilities for detecting:
      1. Hardware failures and anomalies,
      2. Software (application and services) failures and anomalies,
      3. Operating System failures and anomalies, and
   B. All such PCS failures and anomalies should be treated as process alarms (i.e., annunciated and subjected to alarm management functions). PCS fault conditions that potentially impact data quality should be propagated and accommodated, as appropriate, in data processing, collection, and display.

2.18 REMOTE PCS ACCESS
   A. The PCS architecture should include a secure network interface to the Owner's Local Area Network (LAN). Authorized LAN users should have selected ability to monitor the process remotely. No control or engineering capability should be accessible from any remote interface (i.e., interfaces that are not within the scope of the PCS should be view-only).

2.19 ACCESSORIES
   A. Enclosures: Provide an enclosure for each item of process control hardware except that installed above suspended ceilings; a single enclosure may be used for multiple items.

PART 3 EXECUTION
3.01 INSTALLATION - GENERAL
   A. Install process control system fully programmed and ready for operation.
   B. Install with adequate clearance for maintenance, calibration, removal and replacement, and repair of process control devices.
   C. Install without interference with clearance requirements for other equipment.
   D. Install process control system devices in accordance with manufacturer's recommendations and as indicated.
   E. Provide dielectric isolation where dissimilar metals are used for connection and support.
   F. Labeling and Tagging: See Section 46 05 00 for identification requirements.

3.02 INSTALLATION - PROCESS CONTROL NETWORK
   A. Install network wiring without splices between control devices and in accordance with NFPA 70.
   B. Install grounding as recommended by device manufacturers and as necessary to prevent ground loops, noise, and surges from adversely affecting operation of the system; test ground rods as specified in IEEE 142.
   C. Install wiring that is outside of enclosures in raceways, except as follows:
      1. Low-voltage plenum rated cable in suspended ceilings over occupied spaces may be installed without raceways
      2. Low-voltage nonmetallic-sheathed cables or metallic-armored cables may be installed as permitted by NFPA 70.
   D. Tag wiring at both ends, with identifier shown on shop drawings.

3.03 FIELD QUALITY CONTROL - PRIOR TO STARTUP
   A. Adjust, calibrate, measure, program, configure, and otherwise perform all necessary actions to ensure that process control system will function as required by the contract documents.
   B. Physical Inspection:
      1. Verify that each component of the process control system has been installed and is correctly connected to its power source and to the process control network.
      2. Verify that instruments without built-in transceivers are correctly connected to their transceiver.
3. Verify that instruments are correctly installed in the manner necessary to sense the variables they are intended for.
4. Verify that software has been installed and programmed.
5. Verify that controller configuration settings and/or programs are correct.

C. Shutdown Condition Demonstration: Set all controller Hand-Off-Auto switches to OFF.
   1. Verify that power and air, where required, are available.
   2. Verify that output devices are in their OFF positions.
   3. Verify that all display panels indicate shutdown conditions.

D. Bandwidth and Endurance Test: Operate control system continuously for one-week period while polling all points at intervals.
   1. Measure and record network bandwidth usage on all channels including backbone.
   2. Poll points associated with graphical displays, trending, and overrides at 15 minute intervals.
   3. Poll all other points at 5 minute intervals.
   4. Include in Startup Plan a description of the methodology to be used for this test.
   5. If there are any failures during this period, repair and re-start test.

E. Peak Bandwidth Test: Demonstrate that process control network is capable of supporting poll requests for all points within a 2 minute interval without exceeding peak expected bandwidth specified, using same methodology as bandwidth and endurance test; compare to approved bandwidth usage calculation submittal.

3.04 OWNER PERSONNEL TRAINING
   A. Provide training for Owner's personnel.
      1. Operating Personnel Training - Equipment:
         a. Sessions: One.
      b. Maintenance Personnel Training - Equipment:

B. Operating Personnel Training - Software:
   1. Sessions: Two.

3.05 FIELD QUALITY CONTROL - AFTER STARTUP
   A. Controller Tuning: Tune controllers initially at whatever flow conditions exist; verify adequate tuning and re-tune if necessary until tuning is satisfactory for peak flow, average daily flow and minimum flow conditions.
      1. Adjust proportional, integral, and, where applicable, derivative settings to provide stable closed-loop control.
         a. Make controlled variables settle out at a new setpoints with no more than two oscillations above and below setpoint with steady output.
         b. With the exception of naturally slow processes, make controllers settle out at new setpoints within five minutes.
      2. Set controllers to correct setpoints and record final PID configuration settings on project record Points Schedule and submit with O&M data.

B. Functional Tests: Demonstrate compliance of process control system with contract documents, using approved test plans.
   1. Demonstrate all physical and functional requirements of system.
   2. Show, step-by-step, the actions and results for each sequence of operation.
   3. Demonstrate that all alarms work correctly.

C. If test results are unsatisfactory or equipment cannot be adjusted to perform properly, modify, repair, or replace, and retest.
   1. When new units are installed, restart testing from beginning.
   2. Owner reserves the right to reject installed equipment if performance appears to be unachievable with installed equipment.
   3. Prior to retesting, obtain Owner's approval of retesting schedule.

END OF SECTION
SECTION 46 33 42  
DIAPHRAGM-TYPE CHEMICAL FEED PUMPS

PART 1 GENERAL

1.01 SCOPE OF WORK  
A. Furnish all labor, materials, equipment, and incidentals to install and test complete and ready for operation, two (2) positive displacement, diaphragm pumps with integral dosing adjustment and required accessories as shown on the Drawings and as specified herein.

1.02 SYSTEM DESCRIPTION  
A. The pumps specified herein are intended to be standard equipment designed for metering the chemical specified in this Section.

B. Carbon Source Solution Feed Pumps (Anoxic Reactor #3):  
1. Two (2) pumps shall be provided for the dosing of non-flammable carbon source solution (Polysweet, Micro C, Sugar Water) to the locations indicated on the Drawings.
2. Each pump shall be capable of delivering from 3 - 60 gallons per hour @ 60 psi.
3. The pumps shall be suitable for pumping carbon source solution indicated.  
   a. Viscosity: 220 centipoise  
   b. Density: 11.2 lbs/ gallon
4. Pumps shall be supplied with the valves and accessories as identified in Accessories Type A - Dual Metering Pumps Dosage Package .

1.03 SUBMITTALS  
A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data shall include at least the following:  
   1. Certified shop and erection drawings showing all important details of construction and dimensions.
   2. Descriptive literature, bulletins, and/or catalogs of the equipment.
   3. Data on the characteristics and performance of the pumps. Data shall include certified performance curves, based on actual shop tests of duplicate units, which show that they meet the specified requirements for head, capacity, efficiency, allowable NPSH, allowable suction lift and horsepower. Curves shall be submitted on 8-1/2 inch x 11-inch sheets.
   4. The total weight of the equipment including weight of the single largest item.
   5. A complete total bill of materials for all equipment.
   6. A list of manufacturer's recommended spare parts.
   7. Complete data on motors.
   8. Manufacturer's wiring diagrams for instrumentation and control system, including necessary field connections (if required).

C. The manufacturer shall clearly identify any exception to this Section, related sections, or the Drawings. Failure to do this shall be grounds for rejection of the submittal.

1.04 QUALITY ASSURANCE  
A. The pumps covered by this Section are intended to be standard pumping equipment, as modified by this Section, of proven ability, as manufactured by a single manufacturer, having long experience in the production of such pumps. The pumps furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and specified herein.

B. In the event that equipment which differs from this Section be offered and determined to be equal to that specified, such equipment shall be acceptable only on the basis that any revisions in the design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc. required to accommodate such a substitution shall be made at no cost to the Owner and be as approved by the Engineer.
1.05 DELIVERY, STORAGE, AND PROTECTION
   A. In accordance with Section 01 60 00.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. ProMinent Fluid Controls, Inc.

2.02 GENERAL DESCRIPTION
   A. The chemical metering pumps shall be motor-driven, reciprocating, mechanically-actuated
      diaphragm type. All pumping functions shall be set by membrane-switch keypad and status
      shall be displayed on an illuminated LCD which is readable. Keypad will allow for simple
      scrolling and display of programmed parameters. The housing shall be rated NEMA 4X.
   B. The power supply shall be 115VAC, 60Hz, single phase.
   C. The liquid end shall be physically separated from the drive unit by a backplate with weep hole
      creating an air gap. The diaphragm shall be constructed of a steel core, vulcanized into nylon-
      reinforced EPDM, with PTFE-faced fluid contact surface.
   D. Each pump shall include integral motor, oil-lubricated gear reducer and cam-and-spring drive
      mounted in an aluminum housing, such housing to be sealed into an outer plastic housing for
      corrosion protection with heat sink fins for cooling.

2.03 LIQUID END
   A. The liquid end shall be constructed of PVDF with Teflon seals, with built-in coarse valve and
      needle valve for air bleed, manually adjusted for continuous degassing of process fluid and
      self-priming against pressure. The suction and discharge valves shall be of the double ball
      check design for discharge pressures greater than 100 psi.

2.04 PROGRAMMING AND CONTROL
   A. Stroke length control shall be manually adjusted between 0% and 100% with a stroke
      adjustment knob on the pump face control. The LCD shall digitally display stroke length setting
      in 1% increments in the full range between 0% and 100%.
   B. Programming shall allow pump to be calibrated so as to display pump output in gallons/hour or
      liters/hour. Calibration shall be maintained when stroke length is altered up to plus or minus
      10% on the stroke length knob. If stroke length is altered by more than 10%, a yellow warning
      light and a flashing message “calib” will appear.
   C. The pump shall be equipped with the programmable function of electronic interlocking of the
      keypad by access code to prevent unauthorized adjustments to the pump.
   D. Keypad shall allow for scrolling and display on LCD such parameters as stroke frequency,
      stroke length, stroke counter, pump output in gals/hr or l/hr, dosing quantity, mA current input
      being received by pump, and indication of external mode.
   E. Stroke frequency control shall be manually adjusted by touch keypads, with the set stroke rate
      displayed on the LCD. The metering pump shall be capable of receiving a pulse input via
      optional external control cable such that 1 pulse gives 1 pump stroke rate. The pump shall be
      capable of remote ON-OFF operation using the pause function via a voltage free contact relay
      through an optional control cable.
   F. ANALOG- The pump shall accept an analog signal such that stroke frequency is proportional to
      0/4-20mA or 20-4/0mA, the choice of which is programmable at the pump. The pump shall
      allow the setting of a maximum stroke rate which corresponds to the maximum analog signal,
      with stroke rate proportional to signal strength below that rate. Programming for curve
      processing shall also be possible, in which any stroke frequency ratio in proportion to the
      electrical signal can be configured. Analog to digital converters external to the pump shall not
      be allowed.
2.05 FLOW ASSURANCE

A. Flow Monitor - A flow monitor shall be installed on the discharge line to automatically stop pumping and annunciate a fault condition on the pump LCD display upon loss of discharge flow. The pump shall be programmable, between 1 and 125 strokes per minute, to actuate the fault annunciation after flow is lost.

B. Relay Output - An SPDT relay shall be installed for fault condition (i.e. low chemical supply in tank/lack of chemical supply shut down, flow monitor, system faults, and fuse/power supply failure). Configure as NO contact closure relay.

C. Diaphragm Failure - A diaphragm failure detector will alert the possibility of a ruptured or distressed diaphragm.

2.06 ACCESSORIES TYPE A - DUAL METERING PUMP DOSING SKID PACKAGES

A. The pumps shall be mounted on a polypropylene/304 stainless support stand suitable for floor mounting. A single chemical metering pump manufacturer shall be responsible for supplying and assembling all components of the skid, in addition to testing the skid-mounted metering system prior to shipment. The stand shall include the following accessories, pre-piped:
   1. A foot valve and strainer, constructed of materials compatible with chemical to be used, shall be provided with each pump.
   2. An injection valve, constructed of materials compatible with chemical to be used, shall be provided with each pump.
   3. A universal control cable with 5-pole round plastic connector and 5-wire cable with loose ends shall be provided with each pump.
   4. A two stage float switch compatible with chemical to be used shall be provided to monitor tank level.
   5. A diaphragm failure detector shall be provided to close a contact for alarm in the event of a diaphragm failure.
   6. An adjustable-pressure, diaphragm-type back pressure/anti-siphon valve, constructed of materials compatible with chemical to be used, shall be provided with each pump.
   7. An in-line, adjustable-pressure, diaphragm-type pressure relief valve, constructed of materials compatible with chemical to be used, shall be provided with each pump.
   8. A pressure gauge with isolator constructed of materials compatible with chemical to be used, shall be provided for each pump.
   9. An air-charged, bladder type pulsation dampener constructed of materials compatible with chemical to be used, shall be provided for each pump.
  10. A clear PVC 500 mL calibration column with FNPT fitting on top and bottom shall be provided with each pump package. The column shall be sized to provide at least 2 minutes draw down at maximum pump capacity.
  11. Fifteen feet of tubing compatible with chemical to be used shall be provided with each pump.

2.07 ACCESSORIES TYPE B - MULTIPLE PUMP DOSING PACKAGE

A. The pumps and accessories shall be provided by the manufacturer for contractor installation as indicated on the Drawings. A single chemical metering pump manufacturer shall be responsible for supplying and assembling all components. The package shall include the following accessories:
   1. A foot valve and strainer, constructed of materials compatible with chemical to be used, shall be provided with each pump.
   2. An injection valve, constructed of materials compatible with chemical to be used, shall be provided with each pump.
   3. A universal control cable with 5-pole round plastic connector and 5-wire cable with loose ends shall be provided with each pump.
   4. An adjustable discharge flow monitoring device, compatible with chemical to be used, shall be provided with each pump. The flow monitor shall be capable of signaling a fault condition to the pump.
5. A diaphragm failure detector shall be provided to close a contact for alarm in the event of a diaphragm failure.
6. An adjustable-pressure, diaphragm-type back pressure/anti-siphon valve, constructed of materials compatible with chemical to be used, shall be provided with each pump package.
7. An in-line, adjustable-pressure, diaphragm-type pressure relief valve, constructed of materials compatible with chemical to be used, shall be provided with each pump.
8. A pressure gauge with isolator constructed of materials compatible with chemical to be used, shall be provided for each pump.
9. An air-charged, bladder type pulsation dampener constructed of materials compatible with chemical to be used, shall be provided for each pump on the discharge side.
10. A clear PVC 500 mL calibration column with FNPT fitting on top and bottom shall be provided with each pump package. The column shall be sized to provide at least 2 minutes draw down at maximum pump capacity.
11. Fifteen feet of tubing compatible with chemical to be used shall be provided with each pump.

PART 3 EXECUTION

3.01 INSTALLATION
A. Install in accordance with manufacturer's instructions and recommendations in the locations shown on the Drawings.

3.02 FIELD QUALITY CONTROL
A. After the pumps have been completely installed, conduct such tests as are necessary to indicate that pump efficiency and discharge conform to the Specifications. Field tests shall be performed on all pumps furnished under this Section. Supply all electric power, labor and water and auxiliary equipment required to complete the field tests.
B. If the pump performance does not meet the Specifications, corrective measures shall be taken, or pumps shall be removed and replaced with pumps which satisfy the conditions specified.
C. Any component parts which are damaged as a result of testing or which fail to meet the requirements of these Specifications shall be replaced, reinstalled and retested at the Contractor's expense.

END OF SECTION
SECTION 46 33 46
PROGRESSIVE CAVITY CHEMICAL FEED PUMPS

PART 1 GENERAL

1.01 SCOPE OF WORK
A. Furnish all labor, materials, equipment, and appurtenances required and install complete and make ready for operation two (2) progressive cavity pumps, as shown on the Drawings and as specified herein.

1.02 SYSTEM DESCRIPTION
A. All of the equipment specified herein is intended to be standard equipment designed for use in pumping cationic polymers.
B. Polymer Feed Pumps
   1. A total of two (2) Polymer Feed Pumps shall be provided.
   2. Each pump shall have a maximum pumping capacity of 300 gallons/hour at 60 psi.
   3. The pump drive shall consist of a motor controlled by a DC variable frequency drive with a turn down ratio capable of delivering 30 gallons/hour.
   4. The pump drive shall consist of a motor which shall be direct connected to the pump shaft.

1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data shall include at least the following:
   1. Certified shop and erection drawings showing all important details of construction and dimensions.
   2. Descriptive literature, bulletins, and/or catalogs of the equipment.
   3. Data on the characteristics and performance of the pumps. Data shall include certified performance curves, based on actual shop tests of duplicate units, which show that they meet the specified requirements for head, capacity, efficiency, allowable NPSH, allowable suction lift and horsepower. Curves shall be submitted on 8-1/2 inch x 11-inch sheets.
   4. The total weight of the equipment including weight of the single largest item.
   5. A complete total bill of materials for all equipment.
   6. A list of manufacturer's recommended spare parts.
   7. Complete data on motors.
   8. Manufacturer's wiring diagrams for instrumentation and control system, including necessary field connections (if required).
C. The manufacturer shall clearly identify any exception to this Section, related sections, or the Drawings. Failure to do this shall be grounds for rejection of the submittal.

1.04 QUALITY ASSURANCE
A. The pumps covered by this Section are intended to be standard pumping equipment, as modified by this Section, of proven ability, as manufactured by a single manufacturer, having long experience in the production of such pumps. The pumps furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and specified herein.
B. In the event that equipment which differs from this Section be offered and determined to be equal to that specified, such equipment shall be acceptable only on the basis that any revisions in the design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc. required to accommodate such a substitution shall be made at no cost to the Owner and be as approved by the Engineer.
C. The rated horsepower of the drive unit shall be such that the unit will not be overloaded nor the service factor reduced when the pump is operated at any point on the pump's capacity curve. If, due to the slope of the pump's performance curve, a drive unit of greater horsepower than specified is required to meet this condition, the pump will be considered for approval only if any
and all changes in electrical work, etc. required by such a change will be provided at no additional cost to the Owner and be to the satisfaction of the Engineer.

1.05 DELIVERY, STORAGE, AND PROTECTION
   A. In accordance with Section 01 60 00.

1.06 EXTRA MATERIALS
   A. One set of all special tools required for normal operation and maintenance shall be provided.
   B. The following spare parts shall be provided:
      1. One set of packing for each pump.
      2. One set of gaskets for each pump.
      3. One rotor and one stator.
      4. One set of shaft universal joints.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Moyno Inc. - Robbins, OH
   B. Seepex Pumps
   C. Netzch
   D. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 MATERIALS
   A. General:
      1. The equipment covered by these Specifications is intended to be standard pumping equipment of proven ability as manufactured by a reputable firm having long experience in the production of such equipment. The equipment furnished shall be designed, constructed and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings.
      2. All parts shall be so designed and proportioned as to have liberal strength and stiffness and to be especially adapted for the work to be done. Ample room and facilities shall be provided for inspection, repairs and adjustment.
      3. All necessary bolts, plates, nuts, and washers shall be furnished and shall be of Type 304 stainless steel.
      4. Brass or stainless steel nameplates giving the name of the manufacturer and any other pertinent data shall be attached to each pump.
      5. The manufacturer shall supply all motors and drives for field mounting as shown on the Drawings.
      6. No rubber parts shall be used which come in contact with the pumped fluid. All wetted parts shall be compatible with petroleum products.
   B. Pumps:
      1. Pumps shall be heavy duty, positive displacement, progressive cavity type. The pump body shall be of thick-walled cast iron and shall incorporate two inspection ports 180 degrees apart. The pump shall be cradle mounted to permit the suction port to be rotated to any angle perpendicular to the centerline of the pump. Suction and discharge connections shall be threaded.
      2. The pump rotor shall be machined of high carbon tool steel, hardened to a Rockwell "C" value of 57 to 60 and covered with a heavy layer of hard chrome plate at least 0.01" thick for abrasion resistance.
      3. The rotor shall rotate relative to a one piece, EPDM stator of approximate 65 Durometer hardness (Shore A) securely bonded to its steel tube housing. The stator shall be arranged to prevent the pumped material from contacting the bonding or the tube.
      4. The rotor shall be joined to the drive shaft by a carbon steel connecting rod and crowned-gear type, grease lubricated, sealed universal joints of chrome alloy tool steel of adequate design to transmit the required thrust and torque while allowing the rotor to move through
its eccentric path. The gear joints shall be clamped at both outside and inside diameters and recessed within heavy walled steel tubing to prevent damage by rags or other objects.

C. Motors:
1. The motor shall be controlled by a variable frequency drive DC controller wired for 120 V, Single Phase, 60 Hz.
2. Motors shall be horizontal, totally enclosed, fan cooled, foot mounted, 1-phase 115/230V, at a horsepower and speed suitable for the system.

D. Couplings:
1. The motor, drive and pump shafts shall be connected by flexible shaft couplings, complete with guard in conformance with OSHA regulations.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer’s instructions and recommendations in the locations shown on the Drawings. Installation shall include furnishing the required oil and grease for initial operation. The grades of oil and grease shall be in accordance with the manufacturer’s recommendations.

B. Contractor shall provide the Metering Pump Dosing Stands as follows:
1. Each set of three (3) pumps shall be mounted on a stainless steel pump stand as shown on the Drawings and as specified herein. Each metering pump dosing stand shall include all piping, fittings, and accessories (as described below) and shall be mounted on a stainless steel stand. Piping and fittings for each stand shall be suitable for the chemical to be pumped.
   a. Strainer on suction line from chemical storage tank.
   b. Pressure Relief Valve for each pump.
   c. Pressure Gauge for each pump.
   d. Separate Discharge to each Treatment Train.
   e. Two (2) Self Filling Calibration Column Assemblies for each stand.
      1) Polymer Feed Stand: 4,000 mL
      2) Carbon Source Solution Stand: 1,000 mL

3.02 FIELD QUALITY CONTROL

A. After the pumps have been completely installed, conduct such tests as are necessary to indicate that pump efficiency and discharge conform to the Specifications. Field tests shall be performed on all pumps furnished under this Section. Supply all electric power, labor and water or wastewater and auxiliary equipment required to complete the field tests.

B. If the pump performance does not meet the Specifications, corrective measures shall be taken, or pumps shall be removed and replaced with pumps which satisfy the conditions specified. A twelve (12) hour operating period of the pumps will be required before acceptance.

C. Any component parts which are damaged as a result of testing or which fail to meet the requirements of these Specifications shall be replaced, reinstalled and retested at the Contractor’s expense.

END OF SECTION
SECTION 46 41 27
FLOATING MIXER / AERATOR

PART 1 GENERAL
1.01 SCOPE OF WORK
A. Furnish all labor, materials, equipment, and incidentals to install and test, complete and ready for operation, ten (10) floating mixer / aerators each with regenerative blowers as shown on the Drawings and as specified herein.

1.02 SYSTEM DESCRIPTION
A. Each mixer/aerator shall consist of an electric motor, direct drive impeller driven at a constant speed, regenerative blower, and an integral flotation unit. mixer/aerators that self-aspirate are not acceptable.
B. The mixer/aerators shall be designed for continuous duty under severe operating conditions.

1.03 DESIGN REQUIREMENTS
A. Aerobic Digester #1 Floating Mixer / Aerators:
   1. Existing barrier wall oxidation ditch. The existing barrier wall will remain intact. The mixers shall provide complete mixing as in a plug flow reactor.
   2. Nominal Basin Volume: 3.0 MG
   3. Nominal Basin Length: 500 feet
   4. Nominal Basin Width: 98 feet
   5. High Water Level: 8 feet
   6. Low Water Level: 5 feet
   7. Suspended Solids Concentration of Liquid: 30,000 mg/L (design)
   8. Number of Units: Six (6)
   9. Design AOR: 200 #O2/hr
   10. Mixer Motor Nominal HP: 60 HP
   11. Blower Motor Nominal HP: 10 HP
   12. Electrical voltage and Characteristics of Motor: 460V, 3 phase, 60 Hz
   13. Anchor Type: Cable Mooring

B. Aerobic Digester #2 Floating Mixer / Aerators:
   1. Existing circular precast concrete tank.
   2. Nominal Basin Volume: 0.40 MG
   3. Nominal Diameter: 86 feet
   4. High Water Level: 9.5 feet
   5. Low Water Level: 5.5 feet
   6. Suspended Solids Concentration of Liquid: 30,000 mg/L (design)
   7. Number of Units: Two (2)
   8. Design AOR: 100 #O2/hr
   9. Mixer Motor Nominal HP: 50 HP
   10. Blower Motor Nominal HP: 7.5 HP
   11. Electrical voltage and Characteristics of Motor: 460V, 3 phase, 60 Hz
   12. Anchor Type: Mooring Posts

C. Aerobic Digester #3 Floating Mixer / Aerators:
   1. Existing circular precast concrete tank.
   2. Nominal Basin Volume: 0.40 MG
   3. Nominal Diameter: 86 feet
   4. High Water Level: 9.5 feet
   5. Low Water Level: 5.5 feet
   6. Suspended Solids Concentration of Liquid: 30,000 mg/L (design)
   7. Number of Units: Two (2)
   8. Design AOR: 100 #O2/hr
9. Mixer Motor Nominal HP: 50 HP
10. Blower Motor Nominal HP: 7.5 HP
11. Electrical voltage and Characteristics of Motor: 460V, 3 phase, 60 Hz
12. Anchor Type: Mooring Posts

**1.04 SUBMITTALS**

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Data to be submitted:
   1. The Manufacturer shall submit detailed installation drawings for the units which he proposes to supply, showing: Brake Horsepower, Power Input to Electric Drive Motor and descriptive data and specifications describing in detail the construction of the complete units.
   2. The manufacturer shall furnish evidence that he has equipment of a similar type in satisfactory operating condition for not less than 5 years. A list giving locations and date of installation shall be furnished to the Engineer.
   3. The Manufacturer shall certify in writing that the products supplied shall completely mix the contents of the basin up to a mixed liquor suspended solids concentration of 30,000 mg/L.
   4. The equipment manufacturer must submit a clean water oxygen transfer test within 10% of the specified horsepower in accordance to the American Society of Civil Engineers “Measurement of Oxygen Transfer in Clean Water,” that is verified by an independent third party. Theoretical calculations are not acceptable. If a clean water oxygen transfer test verified by an independent third party is not submitted at the time of the bid, the equipment supplier shall meet the oxygen output specified above in the equipment design criteria or will need to use an efficiency of 1.4 lbs SAE to ensure adequate oxygen is supplied.

C. Dimensional Data:
   1. Provide shop drawings certified as correct, showing all weights and dimensions necessary for the installation.

D. Operation and Maintenance Data: Operation and Maintenance data for each piece of equipment supplied.
   1. Provide a copy of the training material that will be utilized to instruct Owner’s personnel on operation and maintenance. Provide two (2) paper copies and an electronic copy in pdf format.

E. Certificates: Certify that products of this section meet or exceed specified requirements.

F. Manufacturer's Field Reports: Provide copies of the manufacturer's field reports from inspection and system start-up services.

G. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

H. Certification: The Manufacturer shall provide a certification stating that they have reviewed the Drawings and Specification for this project and have verified that the applicability of the specified equipment to be provided by the Manufacturer for the intended use per the Drawings and Specifications.
   1. The Manufacturer shall provide to the Engineer, as part of the certification, in writing any recommended revisions to the design based upon the Manufacturers review of the Specifications and Drawings.

I. The manufacturer shall clearly identify any exception to this Section, related sections, or the Drawings. Failure to do this shall be grounds for rejection of the submittal.
1.05 QUALITY ASSURANCE
   A. The mixers covered by this Section are intended to be standard mixing equipment, as modified by this Section, of proven ability, as manufactured by a single manufacturer, having long experience in the production of such mixers. The mixers furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and specified herein.
   B. In the event that equipment which differs from this Section be offered and determined to be equal to that specified, such equipment shall be acceptable only on the basis that any revisions in the design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc. required to accommodate such a substitution shall be made at no cost to the Owner and be as approved by the Engineer.
   C. The rated horsepower of the drive unit shall be such that the unit will not be overloaded nor the service factor reduced.

1.06 DELIVERY, STORAGE, AND PROTECTION
   A. In accordance with Section 01 60 00 - Product Requirements.
   B. Mixer / Aerator shall arrive at the installation site fully assembled and ready for attachment to the flotation or support equipment.
   C. Units with couplings that can become misaligned during shipment or installation are not acceptable.

1.07 EXTRA MATERIALS
   A. See Section 01 60 00 - Product Requirements, for additional provisions.

1.08 WARRANTY
   A. Provide a 3- year non-prorated factory warranty.
   B. All parts supplied by the aerator Manufacturer must be warranted by the same.

PART 2 PRODUCTS
2.01 MANUFACTURERS
   A. Aeration Industries International (Aire-O2)
   B. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 MATERIALS AND CONSTRUCTION FEATURES
   A. MIXER DRIVE MOTOR
      1. The motor shall be rated for 460 volts, 60 cycle, 3-phase service. Motors shall be specifically designed for operating at an angle.
      2. The motor shall be totally enclosed, fan cooled.
      3. The motor shall in all cases equal or exceed standard NEMA specifications.
      4. The motor winding insulation shall in all cases equal or exceed NEMA class F design and shall be nonhygroscopic.
      5. Insulation shall equal or exceed NEMA Class F with Class B temperature rise.
      6. A minimum service factor of 1.15 shall be furnished.
      7. Complete internal rotating assembly and stator winding shall be epoxy coated to maximize corrosion protection of electrical components.
      8. The motor must be supplied with premium insulation for extended life in harsh environments.
      9. A stainless steel nameplate shall be provided with each motor, and shall be securely fastened thereto. The voltage, speed, phase, insulation class, amperage, service factor, wiring diagram, motor serial number, and manufacturer's name and address shall be stamped thereon or otherwise permanently marked.
      10. The motor shaft shall be balanced to within 1 mil to be measured on any part of the motor frame including the C-face.
11. The motor terminal box shall be firmly bolted to the motor frame at four points. The terminal box shall be sized to meet the NEMA standards.
12. The terminal box shall be drilled and tapped to receive one compression watertight fitting to accommodate the appropriate electrical service cables.
13. The motor must use thrust bearings. Conrad-type bearings are not acceptable.

B. BLOWER
1. The equipment shall include a high efficiency regenerative blower sized to provide sufficient airflow to yield the rated oxygen transfer capacity. Each blower includes the following features:
   a. Maintenance free
   b. Aluminum alloy construction
   c. Inlet and outlet sound attenuating silencers to minimize noise.
   d. Inlet filters with epoxy-coated wire mesh media rated for 70 microns or better.
   e. CE compliant - Declaration of Conformity on file
   f. The blowers shall be tropicalized for corrosion resistance and deliver the specified horsepower maximum rated for 460 volts, 60 cycle, 3 phase service. Blower motors shall be wired separately.

C. MOUNTING FLANGE
1. The mounting flange shall be stainless steel and shall permit removal of the mixer mechanism leaving the motor in place. The mounting flange will allow the mixer to be rotated out of the water for inspection, maintenance or storage.

D. SHAFT/UNIVERSAL JOINT COUPLING
1. The shaft shall be stainless steel full-welded to a carbon steel universal joint coupling. This shaft shall be dynamically balanced. Units that utilize vibration dampeners to control fatigue stress failures due to vibration are not acceptable. Units that use solid shafts are not acceptable.
2. The universal joint coupling shall include standard grease fitting for maintenance lubrication. Units that utilize a flexible coupling to attach the shaft to the motor are not acceptable.
3. The shaft shall be stabilized by a replaceable water lubricated bearing located within one inch from the propeller hub. The area of the shaft supported by the bearing shall be fitted with a replaceable hardened non-metallic sleeve.
4. Units supplied with couplings that require alignment are not acceptable.
5. Any shafts requiring factory replacement to validate warranty requirements are not acceptable.

E. HOUSING
1. The housing shall be stainless steel and flanged for mounting to the mixer. The housing shall form a guard around the shaft and support a field replaceable, water lubricated bearing press-fitted into the housing lower end. Water lubrication holes shall penetrate the housing in the area surrounding the bearing.

F. BEARING
1. The mixer shall be supplied with a field replaceable water lubricated lower support bearing. The bearing shall be constructed of an appropriate material for the application inside a fiber backing. The bearing shall be press-fitted into the housing to allow ease of replacement.
2. Units utilizing a cantilever design without a lower support bearing or regreaseable tapered roller bearings are not acceptable.
3. Bearings requiring factory replacement to validate warranty requirements are not acceptable.
G. SLEEVE
1. The replaceable sleeve shall be the only moving part in contact with the bearing and shall
spin with the shaft as one unit. The sleeve shall be solid and homogenous. Units supplied
without sleeves are not acceptable.

H. PROPELLER
1. The stainless steel propeller shall be specifically designed to maximize mixing and oxygen
transfer characteristics. Propellers shall be self-tightening such that the propeller threads
tighten on the shaft threads during normal operation. The entire flow of air shall pass
through the propeller shaft via the hollow drive shaft along the axis of the propeller hub.
Aluminum and standard marine type propellers are not acceptable.
2. The propeller design shall be tested in clean water and shown to draw a minimum of 85%
of the recommended full motor amperage load at nameplate voltage and power factor.
3. The propeller shall be designed to allow easy removal in the field.

I. SATURN RING / DIFFUSER
1. The Aerator shall be equipped with a stainless steel Saturn Ring diffuser, smaller than the
mixing propeller, consisting of two concentric rings of differing diameters fixed to the
diffuser body. The rings shall be specially designed to maximize oxygen transfer and to
prevent self aspiration when the regenerative blower is turned off to accomplish anoxic
mixing.
2. The entire flow of forced air shall exit through the Saturn Ring diffuser opening.

J. VORTEX SHIELD
1. A vortex shield shall be furnished with each mounting assembly to eliminate the formation
of vortices, and prevent cavitation damage to the propeller during operation. Units without
vortex shields are not acceptable.

K. FLOTATION
1. The mixer flotation assembly shall be constructed of molded low-density polyethylene with
ultraviolet inhibitor, filled with urethane foam. The pontoon shape shall be designed with
smooth, beveled edges to allow freezing into ice without breakage. The pontoons shall be
connected by 304 stainless steel structural members to prevent corrosion. Structural
aluminum is not acceptable. To allow for servicing, the flotation assembly shall be
designed so the mixer may be rotated completely out of the water without removing the
mixer from the flotation. Welded stainless steel floats will not be acceptable.

L. FLOAT SUPPORTS
1. The float supports will be 304 stainless steel and designed to prevent damage to the
propeller and power assembly.

M. ELECTRICAL SERVICE CABLE
1. Cable shall be CSA/UL approved for severe environments, suitable for underwater service
and one continuous length.
2. The cable shall be jacketed, flexible stranded cable with individually wrapped conductors
rated SEOOW or equal.

PART 3 EXECUTION

3.01 LOCATION, SUPPORT, AND MOORING

A. The Manufacturer shall provide recommendations on mixer placement, installation and
operation.

B. Anchor cables shall and mooring hardware shall be stainless steel.

3.02 MANUFACTURER'S FIELD SERVICES

A. Provide services of a factory-employed service technician for one (1) trip consisting of a
minimum of four (4) days to verify the proper installation and supervise the start-up of the
mixer/aerators. Operation and maintenance instructions shall be given to the Engineer/Owner
through the use of illustrated material within the manual.
B. Provide services of a factory representative for one (1) trip consisting of a minimum of two (2) days after initial startup operations to instruct Owner’s personnel on operation and maintenance.

1. Provide written operation training material for on-site operational training that is conducted.

3.03 SERVICING

A. Mixer mounting assemblies shall be designed so the mixer may be rotated completely out of the water to allow servicing without removing the mixer from the mount.

END OF SECTION
SECTION 46 41 41
VERTICAL SHAFT IMPELLER MIXERS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidentals to receive, off-load, store, install and test, complete and ready for operation, four (4) vertical shaft impeller mixer as shown on the Drawings and as specified herein.

1.02 SYSTEM DESCRIPTION

A. Each mixer assembly shall consist of a heavy-duty gearbox, electric motor connected by a flexible coupling, base plate, mixing shaft and mixing impeller.

B. Upon installation, each unit shall be run to demonstrate its ability to operate without overloading, jamming, or excessive vibration during normal operation.

1.03 DESIGN REQUIREMENTS

A. Clarifier Flocc Tank:
1. Number of Mixers: One (1)
2. Nominal Tank Volume: 25,000 gallons
3. Nominal Tank Width: 15 feet
4. Nominal Tank Length: 15 feet
5. Maximum Liquid Height: 15 feet above bottom
6. Minimum Liquid Height: 9.5 feet above bottom
7. Tank Height: 17 feet above bottom
8. Number of Impellers: One (1) (to be confirmed by manufacturer)
9. Number of Blades: Three (3)
10. Tank Contents: MLSS at maximum 6,000 ppm
11. Motor: 5 HP, 460 V/60 Hz/3 Phase
   a. Manufacturer shall confirm specified HP. If a different HP is required per the manufacturers design/recommendations the manufacturer shall provide the revised HP mixer at no additional cost to the Owner. The Engineer shall be informed immediately.
12. Mixer shall be suitable for VFD operation.

B. Polymer Mix Tank:
1. Number of Mixers: Two (2)
2. Tank Diameter: 10 ft. - 0 in
3. Tank Height: 6 ft. - 11 in
4. Mixer Mounting Height: Contractor to Coordinate
5. Number of Impellers/Mixer: Two (2) (to be confirmed by manufacturer)
6. Number of Blades: Four (4)
7. Tank Contents: Polymer @ 3,000 mg/L (Maximum)
8. Motor: 2 HP, 460 V/60 Hz/3 Phase
   a. Manufacturer shall confirm specified HP. If a different HP is required per the manufacturers design/recommendations the manufacturer shall provide the revised HP mixer at no additional cost to the Owner. The Engineer shall be informed immediately.
9. Mixer shall be suitable for VFD operation.

C. Screw Press Influent Tank:
1. Number of Mixers: One (1)
2. Tank Diameter: 10 ft. - 0 in
3. Tank Height: 6 ft. - 11 in
4. Mixer Mounting Height: Contractor to Coordinate
5. Number of Impellers/Mixer: Two (2) (to be confirmed by manufacturer)
6. Number of Blades: Four (4)
7. Tank Contents: Digested Waste Activated Sludge @ 30,000 mg/L
8. Motor: 5 HP, 460 V/60 Hz/3 Phase
   a. Manufacturer shall confirm specified HP. If a different HP is required per the manufacturers design/recommendations the manufacturer shall provide the revised HP mixer at no additional cost to the Owner. The Engineer shall be informed immediately.
9. Mixer shall be suitable for VFD operation.

1.04 PERFORMANCE REQUIREMENTS
   A. The mixer shall be designed to completely mix the contents of the tank.

1.05 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Data to be submitted:
      1. The Contractor shall submit detailed installation drawings for the units which he proposes to supply, showing: Brake Horsepower, Power Input to Electric Drive Motor and descriptive data and specifications describing in detail the construction of the complete units.
      2. The manufacturer shall furnish evidence that he has equipment of a similar type in satisfactory operating condition for not less than 5 years. A list giving locations and date of installation shall be furnished to the Engineer.
   C. Dimensional Data:
      1. The successful bidder shall submit to the Engineer for approval, within 45 days after the award of the Contract, shop drawings certified as correct, showing all weights and dimensions necessary for the installation.
   D. Operation and Maintenance Manuals

1.06 QUALITY ASSURANCE
   A. The mixers covered by this Section are intended to be standard mixing equipment, as modified by this Section, of proven ability, as manufactured by a single manufacturer, having long experience in the production of such mixers. The mixers furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and specified herein.
   B. In the event that equipment which differs from this Section be offered and determined to be equal to that specified, such equipment shall be acceptable only on the basis that any revisions in the design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc. required to accommodate such a substitution shall be made at no cost to the Owner and be as approved by the Engineer.
   C. The rated horsepower of the drive unit shall be such that the unit will not be overloaded nor the service factor reduced.

1.07 DELIVERY, STORAGE, AND PROTECTION
   A. In accordance with Section 01 60 00 - Product Requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Lightin Mixers
   B. Hayward Gordon
   C. Philadelphia Mixing Solutions
   D. Substitutions: See Section 01 60 00 - Product Requirements.
2.02 COMPONENTS

A. Shaft and Impeller:
1. The mixer shall have an impeller to provide low level mixing.
2. The impeller and shaft shall be constructed of 316 SS material.
3. The maximum combined stress in any impeller component shall not exceed 11,000 psi under maximum operating loads.
4. The shaft/impeller design shall be such that its operating speed shall not exceed 70% of its first lateral critical speed. Upon request, stress and critical speed calculations supporting shaft and impeller design are to be supplied.

B. Gear Reducer:
1. The mixer gear reducer must be built in accordance with current AGMA standards. The reducer shall be a right angle design with horizontal input shaft and vertical output shaft.
2. Speed reduction to be accomplished by use of a double reduction gearbox with high speed helical gearing and low speed spiral bevel gearing. The maximum ratio for any one gear set will be 6.2:1. Efficiency shall be no less than 98.5% efficiency per gear mesh.
3. The housing shall be fabricated steel. The housing shall have an enlarged low speed bore to allow for assembly and adjustment of the low speed bevels without disturbing the high-speed gearing.
4. The housing shall have a removable high-speed end for easy ratio change and assembly/disassembly of the high-speed end without disturbing the low speed gearing. Each unit shall be provided with an integral or separate base plate suitable for mounting as shown on the drawings.
5. All gearing shall be lubricated by means of oil splash or immersion into the oil bath. The drive shall be equipped with a dipstick and/or an oil level sight glass to check the oil level.
6. The drives must incorporate a drywell feature in the output area to eliminate the possibility of oil leakage down the shaft. Selected bearings may be grease lubricated provided they include a high quality seal to retain the grease.
7. The drive's minimum AGMA service factor, based on motor nameplate horsepower, will be 1.5. Upon request, documentation supporting gear ratings are to be supplied with the submittal package. Thermal ratings shall be calculated for continuous operation per AGMA standards based on a maximum sump temperature of 200 degrees F and an ambient temperature of 100 degrees F.
8. All drive bearings shall be of the anti-friction type, ball or roller bearings. All bearings within the drive, including the output shaft bearings, shall have a minimum L-10 bearing life of 80,000 hours, when operating at full motor nameplate horsepower at the design speed. Upon request, documentation supporting bearing life shall be supplied with the submittal package.

C. Coupling:
1. The mixing shaft shall be coupled to the gearbox output shaft by means of a rigid flanged coupling. Mating coupling faces shall have a male/female piloted connection for accurate concentricity and shall not require match marking for alignment.
2. The mixing shaft and coupling half shall be constructed of 316 SS material. The shaft shall be designed such that the maximum combined stress does not exceed 9,000 psi under maximum operating loads. It shall be of overhung design - the use of underwater steady bearings is not permitted. Shaft straightness and rigid coupling squareness must be such that the maximum total indicated run out at the lower end of the shaft does not exceed 0.125" for every 10" of shafting, as measured when turning over by hand.

D. Motor:
1. The electric motor shall be rated for continuous duty in a humid corrosive environment. Insulation shall be Class F with a Class B temperature rise at 40 degrees C ambient at 1.0 service factor. Service factor shall be 1.15.
2. The motor shall be squirrel cage induction type for operation on 3 Phase, 60 Hz, 460 Volt. Synchronous speeds shall be 1,800 RPM. All motors shall be designed with applicable IEEE, NEMA, and ANSI standards.
3. Motors shall be connected to the reducer's input shaft with an easily accessible torsionally resilient flexible coupling protected by an OSHA coupling guard.
4. Motors shall be suitable for operation on a variable frequency drive.

PART 3 EXECUTION

3.01 INSTALLATION

A. Contractor shall provide and install I-Beams to which the motor and gear reducer shall be mounted.
B. Install in accordance with manufacturer's instructions.

END OF SECTION
SECTION 46 43 21
CLARIFIER MECHANISM

PART 1 GENERAL
1.01 SCOPE OF WORK
A. The equipment specified in this section shall be installed by the Owner under a separate Contract. The clarifier mechanism and its installation are not included in the scope of this project.
B. Furnish all labor, materials, equipment, and incidentals to install and test, complete and ready for operation two (2) Clarifier Mechanisms as shown on the Drawings and as specified herein.

1.02 RELATED SECTIONS
A. Section 46 43 23 - Fiberglass Reinforced Plastic (FRP) Components
B. Section 09 90 00 - Paints and Coatings (Field application of Coal Tar Epoxy)
C. Section 46 43 25 - Automated Clarifier Brush Cleaning Device (Algae Sweeps)

1.03 SYSTEM DESCRIPTION
A. Two (2) suction type sludge collector mechanisms shall be furnished each being suitable for installation in one (1) tank with a nominal diameter of 110'-0" diameter x 12' side water depth. The tank floor will pitch at a constant slope of 1/16" in 12". All dimensions are to be field verified.
B. Final Effluent Trough shall be 24" wide x 18" deep with scum baffle 8" from Final Effluent Trough.
C. The clarifier mechanisms shall be designed for installation in an existing above grade concrete tank.
D. The clarifier mechanisms shall be designed for the attachment of algae sweeps to the skimmer arm to clean trough, baffle, and weir surfaces when engaged.
E. The clarifier mechanisms shall replace the existing WAWCON clarifier mechanisms. The clarifier mechanism manufacturer shall design and supply all necessary appurtenance required to modify the existing center pier to function with the supplied new mechanism.
F. The clarifier mechanisms shall be installed utilizing the existing bridge, walks and platforms.

1.04 DESIGN REQUIREMENTS
A. Each clarifier mechanism shall be designed for the following hydraulic flow conditions:
   1. Influent Mixed Liquor Flow per clarifier:
      | Average: | 1 Clarifier in Service | 2 Clarifiers in Service |
      | Design Maximum: | 6.00 MGD | 8.00 MGD |
      | Peak: | 11.00 MGD | 6.50 MGD |
   2. Effluent Flow per clarifier:
      | Average: | 3.00 MGD | 1.50 MGD |
      | Design Maximum: | 4.00 MGD | 2.00 MGD |
      | Peak: | 5.00 MGD | 2.50 MGD |
3. Return Sludge Flow per clarifier:

<table>
<thead>
<tr>
<th></th>
<th>1 Clarifier in Service</th>
<th>2 Clarifiers in Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average:</td>
<td>3.00 MGD</td>
<td>1.50 MGD</td>
</tr>
<tr>
<td>Design Maximum:</td>
<td>4.00 MGD</td>
<td>4.00 MGD</td>
</tr>
<tr>
<td>Peak:</td>
<td>6.00 MGD</td>
<td>4.00 MGD</td>
</tr>
</tbody>
</table>

### 1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Submit product data, including Manufacturer's data, for specified products.

1. System Description: Include the following:
   a. Manufacturer's data, order sheet, or equivalent for each major piece of equipment, component, instrument or device being supplied.
   b. Manufacturer's outline and mounting dimensions for all field mounted components, including, but not limited to, drives, motors, pumps, liquid jet headers, air headers, instrumentation and controls.
   c. Manufacturer's wiring diagrams for instrumentation and control system, including necessary field connections (if required).
   d. Manufacturer's Dimensions and Field Fabrication Details for all mechanical equipment.
   e. Mounting Details.
   f. The Manufacturer shall clearly identify any exception to the specification or drawings. Failure to do this shall be grounds for rejection of the submittal.
   g. All equipment to be furnished under this Section must be approved prior to being released for manufacturing unless otherwise noted by the Engineer.
   h. Instrument and control panel layout to scale and dimensioned, with overall size, mounting and field entries dimensioned.

### 1.06 QUALITY ASSURANCE

A. The clarifier mechanisms covered by this Section are intended to be standard equipment, as modified by this Section, of proven ability, as manufactured by a single manufacturer, having long experience in the production of such equipment. The equipment furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and specified herein.

B. In the event that equipment which differs from this Section be offered and determined to be equal that specified, such equipment shall be acceptable only on the basis that any revisions in the design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc. required to accommodate such a substitution shall be made at no cost to the Owner and be as approved by the Engineer.

### 1.07 DELIVERY, STORAGE, AND PROTECTION

A. In accordance with Section 01 60 00.

B. The equipment will be shipped as follows:

1. Unless otherwise approved by the Engineer, the bridge will be shipped in one (1) section with bolted field splices.
2. The handrail will be piece marked for field assembly.
3. The influent well will be shipped in four (4) sections.
4. The center cage will be shipped in one (1) section.
5. The center column will be shipped as one (1) assembly.
6. The truss arms will be shipped in one (1) section.
7. Skimmers will be shipped loose for field assembly.
8. The header will be shipped in two (2) sections for bolted field assembly.
1.08 WARRANTY

A. See Section 01780 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Evoqua/Envirex

2.02 COMPONENTS

A. Collector Mechanism:

1. Each clarifier mechanism shall include the following components:
   a. Drive mechanism complete with reducer, motor and overload device
   b. Unitube sludge removal header and manifold Influent feedwell and supports.
   c. Center pier and center cage.
   d. Two surface skimmers.
   e. Two scum trough with a flushing device.

2. Each sludge collector mechanism will utilize a center drive mounted on a stationary center support pier. A welded structural steel cage attached to the drive will support and rotate the unitube sludge collector header and manifold. The header will be located parallel to the tank bottom and will have a series of inlet orifices so that in a single revolution the entire tank bottom is swept clean. The header will continuously remove the required proportional settled sludge volume to effect a uniform withdrawal over the entire radius of the tank. The header will be hydraulically designed to remove larger volumes of sludge at greater distances from the tank center. The slowly revolving mechanism will collect the sludge from the tank bottom and carry it through the header to the center outlet, the removal being accomplished by pumping.

3. Each mechanism will be designed so there is no field welding required.

B. Drive Mechanism:

1. Internal Gear Pitch Diameter: 38 inches
2. Ball Race Diameter: 42 inches
3. Motor Horsepower: 0.75 HP
4. AGMA Rated Torque: 31,300 foot-pounds
5. Speed: 0.04 RPM

6. The drive mechanism will be completely factory assembled and will consist of a primary gear reduction unit, an intermediate reduction unit, plus a final reduction unit consisting of a pinion and internal gear enclosed in a turntable base. All gearing will be enclosed in gray cast iron ASTM A-48 Class 40B housing.

7. The primary reduction unit will be helical gear reducer. All bearings will be anti-friction type running in oil in a cast iron housing.

8. The motor will be totally enclosed, ball bearing type, of ample power for starting and continuously operating the mechanism without overloading. The motor will conform to NEMA standards and be nameplated for operation on 230/460 volt, 60 Hz current, three (3) phase.

9. The primary reduction gear reducer will drive the intermediate reduction unit through a chain and sprocket arrangement. The drive chain will be 80 L self-lubricated roller chain and be covered with an OSHA approved removable guard constructed of fiberglass reinforced plastic. Proper chain tension will be provided for by an adjustable steel base mounted on the intermediate reduction unit.

10. The intermediate reduction unit will be a heavy duty, worm gear speed reducer constructed of centrifugally cast aluminum, bronze, in a gray cast iron housing, with grease and oil lubricated, anti-friction type bearings. The unit will be mounted on a machined face on the top of the final reduction unit and properly aligned to maintain accurate centers for the final reduction gearing.
11. An overload device will be mounted on the drive head at the thrust end of the worm shaft. The components of the overload device will be enclosed in a weather tight, gray cast iron housing, gasketed and mounted to the gear housing. The components of the overload device will consist of:
   a. A plate spring assembly.
   b. A plunger indicator dial.
   c. Two (2) microswitches; One (1) Normally Open, and One (1) Normally Closed.
   d. A terminal block.
   e. The end thrust of the worm shaft against the plate spring will actuate the plunger, which in turn will move the indicator dial.

12. A visual torque dial indicator will be provided and oriented so it may be read from the walkway.

13. The microswitches will be factory set to:
   a. Sound an alarm when the load on the mechanism reaches 100% of the AGMA rated torque capacity of the drive.
   b. Stop the motor when the load reaches 120% of the AGMA rated torque capacity.

14. A shear pin device, set for 130% of the AGMA rated torque will be furnished.

15. The internal final gear will be driven by a heat treated steel pinion from the slow speed shaft of the intermediate gear reduction unit. The internal gear will be split for easy removal, will be of ductile iron and will be designed to support the center cage and collector.

16. The turntable base will have an annular raceway to contain balls upon which the internal gear rotates. The ball race will ensure a low unit ball load, long life and stability, without the necessity of guide shoes or steady bearings. The balls will be alloy steel and will bear vertically and horizontally on four (4) renewable special hardened (38-42 Rockwell C) steel liner strips force fitted into the turntable base and internal gear. Pins or cap screws are not acceptable. The liner strips will be 3/8” thick x 3/4” wide. The internal gear pinion, and ball race will run in an oil bath and be protected by a felt seal and steel dust shield.

17. The turntable base will be bolted to the center column and be designed to support the internal gear with the rotating mechanism and the access bridge. An oil filling and level pipe along with a drain plug and sight gauge, will be furnished as part of this unit. A pipe will be attached to the bottom of the turntable base for purposes of condensate removal. The oil piping will terminate within the center of the base for each access.

18. The turntable assembly will be so designed that the split internal gear, balls and strip liners may be removed without raising the access bridge.

19. The drive mechanism shall be designed in accordance with AGMA Sections 2001-B88 (1988), "Fundamental Rating Factors and Calculation Methods for Involute and Helical Gear Teeth"; and 6034-A87 (1988), "Practice for Enclosed Cylindrical Worm Gear Speed Reducers and Gearmotors"; for 24 hour continuous duty, and 20 year design gear life, based on the AGMA rated torque. All bearings shall be designed for a minimum B-10 life of 200,000 hours.

C. Center Pier:
   1. A cylindrical steel center pier will support the drive, collector mechanism, and access bridge. The top of the pier will have a drive mechanism mounting plate which will be set plumb within the centerline. The drive mechanism will be positioned, shimmed, leveled, and grouted in place with a non-shrink grout.
   2. The center pier will be fabricated of 1/4” thick steel plate and will be anchored to the concrete base with a minimum of eight (8) 1" diameter anchor bolts.
   3. The mechanism manufacturer shall provide a steel template to accurately locate these anchor bolts.
   4. The center pier will serve as an influent pipe and will have a minimum of eight (8) large inlet areas at its upper end to diffuse flow into the influent well at a velocity not to exceed 1 fps at maximum flow.
D. Influent Well:
   1. The influent well will be fabricated of 3/16” steel plate sections with bolted connections, supported from the center cage and will be of adequate size and design to diffuse the flow into the tank uniformly.
   2. The well will be designed such that the flow through velocity does not exceed 0.10 fps at maximum flow. Ports will be cut in the influent well to permit the escape of entrapped scum. The ports will have baffles to prevent short circuiting.

E. Sludge Return Header:
   1. The unitube header, of a rectangular-shaped full tapered section, will vary in size from a maximum near the tank center to a minimum at the outer end to provide uniform sludge draw-off velocities throughout and it will be fabricated of 1/4” thick steel plate and galvanized after fabrication.
   2. The longitudinal cross sectional axis of the header will be mounted at an angle of 45 degrees with the tank bottom to physically trap sludge for maximum solids concentration. The bottom edge of the header will extend downward 2” to provide a fluidizing vane as an integral parts of the header and to direct the sludge into the area of influent of the orifices with minimum sludge agitation. Attached to this vane will be a neoprene squeegee with a steel backing plate. The squeegee will have slotted holes for 1” vertical adjustment. At the inner end of the header, a flange will be provided for bolting to the center scraper of 1/4” steel plate with a neoprene blade to clean the tank bottom around the manifold directing the sludge to the first orifice.
   3. At regular intervals, not to exceed 30”, inlet orifices varying in size from a minimum diameter near the tank center to a maximum at the outer end will be accurately located in the header.
   4. The design of each orifice will be proportionate to the volume of sludge withdrawn and the design of the orifices and header will be such as to insure hydraulic balance in the tank and uniform sludge withdrawal from the entire tank bottom at all flows.
   5. Control of sludge withdrawal will be external of the basin, and consist of a single operation for each basin.

F. Header Supports:
   1. The sludge return mechanism header will be supported by a truss arm of all-welded steel construction with members having a minimum thickness of 1/4”. The connections between the truss and header will be of 1/4” steel plate.

G. Center Cage, Truss, and Manifold
   1. The center cage will be of an all-welded construction made up of structural steel members having minimum thickness of 1/4”.
   2. The manifold will be constructed of 1/4” minimum thickness steel and fitted with two (2) sealing rings. A bottom plate will be securely anchored to the concrete floor and grouted in place after proper aligning.
   3. Opposite the unitube header, a truss arm will be provided, supported from the center cage and manifold induced for the skimmer support. The arm will be of all-welded steel construction with members having a minimum thickness of 1/4”.

H. Surface Skimmer, Scum Trough, and Skimmer Blade Ramp:
   1. Two (2) full surface skimmers will be furnished consisting of a scum blade supported from the influent well and structural A frames mounted on top of the truss arms. A hinged wiper assembly will be mounted on the outer end of the scum blade to form a pocket for trapping the scum.
   2. The hinged arrangement will insure continual contact and proper alignment between wiper blade, scum baffle and beach as the blade travels up the beach. The wiper blade will have a wearing strip on its outer end which contacts the scum baffle and a neoprene strip on its lower and inner edge. The scum will be trapped as the wiper blade meets the skimmer blade ramp and is raised up the beach to be dumped into the scum troughs.
3. Two (2) scum trough shall be furnished each fabricated of 1/4" thick steel plate, adequately supported from the tank wall. The scum troughs will be 4'-0" wide, with a length of 4'-9" along the tank wall. A 6" standard pipe flange will be provided for connection to the scum discharge piping.

I. Drain Plug:
   1. The unit will allow the tank to be drained through the header to the level of the orifices. The Contractor will provide a final drain fitting in the sludge line for complete tank drainage as indicated on the Drawings. A special plug for this drain will be furnished by the Manufacturer.

J. Anchor Bolts:
   1. All equipment anchor bolts shall be furnished by the Manufacturer and shall be zinc plated steel, and of ample size and strength for the purpose intended. All anchor bolts will be set by the Contractor in accordance with the Manufacturer's instructions.

K. Sludge Judge:
   1. Manufacturer shall provide a sludge judge of at least 18 ft. in length.

2.03 PAINTING AND SURFACE PREPARATION

A. Chain - One coat of slush oil.
B. Shafting and exposed machined surfaces - solvent wiping followed by one coat of Mobil-Arma 633, or equal.
C. Wood, nonferrous materials and galvanized surfaces - unpainted.
D. Drive units and controls - Manufacturer's Standard
E. Submerged and non-submerged castings, steel plates and shapes - Surfaces will be prepared by blast cleaning, then followed by one shop coat of Tnemec 37-77, or equal.
F. Touch-up shall be furnished and applied by Contractor.
G. Contractor shall apply two (2) coats of coal tar epoxy on all submerged components. Refer to section 09900 - Paints and Coatings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in strict accordance with manufacturer's instructions.
B. Contractor shall supply and install 2" grout layer in bottom of clarifier utilizing the clarifier mechanism to screed the grout in accordance with the manufacturer’s instructions.

3.02 FIELD QUALITY CONTROL

A. After the clarifier mechanism has been completely installed, conduct such tests as are necessary to verify that operation is in conformance with the Specifications. Supply all electric power, labor, and auxiliary equipment required to complete the field tests.
B. If the clarifier mechanism does not meet the Specifications, corrective measures shall be taken, or the mechanism removed and replaced with a mechanism which satisfies the conditions specified.
C. Any component parts which are damaged as a result of testing or which fail to meet the requirements of these Specifications shall be replaced, reinstalled and retested at the Contractor's expense.

3.03 MANUFACTURER'S FIELD SERVICES

A. The services of a factory trained representative of the Manufacturer shall be provided to inspect the installation of the equipment, make any necessary adjustments (before initial start-up), and place it in initial trouble-free operation. The factory trained representative must be provided for two (2) trips for a total of four (4) days on-site.

END OF SECTION
SECTION 46 43 23
FIBERGLASS REINFORCED PLASTIC (FRP) TROUGHS, WEIRS, AND BAFFLES

PART 1 GENERAL

1.01 SCOPE OF WORK
   A. The equipment specified in this section shall be installed by the Owner under a separate
      Contract. The Fiberglass Reinforced Plastic (FRP) Troughs, Weirs, and Baffles and the
      installation thereof are not included the scope of this project.
   B. Furnish all labor, materials, equipment, and incidental to install and test complete and ready
      for operation fiberglass reinforced plastic (FRP) troughs, weirs, baffles and ancillary
      components as shown on the Drawings and specified herein.

1.02 RELATED SECTIONS
   A. Section 46 43 25 - Automated Clarifier Brush Cleaning Device

1.03 SYSTEM DESCRIPTION
   A. The fiberglass reinforced plastic (FRP) trough, weir plate, baffle, support brackets, and
      stainless steel hardware shall be supplied by a single manufacturer and installed by the
      Contractor in accordance with the manufacturer's instructions.
   B. Contractor is responsible for field verification of existing clarifier dimensions.

1.04 DESIGN REQUIREMENTS
   A. Existing Final Clarifier #1 & #2:
      1. Provide FRP trough, weir plate, baffle, support brackets, drop box, and stainless steel
         hardware. Remove and dispose of existing components to be replaced.
      2. Nominal Clarifier Diameter: 110 feet
   B. Contractor is responsible for field verification of all dimensions.

1.05 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. The following shall be submitted in accordance with the General and Special Provisions.
      1. Shop Drawings
         a. Dimensions.
         b. Job specific layout.
         c. Sectional assembly.
         d. Location and identification mark.
         e. Weir locations and attachment
         f. Scum Baffle locations and attachment.
         g. Accessories, attachments, transition pieces.
         h. Connection details.
      2. Manufacturer's catalog data showing:
         a. Dimensions, spacing, and construction details
         b. Materials of construction.
         c. Description.
      3. Certificates
         a. Submit Manufacturer's certification that all materials furnished are in compliance with
            the applicable requirements of this specification.
      4. Manufacturer's Instructions
         a. Submit complete information and instructions relating to the storage, handling,
            installation, and inspection of all equipment related to this Section.
1.06 QUALITY ASSURANCE
A. The material covered by these specifications shall be furnished by a reputable and qualified manufacturer of proven ability that is regularly engaged in the manufacture and installation of FRP products.
B. Fabricator shall be experienced in successfully producing FRP products specified for this project, with sufficient production capacity to produce required units without causing delay in the work.
C. Fabricator shall provide a list of five (5) installations of comparable size in operation for at least three (3) years.

1.07 DELIVERY, STORAGE AND PROTECTION
A. All FRP components shall be shop fabricated and assembled into the largest practical size suitable for transporting.
B. The parts and assemblies that are shipped unassembled shall be packaged and tagged in a manner that will protect the equipment from damage and facilitate the final assembly in the field.
C. All FRP materials shall be stored before, during, and after shipment in a manner to prevent cracking, twisting, bending, breaking, chipping or damage of any kind to the materials.

1.08 WARRANTY
A. The Manufacturer shall warrant to the Owner all FRP components to be free of defects in materials and workmanship for a period of two (2) years after the date of Substantial Completion.
B. In the event a component fails to perform as specified or is proven defective in service during the guarantee period, the manufacturer shall provide a replacement part without cost to the Owner. The contractor shall provide, without cost, such labor as may be required to replace, repair or modify all materials and equipment provided pursuant to this specification.

PART 2 PRODUCTS
2.01 MANUFACTURERS
A. The following manufacturer is named to establish a standard of quality necessary for the Project:
   1. NEFCO Inc., 4362 Northlake Boulevard, Palm Beach Gardens, FL 33410

2.02 DESIGN CRITERIA
A. Gravity Load - Downward vertical loads shall include the weight of the trough and appurtenance attachments, such as weir plates, baffles and spreader bars, together with the weight of water to fill the trough. Any additional loads, such as piping, etc., shall also be considered.
B. Buoyant Load - The buoyant load shall act vertically upward, its magnitude equal to the weight of displaced water (trough weight neglected). The line of action passes through the centroid of the submerged cross-sectional area.
C. Lateral Load - Loads acting against the trough sidewalls; specifically those induced by differential water levels on either side of the trough walls. The maximum possible differential, existing when the trough is empty and the tank is full, or, when the trough is full and when the tank is empty, shall be used when calculating deflection, fiber stress, etc.
D. Thermal Stresses - The troughs shall be designed to accommodate temperature induced stresses resulting from differences in coefficients of thermal expansion (contraction) between the trough and tank/support materials over temperature range of -10°F to 100°F.
E. Torsional Stability - The trough system shall be designed to resist torsional oscillations induced by the flow of water over trough edges. Any or all of the following trough stabilization techniques shall be considered.
   1. Trough-to-trough stabilization
   2. Torsional stiffness
3. Support spacing and rigidity
4. Internal baffles and/or flow straighteners

F. Deflection under Load - Maximum vertical deflection under full buoyant or gravity load shall be less than or equal to L/1000, where L is defined as the unsupported trough length in inches. Under no circumstances shall the maximum vertical deflection, measured at mid-point between trough supports, exceed 3/16”.

G. Maximum trough sidewall horizontal deflection under full lateral load shall be less than or equal to D/100, where D is defined as the trough depth, in inches. Under no circumstances shall the maximum bottom deflection exceed 3/16”.

H. Trough bottom deflection (oil canning) under full buoyant or gravity load shall be less than or equal to W/100, where W is defined as the trough width, in inches. Under no circumstances shall the maximum bottom deflection exceed 3/16”.

I. Thermal Expansion/Contraction - The troughs shall be designed to accommodate a thermally induced expansion (contraction) of 1/8” per 20 ft. length of trough over temperature range of -10°F to 100°F, without exceeding the deflection or strain limitations set forth in the preceding sections

### 2.03 MATERIALS

A. The trough laminate shall meet the following minimum physical and mechanical requirements:

1. **Table 1. Laminate Mechanical and Physical Properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Test</th>
<th>Minimum Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile Strength</td>
<td>ASTM D-638</td>
<td>25,000 psi</td>
</tr>
<tr>
<td>Flexural Strength</td>
<td>ASTM D-790</td>
<td>34,000 psi</td>
</tr>
<tr>
<td>Flexural Strength</td>
<td>ASTM D-790</td>
<td>1.48 x 10^6 psi</td>
</tr>
<tr>
<td>Barcol Hardness</td>
<td>ASTM D-2853</td>
<td>40</td>
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<tr>
<td>Notched Izod</td>
<td>ASTM D-256</td>
<td>20 ft-lbs/in</td>
</tr>
<tr>
<td>Water Absorption</td>
<td>ASTM D-570</td>
<td>0.1%</td>
</tr>
</tbody>
</table>

B. Resin - The resin shall be a commercial grade isophthalic polyester thermosetting resin, Corezym COR75-AQ-010 or equivalent, which has either been evaluated in a laminate, or which has been determined to be acceptable for use in a waste treatment plant environment.

C. Fillers: The resin shall contain no fillers. Thixotropic agents for viscosity control are acceptable. Colorants which have been determined by a least five years previous service to be acceptable for the service condition are acceptable. The standard color for the trough shall be green. Ultraviolet stabilizers are required in all trough laminates. Catalysts, accelerators and/or promoters shall be added to provide complete cure of the laminate and must meet the physical properties as indicated in Table 1.

D. Ultraviolet Resistance - Ultraviolet resistance is required in all laminates exposed to ultraviolet light, whether it be in the form of pigmentation or ultraviolet absorbers or a surface veil.

E. Metal Reinforcement - When metal reinforcements are used, they shall be free of rust, oil and any foreign matter. They shall be completely encapsulated with a minimum of 1/8” thick laminate.

F. Glass Mat Reinforcement - Glass mat reinforcement shall consist of chemically bonded surfacing mat and chopped strand or chopped strand mat as hereinafter described. Surfacing mat shall be 0.020 inches thick reinforced with a surfacing mat of Type C veil, 10 to 20 mils thick, with a silane finish and a styrene-soluble binder compatible with the resin; the glass content of this layer shall not exceed 20% by weight. Chopped strands shall be Type E glass, with silane finish and styrene-soluble binder.

G. Woven Roving Reinforcement - The finished laminate shall include one layer of 24 ounce woven roving reinforcement over the entire trough surface.
H. The content of the finished laminate shall be adequate to produce mechanical and physical properties conforming to Section 2.3, Table 1.

I. Other Reinforcement - Additional reinforcement in the form of foam or balsa sheet for high stress areas at the sides and bottom of the trough shall be completely encapsulated within the laminate. Care shall be taken to insure that these areas of the trough laminate are not designated as attachment points or drilled for any purpose.

J. Laminate Construction -
1. Inner trough surface shall be a resin rich layer 0.020 inches thick reinforced with a 10-20 mil ‘C’ veil surfacing mat. This resin rich layer shall contain less than 20% by weight of the reinforcement veil. A gelcoat interior surface may be provided.
2. Structural layers shall consist of plies of chopped strand mat with a maximum of 2 ounces per square foot per spray-up pass. Inter-layered between two layers of mat shall be one layer of 24 ounce woven roving over the entire trough structure. Each successive pass of reinforcement shall be thoroughly wetted with resin and shall be well rolled to exclude all air pockets and bubbles prior to the application of additional reinforcement.
3. Outer trough surface shall consist of a resin rich layer not less than 0.020 inches thick. The outer layer resin shall be applied after cure of the structural layer and suitably embed all reinforcing fibers.
4. Finished trough shall be a minimum of 30% fiber reinforced with a minimum thickness of not less than 1/4”. The laminate tolerance thickness shall be +10%.
5. Materials used in the manufacture of the FRP troughs shall be new stock of the best quality and shall be free from all defects and imperfections that might affect the performance of the finished product.

2.04 DESIGN AND MANUFACTURE
A. The inner surface of the trough shall be smooth and resin rich. The outer surface shall be reasonably smooth, resin rich, and no glass fibers shall be exposed. The size and number of air bubbles shall be held to a minimum. Laminations shall be dense and without voids, dry spots, cracks or crazes.
B. The top edges of the trough shall be level and parallel with a tolerance of plus or minus 1/8” (measured when the trough is not loaded).
C. The length of a trough section shall have a tolerance of ± 1/8” per 10 ft. length.
D. Horizontal stiffening flanges shall be integrally molded along the top edge of each trough side. These flanges shall be 1” to 3” wide, depending upon the trough configuration and shall face outward.
E. End flanges, where required to bolt trough sections together, and blind ends for securing to a wall, shall be a minimum of 1-1/2 times the nominal thickness of the trough.
F. An integrally molded water stop shall be provided on the trough whenever the trough is grouted into and/or passes through a wall.
G. Horizontal stiffeners shall be provided across the width of the trough to increase the structural rigidity of the trough system. The stiffeners shall be 1” diameter PVC pipe with an internal 1/2” stainless steel rod threaded on both ends and fastened through the trough walls on 2-foot centers, or as recommended by the manufacturer.
H. After fabrication, all cut edges, holes and abrasions shall be sanded smooth and sealed with a compatible resin coating to prevent the intrusion of water.

2.05 TROUGH SUPPORTS AND HARDWARE
A. Manufacturer shall be responsible for the design and fabrication of supports suitable for installation of the troughs specified herein.
B. Trough supports may be hot dip galvanized steel, type 316 stainless steel, or FRP.
C. All trough mounting hardware shall be Type 316 stainless steel and shall be supplied by the trough manufacturer.
2.06 FRP WEIRS AND SCUM BAFFLES
   A. Except for bolts and hardware specified herein, the weirs, scum baffles and supports shall be polyester plastic resin, reinforced with glass fiber. All weir plates, weir washers, weir splice plates, scum baffle panels, scum baffle splice plates and baffle support brackets shall be fiberglass reinforced plastic molded to produce uniform smooth surfaces. The surface shall be resin rich, free of voids and porosity, without dry spots, crazes or unreinforced areas and shall provide for increased corrosion resistance and UV protection. The weirs and scum baffles shall be green in color.
   B. The weir plates, splice plates and weir washers shall be 1/4" thick plastic laminate. Weir plates shall not exceed 12' in length unless otherwise noted. The specific dimensions of the weirs and scum baffles shall be as shown on the Drawings. Oversized mounting holes in the weir plates shall be provided for vertical and horizontal alignment of at least 2" with 5" diameter FRP weir washers to cover the holes. The weirs shall be mounted with 1/2" diameter stainless steel bolts at 2' on center. Cut ends of non-standard lengths shall be sealed with resin.
   C. Scum baffle panels and splice plates shall be 1/4" thick plastic laminate. The scum baffle panels shall be 12" high and shall not exceed 12' in length unless otherwise noted. Splice plates shall be 6" x 12". The scum baffle brackets shall be 6" x 6" x 3/8" FRP Angle with slotted holes to provide horizontal, vertical and radial adjustment of the baffle. The brackets shall be installed on 4' centers. Fastening holes in the scum baffle panel shall be countersunk to accommodate flat head fasteners. Cut ends of non-standard lengths shall be sealed with resin.
   D. Expansion anchors, nuts, bolts, washers and other hardware shall be Type 304 stainless steel.

PART 3 EXECUTION

3.01 STORAGE
   A. Should it be necessary to store product prior to installation, precautions should be taken to prevent cracking, twisting, warping, distortion, bending, breaking, chipping or damage of any kind to the materials.

3.02 INSTALLATION
   A. Install troughs and supports in accordance with manufacturer's instructions and approved shop drawings.
   B. Field cutting of troughs is allowed if necessary. All field cut edges and field drilled holes shall be sealed per the manufacturer's instructions.
   C. Ensure that troughs and supports are installed plumb and true, free of warp or twist, within the tolerances specified by the manufacturer and as shown on the drawings.
   D. After the manufacturer has approved the installation, and prior to startup, the Contractor shall clean all surfaces in accordance with the manufacturer's instructions.

END OF SECTION
SECTION 46 43 25
AUTOMATED CLARIFIER BRUSH CLEANING DEVICE

PART 1 GENERAL

1.01 SCOPE OF WORK
A. The equipment specified in this section shall be installed by the Owner under a separate Contract. The automated clarifier brush cleaning device and its installation are not included in the scope of this project.
B. Furnish all labor, materials, equipment, and incidentals to install and test, complete and ready for operation one (1) set of automated clarifier brush cleaning device as specified herein.

1.02 RELATED SECTIONS
A. Section 46 43 21 - Clarifier Mechanism

1.03 SYSTEM DESCRIPTION
A. Provide an apparatus for cleaning algae and debris from the baffle, weir, spillway and effluent flow launder of a circular clarifier. The system consists of an attachment sleeve mounted to existing clarifier equipment as directed by clarifier manufacturer, a mainframe member, several telescopic brush arms, numerous brushes of various sizes, and an assortment of springs in different configurations to provide the biasing forces. A series of brushes are mounted to the frame member and biased into engagement with the baffle, weir, spillway and walls of the effluent flow channel. Furthermore, a bridging device is positioned over the effluent discharge hole to support the launder brush assembly as it passes. All metallic parts of the automated brush system shall be constructed of Type 316 stainless steel or greater with exception of Mainframe and Attachment Assembly which will be 304 stainless steel.
B. The Automated Brush System shall be custom designed, constructed, for the removal of algae and debris and installed on a circular clarifier. Because of custom designed application of the automated brush units, manufacturer is required to have a factory service technician on site for a minimum of up to three working days per unit to observe and advise the installation of Automated Brush System on one scheduled mobilization to site. This is particularly important for fine-tuning / brush adjustment segment of installation.
C. The Automated Brush System shall be designed to work off the power of the existing clarifier drive motor. The system shall be constructed to avoid any noticeable torque increases. The unit shall be capable of encountering an indefinite stall without incurring damage.
D. The unit shall be designed with an engaged position for cleaning, and a dis engaged position allowing the system to ride idle around the tank.

1.04 DESIGN REQUIREMENTS
A. Existing Final Clarifier
1. Provide an automated brush cleaning system for the Existing Final Clarifier.
2. The Automated Brush System for algae and debris control shall be designed for a Brush to make contact with each of the following surfaces (exact dimensions shall be field verified):
   a. Inner Baffle
   b. Outer Baffle
   c. Inner Weir
   d. Outer Weir
   e. Inner Launder Wall
   f. Launder Bottom
   g. Outer Launder Wall

1.05 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data shall include at least the following:
   1. Certified shop and erection drawings showing all important details of construction and dimensions.
   2. Descriptive literature, bulletins, and/or catalogs of the equipment.
   3. The total weight of the equipment including weight of the single largest item.
   4. A complete total bill of materials for all equipment.
   5. A list of manufacturer's recommended spare parts.

C. The manufacturer shall clearly identify any exception to this Section, related sections, or the Drawings. Failure to do this shall be grounds for rejection of the submittal.

1.06 QUALITY ASSURANCE

A. Qualifications of manufacturer: The Manufacturer of Automated Cleaning Brush systems shall regularly engage in the manufacture of Weir Cleaning systems with have a minimum of five (5) years' experience in the manufacture of Automated Weir Cleaning systems. Additionally, Manufacturer of Automated Cleaning Brush System shall and a minimum of seventy-five (75) UNITS of their own units in operation. A history of successful installations (with contact names and phone numbers) must be available and included, if required.

B. Qualifications of manufacturer: Products used in the work specified shall be produced by manufacturers regularly engaged in the manufacture of similar items and with a history of successful production.

C. Use of factory trained workmen, who are completely familiar with the specified requirements of automated brush cleaning devices and the methods needed for proper performance of equipment will be required. One (1) Factory trained and employed technician will be on site for up to 3 days per clarifier to observe and advise the installation and "sign off" on the custom designed, field built Automated Weir Cleaning system with the contractor performing installation. Factory advisement includes calculating bridge clearances, strengthening uprights, placement of ramps over effluent discharge/ scum box areas and adapting brush system for radial variances of the clarifier walls and weir surfaces. It will be the responsibility of the Manufacturer of the Automated Brush system to ensure the brush system is cleaning all effluent surfaces included in the specifications.

1.07 DELIVERY, STORAGE, AND PROTECTION

A. In accordance with Section 01600

1.08 WARRANTY

A. See Section 01780 - Closeout Submittals, for additional warranty requirements.

B. Automated Brush system will include a 5 year parts warranty and 1 year labor warranty provided by the Manufacturer of the Automated Brush system to the Owner. The Manufacturer of the Automated Weir Cleaning Brush system is the sole responsible party for the installation and performance of the Automated Brush system after the system has been "signed off" or accepted.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Ford Hall Company (Weir Wolf)

B. Substitutions: Not permitted.

2.02 ATTACHMENT ASSEMBLY

A. The Attachment Assembly shall provide a means of attaching the Automated Brush System to the skimmer arm and or rake truss so as not to interfere with any other operations of the skimmer arm (such as the effective skimming of floatable solids or the operation of the skimmer blade assembly at the scum box).

B. The Attachment Assembly shall be custom designed for each specific clarifier. It shall be constructed of 304 stainless steel.
2.03 MAINFRAME
A. The Automated Brush System Mainframe shall be constructed of Type 304 stainless steel and designed to slip easily into the Attachment Assembly and be tightened in position with the use of set screws.
B. The Mainframe shall be designed so that the Brush Arms can be positioned at any point on the Mainframe.

2.04 BRUSH ARMS
A. Brush Arms shall be of Type 316 stainless steel and custom designed and installed for individual applications. Factory service technician will be on site to observe and advise the installation of the Brush Arms to allow for cleaning all aforementioned surfaces and allow for the following:
   1. Flexibility to clean effluent surfaces within a plus or minus 4-inch radial variance (specifically: Clarifier walls, both sides of weirs & baffle).
   2. To have opposite the Mainframe end, a Brush Holder component allowing for the insertion of a brush.
   3. To allow Brush Holder to be adjusted telescopically so that a maximum number of Brush Arm adjustments are possible.
   4. To have a means of biasing the arm to the Mainframe so as to provide sufficient force to remove algae and debris.
   5. Include a component that allows for each brush arm to be “locked out” or disengaged. This will allow operators to customize cleaning schedule and extend life of the brushes

2.05 SPRINGS ASSEMBLIES
A. Each Brush Arm requires spring tension to bias the Brush Arm with the Brush Holder and Brushes into tight engagement with the appropriate effluent surface to be cleaned. The Spring Assemblies require the following:
   1. A minimum of one Spring Assembly of 316 stainless steel is required for each Brush Arm.
   2. Spring Assemblies consist of two stainless steel springs & one stainless steel guide.
   3. Each spring will be composed of 316 stainless steel wire with a minimum diameter of 0.95 inch and a minimum of 260 active coils per spring length.
   4. Spring coils will have a mean diameter of 0.655 inches. A minimum inner coil diameter of .56 inch & an outer diameter of .75 inch are required of each stainless steel spring.
   5. Springs to have a minimum initial spring tension of 6.68 lbf and a maximum of 10.02 lbf with a minimum load tolerance of 18.44 lbf.

2.06 BRUSH HOLDER
A. At the end of each Brush Arm, there will be a 316 stainless steel Brush Holder to allow the insertion of a Cleaning Brush.
B. A Brush Holder shall be aligned with each of the following surfaces: both sides of the weir and each of the effluent launder surfaces. Each Brush Holder will:
   1. Consist of a “bolted clamp design” to allow for the easy insertion and removal of Brushes.
   2. Include a factory-supplied brush suitable for prolonged exposure to wastewater environment.
   3. Contain a Shear Safety Component.

2.07 SHEAR SAFETY COMPONENT
A. Each Brush holder will contain a Shear Safety Component having a frangible point designed to break when subjected to a force exceeding an optimum predetermined stress value.
B. The stress value on each Shear Safety Component will be low enough to release the Brush Holder to forgo any damage to Brush Cleaning unit and/or Skimmer equipment but be high enough to allow standard operation of Brush cleaning system.
2.08 BRUSHES
   A. Each Brush Holder shall contain one (1) Cleaning Brush. Brushes shall be provided that slip easily into the Brush Holder and provide the cleaning means necessary to remove algae and debris from their respective surfaces. A brush shall be aligned to make contact with both sides of the baffle, both sides of the weir and all the effluent launder surfaces.
   B. Brush construction shall be as follows:
      1. Brush backing shall be of durable plastic able to withstand continuous exposure to sunlight, seasonal temperature changes and the corrosive elements found in wastewater.
      2. Brush bristles shall be polypropylene with adequate trim length, density, and stiffness for extended continuous use.
      3. Brushes shall be cut and shaped appropriately so as to clean their respective surfaces without binding.
   C. Replacement Brushes shall be stocked by the manufacturer to the exact dimensions and will be available for purchase. Average Brush life is approximately one (1) year.

2.09 LOCK IN / LOCK OUT DESIGN
   A. Each Automated Brush System shall be designed with an engaged or locked in position for cleaning and a disengaged or locked out position for riding idle around the tank.
   B. Each Brush Arm will have permanently mounted to the Brush Arm a Lock Out Hook that corresponds to a Lock Out Ring, which allows disengagement of the individual Brushes. The Lock Out Ring is mounted to a Lock Out Boss that is attached parallel to the Mainframe.
   C. Each Automated Brush System shall be designed so that the entire Brush system can be disengaged or individual Brush Arms can be disengaged allowing for customized cleaning of weir and effluent surfaces.

2.10 BRUSH BRIDGE
   A. Provides the automated brush system Launder Brush Assembly a "Bridge" over the effluent hole on which to travel.
   B. The Brush Bridge shall be constructed entirely out of Type 304 Stainless Steel.

PART 3 EXECUTION

3.01 INSTALLATION
   A. Install equipment in accordance with Manufacturer’s instructions and recommendations.
   B. Basis of acceptance: The manufacturer’s recommended installation procedures, when approved by the Engineer, will become the basis for inspecting and accepting or rejecting actual installation procedures used on this work.

3.02 FIELD QUALITY CONTROL
   A. Provide one (1) Factory trained and employed technician will be on site for up to 3 days per clarifier to observe and advise the installation and "sign off" on the custom designed, field built Automated Weir Cleaning system with the contractor performing installation.
   B. If any part of the automatic brush cleaning system does not meet the specifications, corrective measures shall be taken, or components removed and replaced with components which satisfy the conditions specified.
   C. Any component parts which are damaged as a result of testing or which fail to meet the requirements of these Specifications shall be replaced, reinstalled and retested at the Contractor’s expense.

END OF SECTION
SECTION 46 51 18
SLOT INJECTOR AERATION AND MIXING SYSTEM

PART 1 GENERAL

1.01 SCOPE OF WORK
A. Furnish and provide all labor, materials, equipment, and incidentals to install and test, complete and ready for operation, the Slot Injector System(s) as shown on the Drawings and as specified herein.

1.02 RELATED SECTIONS
A. Division 26 - Electrical

1.03 SYSTEM DESCRIPTION
A. The Slot Injector System shall be supplied by a single manufacturer for all equipment described in this Section and installed by the Contractor in accordance with the manufacturer's instructions.
B. For each basin, the Slot Injector System shall be designed to transfer sufficient oxygen to meet the specified actual oxygen transfer rate (AOTR), as well as, provide sufficient mixing energy in each basin to provide completely mixed conditions with no air supply blowers in operation.
C. The Slot Injector System shall consist of a liquid jet manifold and air manifold complete with necessary supports and hardware, jet recirculation pump, and positive displacement, rotary lobe type blowers as shown on the Drawings and specified herein.

1.04 DESIGN REQUIREMENTS
A. Anoxic Reactor #1:
   1. Nominal Basin Diameter: 140 feet
   2. High Water Level: 28 feet
   3. Site Altitude: < 20 feet Above Sea Level
   4. Design Conditions:
      a. Maintain completely mixed conditions with no air supply blower in operation.
      b. MLSS Concentration: 4,000 - 6,000 mg/L
      c. AOTR at D.O. = 2.0 mg/L
         1) Total Airflow: 9,528 scfm
         2) Temperature: < 30 degrees C
      d. Maximum Air Flow Capacity: 12,000 scfm
   5. Liquid Header Size (primary): 24-inch
   7. Air Header Size (primary): 14-inch
   8. Air Header Size (secondary): 10-inch
   9. Minimum Number of Jet Nozzles per Manifold: 110
   10. A Backflush System shall be provided.
B. Nitrification Reactor #2:
   1. Nominal Basin Diameter: 152 feet
   2. High Water Level: 26 feet
   3. Site Altitude: < 20 feet Above Sea Level
   4. Design Conditions:
      a. Maintain completely mixed conditions with no air supply blower in operation.
      b. MLSS Concentration: 4,000 - 6,000 mg/L
      c. AOTR at D.O. = 2.0 mg/L
         1) Total Airflow: 9,528 scfm
         2) Temperature: < 30 degrees C
      d. Maximum Air Flow Capacity: 12,000 scfm
   5. Liquid Header Size (primary): 24-inch
7. Air Header Size (primary): 14-inch
8. Air Header Size (secondary): 10-inch
9. Minimum Number of Jet Nozzles per Manifold: 110
10. A Backflush System shall be provided.

C. The manufacturer shall supply two (2) end suction centrifugal pump for the Anoxic Reactor #1 slot jet aeration and mixing system with the following minimum requirements:
   1. Design Flow Capacity: 11,000 gpm each
   2. Total Dynamic Head at Design Flow: 47 feet
   3. Maximum Solids Size: 3 inches
   4. Motor Horsepower: 200 HP
   5. Motor Type: TEFC Severe Duty
   6. Motor Configuration: Belt Drive
   7. Pump Suction Size: 16-inch
   8. Pump Discharge Size: 16-inch
   9. Pump Manufacturer: Sulzer (or approved equal)
   10. The pump motor shall be capable of operating on a variable frequency drive (VFD).

D. The manufacturer shall supply two (2) end suction centrifugal pump for the Nitrification Reactor #2 slot jet aeration and mixing system with the following minimum requirements:
   1. Design Flow Capacity: 11,000 gpm each
   2. Total Dynamic Head at Design Flow: 47 feet
   3. Maximum Solids Size: 3 inches
   4. Motor Horsepower: 200 HP
   5. Motor Type: TEFC Severe Duty
   6. Motor Configuration: Belt Drive
   7. Pump Suction Size: 16-inch
   8. Pump Discharge Size: 16-inch
   9. Pump Manufacturer: Sulzer (or approved equal)
   10. The pump motor shall be capable of operating on a variable frequency drive (VFD).

E. The manufacturer shall supply five (5) identical positive displacement blowers with sound attenuating enclosures as follows:
   1. Discharge Volume: 2,382 scfm
   2. Inlet Pressure: 14.2 psia
   3. Inlet Temperature: 100 F
   4. Inlet Humidity: 85 percent
   5. Discharge Pressure: 26.1 psia
   6. Differential Pressure: 11.9 psig
   7. Supply Voltage: 460 Volts, three (3) phase, 60 Hz
   8. Motor Horsepower: 200 HP
   9. Gas: Air
   10. Blower Manufacturers: Aerzen, Kaeser, or approved equal
   11. Blower shall be capable of operation on a variable frequency drive.
   12. The blowers shall be located inside the new equipment building.
   13. The blower will have a piped air intake to the outside of the building.
   14. The blower shall be supplied with air intake silencers or screens.

1.05 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Submit product data, including Manufacturer's data, for specified products.
   1. System Description: Include the following:
      a. Manufacturer's data, order sheet, or equivalent for each major piece of equipment, component, instrument or device being supplied.
Mountaire Farms of Delaware, Inc.
Millsboro, DE
Wastewater Treatment System Upgrade

b. Manufacturer's outline and mounting dimensions for all field mounted components, including, but not limited to, drives, motors, pumps, liquid jet headers, air headers, instrumentation and controls.

c. Manufacturer's wiring diagrams for instrumentation and control system, including necessary field connections (if required).

d. Manufacturer's Dimensions and Field Fabrication Details for all mechanical equipment.

e. Mounting Details.

f. All equipment to be furnished under this Section must be approved prior to being released for manufacturing unless otherwise noted by the Engineer.

C. Operation and Maintenance Data: Operation and Maintenance data for each piece of equipment supplied and the jet aeration and mixing system.

D. Certificates: Certify that products of this section meet or exceed specified requirements.

E. Manufacturer's Field Reports: Provide copies of the manufacturer's field reports from inspection and system start-up services.

F. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

G. Certification: The Manufacturer shall provide a certification stating that they have reviewed the Drawings and Specification for this project and have verified that the applicability of the specified equipment to be provided by the Manufacturer for the intended use per the Drawings and Specifications.

1. The Manufacturer shall provide to the Engineer, as part of the certification, in writing any recommended revisions to the design based upon the Manufacturers review of the Specifications and Drawings.

H. The manufacturer shall clearly identify any exception to this Section, related sections, or the Drawings. Failure to do this shall be grounds for rejection of the submittal.

1.06 QUALITY ASSURANCE

A. The equipment covered by this Section is intended to be standard equipment, as modified by this Section, of proven ability, as supplied by a single manufacturer, having long experience in the production of such equipment. The equipment furnished shall be designed, constructed and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and as specified herein.

B. In the event that equipment which differs from this Section be offered and determined to be equal to that specified, such equipment shall be acceptable only on the basis that any revisions in the design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc. required to accommodate such a substitution shall be made at no cost to the Owner and be as approved by the Engineer.

C. The rated horsepower of the drive units shall be such that the units will not be overloaded nor the service factor reduced when the unit is operated at any point on the curve. If, due to the slope of the performance curve, a drive unit of greater horsepower than specified is required to meet this condition, the drive unit will be considered for approval only if any and all changes in electrical work, etc. required by such a change will be provided at no additional cost to the Owner and be to the satisfaction of the Engineer.

1.07 DELIVERY, STORAGE, AND PROTECTION

A. In accordance with Section 01 60 00.

1.08 FACTORY TESTING OF BLOWERS

A. All critical dimensions of the blower components actually provided by the manufacturer shall be verified and documented prior to assembly.
B. The rotating parts of each blower actually provided by the Manufacturer shall be statically and dynamically balanced before final assembly. The blower alone shall operate without excessive vibration.

C. Each blower actually provided by the Manufacturer shall be slip tested. The Slip RPM shall be documented. A document certifying that the supplied blowers conform to the design specifications shall be provided.

D. On completion of final assembly of the packaged blower and prior to shipment, each packaged blower shall be mechanically run for a minimum of fifteen (15) minutes.

1.09 WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS
2.01 MANUFACTURERS
A. KLa Systems, Inc. - Assonet, MA

2.02 MATERIALS FOR JET RECIRCULATION PUMPS
A. General:
1. Stainless steel nameplates giving the name of manufacturer, the rated capacity, head, speed, and other pertinent data shall be attached to each pump.
2. The manufacturer shall supply complete factory mounted equipment.
3. All electrical materials and equipment shall be UL listed or Factory Mutual approved and NEMA rated.
4. Control panels shall be factory wired, such that field wiring connections shall require connection of power and control wiring to the control panel and to the pumps and alarm wiring to the control panel and the pump failure alarm light. Field wiring connections shall be to numbered terminal strips.
5. The entire control system shall be factory tested prior to shipment.

B. Casing:
1. The casing shall be of ASTM A 48 cast iron construction and shall be end suction with top centerline, self-venting discharge and 125# or 150# ANSI flanges.
2. The casing shall be of a back-pull-out design to allow complete disassembly without disturbing the piping or driver.
3. The casing shall be supported by rigid integral cast feet for maximum resistance and distribution of unanticipated loads.
4. The casing shall be radially split and rabbeted to the stuffing box cover and adapter to assure proper alignment.
5. The shall be sealed by use of a confined gasket between the casing and cover.

C. Impeller:
1. The impeller shall be of ASTM A743 CF8M (316 stainless steel) or ASTM A 890 Grade 3A duplex stainless steel and be of open design, statically and dynamically balanced to ISO 1940 G6.3.
2. The impeller shall be mounted to the shaft by means of an integral spiral cut shaft key or via acme thread cut on the shaft.
3. The impeller shall be locked in place with an impeller bolt with integral locking washer or by an impeller nut.

D. Side Plate:
1. A wear plate of ASTM A743 CF8M (316 stainless steel) or ASTM A 890 Grade 3A duplex stainless steel shall be standard with open impellers.
2. The wear plate shall protect the casing against wear and maintain pump efficiency at the highest levels.
E. Shaft:
1. The shaft shall be of heavy-duty SS 2324 duplex stainless steel with a minimal overhang to the centerline of impeller.
2. The maximum shaft deflection shall be less than 0.002" at the face of the seal box.
3. The shaft and sleeve shall be sealed from the pumped liquid by use of impeller and sleeve o-rings.

F. Dynamic Seal:
1. The dynamic seal assembly shall be of ASTM A743 CF8M (316 stainless steel) or ASTM A 890 Grade 3A duplex stainless steel and must include flow interrupters to prevent solids and fibrous material build-up.
2. The static seal should not contact the shaft during operation and automatically close when the pump is not in operation.

G. Adapter:
1. The adapter shall be rabbet fitted to the bearing unit, back cover and casing to provide exact alignment of the rotating components.

H. Bearing Unit:
1. The bearing unit shall be sealed by use of non-contacting labyrinth isolators to protect the bearings and lubricating oil from external contamination.
2. A bullseye sight glass shall be provided to monitor the oil level.
3. The bearing housing shall be drilled on both sides to allow installation of an optional oiler.
4. The bearings shall be shoulder mounted to the shaft and fixed in the bearing housing to eliminate any axial shaft movement.

I. Bearings:
1. The radial bearing (inboard) is to be a cylindrical roller design with a minimum L-10 life of 100,000 hours.
2. The axial (thrust) bearing shall consist of two 40 degree angular contact bearings mounted back-to-back to provide a minimum L-10 life of 100,000 hours.

J. Lubrication:
1. Bearing lubrication shall be an oil bath.

2.03 MATERIALS FOR BLOWERS

A. Each blower package unit shall be complete with rotary lobe positive displacement blower, drive unit, V-Belt drive, Flexible expansion joints, drive guard, common steel base discharge silencer, inlet filter silencer, pressure relief valve, check valve, discharge pressure gauge, discharge temperature gauge, filter differential pressure gauge, and appurtenances. One manufacturer shall furnish all components.

B. Casing:
1. The casing shall be made of high strength, close grained, cast iron, and shall be adequately ribbed to resist deflection and facilitate cooling.
2. The casing shall be precision machined to allow for minimum clearances.
3. The casing design shall incorporate channels at the discharge port to minimize pulsation.

C. Rotor Assemblies:
1. The rotor assemblies shall be one piece and precision machined from high strength, close grain, spheroidal graphite ductile iron allowing smooth, efficient operation at all rated speeds and pressures.
2. Rotors shall be closed-end using a threaded plug.
3. The integral shafts shall be designed to carry higher loads than calculated for the maximum design load and shall incorporate replaceable seal ring wear sleeves.
4. The rotor assemblies shall be statically and dynamically balanced.
5. The rotors shall be a tri-lobe design in order to minimize pulsation and noise.

D. End Plates:
1. The gear-end plate shall be cast iron.
2. The drive-end plate shall be integral to the blower casing ensuring heavy-duty construction, long life, and maximum machine noise attenuation in all applications.
3. Bearing fits shall be precision machined to ensure accurate positioning of the rotors in the casing.
4. Replaceable seal wear inserts shall be provided on the drive-end and gear-end plates.
5. The end plates shall be heavy-duty cast iron with a precision machined sealing face.

E. Timing Gears:
1. The rotor timing gears shall be precision machined from case hardened and ground alloy steel.
2. Each timing gear shall be straight cut and beveled to eliminate axial bearing loads and ensure long life as well as quiet operation.
3. Gears shall be finish ground on a precision grinder to ensure concentricity.
4. The timing gear set shall be taper-mounted on the rotors for improved rebuild ability and accurate timing.

F. Bearings:
1. All four shaft support locations shall incorporate large, heavy-duty cylindrical roller bearings designed to handle extreme radial loads without sacrificing product integrity and reliability.
2. The minimum acceptable L10 design life at the blower's maximum rated speed and maximum rated differential pressure shall be no less than 70,000 hours.

G. Lubrication:
1. Both the gear-end and the drive-end of the blowers shall be oil splash lubricated for minimal maintenance and long service life.
2. Grease lubricated bearings are not acceptable.
3. The lubrication design shall ensure adequate lubrication of the timing gears and bearings.

H. Seals:
1. There shall be four (4) piston ring type labyrinth seals at each end of each rotor to minimize leakage and maintenance costs.
2. The cavity between the air-side and oil-side seals shall be vented through threaded ports to allow external purging or containment of any lubricating oil or process gas that may have migrated past the seals.
3. Enough ports shall be incorporated in the design to ensure that the cavity is vented from the bottom no matter what blower drive-to-driven shaft orientation is utilized.
4. A vent cavity shall be provided on all four (4) sets of piston ring type labyrinth seals. The two (2) vent holes located on the bottom side of the blower shall be left open. The vent holes at the other locations shall be closed off with threaded metal plugs.
5. The input drive shaft seal shall be a high temperature radial lip type seal with Viton elastomers. The seal design shall incorporate a replaceable wear sleeve on the input drive shaft.

I. Drive Motors:
1. Drive motors shall be designed, manufactured, and tested in accordance with the latest revised editions of NEMA MG-1, IEC, IEEE, ANSI, and AFBMMA standards as applicable and shall be capable of continuous operation.
2. The motor nameplate horsepower rating shall not be exceeded at the design speed.
3. The temperature rise of the motor windings shall not exceed IEC and NEMA standards when the motor is operated continuously at the rated horsepower, rated voltage, and rated frequency in ambient conditions of 40 degrees C.
4. The motors shall conform to the following:
   b. Type: Squirrel Cage Induction.
   d. Service Factor: 1.15.
   e. Duty Cycle: Continuous.
f. Ambient Temperature Rating: 40 degrees C

g. Starting Current: Six (6) times full load current maximum.

h. Winding Insulation: Class F.

i. Temperature Rise: Class B.

j. Voltage/Frequency/Phase: 460/60/3.

k. Bearing Lubrication: Oil, Oil Mist, or Grease (with grease addition fittings

I. Maximum Speed: 3,600 rpm.

m. Speeds: Capable of being operated with a variable frequency

J. Blower Packages:

1. The packaged blowers are to be standard engineered designs of a CE certified manufacturer regularly engaged in the production of packaged blowers to ensure single source accountability and shall include the following listed standard features:

a. The packages shall be driven through V-belts and sheaves. The drive assembly shall be of the high capacity type, oil and heat resistant, with a minimum service factor of 1.5.

b. Automatic tensioning of the V-belts by use of a pivoting, swing frame motor base with adjustable spring assistance and visual indication of V-belt tension shall be provided to ensure the V-belts remain properly tensioned with minimal maintenance and to extend V-belt, sheave, and bearing life. Adjustment of the tensioning device shall be accomplished without removal of the guard or loosening of the motor mounting bolts.

c. The drive guard shall be the manufacturer’s standard sheet metal with provision for ventilation. The installed guard shall be fully enclosed, easily removable, and designed to meet current OSHA recommendations and CE standards.

d. The base shall be an elevated, rigid, fabricated steel design with a solid sub-base. The absorptive type discharge silencer shall be integral to the frame in order to minimize space requirements. The blower shall be mounted horizontally for a compact frame.

e. To prevent transmission of vibration and noise, as well as secure the package to the foundation, the base shall include vibration isolators made of rubber in a steel footing equipped with mounting holes for anchoring purposes.

f. Oil drains from the blower drive-end and gear-end lubricating oil sumps shall be piped to the front of the base for ease of maintenance. The drain valves shall be a ball valve with a fully retained and gasketed threaded cap.

g. The inlet filter shall be integral to the inlet silencer and shall include a washable and reusable polyester element for minimal pressure drop.

h. The inlet silencer shall be of the absorptive type, directly connected to the inlet port of the blower, and shall be mounted horizontally.

i. The discharge silencer shall be of the absorptive type with an integral pulsation dampener and directly connected to the outlet port of the blower. The discharge silencer shall be mounted horizontally and shall be integral to the base frame.

j. The relief valve shall be spring loaded and factory installed in a location to protect the blower from excessive differential pressures. The relief valve exhaust shall be piped out of the enclosure.

k. An elastomeric expansion joint shall be provided for connection of the packaged blower to the system piping to reduce transmission of structure borne noise as well as prevent unacceptable loading of the silencer connection and blower casing.

l. A sound enclosure shall be provided. The sound enclosure shall be sheet steel construction with powder coat finish. It shall have acoustic foam insulation and shall provide sound attenuation of up to 20 dB(A). The enclosure shall have a hinged panel on top and a removable panel on the front of the package to allow maintenance access. Panels shall incorporate locking closures. An installed, integral ventilation fan, sized to provide adequate cooling of the package, shall be provided.

m. A pressure gauge shall be provided, pre-piped and panel mounted, on the sound enclosure.
n. A temperature gauge, with adjustable switching point and contact, shall be provided pre-piped and panel mounted on the sound enclosure.

o. A filter differential pressure gauge with adjustable switching point and contact shall be provided pre-piped and panel mounted on the sound enclosure.

p. The blower package shall be designed to allow all preventive maintenance to be performed from the front of the package. All utility connections and process connections shall be at the rear of the package.

q. Inlet flange connection with an elastomeric compensator/flex connector.

r. Provide an inlet silencer shipped loose for installation on the exterior piped inlet connection blowers.

2.04 COMPONENTS

A. Anoxic Reactor #1

1. Aeration Manifold:
   a. Each aerator shall be a monolithic fabrication with slot injectors arranged as Directional (injectors mounted on one side of the liquid header) aeration manifolds. Slot injectors shall be equally spaced along the length of the header with an aeration area of between 65 and 160 square feet per injector. Liquid header shall be sized such that the maximum motive liquid velocity shall not exceed 8.0 feet per second. Air header shall be sized such that the air velocity shall not exceed 4,400 feet per minute at maximum air flow. The aeration manifolds shall provide uniform distribution of the liquid and air to each slot injector. The slot injectors shall be aligned on a common horizontal plane and angled downwards at 30 degrees in order to maximize gas dispersion such that the outlet of the nozzle is approximately 40 inches above the tank floor.

   b. The liquid header shall be a cylindrical member, internally smooth and free from protrusions, which might create additional head loss or collect stringy material. The air header shall also be a cylindrical member located above and parallel to the liquid header. The air header shall be attached to and supported above the liquid header by an air duct at each injector location. Individual air ducts shall ensure uniform air distribution to each injector. Additional supports shall be provided as necessary.

2. Slot Injectors:
   a. Each slot injector shall consist of an inner propulsion nozzle, outer mixing chamber and an air duct.

   b. The slot injectors shall be fabricated from injection molded reinforced polypropylene and air ducts shall be fabricated from contact-molded reinforced thermosetting laminates in accordance with ASTM C 582-95 and NBS PS 15-69 using Dow Derakane 411 (or equal) vinyl ester resin formulated for ultra-violet protection.

   c. In order to retain more of the jet's kinetic energy, the cross section of the mixing chamber shall transition from a circle to a slot without a reduction in flow area. The shape of the propulsion nozzle will also taper from a circle to a slot in order to assure even distribution of energy across the mixing chamber.

   d. The injectors shall be molded and assembled to be concentric with the propulsion nozzle and mixing chamber in axisymmetric alignment. The propulsion liquid and compressed air shall combine in the outer mixing chamber, discharging as a high energy, fine bubble, flat ribbon shaped cloud in the lower regions of the basin.

3. Liquid and Air Piping:
   a. All air and liquid header piping for fabricating the slot injector system and connection piping within the basin shall be provided as part of the system. Air down-comer and air header pipe shall be sized such that the maximum air velocity shall not exceed 4400 feet per minute and shall connect to the Contractor supplied out-of-basin pipe located on foot above the maximum liquid level.

   b. Liquid suction, discharge and header pipe shall be sized such that the maximum motive liquid velocity shall not exceed 8 feet per second. Standard, 150-lb. drilling flanges shall be furnished for supplier/Contractor interface.
c. The fiberglass reinforced polyester (FRP) pipe used for the Slot Injector System shall be fabricated from premium grade vinylester resin with a pressure rating of not less than 75 psi.

d. The pipe shall incorporate a resin-rich liner on both the inside and outside that consists of a "C" glass veil and resin, to a 10-20 mil nominal thickness, with a minimum amount of wax in the surface resin to allow the pipe to cure.

e. The wall shall be fabricated with a structural wall of continuous glass fibers wound at a 54.75 degree helical angle in a matrix of vinyl ester resin.

f. The pipe shall be fabricated in conformance with ASTM D-2996-01, Type 1, Grade 2, Class E.

g. The pipe shall be formulated for ultra-violet protection.

h. The resin shall remain natural in color (No Pigment Allowed).

i. Unless otherwise noted, the wall thickness of the piping shall be as follows:
   1) 8" pipe = 0.15 inches
   2) 10" pipe = 0.15 inches
   3) 12" pipe = 0.21 inches
   4) 14" pipe = 0.21 inches
   5) 16" pipe = 0.21 inches
   6) 20" pipe = 0.26 inches
   7) 24" pipe = 0.31 inches

j. Pipe, fittings, and air feeds shall be fabricated using Ashland Derakane (or equal) vinyl ester resin.

k. All distribution piping, and manifold sections shall be field connected by FRP field wrap joints.

l. Field wrap joint kits shall be furnished with all necessary materials and instructions.

m. FRP flanges shall be fabricated in accordance with NBS PS 15-69.

4. Fabrication:
   a. The slot injectors, air ducts, flanges, elbows and other fittings shall be attached to the air and liquid headers and connection piping (as required) using hand lay up fabrication methods in accordance with NBS PS 15-69 and ASTM C 582-95.

b. All sharp edges, cuts and burrs are to be sanded and resin coated to seal exposed edges.

c. All flange connections are to straddle the vertical and horizontal centerlines of the equipment in the installed position.

d. Whenever possible flange and fitting to pipe joints are to be hand-layed-up and resin coated internally so there are no internal seams.

e. All external areas of the fiberglass equipment are to be resin coated after completion of all assembly and hand-lay-up procedures.

5. Supports:
   a. All necessary supports for the aeration manifold, and in-basin air and liquid piping shall be provided.

b. Supports shall be spaced on approximately 10-ft. centers.

c. All liquid header supports shall be schedule 40 welded to a supporting base.

d. The support base shall be anchored with four (4) anchor bolts.

e. A contoured saddle shall hold the piping and attach to a contoured clamp with four (4) full thread cap screws with lock washers.

f. Air down-comer supports shall consist of a contoured saddle and one (1) 2-inch diameter, Schedule 40 leg assembly welded to a supporting base.

g. The support base shall be anchored with four (4) anchor bolts.

h. A contoured saddle shall hold the piping and attach to a contoured clamp with four (4) full thread cap screws with lock washers.

i. The saddles and clamps shall be furnished with EPDM pads to prevent abrasion.

j. Supports and clamps shall be 304L stainless steel.

k. Connection hardware shall be 18-8 stainless steel.
l. Anchor bolts shall be furnished and be 316 stainless steel.

6. Back-Flush System
   a. Each jet nozzle manifold system shall be provided with one back-flush system, which
can clear any fouling debris without requiring maintenance personnel to enter the
basin. The system shall be an air-lift type, activated by turning off the recirculation
pump while keeping the blower operating and opening the back-flush valve. The air-
lift shall draw air and liquid in a reverse direction through the inner liquid nozzle, into
the manifold piping, and then exiting the system up the riser pipe, and discharging
back into the basin.
   b. Back-flush system shall include one butterfly valve with hand wheel operator,
discharge pipe and Type 304L SS supports.

B. Nitrification Reactor #2
   1. Aeration Manifold:
      a. Each aerator shall be a monolithic fabrication with slot injectors arranged as
Directional (injectors mounted on one side of the liquid header) aeration manifolds.
Slot injectors shall be equally spaced along the length of the header with an aeration
area of between 65 and 160 square feet per injector. Liquid header shall be sized
such that the maximum motive liquid velocity shall not exceed 8.0 feet per second.
Air header shall be sized such that the air velocity shall not exceed 4,400 feet per
minute at maximum air flow. The aeration manifolds shall provide uniform distribution
of the liquid and air to each slot injector. The slot injectors shall be aligned on a
common horizontal plane and angled downwards at 30 degrees in order to maximize
gas dispersion such that the outlet of the nozzle is approximately 30 inches above the
tank floor.
      b. The liquid header shall be a cylindrical member, internally smooth and free from
protrusions, which might create additional head loss or collect stringy material. The
air header shall also be a cylindrical member located above and parallel to the liquid
header. The air header shall be attached to and supported above the liquid header
by an air duct at each injector location. Individual air ducts shall ensure uniform air
distribution to each injector. Additional supports shall be provided as necessary.
   2. Slot Injectors:
      a. Each slot injector shall consist of an inner propulsion nozzle, outer mixing chamber
and an air duct.
      b. The slot injectors shall be fabricated from injection molded reinforced polypropylene
and air ducts shall be fabricated from contact-molded reinforced thermosetting
laminates in accordance with ASTM C 582-95 and NBS PS 15-69 using Dow
Derakane 411 (or equal) vinylster resin formulated for ultra-violet protection.
      c. In order to retain more of the jet's kinetic energy, the cross section of the mixing
chamber shall transition from a circle to a slot without a reduction in flow area. The
shape of the propulsion nozzle will also taper from a circle to a slot in order to assure
even distribution of energy across the mixing chamber.
      d. The injectors shall be molded and assembled to be concentric with the propulsion
nozzle and mixing chamber in axisymmetric alignment. The propulsion liquid and
compressed air shall combine in the outer mixing chamber, discharging as a high
energy, fine bubble, flat ribbon shaped cloud in the lower regions of the basin.
   3. Liquid and Air Piping:
      a. All air and liquid header piping for fabricating the slot injector system and connection
piping within the basin shall be provided as part of the system. Air down-comer and
air header pipe shall be sized such that the maximum air velocity shall not exceed
4400 feet per minute and shall connect to the Contractor supplied out-of-basin pipe
located on foot above the maximum liquid level.
      b. Liquid suction, discharge and header pipe shall be sized such that the maximum
motive liquid velocity shall not exceed 8 feet per second. Standard, 150-lb. drilling
flanges shall be furnished for supplier/Contractor interface.
c. The fiberglass reinforced polyester (FRP) pipe used for the Slot Injector System shall be fabricated from premium grade vinylester resin with a pressure rating of not less than 75 psi.

d. The pipe shall incorporate a resin-rich liner on both the inside and outside that consists of a "C" glass veil and resin, to a 10-20 mil nominal thickness, with a minimum amount of wax in the surface resin to allow the pipe to cure.

e. The wall shall be fabricated with a structural wall of continuous glass fibers wound at a 54.75 degree helical angle in a matrix of vinylest er resin.

f. The pipe shall be fabricated in conformance with ASTM D-2996-01, Type 1, Grade 2, Class E.

g. The pipe shall be formulated for ultra-violet protection.
h. The resin shall remain natural in color (No Pigment Allowed).

i. Unless otherwise noted, the wall thickness of the piping shall be as follows:
   1) 8" pipe = 0.15 inches
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   3) 12" pipe = 0.21 inches
   4) 14" pipe = 0.21 inches
   5) 16" pipe = 0.21 inches
   6) 20" pipe = 0.26 inches
   7) 24" pipe = 0.31 inches

j. Pipe, fittings, and air feeds shall be fabricated using Ashland Derakane (or equal) vinyl ester resin.

k. All distribution piping, and manifold sections shall be field connected by FRP field wrap joints.

l. Field wrap joint kits shall be furnished with all necessary materials and instructions.

m. FRP flanges shall be fabricated in accordance with NBS PS 15-69.

4. Fabrication:

a. The slot injectors, air ducts, flanges, elbows and other fittings shall be attached to the air and liquid headers and connection piping (as required) using hand lay up fabrication methods in accordance with NBS PS 15-69 and ASTM C 582-95.

b. All sharp edges, cuts and burrs are to be sanded and resin coated to seal exposed edges.

c. All flange connections are to straddle the vertical and horizontal centerlines of the equipment in the installed position.

d. Whenever possible flange and fitting to pipe joints are to be hand-layed-up and resin coated internally so there are no internal seams.

e. All external areas of the fiberglass equipment are to be resin coated after completion of all assembly and hand-lay-up procedures.

5. Supports:

a. All necessary supports for the aeration manifold, and in-basin air and liquid piping shall be provided.

b. Supports shall be spaced on approximately 10-ft. centers.

c. All liquid header supports shall be schedule 40 welded to a supporting base.

d. The support base shall be anchored with four (4) anchor bolts.

e. A contoured saddle shall hold the piping and attach to a contoured clamp with four (4) full thread cap screws with lock washers.

f. Air down-comer supports shall consist of a contoured saddle and one (1) 2-inch diameter, Schedule 40 leg assembly welded to a supporting base.

g. The support base shall be anchored with four (4) anchor bolts.

h. A contoured saddle shall hold the piping and attach to a contoured clamp with four (4) full thread cap screws with lock washers.

i. The saddles and clamps shall be furnished with EPDM pads to prevent abrasion.

j. Supports and clamps shall be 304L stainless steel.

k. Connection hardware shall be 18-8 stainless steel.
I. Anchor bolts shall be furnished and be 316 stainless steel.

6. Back-Flush System
   a. Each jet nozzle manifold system shall be provided with one back-flush system, which can clear any fouling debris without requiring maintenance personnel to enter the basin. The system shall be an air-lift type, activated by turning off the recirculation pump while keeping the blower operating and opening the back-flush valve. The air-lift shall draw air and liquid in a reverse direction through the inner liquid nozzle, into the manifold piping, and then exiting the system up the riser pipe, and discharging back into the basin.
   b. Back-flush system shall include one butterfly valve with hand wheel operator, discharge pipe and Type 304L SS supports.

PART 3 EXECUTION

3.01 INSTALLATION
   A. Install in accordance with manufacturer's instructions and recommendations in the locations shown on the Drawings. Installation shall include furnishing the required oil and grease for initial operation. The grades of oil and grease shall be in accordance with the manufacturer's recommendations. Anchor bolts shall be set in accordance with the manufacturer's instructions and recommendations.

3.02 FIELD QUALITY CONTROL
   A. Perform field inspection and testing in accordance with Section 01 40 00.
   B. After Contractor and Engineer have mutually agreed that the equipment installation is complete and ready for continuous operation, Contractor and a qualified field service representative of the manufacturer shall conduct an operating test of the equipment and the controls in the presence of Engineer to demonstrate that the Slot Injector System and controls will function correctly to the satisfaction of the Owner and Engineer.

3.03 MANUFACTURER'S FIELD SERVICES
   A. The services of a factory trained representative of the manufacturer shall be provided to inspect the installation of the equipment, make any necessary adjustments (before initial start-up), place it in initial trouble-free operation, and instruct the operating personnel in its operation and maintenance.
   B. The factory trained representative shall be provided for three (3) trips and a total of six (6) days on-site for:
      1. Installation inspection of jet headers, pumps and blowers.
      2. Start-up and operating instructions for the in-basin equipment.
      3. Start-up of pumps and blowers.

END OF SECTION
SECTION 46 51 21
FIXED AERATION HEADER DIFFUSER SYSTEM

PART 1 GENERAL

1.01 SCOPE OF WORK
   A. Furnish all labor, materials, equipment, and incidentals to install and test complete and ready
      for operation the coarse bubble diffuser systems in Aerobic Reactor #4 including piping and
      appurtenances as shown on the Drawings and as specified herein.

1.02 DESIGN REQUIREMENTS
   A. Air shall be conveyed from the blowers to the diffuser equipment through an air distribution
      piping network comprising the aeration and mixing system.
   B. The diffused aeration equipment shall diffuse the air uniformly into the tank or basin in which it
      is installed.
   C. Contractor shall modify the existing tank slab per the tank manufacturers recommendations for
      proper installation of the coarse bubble diffuser support anchors.
   D. Aerobic Reactor #4 (Existing 0.55 MG Tank-In-Tank):
      1. Nominal Basin Diameter: 66 feet
      2. Maximum Side Water Depth: 20 feet
      3. Site Altitude: 20 feet Above Sea Level
      4. Design Conditions:
         a. Maintain completely mixed conditions
         b. TSS Concentration: < 6,000 mg/L
         c. Dissolved Oxygen Concentration: 2.0 mg/L
         d. AOTR Design Conditions

<table>
<thead>
<tr>
<th>Design Condition</th>
<th>AOR (lbs/hr)</th>
<th>Air Flow (scfm)</th>
<th>Liquid Depth (feet)</th>
<th>DO (mg/l)</th>
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<td>Design Condition #1</td>
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<tr>
<td>Design Condition #2</td>
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<td>327</td>
<td>2,800</td>
<td>20</td>
<td>2.0</td>
</tr>
</tbody>
</table>

   e. Maximum Airflow: 2,800 scfm
   f. Alpha: 0.85
   g. Beta: 0.95
   h. Water Temperature: 20 degrees C
   5. Diffuser Length: 24 inches
   6. Minimum Number of Diffusers: 80
   7. Minimum Drop Leg Size: 10"

1.03 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Submittal drawings showing plan, elevation and cross sections of the equipment.
   C. Component details of the aeration equipment showing diffusers, diffuser connectors, supports,
      expansion joints and flanges
   D. Materials and manufacturing specifications.
   E. Equipment booklet to include:
      1. Equipment data sheets
      2. Performance data including oxygen transfer calculations.
3. Head loss calculation and pressure requirements.
4. Descriptive literature and bulletins.
5. Customer contact list with telephone numbers (minimum of 10 contacts from similar size facilities).

F. Operation and maintenance manual with installation instructions. Submit after approval of equipment and prior to shipment.

G. Detailed list of any or exceptions taken to these specifications. Include specification reference and proposed alternative with reason stated for exception.

1.04 DELIVERY, STORAGE, AND PROTECTION

A. In accordance with Section 01 60 00.

1.05 WARRANTY

A. Provide a manufacturer's written one-year full warranty from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Aquarius Technologies, LLC.
B. Sanitaire Division of ITT Industries
C. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 DROP-LEGS AND AIR DISTRIBUTION HEADER SYSTEM

A. Drop-leg shall start at flange connection on air supply header and extend down to two to four feet above air distribution header system.
B. Air distribution header system shall convey air from drop-leg to coarse bubble diffuser inlet connections.
C. Air distribution pipe shall be fabricated in sections up to 30 feet in length. Air distribution pipe sections shall be joined with fixed joints, expansion joints, or combination of fixed joints and expansion joints.
D. Air distribution header sections shall be shop fabricated with provisions for mounting diffusers.
E. Bottom elevation of air distribution header shall be same throughout each air distribution header system. Provide eccentric reducers at changes in diameter, for both runs and branches. Orient eccentric reducers so that flow line elevation does not change and crown of pipe elevation changes.
F. Provide removable cap, plug, or flange at dead end of each air distribution header.
G. Clean all welded stainless steel surfaces and welds after fabrication to remove weld splatter and finish clean all interior and exterior welds by full immersion pickling and rinse with water to remove all carbon deposits and contaminants to regenerate a uniform corrosion resistant chromium oxide film per ASTM A380 Section 6.2.11, Table A2.1 Annex A2 and Section 8.3.

2.03 DROP LEG AND AIR DISTRIBUTION SYSTEM MATERIALS

A. Drop-legs and air distribution system shall be fabricated of stainless steel pipe, fittings and flanges and shall meet the following requirements:
1. Stainless Steel Pipe, 4” through 36”
   a. Material for Stainless Steel Pipe, 4” through 36”: AISI 304L Stainless steel.
   b. Pipe Standards for Stainless Steel Pipe, 4” through 36”: ASTM A312 or ASTM A778.
2. Stainless Steel Pipe, 3” or smaller
   a. Material for Stainless Steel Pipe, 3” and smaller: AISI 316L stainless steel.
   b. Pipe Standard for Stainless Steel Pipe, 3” and smaller: ASTM A312.
   c. Dimension Standard for Stainless Steel Pipe, 3” and smaller: ANSI/ASME B36.19M, Schedule 40S.
3. Stainless Steel Fittings 4” through 36”
   a. Material for Stainless Steel Fittings, 4” through 36”: AISI 304L stainless steel.
   b. Material Standard for Steel Fittings, 4” through 36”
      1) Fittings for ASTM A312 Pipe: ASTM A403
      2) Fittings for ASTM A778 Pipe: ASTM A774
   c. Dimension Standards for Stainless Steel Fittings, 4” through 36”
      2) Fitting Dimensions: ANSI B16.9

4. Stainless Steel Fittings, 3” and smaller
   a. Material for Stainless Steel Fittings, 3” and smaller: ASTM 316L stainless steel.
   b. Fitting Standard for Stainless Steel Fittings, 3” and smaller
      1) Forged/Wrought Stainless Steel Fittings: ASTM A182, Grade 316L
      2) Cast Stainless Steel Fittings: ASTM A351, Grade CF 8M.
   c. Dimension Standard for Stainless Steel Fittings, 3” and smaller: ANSI B316.3, Class 150
   d. Stainless Steel Pipe and Fitting Joints
   e. Stainless Steel Pipe and Fittings, 4” through 36”: Flange, welded, or clamp type coupling.
   f. Stainless Steel Pipe and Fittings, 3” and smaller: Threaded or Flange.

5. Flanges for Stainless Steel Pipe and Fittings
   a. Stainless Steel Flange Material
      1) Flanges for 4” through 36” Stainless Steel Pipe and fittings: AISI 304L stainless steel.
      2) Flanges for 3” and smaller Stainless Steel Pipe and Fittings: AISI 316L stainless steel.
   d. Stainless Steel Flange Type
      1) Flanges for Stainless Steel Pipe, 4” through 36”: Welding neck, lap joint, or slip-on.
      2) Flanges for Stainless Steel Fittings, 4” through 36”: Welding Neck.
      3) Flanges for Stainless Steel Pipe and fittings, 3” and smaller: Threaded.
   e. Flange Face Type: 1/16” raised face.

6. Stainless Steel Flange Joint Accessories
   a. Stainless Steel Flange Joint Gaskets
      1) Gasket Type: ring.
      2) Gasket Thickness: 1/8”
      3) Gasket Material: Ethylene-Propylene diene terpolymer (EPDM) rubber.
   b. Bolts, Studs, and Nuts for Stainless Steel Flange Joints
      1) Bolt, Stud, and Nut Material: AISI Type 316 or Type 316N stainless steel.
      2) Bolt and Stud Standard: ASTM A193, Grade B8M, B8MN, or B8MLN.
      3) Nut Standard: ASTM A194, Grade 8M, B8MN, or M8MLN.
      4) Bolt, Stud and Nut Threads: UNC threads.
      5) Stud Length: Studs shall extend through nuts a minimum of ¼”.

B. Provide expansion couplings in air distribution header systems between fixed supports. Expansion couplings shall allow air distribution header system pipe to move longitudinally so that pipe and support system are not stressed or deflected. Expansion coupling shall allow free movement of pipe end over temperature range of 125°F. Expansion couplings shall be AISI Type 304L Stainless Steel with EPDM gaskets.

C. Each unused diffuser tap shall be plugged with hex head stainless steel threaded plug.

D. Fabrication of stainless steel drop-legs and air distribution header system shall be as specified in this Section.
2.04 DIFFUSER CONNECTIONS

A. Each diffuser connection shall be special cast tee. Each diffuser connection shall be designed to connect two diffusers to air distribution header pipe.

B. Diffuser connections shall be stainless steel casting and shall meet the following requirements:
   2. Standard for Stainless Steel Diffuser Connections
      a. ASTM A 182, Grade 316L;
      b. Or ASTM A743, Grade CF3

C. Diffuser connection tee branch shall be factory welded to bottom centerline of air distribution header pipe. All diffuser connections in each air diffusion system shall be on common horizontal plane. Diffuser connection tee branch shall be of sufficient length that air exits diffusers below flow line of air diffusion header pipe.

D. Diffuser connection, including cast tee and connection to air diffusion header, shall withstand a moment of 1,000 inch-pounds applied at diffuser connection without any permanent deformation of diffuser connection or air diffusion header. Diffuser connection shall be reinforced with, gussets, plates, or a combination of gussets or plates as required to meet the requirements specified in this Section.

E. Each diffuser connection shall have air passage from air diffusion header pipe to diffusers. Air shall pass from air diffusion header pipe into diffuser connection through neat, clean hole in bottom of air diffusion header pipe. Hole in bottom of air diffusion header pipe shall be centered over axis of diffuser connection tee branch. Diameter of hole in bottom of air diffusion header pipe shall be same inside diameter connection inlet.

F. Diffusers shall connection to diffuser connection tee run ends. Run ends of diffuser connection tee shall have ¾” NPT female threads.

2.05 COARSE BUBBLE DIFFUSERS

A. Diffusers shall be non-clogging coarse bubble diffusers with no flexing or moving parts. Each diffuser shall consist of inlet connection, inlet air control device, inverted air reservoir, and graduated air exit ports.

B. Diffuser body shall be formed to provide air reservoir in top of diffuser body for full length of diffuser body. Graduated air exit ports shall be distributed along side of diffuser body for full length of diffuser body. Free air discharge slots, or opening, shall be provided in lower part, or bottom, of diffuser body for full length of diffuser body. Lower part of diffuser body shall be designed to direct liquid being aerated along exterior of diffuser body walls. Air existing diffuser shall through air exit ports be sheared into relatively small bubbles and distributed into liquid being aerated. Diffuser body shall be formed of AISI Type 304L Stainless Steel plate, 20 gauge minimum. Nominal length of diffuser body shall be 12” or 24”.

C. Diffuser ends shall be Stainless Steel castings.
   1. Diffuser end castings shall meet the following requirements:
      a. Stainless Steel Diffuser Connection Material: AISI 304L Stainless Steel.
   2. Diffuser inlet end cap shall have diffuser inlet connection and air control device. Diffuser inlet opposite diffuser inlet shall be plane with no openings.
   3. Diffuser end caps shall support ends of diffuser body. Diffuser end caps shall be welded to diffuser body.
   4. Diffuser inlet end cap shall have ¾” nipple with NPT mail threads. Diffuser end cap nipple dimensions shall meet the requirements of ANSI/ASME B36.19M, Schedule 80S. Diffuser inlet shall screw into diffuser connection tee. Diffuser inlet end connection shall have integral square or hexagon nut for installation and removal of diffuser.
   5. Provide air inlet control device in each diffuser inlet end cap. Air control device shall be orifice or nozzle. Air inlet control orifice, or nozzle, shall limit air flow to diffusers so that uniformity of air flow to diffusers is between 0.95 and 1.05.
2.06 AIR DISTRIBUTION HEADER SYSTEM AND DIFFUSER SUPPORT SYSTEM

A. General
1. Air distribution header system and diffuser support systems shall support air distribution header system and diffusers when tanks are empty and when air distribution header system and diffusers are submerged at any depth to maximum depth of water in tanks. Air distribution header system and diffuser support systems shall prevent air distribution header system and diffusers from floating when air distribution header system and diffusers are submerged at any depth to maximum depth of water in the tank. Air distribution header system and diffuser support systems shall not loosen when air diffusion system is operated continuously or intermittently for minimum of three years.
2. Air distribution header system and diffuser supports shall be fabricated from AISI Type 304L stainless steel.
3. Submit calculations that show support system meets the requirements of this Section. Calculations shall be certified by an Engineer registered in the State of the State in which the Project is located.

B. Air Distribution Header Supports
1. Each air distribution header pipe shall be supported by a minimum of two supports. Spacing between manifold supports shall not exceed 12 feet.
2. Air distribution header supports shall resist thrust generated by expansion and contraction of air distribution pipe.
3. Air manifold supports shall resist bending moment of 550 inch-pounds without exceeding 22,500 psi design stress.
4. Inside surface of air manifold support elements that directly contact air distribution header pipe shall be contoured to match exterior surface of air distribution header pipe. Width of bearing surface contacting air distribution header pipe shall not be less than 2”.
5. Air distribution header system support system shall include mechanism that provides ± 2” vertical adjustment and ± ½” horizontal adjustment for field alignment of air distribution header pipes. Adjusting and aligning mechanism shall be infinitely adjustable within specified vertical and horizontal adjustment limits.

C. Air Distribution Header System and Diffuser Support System Anchors
1. Supports shall be anchored to tank, or channel, floors, or concrete support bases, with stainless steel epoxy adhesive anchor bolts designed for embedment in existing reinforced concrete.
2. Coordinate anchor bolt locations and attachment requirements with structural Drawings.
3. Anchor bolt material shall be AISI Type 316, Type 316D, Type 316L or Type 316N stainless steel.
4. Support System shall be designed so that, under full buoyancy anchor withdrawal force shall not exceed 450 pounds.

2.07 STAINLESS STEEL FABRICATION

A. Welding of Stainless Steel Fabrications
1. Welded stainless steel fabrications shall be shop welded. Field welding of stainless steel components will not be accepted.
2. Shop welding shall use shielded arc, inert gas, MIG, or TIG method.
3. Filler wire shall be added to welds and shall provide cross sections and weld metal thickness equal to or greater than parent metal.
4. Butt welds shall fully penetrate to interior surfaces. Gas shielding shall be provided to interior and exterior of joint.
5. Interior weld beads shall be smooth and evenly distributed with interior projection not exceeding 1/16”.

B. Pack equipment to provide ample protection from damage during shipment, handling, and storage. Cap and seal openings.
PART 3 EXECUTION

3.01 INSTALLATION
   A. Follow equipment manufacturer’s recommendations for sequencing of equipment installation.
   B. Layout and install support anchors in accordance with equipment manufacturer’s recommendations and anchor setting plan.
   C. Level aeration system such that all diffusers connected to a header are within plus or minus 3/8 inch of a common horizontal plane.

3.02 TESTING
   A. Following installation, adjustment, elimination of leaks, and replacement of defective diffusers, test air diffusion system.
   B. Place water in tank to minimum allowable operating depth of diffusers. Turn on air flow to diffusers at minimum rate required to observe operation of diffused air system.
   C. Slowly fill tank. Observe operation of air control valve, diffusers, air distribution and mixing of tank contents during filling of tank.
   D. Record air flow rate during filling of tank.
   E. If any part of air diffusion system fails, or is damaged during testing, correct defects by adjustment, repair, modification or replacement. Re-test equipment following correction of defects. Re-test equipment at no additional cost to Owner.
   F. If air diffusion system does not, in the opinion of the Engineer, meet requirements of this Section through observation of system operation or measurements of dissolved oxygen concentration, field performance testing shall be conducted under provisions of the General Conditions.

3.03 CLEANING
   A. Clean grease, oil, or any other debris from the exterior surfaced of air diffusion system piping and diffusers.
   B. Remove debris from diffusers.

3.04 MANUFACTURER’S FIELD SERVICES
   A. Provide services of a factory representative for (1) day to verify the proper installation of the equipment.
   B. Provide services of a factory representative for (1) day to instruct owner’s personnel on operation and maintenance.

END OF SECTION
SECTION 46 61 26
TERTIARY DENITRIFICATION UPFLOW FILTER CELLS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, material, equipment, and incidentals required to install, ready for operation, a complete upflow Tertiary Denitrification sand filter consisting of eighteen (18) filter modules installed in nine (9) cells with two (2) modules per cell, each filter module shall be 50 ft² as shown on the Drawings and specified within.

B. Equipment to be included for each filter cell; bottom hopper cone, feed pipe, feed distribution radials, airlift pipe, internal sand washer, sand distribution cone, reject compartment with weirs, compressed air control panel, PLC Control panel, support channels for reject troughs and grating, access grating and matting over each cell.

1. Filtration media: Silica sand per AWWA Standard B-100. Sand to be delivered to the site.
2. Air compressor: Compressed air system to deliver air to each airlift.
3. Butterfly valves to isolate the feed to each cell.

1.02 RELATED SECTIONS

A. Section 01 30 00 - Administrative Requirements.
B. Section 01 60 00 - Product Requirements.
C. Section 03 20 00 - Concrete Reinforcement.
D. Section 03 30 00 - Cast-In-Place Concrete.

1.03 SYSTEM DESCRIPTION

A. The filter system shall be suitable for tertiary filtration with the capability to add denitrification in the future.

B. The filter shall produce a continuous filtrate stream and an intermittent reject stream and shall not be shut down for any backwash cycles. No backwash valves, pumps or instrumentation shall be required for backwash cycles.

C. During backwash cycles the sand bed shall be continuously backwashed internally and redistributed on top of the sand bed an average of 4-6 times per 24 hours. No external sand movement or washing will be allowed.

D. The frequency of sand backwashing shall be intermittent and performed within the filter using filtered water. Filter influent (feed) shall not be used for sand cleaning. The daily total reject amount shall not exceed 5% of the daily influent feed average.

E. Backwash (reject) flow shall be controlled by the PLC using a pneumatic valve for reject control. The backwash frequency and duration shall be controlled by the central PLC using either programmed differential pressure or programmed time control.

F. Sand movement for each individual filter shall be monitored using a sand movement monitoring system. This system shall monitor each filter during backwash and non-backwash periods and shall include a programmed automatic re-start operation, "no-sand movement" alarm, and remote monitoring capability.

G. The air compressor shall be sized such that all sections of the filter can be in the backwash mode at the same time. No backwash pumps, clearwells or mudwells shall be required.

H. The filter shall be an upflow, deep bed, single media filter. Mixed or multiple media shall not be allowed.

I. The filter shall operate counter currently. The feed shall be upflow with sand moving downward.

J. The filter shall be designed for a filtration bed depth of 80 ”.

K. The filter shall not contain any moving parts.
L. The filter shall not contain any screens, wedge wires, grids, etc., to retain the media in place.
M. The headloss through the filter shall not exceed 48”.
N. The backwash surface-loading rate shall exceed 50 US gpm/ft² to ascertain a superior scouring and cleaning of the sand.
O. The air scouring of the sand shall exceed 100 SCFM/ft². This shall be accomplished by the supply of 2.6 SCFM of air per filter cell at (15-25 PSI).
P. The air supply system shall consist of a separate NEMA 3R panel including an air filter, control valve, air flow meter, pressure regulator and pressure gauge (one panel for each cell). Each control panel includes a solenoid valve and level switch to allow automatic start/stop of airflow to airlifts corresponding to flow of water through filter cell. An additional solenoid valve and timer provide a burst of air to the airlifts when flow starts. A 115/1/60 electrical supply is required for each panel.
Q. For multiple unit (cell) installations, the flow between filters (cells) shall be self-equalizing. No flow controls; regulators, etc. shall be required. Equalization shall not be accomplished by overflow weirs or feed recycle.

1.04 DESIGN REQUIREMENTS

A. Capacity:
1. Flow
   a. Average Daily Flow: 3.00 MGD
   b. Maximum Daily Flow: 4.00 MGD
   c. Peak: 5.00 MGD
2. Configuration:
   a. No. of Modules per Cell: 2
   b. Number of Cells: 9
   c. Total No. of Filter Modules: 18
3. Area:
   a. Filter Module: 50 sq. ft./filter
   b. Per Cell: 100 sq. ft./filter
   c. Total: 900 sq. ft.
4. Loading Rate:
   a. Average: 2.31 gpm/sq. ft.
   c. Peak: 3.85 gpm/sq. ft.
5. Air Flow Requirements:
   a. Filter Module: 2.6 scfm/module
   b. Cell: 5.2 scfm/cell
   c. Total: 46.8 scfm
6. Influent Feed:
   a. Total Suspended Solids:
      1) Average: 15.0 mg/L
      2) Maximum: 30.0 mg/L
   b. Temperature: 10 - 18 degrees C
   c. Dissolved Oxygen: 1.0 - 6.0 mg/L
   d. pH: 7.0 s.u.
7. Effluent Quality:
   a. Total Suspended Solids: < 5.0 mg/L

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Submit to the Engineer for review, complete drawings showing installation details, materials of construction, arrangement details, loadings, elevations, and all items furnished under this section.
C. Each bidder shall submit a list of at least five U.S. installations on similar applications, which have been in continuous operation for at least two years in concrete basins.

D. Each bidder shall provide a written guarantee detailing filtrate quality. This guarantee shall be based upon laboratory filtration test, on-site pilot tests, or past operating experience. If the guarantee is based on past operating experience, documentation of that experience shall be submitted with the proposal.

E. Certification: The Manufacturer shall provide a certification stating that they have reviewed the Drawings and Specification for this project and have verified that the applicability of the specified equipment to be provided by the Manufacturer for the intended use per the Drawings and Specifications. 
1. The Manufacturer shall provide to the Engineer, as part of the certification, in writing any recommended revisions to the design based upon the Manufacturer’s review of the Specifications and Drawings.

1.06 SPARE PARTS

A. Filter Equipment: The only recommended spare parts are for the airlift pumps and control panel, as follows (one each):
1. O-ring - air lift pump chamber
2. O-ring - air lift inlet nut
3. Screen - air lift pump
4. Regulator - air control panel
5. Air flow indicator - air control panel

1.07 QUALITY ASSURANCE

A. Basis of Design: The drawings and specifications are based on Parkson Corporation DynaSand Filter equipment. Any costs resulting from changes to the structure, piping, etc., required for other approved filter equipment, shall be borne by the Contractor. The Contractor shall submit drawings to the Engineer for approval, showing proposed changes in the structure, piping, equipment, etc.

B. Responsibility: To ensure that all the equipment required for the installation of the filter modules and air supply is properly coordinated and will function as a unit in accordance with the intent of these Specifications, the Contractor shall obtain all the equipment specified under this Section, from a single supplier in whom the responsibility for the proper function of all the equipment, regardless of manufacturer, as an integrated and coordinated system shall be vested. The intent of this paragraph is to establish unit responsibility for all the equipment with the filter equipment supplier. The use of the word “responsibility” relating to the equipment supplier is in no way intended to relieve the Contractor’s ultimate responsibility for equipment coordination, installation, operation, and guarantee.

1.08 GUARANTEE

A. The Filter Manufacturer shall guarantee the filter system as required under the General Conditions, and as specified herein. If, during the guarantee period, the filter system fails or does not meet any of the specified requirements or test criteria herein, the Filter Manufacturer shall correct such deficiencies as may be necessary to meet these requirements and criteria, and at no additional cost to the Owner. The Engineer must first review any proposed remedial measures before any work is done.

1.09 WARRANTY

A. The Contractor shall guarantee the filter system as required under the General Conditions, and as specified herein. If, during the guarantee period, the filter system fails or does not meet any of the specified requirements or test criteria herein, the Contractor shall correct such deficiencies as may be necessary to meet these requirements and criteria, and at no additional cost to the Owner. The Engineer must first review any proposed remedial measures before any work is done.
PART 2 - PRODUCTS

2.01 MANUFACTURER
   A. Parkson Corporation - Ft. Lauderdale, Florida

2.02 GENERAL
   A. All structural steel shall conform to "Standard Specifications for Structural Steel of the A.S.T.M.".
   B. All equipment shall be designed for continuous, twenty-four hour operation, and all parts of the mechanism shall be amply proportioned for all stresses, which may occur during fabrication, erection, and operation.
   C. All anchor bolts shall be stainless steel and shall be of ample size and strength of the purpose intended. The filter manufacturer shall furnish with the equipment all anchor bolts. The Contractor shall install the anchor bolts in accordance with the manufacturer's instructions.
   D. All wetted parts shall be stainless steel, FRP, high density polyethylene, or polypropylene.
   E. All parts above the water line associated with the support steel, platforms, and handrails to be aluminum. No painted carbon steel allowed.
   F. Fiberglass grating to be Duragrid T--3300 T-bar pultruded grating by Strongwell or approved equal. Bear bars are to be 2-inch thick and spaced at 1.5-inches on center with cross rods spaced at 6-inches on center.
   G. Rubber matting shall be provided to overlay the grating walk surface to prevent debris from entering the filters.
   H. One (1) air compressor system shall be provided, sized to provide the required air flow for the filtration system.

2.03 MATERIALS OF CONSTRUCTION
   A. Basin: Concrete (by Contractor)
   B. Filtrate trough: Concrete (by Contractor)
   C. Grouting of Filter Bottoms: Grout (by Contractor)
   D. Bottom cone: FRP
   E. Feed assembly: 304 SS
   F. Sand washer labyrinth: High Density Polyethylene
   G. Reject compartment: FRP
   H. Reject weirs: PVC
   I. Reject supports: Aluminum
   J. Airlift housing: 304 SS
   K. Airlift pump assembly: PVC
   L. Internal pipe connections: Rubber with stainless steel clamps
   M. Feed pipe: PE
   N. Reject and drain piping: PVC
   O. Nuts, bolts and fasteners: 304 SS
   P. Anchor bolts: 304 SS
   Q. Cover (Except Over Washers): Fiberglass Grating with rubber matting
   R. Cover Over Washers Fiberglass Grating with rubber matting
   S. Grating supports: Galvanized Steel
   T. Handrails: Galvanized Steel
2.04 FILTER MEDIA

A. Sand Specification (per AWWA spec B-100)
   1. Effective size and uniformity coefficient shall be as recommended by the manufacturer for
      the application. Confirm at time of ordering.
   2. Media type – high grade silica sand, at least 80% silica. Saturated surface - dry specific
      gravity 2.5 or more.
   3. Media hardness = 6.0 or greater on Moh’s scale (ref. Testing and Inspection of
      Engineering Materials; McGraw-Hill Cook Company, New York, NY; 3rd Edition; page
      209).
   4. Grain shape shall be round to sub-angular. Crushed gravel is usually not acceptable.
   5. Acid solubility: <5% total loss in mass after 30 minutes immersion in a concentrated (1
      part HCl to 1 part distilled H2O) hydrochloric acid solution (HCl).
   6. Filter media to be in general accordance with AWWA Standard B-100.
   7. Provide 324 tons of sand. Contractor to install, disinfect (if necessary - potable water
      only), and wash the media per the filter manufacturer's recommended procedures.

2.05 COMPRESSED AIR SYSTEM

A. The filter manufacturer shall provide a duplex air compressor package complete with integral air
   receiver tank, reciprocating-type air-cooled compressors, and control panel. The air
   compressor package shall be Ingersoll Rand Type 30, Model 202000A20 completely pre-piped,
   pre-wired skid-mounted compressed air system with the following components:
   1. Two (2) Gardner Denver air compressors, lubricated, air cooled, two-stage, single acting
      reciprocating type with two (2) cast iron cylinders, heavy duty cast iron frame, inlet
      silencer, air-cooled intercooler and aftercoolers, 20 HP TEFC motor, 460/3/60, 1750 rpm,
      V-belt drive, and totally enclosed belt guard.
   2. Two (2) 120 gallon capacity horizontal type air receiver tank, ASME code stamped, rated
      for working pressure of 200 psi with pressure gauge, safety valve, automatic drain valve,
      interconnecting piping, and pressure switch.
   3. NEMA 4 combination alternator/control panel with HOA switches, starters, fusible
      disconnects, manual reset buttons, control voltage transformer and hour meters.
   4. Desiccant Air Dryer I-R Model TZM88, 88 cfm capacity at 150 psig, 115/1/60, 0.5 A
   5. Pre-Filter I-R Model GP216, aluminum housing with automatic drain, differential pressure
      indicator, stainless steel elements with multi-layered borosilicate microfiber media.
   6. After-Filter I-R Model HE216 same as Pre-Filter above.
   7. Externally mounted control voltage transformer, NEMA 4, 460/120 V, 2 KVA.

2.06 CONTROLS

A. The filter supplier shall provide a control system consisting of cell air control panels (CACP),
   one per cell, and a central control panel (CCP), one per installation. The control system shall be
   capable of:
   1. Control and determine the proper functionality of the filtration system.
   2. Detect if an airlift is not properly lifting media.
   3. Check and restart automatically each airlift.
   4. Receive information of the sand filter system influent flow measurement.
   5. Efficiently control the tertiary denitrification and phosphorus removal system to achieve the
      desired process results.

B. The control system will be located in the control building and be protected from extreme heat,
   rain, water, ice, humidity, sun or other properties of weather.

C. Each filter module shall be equipped with a sand movement sensor which will provide a signal
   back to the CCP.

D. Each cell or sub cell shall be equipped with a pneumatic valve installed on the reject pipe and
   controlled by the CCP.
E. All control panels shall have the UL 508A label for the assembled control panel.

F. Cell Air Control Panel (CACP)
   1. Each CACP panel shall include:
      a. Air filter, pressure regulator and pressure gauges
      b. Solenoids for air control and reject control
      c. Air flow meters to adjust air to each module
      d. Gauges to display the backpressure produced by each airlift and the associated tubing. The backpressure gages are liquid filled Bourdon tube type and SS case.
      e. Inner door, where air flow meters and backpressure gauges should be mounted, and a viewing window to allow operators to read these instruments without opening the front door of the panel.
      f. All fittings and pipe inside the panel shall be Swagelok or Parker. The tube fittings must be a dual ferrule fitting.
   2. The CACP panels shall be mounted on top of each cell, therefore these panels shall be rated for outdoor condition, shall be a NEMA 4X, FRP enclosure.

G. Central Control Panel (CCP)
   1. CCP shall be a PLC based electrical control panel equipped with a Human Machine Interface (HMI). The controller shall have sufficient memory and I/O as required to safely and efficiently control the sand movement monitoring system, the reject control system and the tertiary denitrification and phosphorus removal system to achieve the desired process results. Microprocessor based controller shall be capable of:
      a. Receive signals from each filter sand movement sensor and each cell low level switch, to be able to control all the solenoids of the CACP’s.
      b. The controller shall collect the information from instrumentation probes and online analyzer through 4-20 mA analog signals. The PLC shall have provision for additional discrete I/O for online analyzer:
         1) Two(2) discrete input (online analyzer online and online analyzer maintenance required)
         2) Two(2) discrete output (Influent Sample ON and Effluent Sample ON)
      c. The Control Scheme shall include two independent loop control functions. One control loop will control the carbon source chemical feed pump and the second control loop will control the coagulant chemical feed pump.
      d. Ethernet communication with Plant SCADA system.
      e. Industrial Allen Bradley Ethernet TCP/IP to communicate with other plant PLC’s over the network.
   2. Microprocessor Based Controllers and Operator Interface:
      a. The controller shall be a Programmable Logic Controller (PLC), Allen-Bradley CompactLogix L32E;
      b. Connections between the sensors and the controller shall be through I/O Modules;
      c. The Operator Interface unit shall allow operators to navigate through the screens, change the set points if necessary and stop the process for maintenance purposes;
      d. The Operator Interface unit shall have a built-in data logger with the capacity to store data on 15-minute intervals for up to 6 months;
      e. The interface unit shall be a Color 10” Panel View Plus, or Siemens MP277 Touch Screen type HMI;
      f. Power feed to the Central Control Panel shall be 120 VAC, 40 Amps, 60 Hz;
      g. The controller shall be warranted for two full years against defects in material and workmanship;
      h. Programmable Logic Controller (PLC) and the Operator Interface shall be incorporated into a NEMA 4X, FRP enclosure.
H. In order to insure overall quality and reliability, the control panel manufacturer shall be listed as a current "Certified Member" of the Control and Information Systems Integrator Association (CSIA). This member shall have achieved "Certified Member" status by successfully passing an audit of its business, quality and technical practices conducted in accordance with CSIA's "Best Practices and Benchmarks Manual" by a CSIA sanctioned third party auditor.

2.07 PAINTING
A. There are no carbon steel components requiring painting.

PART 3 - EXECUTION

3.01 INSPECTION
A. The Contractor shall inspect all equipment prior to erection. Repair or replace damaged items as directed by the Engineer, at no additional cost to the Owner.

3.02 INSTALLATION
A. General: The Contractor shall install filter modules, reject supports, platforms and handrails, and slide gates in conformance with provisions of these specifications, as shown on the drawings, and in accordance with the manufacturer's recommendations.
B. The Contractor shall install filter media in each filter module per the filter manufacturer's installation instructions.
C. The Contractor shall install compressor system per the compressor manufacturer's installation instructions.

3.03 TESTING AND CORRECTION OF DEFICIENCIES
A. General
1. All testing shall be performed under the supervision of the filter manufacturer's representative as specified in Paragraph 1.06 of this section. The Contractor shall conduct all specified tests and shall furnish all power, material, instrumentation, equipment, personnel, etc., for conducting tests as specified herein. The Contractor shall give the Engineer sufficient advance notice of the testing to enable the Engineer to witness the tests.
2. The Contractor shall submit to the Engineer three copies of full and complete test reports for all tests, describing the units tested; the type of test; test set-ups, and procedures and instrumentation; and test flow rates, pressures, levels and all other data and results as required to demonstrate that all items tested meet specified requirements.
B. Start-Up
1. The Contractor shall have manufacturer's representative check and verify that installation of the filter modules is in accordance with drawings and manufacturer's installation instructions.
2. The Contractor shall have manufacturer's representative adjust all reject weir plates and air rates to each airlift.
3. The Contractor shall start-up and test in accordance with these specifications.
4. The Contractor shall have manufacturer's representative instruct plant personnel on operation and maintenance of filters.
5. The filter manufacturer shall include 2 trips to the site, each 3 days: one trip to advise the Contractor on the installation of the filter equipment and one trip to start-up the filter system and to train the operators.
C. Guarantee
1. The filters shall be tested at the specified design flow rate and influent conditions and produce a filtrate with a Total Suspended Solids concentration less than 2.0 mg/L.

END OF SECTION
SECTION 46 66 53
OPEN CHANNEL ULTRA-VIOLET DISINFECTION SYSTEM

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and appurtenances required to provide an open channel, gravity flow, low pressure high intensity ultraviolet lamp (UV) disinfection system complete with stainless steel channel and inlet and outlet transition boxes. The UV system to be complete and operational with all control equipment and accessories as shown and specified herein. This system will be capable of disinfecting effluent to meet the water quality standards listed in this section.

1.02 RELATED SECTIONS

A. Division 26 - Electrical

1.03 SYSTEM DESCRIPTION

A. The UV system shall be installed in a concrete channel as shown on the drawings.

1. The manufacturer shall provide stainless steel baffle(s) as shown on the drawing to reduce the concrete channel width at the UV bank(s).

B. System configuration:

1. The UV system configuration will be as follows:
   a. Number of Channels: 1
   b. Channel Width: 4 feet
   c. Number of Banks per Channel: 3 (2 duty, 1 standby)
   d. Number of UV Modules per Bank: 7
   e. Number of Lamps per UV Module: 8
   f. Total Number of Lamps in the UV System: 168
   g. Number of Power Distribution Centers: 3
   h. Number of System Control Centers: 1

2. Number of Level Controllers: 1
   a. Type of level controller: Motorized Weir Gate (Full Channel Width)

3. Lamp array configuration:
   a. The lamp array configuration shall be evenly spaced in both horizontal and vertical rows with all lamps parallel to each other and to the effluent flow.
   b. The total number of lamps is based upon a power current of 510 mA per lamp, a production of 250 watts of UV light per lamps, and a guaranteed lamp output of at least ninety-eight (98) percent at the end of lamp life (12,000 Hrs. MINIMUM).

1.04 DESIGN REQUIREMENTS

A. Provide equipment that will disinfect effluent with the following characteristics:

1. Average Flow: 3.00 MGD
2. Maximum Flow: 4.00 MGD
3. Peak Flow: 5.00 MGD
4. Total Suspended Solids: 5.0 mg/L, 30 day average of grab
5. Effluent Temperature Range: 33 to 85 F
6. Ultraviolet Transmittance @ 253.7 nm: 50 %, minimum
7. Maximum Mean Particle Size: 30 microns
8. Effluent standards to be achieved:
   a. 200 MPN/100 mL fecal coliform based on a 30 day geometric mean of daily samples for the effluent standard as specified in 1. through 6. Effluent standards will be guaranteed regardless of influent count to UV system.
1.05 PERFORMANCE REQUIREMENTS

A. The UV system will be designed to deliver a minimum UV dose of 30 mJ/cm² at peak flow, in effluent with a UV transmission of 50% after reductions for quartz sleeve absorption, sleeve fouling, and at end of lamp life (EOLL). The basis for evaluating the UV dose delivered by the UV system will be the manufacturer’s bioassay as carried out by an independent third party. Bioassay validation methodology to follow protocols described in the US EPA Design Manual – Municipal Wastewater Disinfection (EPA/625/1-86/021), without exception.

B. The UV Dose will be adjusted using an end of lamp life factor of 0.5 to compensate for diminishing lamp output over one (1) year of lamp operation. The use of a higher lamp aging factor will be considered only upon review and approval of independent third party verified data that has been collected and analyzed in accordance with protocols described in NWRI Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse (May 2003).

C. The UV Dose will be adjusted using a quartz sleeve fouling factor of 0.8 when sizing the UV system in order to compensate for attenuation of the minimum dose due to sleeve fouling during operation. The use of a higher quartz sleeve fouling factor will be considered only upon review and approval of independently verified data that has been collected and analyzed in accordance with protocols described in NWRI Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse (May 2003).

D. The system will be able to continue providing disinfection while replacing UV lamps, quartz sleeves, ballasts and while cleaning the UV lamp sleeves.

E. The system will be designed for complete outdoor installation.

1.06 PERFORMANCE GUARANTEE

A. The manufacturer shall guarantee that the UV disinfection system will meet the required fecal coliform limits as stated in Part 1.04. These limits must be met regardless of the influent fecal coliform concentration, as long as the design parameters for peak flow, suspended solids and UVT as listed in Part 1.04 are not exceeded. Manufacturers of equipment whose guarantee is limited to a maximum influent fecal coliform concentration will not be allowed.

1.07 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Submit for review, shop drawings showing the following:
   1. Complete description in sufficient detail to permit an item comparison with the specification.
   2. Dimensions and installation requirements.
   3. Descriptive information including catalogue cuts and manufacturers’ specifications for major components.
   4. Electrical schematics and layouts.
   5. Written verification from an independent, third-party laboratory certifying that the lamp output complies with Design Requirements.
   6. Submit the manufacturer’s written guarantee that the lamp warranty complies with Design Requirements.
   7. Independent bioassay report and dosage calculations demonstrating compliance with the specified dose requirements.

1.08 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. Provide equipment which is a standard product of the manufacturer.
   2. To be qualified, the UV manufacturer must provide documentation on at least THIRTY (30) of its wastewater disinfection systems which have been in satisfactory operation for a minimum of ten (10) years. The lamps are to be parallel to the flow, in a uniform array, and in an open channel, as shall be furnished on this project.
B. Prequalification Requirements:
   1. Demonstrate that the dose required in the performance specification is being met or exceeded in an effluent at 40 degrees Fahrenheit. The UV equipment manufacturer will provide both an EPA and a bioassay calculation. The bioassay calculation, as the name implies, shall be based on an independently produced bioassay report on the proposed UV equipment. The bioassay calculation shall be conducted at the full scale system's per lamp flow. Both the EPA and bioassay calculations shall demonstrate that the proposed UV system design will deliver the intended dose.
   2. In order to verify the lamp output assumption made in the EPA calculation, the UV equipment manufacturer shall provide a UV Lamp Output Graph. This UV output graph shall be verified by an independent agency. The proposed electronic ballast for the full scale system shall have a minimum operating current of 500 mA. The curve shall show the output of the identical lamp individually being driven by both ballasts, while immersed in a liquid over the operating temperature range of 40 to 100 degrees Fahrenheit. The most recent radiometer calibration documentation, as used in the test procedure, and a complete procedural description shall be supplied with the calculations.
   3. The Engineer shall reserve the right to require that the test be modified and repeated if the protocol used is not satisfactory.

1.09 DELIVERY, STORAGE, AND PROTECTION
A. In accordance with Section 01 60 00.

1.10 WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Equipment:
   1. The equipment furnished under this section will be free of defects in material and workmanship, including damages that may be incurred during shipping for a period of 12 months from date of start-up or 18 months after shipment, whichever comes first.
C. UV Lamps:
   1. The UV lamps to be warranted for a minimum of 12,000 hours when operated in automatic mode, prorated after 9,000 hours.
D. Ballasts to be warranted for 5 years, prorated after 1 year.

1.11 EXTRA MATERIALS
A. The following spare parts and safety equipment to be supplied.
   1. Eight (8) UV Lamps
   2. Eight (8) Quartz Sleeves
   3. Eight (8) Lamp Holder Seals
   4. One (1) Ballast
   5. One (1) Operators kit including face shield, gloves and cleaning solution.
   6. To be considered as an alternate, systems that require more lamps than specified, the UV manufacturer will provide spares in the amount equal to the quantities listed plus an additional quantity equal to the percentage of lamps required over and above the number of lamps specified.

PART 2 PRODUCTS
2.01 MANUFACTURERS
A. Trojan Technologies, Inc. - London, Ontario, Canada
B. Substitutions: Not permitted.

2.02 GENERAL REQUIREMENTS
A. Provide a UV disinfection system complete with UV lamp modules and channels with level control, and transition boxes, as shown on the Contract Drawings and as herein specified.
B. The installation contractor shall be responsible for supplying electrical power to each module and providing sufficient electrical outdoor receptacles. The receptacles to be rated for continuous operation of the UV lamp modules. The contractor is also to provide Ground fault interrupter protection from the power source.

2.03 DESIGN, CONSTRUCTION, AND MATERIALS

A. General:
1. All welded metal components in contact with effluent will be 316 stainless steel.
2. All metal components above the effluent will be Type 304 stainless steel with the exception of the ballast enclosure, which is constructed of anodized aluminum.
3. All wiring exposed to UV light will be TeflonTM coated.
4. All wires connecting the lamps to the ballasts will be enclosed inside the frame of the UV module and not exposed to the effluent. To be considered as an alternate, wires that are exposed to the effluent will be warranted for fifteen (15) years and will be TeflonTM coated to prevent degradation under constant exposure to UV light.

B. Lamp Array Configuration:
1. The lamp array configuration will be the uniform array with all lamps parallel to each other and to the flow.
2. The system will be designed for complete immersion of the UV lamps including both electrodes and the full length of the lamp tube in the effluent. Both lamp electrodes will operate at the same temperature and be cooled by the effluent.

C. UV Module:
1. Each UV module will consist of UV lamps with an electronic ballast enclosure mounted on a Type 316 stainless steel frame. To be considered as an alternate, ballasts housed in a separate enclosure located external to the channel will be equipped with a suitable air conditioning system, supplied by the UV manufacturer, to maintain internal enclosure temperatures below 80F. No forced air ventilation will be allowed.
2. Each lamp will be enclosed in its individual quartz sleeve, one (1) end of which will be closed and the other end sealed by a lamp end seal. To be considered as an alternate, lamp quartz sleeves that are open at both ends will be supplied with twice the amount of specified spare seals and lamps.
3. The closed end of the quartz sleeve will be held in place by means of a retaining O-ring. The quartz sleeve will not come in contact with any steel in the frame.
4. The ends of the lamp sleeve will not protrude beyond the stainless steel frame of the UV module.
5. Lamp wires will terminate in the electronic ballast enclosure located at the top of the UV module.
6. All lamp to ballast connections will be made by and tested by the UV Manufacturer.
7. The electronic ballast enclosure will contain the electronic ballasts and addressable lamp status monitoring systems.
8. Each UV module will be connected to a receptacle on the Power Distribution Center.
9. At the point of exit from the UV Module frame the multiconductor cable will pass through a waterproof strain relief.
10. Each UV module will have a rating of Type 6P.

D. UV Lamps:
1. Lamps will be high intensity low pressure amalgam design. The lamp will be preheated to promote longevity. Lamps that are not amalgam or that are based on driving a low pressure lamp at an amperage greater than 500 milliamps will not be allowed.
2. The filament will be of the clamped design, significantly rugged to withstand shock and vibration.
3. Electrical connections will be at one (1) end of the lamp and have four (4) pins, dielectrically tested for 2,000 vrms. Lamps that do not have four (4) pins will be considered instant start. To be considered as an alternate, instant start lamp systems will supply replacement spare lamps equal to 50% of the total number of lamps in the system.
4. Lamps will be rated to produce zero levels of ozone.
5. Lamps will be operated by electronic ballasts with variable output settings.

E. Lamp End Seal and Lamp Holder:
1. The open end of the lamp sleeve will be sealed by means of a sleeve nut which threads onto a sleeve cup and compresses the sleeve O-ring.
2. The sleeve nut will have a knurled surface to allow a handgrip for tightening. The sleeve nut will not require any tools for removal.
3. The lamp will be held in place by means of a molded lampholder that will incorporate two (2) seals. The lampholder will incorporate a double seal against the inside of the quartz sleeve to act in series with the external O-ring seal.
4. The second seal on the lampholder will isolate and seal the lamp from the module frame and all other lamps in the module.
5. In the event of a quartz sleeve fracture the two (2) seals of the lamp holder will prevent moisture from entering the lamp module frame and the electrical connections to the other lamps in the module.
6. The lamp holder will also incorporate a UV resistant PVC molded stop that will prevent the lamp sleeve from touching the steel sleeve cup.

F. UV Lamp Quartz Sleeves:
1. Type 214 clear fused quartz circular tubing as manufactured by General Electric or equal.
2. Lamp sleeves will be domed at one (1) end.
3. The nominal wall thickness will be 1.5 mm.

G. UV Lamp Module Support Rack:
1. The module support rack will be Type 304 stainless steel and be suspended above the effluent in the channel allowing adjustment to the precise height of the channel.
2. The module support rack will be designed so that no ultraviolet light will radiate above the channel when the UV lamp modules are energized and fully immersed in the effluent.

H. Effluent Level Controller:
1. Modulating Weir Gate
   a. Modulating Weir Gates (MWGs) shall be self-contained and shall be designed and manufactured by an experienced and reputable manufacturer, based on the AWWA C561 Standard for Fabricated Stainless Steel Slide Gates and AWWA C542 Standard for Electric Motor Actuators for Valves and Slide Gates in effect as of the date of this specification.
   b. Modulating weir gates will be designed to maintain the minimum channel effluent level required to keep lamps submerged at all times
   c. MWGs shall be designed for the following performance criteria:
      1) MWG actuation speeds shall be between 10” (255 mm) and 14” (356 mm) per minute.
      2) MWG maximum design rate of change of flow shall be limited to 25% of the Peak Design Flow/Channel per minute, or alternatively, flow shall be ramped up (zero to peak) or down (peak to zero) in no less than 4 minutes.
      3) MWG actuators shall employ AWWA S4-50% duty class motors with a rated minimum 900 starts per hour capability.
      4) MWG actuators shall employ AWWA Class B solid-state Thyristor based switchgear capable of at least 5,000,000 modulating steps before overhaul; electromechanical type actuators and controls shall not be permitted.

I. Low Water Level Sensor:
1. One (1) low water level sensor will be provided by the UV Manufacturer for each UV channel.
2. During manual, automatic and remote modes of system operation, the water level sensor will ensure that lamps extinguish automatically if the water level in the channel drops below an acceptable level.
3. The low water level sensor will be powered by the Power Distribution Center.
J. Electrical:
1. Each UV module within a bank will be powered from the bank’s dedicated Power
   Distribution Center.
2. UV manufacturer to supply all cabling and conduit between lamps and ballasts.
3. UV manufacturer to perform all terminations between lamps and ballasts.
4. Each electronic ballast within a UV module will operate two lamps.
5. Power factor will not be less than 98% leading or lagging.
6. Electrical supply to each Power Distribution Center will be 480/277V, 3 Phase, 4 Wire, +
   Gnd, 60Hz, 14.3 kVA.
7. Electrical supply to the Hydraulic System Center will be 480V, 3 Phase, 3 Wire, + Gnd,
   60Hz, 2.5 kVA.
8. Electrical supply for the water level sensor will be provided by the PDC and be 12 Volt DC.
9. Electrical supply to the System Control Center will be 120V, 1 Phase, 2 Wire, + Gnd,
   60Hz, 0.15 VA.

K. Power Distribution Center (PDC):
1. Power distribution will be through environmentally sealed receptacles on the PDC(s) to
   allow for local connection of UV modules.
2. Data concentration will be through integrated circuit boards located inside the Power
   Distribution Center.
3. PDC enclosure material will be Type 304 Stainless Steel - Type 4X (IP66).
4. All internal components will be sealed from the environment.
5. All Power Distribution Centers to be UL listed and UL listed to Canadian safety standards or
   equivalent with a rating of Type 4X.
6. One separate sealed Power Distribution Center will be provided per bank of lamps.
7. To be considered as an alternative, systems that have ballasts mounted in cabinets, the
   UV manufacturer will provide one complete cabinet for each bank of lamps, to ensure that
   each bank is electrically isolated for safety during maintenance and to provide redundancy
   under average flow conditions.

L. Control and Instrumentation:
1. System Control Center (SCC):
   a. The operation of the UV system shall be managed at the SCC by a PLC based
      controller which continuously monitors and controls the system functions. PLC will be
      “Compact Logix” as manufactured by Allen Bradley.
   b. The operator interface display screen will be menu driven with automatic fault
      message windows appearing upon alarm conditions. Operator Interface will be Beijer
      -Type 4X (7”) Outdoor Rated
   c. Alarms will be provided to indicate to plant operators that maintenance attention is
      required or to indicate an extreme alarm condition in which the disinfection
      performance may be jeopardized. The alarms will include but not be limited to:
      1) Lamp Failure
      2) Multiple Lamp Failure
      3) Low UV Intensity
      4) Module Communication Alarm
   d. The 100 most recent alarms will be recorded in an alarm history register and
      displayed when prompted.
   e. Bank status will be capable of being placed either in Manual, Off or Auto mode.
   f. Elapsed time of each bank will be recorded and displayed on the display screen
      when prompted.
   g. Optional: Digital I/O modules will be provided to remotely indicate status and alarms
      such as:
      1) Alarm conditions (major, critical)
      2) Bank Status (one for each UV bank supplied)
M. UV Detection System:
   1. A submersible UV sensor will continuously monitor the UV intensity produced in each bank of UV lamps.
   2. The sensor will measure only the germicidal portion of the light emitted by the UV lamps. The detection system will be factory calibrated. Detection systems that can be field calibrated will not be permitted.

N. Dose-Pacing:
   1. A dose-pacing system will be supplied to modulate the lamp UV output in relationship to a 4-20 mA DC signal from an effluent flow meter, in conjunction with entered UV transmittance values. Dose pacing using the UV Detection System will not be allowed.
   2. The system to be dose-paced such that as the flow and effluent quality change, the UV dose delivered is optimized while conserving power.
   3. The dose-pacing system will allow the operator to vary the design dose change. Logic and time delays will be provided to regulate the UV bank ON/OFF cycle.

O. Hydraulic Systems Center (HSC):
   1. One (1) HSC will be supplied to house all components required to operate the automatic cleaning system.
   2. Enclosure material of construction will be Type 304 stainless steel.
   3. The HSC will contain a hydraulic pump complete with integral 4-way valve and fluid reservoir housed inside the HSC.

P. Cleaning System:
   1. An automatic cleaning system will be provided to clean the quartz sleeves using both mechanical and chemical methods. Wiping sequence will be automatically initiated with capability for manual override.
   2. The cleaning system will be fully operational while UV lamps and modules are submerged in the effluent channel and energized.
   3. Cleaning cycle intervals to be field adjustable.
   4. Remote Manual and Remote Auto cleaning control options will be provided.
   5. The cleaning system will be provided with the required solutions necessary for initial equipment testing and for equipment start-up.

PART 3  EXECUTION

3.01 INSTALLATION
   A. Install in accordance with Contract Documents, Shop Drawings, and manufacturer’s instructions.
   B. In accordance with contract drawings, manufacturers’ shop drawings, instructions and installation checklist. Contractor Installation Checklist to be completed and returned at least two (2) weeks prior to date requested for commissioning. Photographs illustrating site readiness are required. The Contractor assumes all responsibility for the installation readiness of the UV system.
   C. All labor, materials and test apparatus necessary for completing the installation shall be furnished by the Contractor at no additional cost to the Manufacturer.

3.02 FIELD QUALITY CONTROL
   A. As required for complete and proper installation and start-up the equipment, and Training of the plant’s operating personnel.
   B. Operator Training: One (1) full day on site.
   C. Warranty Service: As required during the warranty period.

END OF SECTION
SECTION 46 76 22
SLUDGE DEWATERING SCREW PRESS

PART 1: GENERAL

1.01 SCOPE OF WORK
A. Furnish all labor, materials, equipment, and incidentals to install and test, complete and ready for operation, two (2) sludge dewatering screw press(s) as shown on the Drawings and as specified herein.

1.02 RELATED SECTIONS
A. Division 26 - Electrical

1.03 REFERENCES
A. American Society for Testing and Materials (ASTM) Publications:
   3. Anti-Friction Bearing Manufacturers Association (AFBMA) Publications:
      a. Standard 9-90 Load Ratings and Fatigue Life for Ball Bearings.
   4. American Institute of Steel Construction (AISC) Publications
   5. American Welding Society (AWS) Publications
   6. American Structures Painting Council (ASPC) Publications

1.04 SYSTEM DESCRIPTION
A. The screw press(s) shall be suitable for dewatering waste activated sludge produced from the treatment of industrial wastewater from a poultry processing facility with onsite rendering.
B. Each sludge dewatering screw press consists of the following major parts:
   1. Screw Press incl. support legs
   2. Influent Pipeline Flocculator
   3. Polymer dosing system
   4. Sludge Feed Pump
   5. Dewatered Cake Conveyor
   6. Control Panel
C. The screw press(s) shall be manufactured from AISI stainless steel shapes. Fabrication and assembly shall be in conformance with these specifications and drawings.
D. All parts of the dewatering press shall be designed and appropriate for the service specified and indicated and for continuous operation.
E. All parts shall be designed and manufactured to handle the forces that may be exerted on the screw press during fabrication, shipping, erection, and proper operation according to the O&M manual.
F. All components shall be so arranged that they can be serviced from the operating floor.
G. All components shall be balanced so that jamming at any point will not result in structural failure, but will cause the drive motor to stall. All components, including the gear reducer, shall be designed to withstand, without damage or permanent distortion, the full stalling torque of the drive motor.
H. A complete dewatering system shall be furnished including screw press, drive motors, gear reducers, support legs, anchor bolts, controls, and all accessories and appurtenances specified or otherwise required for a complete and properly operating installation.
I. Contractor shall coordinate all details of the equipment with other related parts of the work. He shall verify that all structures, piping, wiring, and equipment components are compatible. Contractor shall be responsible for all structural and other alterations required to accommodate equipment differing in dimensions or other characteristics from these specifications and drawings.

J. Contractor shall install the equipment according to instructions and recommendations of the equipment manufacturer.

K. A polymer make-down system shall be provided for the sludge dewatering system. A dedicated polymer make-down system shall be provided per screw press.

L. A sludge feed pump shall be provided for each screw press. One installed standby pump shall also be provided.

1.05 DESIGN REQUIREMENTS

A. Sludge Dewatering Screw Press(s)
   1. Sludge: Aerobically Digested waste sludge from an activated sludge wastewater treatment system, treating poultry processing and rendering wastewater.
   2. Number of Screw Presses: Two (2)
   3. Solids concentration: 1.0 - 3.0 %
   4. Solids to be Dewatered: 20,000 lbs. dry solids/day
   5. Dewatering Operation Time: 16 hours/day (approximately)
   6. Design Point No.1: 100 gpm per press at 1.0% TSS
   7. Design Point No.2: 45 gpm per press at 3.0% TSS
   8. Final Solids Content: 16-20%
   9. Solids Capture Rate: >95%

1.06 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. The following information shall be submitted to the engineer:

C. Product Data shall include at least the following:
   1. Descriptive literature, brochures, catalogs, cut-sheets and other detailed descriptive material of the equipment.
   3. Gear reducer data including service factor, efficiency, torque rating, and materials.
   4. Parts list including a list of recommended spare parts.

D. Shop Drawings: Include the following:
   1. Manufacturer’s installation drawings.
   2. Wiring and schematic diagrams.

E. Operations and maintenance manual: See Section 01 30 00.

F. Detailed installation instructions, with clear step-by-step points on the correct mechanical and electrical installation procedures.

G. Equipment weights and lifting points.

H. Recommendations for short and long-term storage.

I. A copy of the manufacturer’s warranty.

J. A copy of documents proving certification of the Manufacturer’s Quality Management System according to ISO 9001 and Environmental Protection Management System according to ISO 14001.

K. Failure to include all drawings applicable to the equipment specified in this section will result in rejection of the entire submittal with no further review.
L. Certification: The Manufacturer shall provide a certification stating that they have reviewed the Drawings and Specification for this project and have verified that the applicability of the specified equipment to be provided by Manufacturer for the intended use per the Drawings and Specifications.
   1. The Manufacturer shall provide to the Engineer, as part of the certification, in writing any recommended revisions to the design based upon the Manufacturers review of the Specifications and Drawings.

M. The Manufacturer shall clearly identify any exception to this Section, related sections, or the Drawings. Failure to do this shall be grounds for rejection of the submittal.

N. The manufacturer shall review the installation drawings and provide a certification that the influent pipe design is sufficient for upstream chemical feed and flocculation.

1.07 QUALITY ASSURANCE

A. To ensure quality, conformance, and reliability with regard to the manufacturing and production of the machinery described in this section, the equipment manufacturer shall meet the requirements listed in this section

B. Manufacturer shall have established an ISO 9001 certified quality management system.

C. Manufacturer shall have established an ISO 14001 certified environmental protection management system.

D. All stainless steel components and structures shall be submersed in a chemical bath of nitric acid and hydrofluoric acid (pickling bath) to remove any residues that may be present on the material as a result of forming, manufacture, or handling. After removal from the pickling bath, the equipment must be washed with a high-pressure wash of cold water to remove any remaining surface debris and promote the formation of an oxidized passive layer which is critical to the long life of the stainless steel. No stainless steel components may be fabricated or assembled in a factory where carbon steel products are also fabricated, in order to prevent contamination by rust.

E. Screw Press shall be manufacturer’s standard product and only be modified as necessary to comply with the drawings, specifications, and specified service conditions.

F. All welding is performed in accordance with American Welding Society (AWS) D1.1 Structural Welding Code, or equivalent.

G. Manufacturer shall provide screw press, motors, gear reducers, controls, control panels, and lifting attachments as a complete integrated package to ensure proper coordination, compatibility, and operation of the system.

H. Manufacturer shall provide services by a factory-trained service technician, specifically trained on the type of equipment specified. Service technician requirements include, but are not limited to the following:
   1. Service technician shall be present during initial energizing of equipment to determine directional testing as described in Section 4.01 C (Installation).
   2. Service technician shall inspect and verify location of anchor bolts, placement, leveling, alignment and field erection of equipment, as well as control panel operation and electrical connections.
   3. Service technician shall provide classroom and/or field training on the operation and maintenance of the equipment to operator personnel.
   4. Manufacturer shall state field service rates for a service technician to owner and contractor. In the event that the field service time required by this section should not be sufficient to properly place the equipment into operation, additional time shall be purchased by contractor to correct deficiencies in installation, equipment, or material without additional cost to owner.

I. Contractor shall guarantee all equipment against faulty or inadequate design, improper assembly or installation, defective workmanship or materials, and breakage or other failure. Materials shall be suitable for service conditions.
J. All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service prior to delivery, except as required by testing.

K. Each major component of equipment shall have the manufacturer’s name, address and product identification on a nameplate securely affixed to the equipment.

1.08 DELIVERY, STORAGE, AND HANDLING OF EQUIPMENT

A. Equipment shall be shipped and delivered fully assembled, except where partial disassembly is required in order to conform to transportation regulations or for the protection of components.

B. Contractor shall be responsible for unloading and shall have equipment on-site at the time of delivery permitting proper hoisting of the equipment.

C. In accordance with Section 01 60 00.

1.09 WARRANTY

A. The manufacturer will warrant against any defects in material or workmanship to the screw press and framework. This warranty will commence upon delivery of the products and will expire on the earlier to occur of one (1) year from initial operation of the product or 18 months from delivery thereof (the “Warranty Period”).

1.10 SPARE PARTS

A. A. The following Spare Parts shall be included and supplied together with the equipment:
   1. One (1) wiper set with mounting hardware
   2. One (1) solenoid valve 1-inch, 110 V for spray bar washing system
   3. Ten (10) nozzles for spray bar washing system
   4. One (1) spare part kit for neat polymer pump.

B. Spare parts shall be packaged with labels indicating the contents of each package, and shall be delivered to Owner as directed.

PART 2: PRODUCTS

2.01 MANUFACTURERS

A. Screw Press System:
   1. Huber Technology, Inc.
   2. BDP Industries
   3. Or Approved Equal

B. Polymer System:
   1. Velodyne
   2. UGSI
   3. Or Approved Equal

C. Sludge Feed Pumps:
   1. Netzsch
   2. Seepex
   3. Wangen
   4. Or Approved Equal

D. Dewatered Cake conveyor:
   1. Huber Technology, Inc.
   2. BDP Industries
   3. Or Approved Equal

E. Substitutions: See Section 01 60 00 - Product Requirements.
2.02 MATERIALS

A. Sludge dewatering press shall be manufactured from AISI 304L stainless steel shapes (rods, angles, and channels), pipes, and sheets. In particular, wedge wire basket, screw, shaft, support legs, fasteners, and anchor bolts shall be made of this material.

B. Press access covers shall be either stainless steel or a composite of acrylonitrile butadiene styrene (ABS) and poly(methyl methacrylate) (PMMA). Materials other than stainless steel shall be acceptable if the material meets the following requirements:
   1. Is not a structural load-bearing component.
   2. Is equal to or exceeds stainless steel’s resistance to wastewater environment chemicals.
   3. Is resistant to heat degradation up to 185°F (85°C).
   4. Is equal to or exceeds stainless steel’s resistance to UV degradation.
   5. Is resilient to impact.
      a. Wipers for helical screw flights shall be of wear resistant polyurethane (PU) material. Wipers must have a basket contact width of at least .315 in (8 mm). The wiper is held in place by stainless steel clamps and set screws which can be easily removed. The wiper shall have a self-contained a dampening mechanism to maintain constant contact with the basket while limiting wear. Wiper self-contained dampening mechanism shall compensate for up to 4mm of radial wiper wear. Brushes without this functionality shall not be accepted.

2.03 DESIGN

A. The screw press shall be installed inclined (at 10°). Dewatering of the sludge takes place in a basket, which consists of three sections of wedge wire baskets. The overall basket length shall be 157.5 in (4,000 mm). The basket diameter shall be 31.5 in (800 mm).

B. The screw press support legs shall be capable of field adjustment for ease of installation.

C. The screw press shall be completely enclosed to prevent odor emission. The whole dewatering section and basket area shall be easily accessible through an inspection lid, which is mounted via hinges on the top of the machine.

D. Each section of the wedge wire basket shall be split in half along the length of the basket to allow for easy separation of the basket into halves for servicing of the wiper. The basket shall be fastened together using bolt fasteners made of stainless steel. The screw press shall be provided with alignment pins for ease of basket alignment during reassembly. The bottom half of the wedge wire basket shall remain inside of the machine during servicing of the wiper for ease of maintenance. Designs which require the bottom half of the basket to be removed from the machine for servicing the wiper will not be accepted.

E. The screw press shall be completely enclosed to prevent odor emission. The whole dewatering section and basket area shall be easily accessible through an inspection panels, which are mounted via hinges on the sides and quick release latches on the top of the machine.

F. A screw shall be installed inside of the screen basket. The screw transports the sludge from the inlet to the discharge area at the end of the pressure zone. Its shaft diameter shall be conical towards the discharge section of the machine. The flights of the helical screw shall be provided with brushes to clean the wedge wire screen from the inside.

G. The screw shall be shafted and shall be made of stainless steel. A shaft-less screw is not acceptable. A bearing shall support the feed end of the screw shaft. Wear strips are not acceptable.

H. A screw drive shall be provided at the discharge side of the press. The nominal motor power shall be 5.0 HP. The motor speed shall be controlled with a VFD. The drive unit shall be directly coupled to the screw shaft through a planetary gearbox.

I. A pressure sensor shall be installed at the inlet housing of the screw press. The pressure sensor provides a signal which is used to control the speed of the auger. The pressure in the inlet box shall automatically adjust the speed of the screw via the control system and the range
for the pressure shall be adjustable at the HMI. Designs which do not control the screw speed based on the inlet pressure are not acceptable.

J. The cleaning of the wedge wire screen from the outside shall be performed by a rotating spray bar washing system utilizing a single drive (drive: 0.25 hp, 460 V, 3 phase) made of stainless steel piping and PVDF spray nozzles. The spray wash system shall be split into four sections, upper feed, lower feed, upper discharge, and lower discharge, to cover the entire area of the basket by rotating around the circumference of the basket. Its spraying shall cover the entire area of the screen and also cover the interior of the screw press housing. In total four solenoid valves control the flow to each section of the spray bar washing system. The spray bar washing sections shall have the ability to rotate independently. Designs which do not rotate around the circumference of the basket over the entire length of the basket will not be accepted.

K. To optimize wash water consumption, the spray bar system shall have the ability to perform a quick wash of only the lower basket and/or an extended wash of the entire basket. Designs which do not have the quick wash ability shall not be accepted. Contractor shall provide water supply piping to the manifold of the spray system that shall have a 1-¼ inch female threaded connection. The system shall include two (2) proximity switches to prevent over travel of the spray bar system.

L. Spray water supply shall be designed for a minimum flow of 40 GPM (can be filtered non-potable water, allowed particle size 800 microns at maximum 200 ppm) at a minimum pressure of 70 PSI. Water pressure at each nozzle of the spray bar shall be a minimum of 70 PSIG. Average spray water consumption shall not exceed 101 Gallons at 70 PSIG per wash cycle. The basket shall rotate with maximum speed as mentioned in section 2.05 below.

M. The spray wash system shall be designed to allow adjustability on two levels: timer and water demand (average per cycle). The timer and average water demand shall be adjustable at the HMI ranging from 50 to 101 gal per cycle.

N. A pneumatically actuated cone that serves for adjusting the pressure in the pressure zone shall be provided at the discharge end of the screening basket. The pressurized air supply shall be provided by the contractor.

O. The pneumatically actuated cone is controlled by a 5-2-way solenoid valve. The solenoid directs the pressurized air to the ports which engage or disengage the cone at the discharge of the screw press. The control valve shall be installed in a local control station which also houses the pressure control valve and the pressure switch. The switch monitors the availability of pressurized air. If the supply of pressurized air is interrupted, the switch shall send a signal to the PLC and an alarm message will be generated.

P. Sludge cake shall be automatically discharged through a rectangular sludge discharge opening. The discharge height shall be minimum 39 in above floor level. Designs which discharge lower than this height will not be accepted.

Q. Contractor shall provide a 6 in diameter drain line for the filtrate and connect it to the bottom drain connection of the screw press. The contractor shall also provide a 1.5 in flush connection with manual ball valve for the drain connection.

2.04 INTERNAL PIPING

A. Contractor shall provide sludge feed pipe from the sludge feed pump (with VFD) through a magnetic-inductive flow meter through a polymer-dosing ring, polymer mixing valve.

B. Polymer dosing ring and polymer mixing valve shall be supplied by the screw press manufacturer.

C. Pipe flocculator to be supplied by the contractor as designed by the screw press manufacturer and shall provide a minimum retention time of 45 seconds at design flow for the polymer and sludge mixture.

D. The design of the flocculation pipe reactor shall be provided by the screw press manufacturer.
2.05 DRIVE

A. The press screw shall be driven by a shaft mounted planetary gearbox and motor assembly. The planetary gearbox shall be bolted to a machined flange welded to the upper end of the press.

B. The gear reducer shall be driven by a 1,680 rpm, 3-phase, 60 Hertz, 230/460 volt, continuous-duty, permanent magnet motor with a conduit box suitable for outdoor operation. The motor power shall be 5.0 hp. Motor efficiency shall exceed 75% over the complete operational range of the press.

C. Spray wash system shall be driven by a gearbox connected to a 0.25 hp, 3-phase, 60 Hertz, 230/460 V motor.

D. Drives shall be enclosed by protective FRP covers.

E. The output speed of the gear reducer shall be 10.7 rpm at frequency of 60 Hz.

F. Chain-drives, belt drives, hydraulic drives or a separate upper bearing for the transport screw will not be acceptable for this project.

2.06 AIR COMPRESSOR

A. Provide one (1) air compressor system to supply compressed air to the screw press(s).

B. The air compressor system shall consist of two air compressors and a single receiving tank.

C. The air compressor(s) and the air compressor tank shall be sufficiently sized to provide 2 cfm at 90 psi.

D. If any of the above specified parameters for the air compressor deviate from the screw press manufacturer's recommendations, then the screw press manufacturer shall immediately inform the Engineer, and provide the sufficiently sized (capacity, power, volume, etc.) air compressor system at no additional cost to the Owner.

2.07 POLYMER DOSING SYSTEM FOR LIQUID POLYMER

A. A polymer dosing system shall be provided for each screw press.

B. System shall be designed for the preparation, aging and dosing of up to 40 GPM of polymer solution having an active polymer concentration between 0.05 and 0.25%. The actual size of the polymer system depends on the specified type of sludge, maximum capacity and polymer consumption.

C. The polymer station shall be self-contained with pumps, piping, fittings, and accessories, and shall be factory assembled and tested to eliminate field assembly work and therefore to minimize installation and start up time. The frame shall be 304 stainless steel and the piping SCH.80 PVC.

D. A polymer mixing chamber shall be provided. A high energy, multi zoned, hydro-mechanical mixing device shall be provided. The mixing chamber shall have a translucent front cover.

E. The hydro mechanical impeller shall be designed to produce variable intensity, back flow mixing action to optimize polymer performance without damaging polymer molecular structure.

F. The motors shall be 0.5hp, 1750rpm, 90 V, 60Hz, wash down duty with keyless shaft and left hand impeller mounting screw.

G. Materials: Impeller - PVC; body of mixing device - PVC; cover - clear Lexan; fastener - 316 SS; seals - Viton; pressure rating - maximum 150 PSI.

H. Contractor shall provide a drinking water connection for the dilution of the polymer in the polymer tank. The water piping to the polymer blend system shall include a minimum 1 in inlet (NPT female), an UL listed solenoid valve (rated IP65), and a flow meter with a rate adjusting valve and low pressure alarm switch.

I. A neat polymer metering pump with hose connector shall be provided and connected through a 1/2 in barbed hose to the polymer mixing device. The neat polymer pump shall be a progressive cavity type pump.
J. Control Panel: NEMA 4X FRP enclosure, 120 VAC, 60 Hz, 1 PH service.
   1. Operator interface - discrete selector switch (system ON/OFF/REMOTE); mechanical mixer speed adjust potentiometer; stroke length / stroke speed adjustment at metering pump
   2. Status / Alarm indicators: system running indication; LCD display of metering pump rate (on metering pump); low pressure switch alarm
   3. Inputs: remote start / stop (discrete dry contact); pacing signal from main control panel (4-20mA)
   4. Outputs: system running (discrete dry contact); remote mode (discrete dry contact); low pressure alarm (discrete dry contact); low flow alarm (discrete dry contact)
K. The pressure side of the polymer system shall be connected through a minimum 1 in diameter PVC pipeline and a magnetic inductive flow meter to the polymer injection ring described above.
L. The injection ring is the place where the polymer is added to the sludge. A mixing valve with adjustable weight follows to ensure optimum mixing conditions and creating the right size and strength of flocks. The retention time between the mixing valve and the dewatering machine shall be a minimum of 30 seconds at maximum flow.

2.08 SLUDGE FEED PUMP
A. General - Unless otherwise stated, the sludge pumps shall be progressing cavity Moineau principle type suitable for pumping sludge as indicated below:
   1. The sludge feed will be waste activated sludge as described in Paragraph 2.02.A.1.
   2. The progressing cavity pump should meet the following performance parameters:
   3. Quantity: Three (3)
   4. Flow: 100 GPM
   5. Discharge Pressure: 50 PSI
   6. Maximum RPM: 350 RPM
   7. Maximum Horsepower: 5.4 HP
   8. Flange Sizes: 4-INCH ANSI
   9. Pump Suction and Discharge Casing
      a. The pump casing shall be designed for the type of service specified and shall be of sufficient strength, weight and metal thickness to ensure long life, accurate alignment and reliable operation. The suction casing shall be constructed of close-grained cast iron and have two clean out ports. The casing shall have connection for vents, drains, and gauges.
      b. The suction and discharge connections shall be ANSI/B16.1 flanges sized for the pump specified. The discharge flange shall have a vent/gauge connection that can be rotated in 90° increments. The discharge support feet shall be separate from the discharge flange.
      c. The pump shall be supplied with adequate NPT connections for stuffing box drainage, pump drainage, flushing and gauge connections.
   10. Stator
      a. The pump’s stator shall be formed from a single piece Buna-n rubber sleeve inside a two piece extruded aluminum shell. The stator shall be affixed to the suction casing by the use of four (4) thru-bolts for easy removal and replacement. Stators shall not be affixed to the suction casing by threaded connections or by snap rings. The suction edge of the stator shall be chamfered to allow for unrestricted flow into the pumping elements. The seal shall be integral to the stator sleeve at the suction and discharge to prevent leakage. The use of separate o-rings or flat rings for stator sealing shall not be required. Stator designs that limit nominal pump pressure capability to less than 90 PSI shall not be acceptable.
   11. Rotor
      a. The rotor shall be precision machined from tool steel with a chromium content of 11-13.5% hardened to a Rockwell C hardness of C57-60 and then covered with heavy
layers of hard chrome plating. The rotor shall be driven by means of a heavy duty sealed drive train.

12. Drive Train
   a. The rotor shall be precision machined from 316 stainless steel. The rotor shall be driven by means of a heavy duty sealed drive train. The rotor shall be joined to the drive shaft by means of a connecting rod with sealed pin type universal joint at each end. The sealed pin type universal joints shall be factory lubricated with oil and completely sealed from the fluid being pumped, utilizing a metal cover over the pin and flexible rubber seal on the connecting rod end. The joint seal shall not employ sacrificial parts such as clamp bands and shall not require special tools to assemble. To optimize seal and pin joint life, the connecting rod shall be of sufficient length to maintain its operating angle within 1 degree. Flexishafs, cardin joints, and unsealed pin joints are not acceptable.

13. Shaft Seal
   a. The pumps shall be fitted with a Single Mechanical Seal with Silicon Carbide Seal faces and 316 stainless steel metal parts. The mechanical seal shall be a rubber bellows seal. Mechanical seal shall be inside mounted, located inside the pump suction housing with ample open area around the seal and not in a dead-end enclosed housing where solids or scum could accumulate.

14. Pump Drive Shaft
   a. The drive shaft shall be of the solid drive shaft design in order to avoid clogging and/or trapping of solids, which could either interrupt the movement of the connecting rod or disturb the seal of the rear pin joint. Maximum shaft deflection under normal operating conditions shall not exceed .002”. The portion of the drive shaft that passes through the stuffing box shall be hard chrome plated or shall be provided with a replaceable hardened chrome plated shaft sleeve. Hollow or telescoping designed drive shafts are not acceptable.
   b. The universal joint head shall be removable from the drive shaft to allow access to the stuffing box or mechanical seal without disturbing the drive end of the pump.

15. Motor Features
   a. The motor to be TEFC, Premium Efficient with class F insulation, 1.15 service factor. If the pump is to be controlled by a Variable Frequency Drive then the motor to be Inverter Duty, suitable for a 5:1 constant torque turndown ratio. Motors are to be manufactured by Nord.

16. Gear Reducer Features
   a. The gear reducer shall be parallel in-line helical reducer with a 1.4 service factor. The gear case is to be single piece SAE 30 gray cast iron with internal reinforcements for strength and rigidity. This design eliminates oil leakage, oil contamination and gear set misalignment problems common to drives with bolt-on output cover or flanges.

17. Protection Sensors
   a. The sludge feed pumps shall be equipped with a high discharge pressure shut off system.

2.09 CAKE CONVEYOR

A. Screw Conveyor Design Summary
   1. Quantity: Two (2)
   2. Estimated Total System Maximum Load: 1,350 cuft/day
      a. Manufacturer shall verify maximum load based on the screw press capacity and anticipated feed sludge conditions.
   3. Min. flight outside screw diameter, 9-9/16 inch
   4. Shaft diameter, 3-1/2 inch
   5. Location of drives Pulling
   6. The screw conveyors shall be suitable for the future installation of the transfer auger as shown on the drawings.
7. The screw conveyor shall be designed to handle the maximum load as specified above.
8. The screw conveyor shall be capable of processing spherical objects with a diameter of 3-1/8". Such objects shall be conveyed through the auger and shall be discharged with the sludge.
9. Operation of the screw conveyor shall be automatically initiated when a call to run signal is received. The sludge shall be transported up the screw conveyor and shall be discharged into a dumpster, truck or other receiving container.
10. To minimize odors and nuisance, the conveyance shall be completely enclosed.
11. The control system shall be designed such that the operating characteristics of the screw conveyor can be changed via the programmable controller. Systems which do not offer this feature will not be acceptable for this project.
12. Screw Conveyor Materials
   a. Unless otherwise specified in these specifications, the entire equipment shall be manufactured from AISI 304L austenitic stainless steel shapes (rods, angles, and channels), pipes, and sheets. All mechanical parts shall be designed to handle the forces that may be exerted on the unit during fabrication, shipping, erection, and proper operation according to the O&M manual.
   b. The entire equipment shall be manufactured in a stainless steel only factory to prevent contamination of the stainless steel with rusty dust.
   c. The equipment, after its fabrication, shall undergo a passivation (pickling) process to ensure maximum resistance to corrosion. All stainless steel components and structures shall be submersed in a chemical bath of nitric acid and hydrofluoric acid to remove any residues that may be present on the material as a result of forming, manufacture, or handling. After removal from the pickling bath, the equipment must be washed with a high-pressure wash of cold water to remove any remaining surface debris and promote the formation of an oxidized passive layer which is critical to the long life of the stainless steel. Submergence insures complete coverage. Spray on chemical treatments and glass bead blasting are specifically not acceptable due to their inability to provide complete and uniform corrosion protection.
13. Screw Conveyor Design
   a. The spiral shall have a center shaft. Minimum flight thickness shall be 3/16 inch (5 mm). The spiral flight shall have sufficient stability to prevent distortion and jumping in the trough.
14. Screw Conveyor Trough Design
   a. Each conveyor trough shall be U-shaped, fabricated from a minimum thickness of 1/8" (3 mm) AISI 304L stainless steel plate. Each trough shall be equipped with inlet and discharge connections, as indicated on the drawings. The outlet openings in the trough bottom shall be sized to prevent screw conveyor plugging.
   b. The entire length of the screw conveyor, with the exception of the filling chute, shall be covered by a bolted cover. Covers shall be manufactured from a material thickness of 5/64" (2 mm) AISI 304L stainless steel plate. The covers shall be manufactured in sections with a maximum of 5 foot lengths to allow for easy access.
   c. A wear liner shall be provided for the trough. The wear liner shall be made of a minimum 5/16 inch (8 mm) thick ultra-high-molecular-weight polyethylene. The wear liners shall be manufactured in sections with a maximum length of 39 inches to allow for easy replacement.
15. Screw Conveyor Supports Design
   a. Each conveyor shall be furnished complete with supports suitable for mounting as shown on the Drawings and as required by the supplier's design. The supports shall be shop fabricated from structural AISI 304L stainless steel shapes and plates. At a minimum, each screw conveyor trough shall have supports at the drive end and other end of the trough plus intermediate supports at a maximum of 11-1/2 foot intervals. The supports shall be designed to avoid interference with other equipment or equipment supports. The supports shall be designed to prevent excessive vibration of any portion of the conveyor unit under all loading conditions.
16. Screw Conveyor Drive Design
   a. The screw conveyor mechanism shall be driven by a shaft mounted gearbox and
      motor assembly. The gear reducer shall be bolted to a machined flange welded to
      the upper end of the conveyor trough.
   b. The gear reducer shall be driven by a 1,760 rpm, 3-phase, 60 Hertz, 230/460 volt,
      continuous duty motor with a conduit box suitable for outdoor operation. Motor power
      shall be 2.0 hp.
   c. Chain-drives, belt drives, hydraulic drives or a separate upper bearing for the
      transport screw will not be acceptable for this project.

17. Screw Conveyor Anchor Bolts
   a. Equipment manufacturer shall furnish all anchor bolts of ample size and strength
      required to securely anchor each item of equipment. Anchor bolts, hex nuts, and
      washers shall be stainless steel. Anchor bolts shall be wedge or epoxy type.
   b. Anchor bolts shall be set by the Contractor. Equipment shall be placed on the
      foundations, leveled, shimmed, bolted down, and grouted with a non-shrinking grout.

2.10 CONTROLS AND INSTRUMENTATION
   A. One control panel shall be provided for two (2) new screw press with the ability to add one (1)
      future screw press system and one (1) future transfer sludge cake auger.
   B. The entire control system shall be provided by the Manufacturer of the Screw Press.
   C. The contractor shall provide wiring between all system components as required.
   D. The contractor shall provide separate power supplies as followed:
      1. 120 V, 60 Hz, 3 phase power supply to the main control panel
      2. 120 V, 60 Hz, single phase power supply to the polymer system.
      3. 120 V, 60 Hz, single phase power supply to the air compressor.
   E. Each dewatering system shall be full-automatic and shall include the following:
      1. Main control panel for screw press (per press)
      2. Polymer system control panel (per polymer system)
      3. Magnetic-inductive flow meter for thin sludge feed (per press)
      4. Automatic control for the pneumatic pressure cone (per press)
   F. A 120-volt main control panel shall be provided in a NEMA 4X rated stainless steel enclosure.
      The enclosure shall be suitable for wall mounting, shall have hinged covers which swing
      horizontally and shall be held closed with 3-Point Latch, and shall include the following:
      1. Pressure sensor at the inlet of the screw press: 4-20 mA signal is sent to the PLC. The
         sensor shall also have a discrete relay output, freely adjustable at the sensor, indicating
         high pressure conditions at the screw press inlet
      2. Programmable logic controller (PLC) Allen Bradley CompactLogix with on-board Ethernet.
      3. Operator Interface (OIU), Allen Bradley PanelView 700 with color touch screen and
         Ethernet communication.
      4. The PLC shall have the capability to work as a data logger. The data logger shall
         document all important process parameter but not limited to the following list:
         a. Operation mode: OFF, dewatering, back wash, shutdown
         b. Drive operation: forward, reverse
         c. Sludge flow [GPM]
         d. Screw Speed
         e. Polymer pacing signal
         f. Pressure screw press inlet
         g. Press Motor amperage draw
         h. Set points: feed solids, polymer consumption, solid loading
   5. Text messages displayed on touch screen:
      a. Over-current indications
      b. Spray bar washing system on
      c. Polymer dosing station status
d. Running time meter for screw press and spray drive

6. Operating and warning lights for the following:
   a. Power on
   b. Dewatering system in operation
   c. Malfunction indication
   d. Reset button
   e. E-Stop button

7. Laminated plastic nametags shall be provided for the name of the control panel and all disconnects, switches, lights, and meters.

8. Terminal connections for interfacing with remote systems, shall include the following:
   a. Remote Polymer Injection System:
      1) Inputs to Dewatering Control Panel:
         (a) Dry 120VAC Rated, 2 amp Minimum
            (1) Polymer System In Remote
            (2) Polymer System Running
            (3) Polymer System Common Fault
         2) Outputs from Dewatering Control Panel:
            (a) Dry 120VAC Rated, 2 amp Minimum
                (1) Polymer System Call to Run
                (b) 4 - 20 mA Analog Output
                    (1) Polymer Pacing Signal
   b. Remote Sludge Feed Pump VFD:
      1) Inputs to Dewatering Control Panel:
         (a) Dry 120VAC Rated, 2 amp Minimum
             (1) Sludge Pump In Remote
             (2) Sludge Pump Running
             (3) Sludge Pump Common Fault
         2) Outputs from Dewatering Control Panel:
            (a) Dry 120VAC Rated, 2 amp Minimum
                (1) Sludge Pump Call to Run
                (b) 4 - 20 mA Analog Output
                    (1) Sludge Pump Pacing Signal
   c. SCADA Status:
      1) Inputs to Dewatering Control Panel:
         (a) Dry 120VAC Rated, 2 amp Minimum
             (1) Remote Dewatering System Start Command
      2) Outputs from Dewatering Control Panel:
         (a) Dry 120VAC Rated, 2 amp Minimum
             (1) Press Running
             (2) Press Fault
             (3) Dewatering Mode
             (4) System Disturbance

PART 3: EXECUTION

3.01 INSTALLATION

A. Contractor shall verify all dimensions in the field to ensure compliance of equipment dimensions with the drawings. Contractor shall notify engineer of significant deviations.

B. Installation of the equipment shall be in strict accordance with the contract documents and the manufacturer’s instructions and shop drawings. Manufacturer shall supply anchor bolts for the equipment. Contractors shall install the anchor bolts in accordance with the manufacturer’s recommendations.
C. After installation touch-up paint shall be applied to all scratched, abraded and damaged shop painted surfaces. Coating type and color shall match shop painting. Contractor shall passivate all field welds.

3.02 MANUFACTURER’S FIELD SERVICES

A. Supplier shall furnish the services of a factory-trained service technician for two (2) trips including a total of six (6) workdays to inspect the installation, observe start up, and provide operator training.

1. Equipment shall not be energized, or “bumped” to check the electrical connection for motor rotation without the service technician present.

2. The service technician shall make all necessary adjustments and settings to the controls.

3. The service technician shall demonstrate proper and sequential operation of the dewatering system. The dewatering system shall be able to operate fully automatically.

END OF SECTION
# APPENDIX No. 1
## PUMP CURVES

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**Anaerobic Lagoon By Pass Short Circuit Influent Pump Station**  
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Pump/Lift Station Information

Plant Site Pump Station #1
Pump Curve

Plant Site Pump Station #2
Pump Curve
Section 1
Anaerobic Lagoon #1 & #2 Effluent Pump Station
Pump Curve
Vaughan Self-Priming
Chopper Pump

PERFORMANCE CURVE

Model SP8N Variable Speed Curve

<table>
<thead>
<tr>
<th>CURVE</th>
<th>POWER (HP/KW)</th>
<th>SPEED (RPM)</th>
<th>IMPELLER DIAMETER</th>
<th>REPRIME LIFT (FT/METERS)</th>
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3 Blade Impeller
8” Discharge (10” avail)
10” Suction (12” avail)

Pumping to Anoxic Reactor #1:
1,750 gpm @ 45 ft TDH

Low Head Condition to AL #3:
1,750 gpm @ 17 ft TDH

Form V369-F, REV 0, 11/05
Section 2
Anaerobic Lagoon By Pass Short Circuit Influent PS Pump Curve
Vaughan Self-Priming
Chopper Pump
PERFORMANCE CURVE

Model SP8N Variable Speed Curve

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3 Blade Impeller
8” Discharge (10” avail)
10” Suction (12” avail)

CAPACITY (U.S. GALLONS PER MINUTE)
Section 3
Anaerobic Lagoons #3 Effluent Pump Station
Pump Curve
Figure NPSH required prior to using above table. DO NOT use as available Suction Lifts.
3.00" (76.2 MM) DIA. MAX. SPHERICAL SOLIDS

Performance Curve

Volute 38224-705 Curve T8A-B-3
Impeller 12349 Model T8A-B
Size 8"x8" Imp.Dia. 14.75"
Sp.Gr. 1.0 RPM Noted

Consulate factory on operating conditions above 1200 rpm when TDSL exceeds 20 ft.

1,750 gpm @ 40 ft TDH

Operating Range
Section 4
Nitrate Recycle Pump Station
Pump Curve
Customer: Industrial Hydro Technologies Inc
Inquiry Number/ID: 003
Item number: 5600 GPM @ 15 FT - VFD
Service: 5600 GPM @ 15 FT - VFD
Quantity: 1
Sulzer Reference ID: USA.8356-GSP.18.0206-B1
Date of Last Update: 30 May 2018 1:03 PM

Type / Size: APT52-16 (O)
Stages: 1
Based on curve number: APP52-400_1200_O Rev 1
Efficiency: 84.29%
Power, rated: 25.27 hp
NPSH (3% head drop): 4.89 ft
Fluid density, rated / max: 1.000 / 1.000 SG
Viscosity, rated: 1.00 cP
Cq/Ch/Ce/Cn [ANSI/HI 9.6.7-2010]: 1.00 / 1.00 / 1.00 / 1.00

Flow, rated: 5,600.0 USgpm
Differential head / pressure, rated: 15.00 ft
Speed, rated: 462 rpm
Impeller diameter, rated: 20.98 in
Fluid density, rated / max: 1.000 / 1.000 SG
Viscosity, rated: 1.00 cP
Cq/Ch/Ce/Cn [ANSI/HI 9.6.7-2010]: 1.00 / 1.00 / 1.00 / 1.00
Section 5
Tertiary Filter Influent Pump Station
Pump Curve
Section 6
Return Activated Sludge (RAS) Pump Station
Pump Curve
Section 7
Waste Activated Sludge (WAS) Pump Station
Pump Curve
Section 8
Waste Activated Sludge Aerobic Digester #1 Pump Station
Pump Curve
Section 9
Waste Activated Sludge Aerobic Digester #2 & #3
Pump Station
Pump Curve
Mountaire Farms, Millsboro, DE
Digester Number 2 & 3 Pumps

S-0103-16-ARI
Base Lines: Water (60°F)

Waste Activated Sludge Aerobic Digester #2 & #3 Pump Station

Performance curve
FL 518 Lobe Type G

Capacity [US liquid gallons / min]
Pressure [PSI]

P [horsepower - hp]

Printed in 5/23/2018 by Boerger LLC - USA
Section 10
Plant Site Pump Station #1
Pump Curve
Section 11
Plant Site Pump Station #2
Pump Curve