B. Areas of honeycomb shall be chipped back to sound concrete and repaired as directed by the Engineer.

C. Concrete formwork blowouts or unacceptable deviations in tolerances for formed surfaces due to improperly constructed or misaligned formwork shall be repaired as directed by the Engineer. Bulging or protruding areas, which result from slipping or deflecting forms shall be ground flush or chipped out and redressed as directed by the Engineer.

D. Areas of concrete in which cracking, spalling, or other signs of deterioration develop prior to final acceptance shall be removed and replaced, or repaired as directed by the Engineer. This stipulation includes concrete that has experienced cracking due to drying or thermal shrinkage of the concrete. Structural cracks shall be repaired using an epoxy injection system approved by the Engineer. Non-structural cracks shall be repaired using a hydrophilic resin pressure injected grout system approved by the Engineer, unless other means of repair are deemed necessary and approved by the Engineer. Extensive repair or replacement will be considered for concrete placed having compressive strengths greater than maximum strength specified. All repair work shall be performed at no additional cost to the Owner.

E. Concrete which fails to meet the strength requirements as outlined in Article 3.10, paragraph F, will be analyzed by the Engineer as to its adequacy based upon loading conditions, resultant stresses and exposure conditions for the particular area of concrete in question. If the concrete in question is found unacceptable based upon this analysis, that portion of the structure shall be strengthened or replaced by the Contractor at no additional cost to the Owner. The method of strengthening or extent of replacement shall be directed by the Engineer.

END OF SECTION

SECTION 03350 - CONCRETE FINISHES

PART 1 - GENERAL

1.01 REQUIREMENTS

A. Furnish all materials, labor, and equipment required to provide finishes of all concrete surfaces specified herein and shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03100 - Concrete Formwork

B. Section 03300 - Cast-in-Place Concrete

C. Section 03600 - Grout

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. ACI 301 - Specifications for Structural Concrete for Buildings

2. ACI 318 - Building Code Requirements for Structural Concrete

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300 - Submittals.

1. Manufacturer's literature on all products specified herein.

PART 2 - PRODUCTS

2.01 CONCRETE FLOOR SEALER

A. Floor sealer shall be Diamond Clear VOX or Super Diamond Clear VOX by the Euclid Chemical Company, Sonneborn Kure N Seal 30 by BASF Construction Chemicals.

2.02 CONCRETE LIQUID/SEALER DENSIFIER

A. Concrete liquid sealer/densifier shall be a high performance, deeply penetrating concrete densifier. Product shall be odorless, colorless, VOC-compliant, non-yellowing siliconate based solution designed to harden, dustproof and protect concrete floors subjected to heavy vehicular traffic and to resist black rubber tire marks on concrete surfaces. The product must contain a minimum solids content of 20% of which 50% is siliconate. Acceptable products are Diamond Hard by the Euclid Chemical Company and Seal Hard by L&M Construction Chemicals. Liquid sealer/densifier shall be applied in strict accordance with directions of manufacturer and specifications.

B. Aggregate floor hardener shall be non-metallic. Hardener shall be Harcol by Sonneborn, Maximent by BASF, or Surflex by Euclid Chemical.

2.03 NON-METALLIC FLOOR HARDENER

A. The specified non-metallic mineral aggregate hardener shall be formulated, processed, and packaged under stringent quality control at the manufacturer's owned and controlled factory. The hardener shall be a factory-blended mixture of specifically processed graded mineral aggregate, selected Portland cement, and necessary plasticizing agents. Acceptable products shall be "Surflex" by the Euclid Chemical Company, "Harcol" by Sonneborn, "Maximent" by BASF, and "Mastercon" by BASF.

2.04 NON-OXIDIZING HEAVY DUTY METALLIC FLOOR HARDENER

A. Non-oxidizing heavy duty metallic floor hardener shall be formulated, processed, and packaged under stringent quality control at the manufacturer's owned and controlled factory. The hardener shall be a mixture of specifically processed non-rusting aggregate, selected Portland cement, and necessary plasticizing agents. Product shall be "Diamond-Plate" by the Euclid Chemical Company, or Masterplate by BASF Construction Chemicals. Heavy Duty Metallic Floor Hardener cannot be used in air entrained concrete.

2.05 NON-SLIP AGGREGATE

A. Shake-on aggregate for non-slip floors shall be non-metallic. Shake-on aggregate shall be Frictex NS by BASF Construction Chemicals, A-H Acox by Anti-Hydro, or Non-Slip by the Euclid Chemical Company.

PART 3 - EXECUTION

3.01 FINISHES ON FORMED CONCRETE SURFACES

A. After removal of forms, the finishes described below shall be applied in accordance with Article 3.05 - Concrete Finish Schedule. Unless the finish schedule specifies otherwise, all surfaces shall receive at least a Type I finish. The Engineer shall be the sole judge of acceptability of all concrete finish work.

1. Type I - Rough: All fins, burrs, offsets, marks and all other projections left by the forms shall be removed. Projections, depressions, etc. below finished grade required to be removed will only be those greater than ¼-inch. All holes left by removal of ends of ties, and all other holes, depressions, bugholes, air/blow holes or voids shall be filled solid with cement grout after first being thoroughly wetted and then struck off flush. The only holes below grade to be filled will be tie holes and any other holes larger than ¼-inch in any dimension. Honeycombs shall be chipped back to solid concrete and repaired as directed by the Engineer. All holes shall be filled with tools, such as sponge floats and trowels, that will permit packing the hole solidly with cement grout. Cement grout shall consist of one part cement to three parts sand, epoxy bonding agent (for tie holes only) and the amount of mixing water shall be as little as consistent with the requirements of handling and placing. Color of cement grout shall match the adjacent wall surface.

2. Type II - Grout Cleaned: Where this finish is required, it shall be applied after completion of Type I finish. After the concrete has been predampened, a slurry consisting of one part cement (including an appropriate quantity of white cement in order to produce a color matching the surrounding concrete) and 1-1/2 parts sand passing the No. 16 sieve, by damp loose volume, shall be spread over the surface with clean burlap pads or sponge rubber floats. Mix proportions shall be submitted to the Engineer after a sample of the work is established and accepted. Any surplus shall be removed by scraping and then rubbing with clean burlap.
3. Type III - Smooth Rubbed: Where this finish is required, it shall be applied after the completion of the Type I finish. No rubbing shall be done before the concrete is thoroughly hardened and the mortar used for patching is firmly set. A smooth, uniform surface shall

be obtained by wetting the surface and rubbing it with a carborundum stone to eliminate irregularities. Unless the nature of the irregularities require it, the general surface of the concrete shall not be cut into. Corners and edges shall be slightly rounded by the use of the carborundum stone. Brush finishing or painting with grout or neat cement will not be permitted. A 100 square foot example shall be established at the beginning of the project to establish acceptability.

3.02 SLAB AND FLOOR FINISHES

A. The finishes described below shall be applied to floors, slabs, flow channels and top of walls in accordance with Article 3.05 - Concrete Finish Schedule. The Engineer shall be the sole judge of acceptability of all such finish work.

1. Type "A" - Screeded: This finish shall be obtained by placing screeds at frequent intervals and striking off to the surface elevation required. When a Type "F" finish is subsequently to be applied, the surface of the screeded concrete shall be roughened with a stiff brush or rake prior to final set.

2. Type "B" - Wood or Magnesium Floated: This finish shall be obtained after completion of a Type "A" finish by working a previously screeded surface with a wood or magnesium float or until the desired texture is reached. Floating shall begin when the water sheen has disappeared and when the concrete has sufficiently hardened so that a person's foot leaves only a slight imprint. If wet spots occur, water shall be removed with a squeegee. Care shall be taken to prevent the formation of laitance and excess water on the finished surface. All edges shall be edged with an 1/8-inch tool as directed by the Engineer. The finished surface shall be true, even, and free from blemishes and any other irregularities.

3. Type "C" - Cork Floated: This finish shall be similar to Type "B" but slightly smoother than that obtained with a wood float. It shall be obtained by power or band floating with cork floats.

4. Type "D" - Steel Troweled: This finish shall be obtained after completion of a Type "B" finish. When the concrete has hardened sufficiently to prevent excess fine material from working to the surface, the surface shall be compacted and smoothed with not less than two thorough and complete steel troweling operations. In areas which are to receive a floor covering such as tile, resilient flooring, or carpeting, the applicable Specification Sections and Contract Drawings shall be reviewed for the required finishes and degree of flatness. In areas that are intermittently wet such as pump rooms, only one troweling operation is required to provide some trowel marks for slip resistance. All edges shall be edged with an 1/8-inch tool as directed by the Engineer. The finish shall be brought to a smooth, dense surface, free from defects and blemishes.

5. Type "E" - Broom or Belt: This finish shall provide the surface with a transverse scored texture by drawing a broom or burlap belt across the surface immediately after completion of a Type "B" finish. All edges shall be edged with an 1/8-inch tool as directed by the Engineer.

6. Type "F" - Swept in Grout Topping: This finish shall be applied after a completion of a Type "A" finish. The concrete surface shall be properly cleaned, washed, and coated with a mixture of water and Portland Cement. Cement grout in accordance with Section 03600 shall then be plowed and swept into neat conformance with the blades or arms of the apparatus by turning or rotating the previously positioned mechanical equipment. Special attention shall be paid to true grades, shapes and tolerances as specified by the manufacturer of the equipment. Before beginning this finish, the Contractor shall notify the Engineer and the equipment manufacturer of the details of the operation and obtain approval and recommendations.

7. Type "G" Hardened Finish: This finish shall be applied after completion of a Type "B" or Type "C" finish and prior to application of a Type "D" finish. Hardeners shall be applied in strict accordance with the manufacturer's requirements. Hardeners shall be applied using

a mechanical spreader. The hardener shall be applied in two shakes with the first shake comprising 2/3 of the total amount. Type "D" finish shall be applied following completion of application of the hardener.

a. Non-metallic floor hardener shall be applied where specifically required on the Contract Drawings at the rate of 1.0 pounds/ft.^{2}.

b. Non-oxidizing heavy duty metallic floor hardener shall be applied at the loading docks and where specifically required on the Contract Drawings or specified herein at the rate of 1.5 pounds/ft.^{2}.

8. Type "H" - Non-Slip Finish: This finish shall be provided by applying a non-slip shake-on aggregate concurrently with the application of a Type "D" finish. Application procedure shall be in accordance with manufacturer's instructions.

9. Type "J" - Raked Finish: This finish shall be provided by raking the surface as soon as the condition of the concrete permits by making depressions of ±1/4 inch.

3.03 CONCRETE SEALERS

A. Concrete sealers shall be applied where specifically required on the Contract Drawings or specified herein.

B. Sealers shall be applied after installation of all equipment, piping, etc. and after completion of any other related construction activities. Application of sealers shall be in strict accordance with manufacturer's requirements.

C. Sealers shall be applied to all floor slabs not painted and not intended to be immersed.

D. Floor slabs subjected to vehicular traffic shall be sealed with the concrete liquid densifier and sealer.

E. All other floor slabs to receive sealer shall be sealed with concrete floor sealer.

3.04 FINISHES ON EQUIPMENT PADS

A. Formed surfaces of equipment pads shall receive a Type III finish.

B. Top surfaces of equipment pads, except those surfaces subsequently required to receive grout and support equipment bases, shall receive a Type "D" finish, unless otherwise noted. Surfaces which will later receive grout shall, before the concrete takes its final set, be made rough by removing the sand and cement that accumulates on the top to the extent that the aggregate will be exposed with irregular indentations in the surface up to 1/2 inch deep.

3.05 CONCRETE FINISH SCHEDULE

Item	Type of Finish
Concrete surfaces indicated to receive textured coating (as noted on Drawings and in Section 09800, Special Coatings)	I
Inner face of walls of tanks, flow channels, wet wells, perimeter walls, and miscellaneous concrete structures:	
From 1 feet below water surface to bottom of wall	II
From top of wall to 1 feet below water surface	II
Exterior concrete walls below grade	I
Exterior exposed concrete walls, ceilings, beams, manholes, hand holes, miscellaneous structures and columns (including top of wall) to one foot below grade. All other exposed concrete surfaces not specified elsewhere	II
All interior exposed concrete walls and vertical surfaces	III
Interior exposed ceiling, including beams	III
Floors of process equipment tanks or basins, wetwells, flow channels and slabs to receive roofing material or waterproof membranes	B
All interior finish floors of buildings and structures and walking surfaces which will be continuously or intermittently wet	D
Exterior concrete sidewalks, steps, ramps, decks, slabs on grade and landings exposed to weather	E
Floors of process equipment tanks indicated on Drawings to receive grout topping	F
Garage and storage area floors	G
Precast concrete form panels, hollow core planks, double tees	J

END OF SECTION

SECTION 03370 - CONCRETE CURING

PART 1 - GENERAL

1.01 REQUIREMENTS

A. Protect all freshly deposited concrete from premature drying and from the weather elements. The concrete shall be maintained with minimal moisture loss at a relatively constant temperature for a period of time necessary for the hydration of the cement and proper hardening of the concrete in accordance with the requirements specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03100 - Concrete Formwork

B. Section 03300 - Cast-In-Place Concrete

C. Section 03350 - Concrete Finishes

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. ACI 301 - Specifications for Structural Concrete for Buildings
2. ACI 304 - Guide for Measuring, Mixing, Transporting, and Placing Concrete
3. ACI 305 - Hot Weather Concreting
4. ACI 306 - Cold Weather Concreting
5. ACI 308 - Standard Practice for Curing Concrete
6. ASTM C171 - Standard Specifications for Sheet Materials for Curing Concrete
7. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
8. Federal Specification TT-C-800

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.

1. Proposed procedures for protection of concrete under wet weather placement conditions.
2. Proposed normal procedures for protection and curing of concrete.
3. Proposed special procedures for protection and curing of concrete under hot and cold weather conditions.
4. Proposed method of measuring concrete surface temperature changes.
5. Manufacturer's literature and material certification for proposed curing compounds.

PART 2 - PRODUCTS

2.01 LIQUID MEMBRANE-FORMING CURING COMPOUND

A. Clear curing and sealing compound shall be a clear styrene acrylate type complying with ASTM C 1315, Type 1, Class A with a minimum solids content of 30%. Moisture loss shall not be greater than 0.40 kg/m^2 when applied at 300 sq.ft./gal. Manufacturer's certification is required. Acceptable products are Super Diamond Clear VOX by the Euclid Chemical Company, Sonneborn Kure N Seal 30 by BASF Construction Chemicals, and Cure & Seal 30 Plus by Symons Corporation.

B. Where specifically approved by Engineer, on slabs to receive subsequent applied finishes, compound shall conform to ASTM C 309. Acceptable products are "Kurez DR VOX" or "Kurez W VOX" by the Euclid Chemical Company. Install in strict accordance with manufacturer's requirements.

2.02 EVAPORATION REDUCER

A. Evaporation reducer shall be BASF, "Confilm", or Euclid Chemical "Euco-Bar".

PART 3 - EXECUTION

3.01 PROTECTION AND CURING

A. All freshly placed concrete shall be protected from the elements, flowing water and from defacement of any nature during construction operations.

B. As soon as the concrete has been placed and horizontal top surfaces have received their required finish, provision shall be made for maintaining the concrete in a moist condition for at least a 5-day period thereafter except for high early strength concrete, for which the period shall be at least the first three days after placement. Horizontal surfaces shall be kept covered, and intermittent, localized drying will not be permitted.

C. Walls that will be exposed on one side with either fluid or earth backfill on the opposite side shall be continuously wet cured for a minimum of five days. Use of a curing compound will not be acceptable for applications of this type.

D. The Contractor shall use one of the following methods to insure that the concrete remains in a moist condition for the minimum period stated above.

1. Ponding or continuous fogging or sprinkling.
2. Application of mats or fabric kept continuously wet.
3. Continuous application of steam (under 150°F).
4. Application of sheet materials conforming to ASTM C171.
5. If approved by the Engineer, application of a curing compound in accordance with Article 3.04.

E. The Contractor shall keep absorbent wood forms wet until they are removed. After form removal, the concrete shall be cured by one of the methods in paragraph D.

F. Any of the curing procedures used in Paragraph 3.01-D may be replaced by one of the other curing procedures listed in Paragraph 3.01-D after the concrete is one-day old. However, the concrete surface shall not be permitted to become dry at any time.

3.02 CURING CONCRETE UNDER COLD WEATHER CONDITIONS

A. Suitable means shall be provided for a minimum of 72 hours after placing concrete to maintain it at or above the minimum as placed temperatures specified in Section 03300, Cast-In-Place Concrete, for concrete work in cold weather. During the 72-hour period, the concrete surface shall not be exposed to air more than 20°F above the minimum as placed temperatures.

B. Stripping time for forms and supports shall be increased as necessary to allow for retardation in concrete strength caused by colder temperatures. This retardation is magnified when using concrete made with blended cements or containing fly ash or ground granulated blast furnace slag. Therefore, curing times and stripping times shall be further increased as necessary when using these types of concrete.

C. The methods of protecting the concrete shall be approved by the Engineer and shall be such as will prevent local drying. Equipment and materials approved for this purpose shall be on the site in sufficient quantity before the work begins. The Contractor shall assist the Engineer by providing holes in the forms and the concrete in which thermometers can be placed to determine the adequacy of heating and protection. All such thermometers shall be furnished by the Contractor in quantity and type which the Engineer directs.

D. Curing procedures during cold weather conditions shall conform to the requirements of ACI 306.

3.03 CURING CONCRETE UNDER HOT WEATHER CONDITIONS

A. When air temperatures exceed 85°F, the Contractor shall take extra care in placing and finishing techniques to avoid formation of cold joints and plastic shrinkage cracking. If ordered by the Engineer, temporary sun shades and/or windbreakers shall be erected to guard against such developments, including generous use of wet burlap coverings and fog sprays to prevent drying out of the exposed concrete surfaces.

B. Immediately after screeding, horizontal surfaces shall receive an application of evaporation reducer. Apply in accordance with manufacturer's instructions. Final finish work shall begin as soon as the mix has stiffened sufficiently to support the workmen.

C. Curing and protection of the concrete shall begin immediately after completion of the finishing operation. Continuous moist-curing consisting of method 1 or 2 listed in paragraph 3.01D is mandatory for at least the first 24 hours. Method 2 may be used only if the finished surface is not marred or blemished during contact with the coverings.

D. At the end of the initial 24-hour period, curing and protection of the concrete shall continue for at least four (4) additional days using one of the methods listed in paragraph 3.01D.

E. Curing procedures during hot weather conditions shall conform to the requirements of ACI 305.

3.04 USE OF CURING COMPOUND

A. Curing compound shall be used only where specifically approved by the Engineer. Curing compound shall never be used for curing exposed walls with fluid or earth backfill on the opposite side. A continuous wet cure for a minimum of five days is required for these applications. Curing compound shall not be used on surfaces exposed to water in potable water storage tanks and treatment plants unless curing compound is certified in accordance with ANSI/NSF Standard 61.

B. When permitted, the curing compound shall maintain the concrete in a moist condition for the required time period, and the subsequent appearance of the concrete surface shall not be affected.

C. The compound shall be applied in accordance with the manufacturer's recommendations after water sheen has disappeared from the concrete surface and after finishing operations. Maximum coverage for the curing and sealing compound shall be 300 square feet per gallon for trowel finishes and 200 square feet per gallon for floated or broom surfaces. Maximum coverage for compounds placed where subsequent finishes will be applied shall be 200 square feet per gallon. For rough surfaces, apply in two directions at right angles to each other.

3.05 EARLY TERMINATION OF CURING

A. Moisture retention measures may be terminated earlier than the specified times only when at least one of the following conditions is met:

1. The strength of the concrete reaches 85 percent of the specified 28-day compressive strength in laboratory-cured cylinders representative of the concrete in place, and the temperature of the in-place concrete has been constantly maintained at 50 degrees Fahrenheit or higher.

2. The strength of concrete reaches the specified 28-day compressive strength as determined by accepted nondestructive methods or laboratory-cured cylinder test results.

END OF SECTION

SECTION 03400 - PRECAST CONCRETE

PART 1 - GENERAL

1.01 REQUIREMENTS

A. The Contractor shall construct all precast concrete items as required in the Contract Documents, including all appurtenances necessary to make a complete installation.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02608 - Manholes

B. Section 03200 - Reinforcing Steel

C. Section 03300 - Cast-in-Place Concrete

D. Section 03350 - Concrete Finishes

E. Section 03370 - Concrete Curing

F. Section 03415 – Precast Prestressed Concrete Hollow Core Planks

G. Section 03600 - Grout

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of other requirements of these Specifications, all work specified herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the end of the Bid.

1. Kentucky Building Code

2. ACI 318-Building Code Requirements for Structural Concrete

3. PCI Standard MNL-116 - Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products

4. PCI Design Handbook

1.04 SUBMITTALS

A. The Contractor shall submit the following for review in accordance with Section 01300, Submittals.

1. Shop drawings for all precast concrete items showing all dimensions, locations, and type of lifting inserts, and details of reinforcement and joints.

2. A list of the design criteria used by the manufacturer for all manufactured, precast items.

3. Design calculations, showing at least the design loads and stresses on the item, shall be submitted. Calculations shall be signed and sealed by a Professional Engineer registered in the State of Kentucky.

4. Certified reports for all lifting inserts, indicating allowable design loads.

5. Information on lifting and erection procedures.

1.05 QUALITY ASSURANCE

A. All manufactured precast concrete units shall be produced by an experienced manufacturer regularly engaged in the production of such items. All manufactured precast concrete and site-cast units shall be free of defects, spalls, and cracks. Care shall be taken in the mixing of materials, casting, curing and shipping to avoid any of the above. The Engineer may elect to examine the units at the casting yard or upon arrival of the same at the site. The Engineer shall have the option of rejecting any or all of the precast work if it does not meet with the requirements specified herein or on the Drawings. All rejected work shall be replaced at no additional cost to the Owner.

B. Manufacturer Qualifications

The precast concrete manufacturing plant shall be certified by the Prestressed Concrete Institute, Plant Certification Program, prior to the start of production. Certification is only required for plants providing prestressed structural members such as hollow core planks, double-T members, etc.

C. Plant production and engineering must be under direct supervision and control of an Engineer who possesses a minimum of five years experience in precast concrete work.

PART 2 - PRODUCTS

2.01 CONCRETE

A. Concrete materials including portland cement, aggregates, water, and admixtures shall conform to Section 03300, Cast-in-Place Concrete.

B. For prestressed concrete items, minimum compressive strength of concrete at 28 days shall be 5,000 psi unless otherwise specified. Minimum compressive strength of concrete at transfer of prestressing force shall be 3,500 psi unless otherwise specified.

C. For non-prestressed concrete items, minimum compressive strength of concrete at 28 days shall be 4000 psi unless otherwise specified.

2.02 GROUT

A. Grout for joints between panels shall be a cement grout in conformance with Section 03600, Grout.

B. Minimum compressive strength of grout at 7 days shall be 3,000 psi.

2.03 REINFORCING STEEL

A. Reinforcing steel used for precast concrete construction shall conform to Section 03200, Reinforcing Steel.

2.04 PRESTRESSING STRANDS

A. Prestressing strands shall be 7-wire, stress-relieved, high-strength strands Grade 250K or 270K.

2.05 STEEL INSERTS

A. Steel inserts shall be in accordance with Section 05010, Metal Materials.

B. All steel inserts protruding from or occurring at the surface of precast units shall be galvanized in accordance with Section 05010, Metal Materials.

2.06 WELDING

A. Welding shall conform to Section 05120, Structural Steel.

2.07 BEARING PADS

A. Neoprene bearing pads shall be nominal hardness 50 and shall be cut from new neoprene compound. Pads shall be cut to the lengths, widths and thicknesses as shown on the Drawings. Durometer hardness shall be determined in accordance with ASTM D 2240. Adhesive for use with bearing pads shall be Sikadur 31, Hi-Mod Gel by Sika Corporation or approved equal.

B. Plastic bearing pads shall be multi-monomer plastic strips which are non-leaching and support construction loads with no visible overall expansion, manufactured specifically for the purpose of bearing precast concrete.

PART 3 - EXECUTION

3.01 FABRICATION AND CASTING

A. All precast members shall be fabricated and cast to the shapes, dimensions and lengths shown on the Drawings and in compliance with PCI MNL-116. Precast members shall be straight, true and free from dimensional distortions, except for camber and tolerances permitted later in this clause. All integral appurtenances, reinforcing, openings, etc., shall be accurately located and secured in position with the form work system. Form materials shall be steel and the systems free form leakage during the casting operation.

B. All cover of reinforcing shall be the same as detailed on the Drawings.

C. Because of the critical nature of the bond development length in prestressed concrete panel construction, if the transfer of stress is by burning of the fully tensioned strands at the ends of the member, each strand shall first be burned at the ends of the bed and then at each end of each member before proceeding to the next strand in the burning pattern.

D. The Contractor shall coordinate the communication of all necessary information concerning openings, sleeves, or inserts to the manufacturer of the precast members.

E. Concrete shall be finished in accordance with Section 03350, Concrete Finishes. Grout all recesses due to cut tendons which will not otherwise be grouted during erection.

F. Curing of precast members shall be in accordance with Section 03370, Concrete Curing. Use of a membrane curing compound will not be allowed.

G. The manufacturer shall provide lifting inserts or other approved means of lifting members.

3.02 HANDLING, TRANSPORTING AND STORING

A. Precast members shall not be transported away from the casting yard until the concrete has reached the minimum required 28 day compressive strength and a period of at least 5 days has elapsed since casting, unless otherwise permitted by the Engineer.

B. No precast member shall be transported from the plant to the job site prior to approval of that member by the plant inspector. This approval will be stamped on the member by the plant inspector.

C. During handling, transporting, and storing, precast concrete members shall be lifted and supported only at the lifting or supporting points as indicated on the shop drawings.

D. All precast members shall be stored on solid, unyielding, storage blocks in a manner to prevent torsion, objectionable bending, and contact with the ground.

E. Precast concrete members shall not be used as storage areas for other materials or equipment.

F. Precast members damaged while being handled or transported will be rejected or shall be repaired in a manner approved by the Engineer.

3.03 ERECTION

A. Erection shall be carried out by the manufacturer or under his supervision using labor, equipment, tools and materials required for proper execution of the work.

B. Contractor shall prepare all bearing surfaces to a true and level line prior to erection. All supports of the precast members shall be accurately located and of required size and bearing materials.

C. Installation of the precast members shall be made by leveling the top surface of the assembled units keeping the units tight and at right angles to the bearing surface.

D. Connections which require welding shall be properly made in accordance with Section 05120, Structural Steel.

E. Grouting between adjacent precast members and along the edges of the assembled precast members shall be accomplished as indicated on the drawings, care being taken to solidly pack such spaces and to prevent leakage or droppings of grout through the assembled precast members. Any grout which seeps through the precast members shall be removed before it hardens.

F. In no case shall concentrated construction loads, or construction loads exceeding the design loads, be placed on the precast members. In no case shall loads be placed on the precast members prior to the welding operations associated with erection, and prior to placing of topping (if required).

G. No Contractor, Subcontractor or any of his employees shall arbitrarily cut, drill, punch or otherwise tamper with the precast members.

H. Precast members damaged while being erected will be rejected or shall be repaired in a manner approved by the Engineer.

END OF SECTION

SECTION 03600 - GROUT

PART 1 - GENERAL

1.01 REQUIREMENTS

A. Furnish all materials, labor, and equipment required to provide all grout used in concrete work in accordance with the Contract Documents.

1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. CRD-C 621	Corps of Engineers Specification for Non-shrink Grout
2. ASTM C 109	Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2 inch or 50 mm cube Specimens)
3. ASTM C 531	Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts and Monolithic Surfacings
4. ASTM C 579	Test Method for Compressive Strength of Chemical-Resistant Mortars and Monolithic Surfacings
5. ASTM C 827	Standard Test Method for Early Volume Change of Cementitious Mixtures
6. ASTM C 144	Standard Specification for Aggregate for Masonry Mortar
7. ASTM C 1107	Standard Specification for Packaged Dry, Hydraulic Cement Grout (Nonshrink)

1.03 SUBMITTALS

A. Submit the following in accordance with Section 01300 - Submittals.

1. Certified test results verifying the compressive strength and shrinkage and expansion requirements specified herein.

2. Manufacturer's literature containing instructions and recommendations on the mixing, handling, placement and appropriate uses for each type of grout used in the work.

1.04 QUALITY ASSURANCE

A. Field Tests (required for pump station and storage tank projects)

1. Compression test specimens will be taken during construction from the first placement of each type of grout and at intervals thereafter as selected by the Engineer to insure continued compliance with these Specifications. The specimens will be made by the Engineer or their representative.

   a. Compression tests and fabrication of specimens for cement grout and non-shrink grout will be performed as specified in ASTM C 109 at intervals during construction as selected by the Engineer. A set of three specimens will be made for testing at seven days, 28 days and any additional time period as appropriate.

b. Compression tests and fabrication of specimens for epoxy grout will be performed as specified in ASTM C 579, Method B, at intervals during construction as selected by the Engineer. A set of three specimens will be made for testing at seven days and any other time period as appropriate.

2. The cost of all laboratory tests on grout will be borne by the Owner, but the Contractor shall assist the Engineer in obtaining specimens for testing. The Contractor shall be charged for the cost of any additional tests and investigation on work performed which does not meet the specifications. The Contractor shall supply all materials necessary for fabricating the test specimens, at no additional cost to the Owner.

3. All grout, already placed, which fails to meet the requirements of these Specifications, is subject to removal and replacement at no additional cost to the Owner.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Cement Grout

1. Cement grout shall be composed of Portland Cement and sand in the proportion specified in the Contract Documents and the minimum amount of water necessary to obtain the desired consistency. If no proportion is indicated, cement grout shall consist of one part Portland Cement to three parts sand. Water amount shall be as required to achieve desired consistency without compromising strength requirements. White Portland Cement shall be mixed with the Portland Cement as required to match color of adjacent concrete.

2. The minimum compressive strength at 28 days shall be 4,000 psi.

3. For beds thicker than 1-1/2 inch and/or where free passage of grout will not be obstructed by coarse aggregate, 1-1/2 parts of coarse aggregate having a top size of 3/8 inch should be added. This stipulation does not apply for grout being swept in by a mechanism. These applications shall use a plain cement grout without coarse aggregate regardless of bed thickness.

4. Sand shall conform to the requirements of ASTM C144.

B. Non-Shrink Grout

1. Non-shrink grout shall conform to CRD-C 621 and ASTM C 1107, Grade B or C when tested at a max. fluid consistency of 30 seconds per CDC 611/ASTM C939 at temperature extremes of 45°F and 90°F and an extended working time of 15 minutes. Grout shall have a min. 28-day strength of 7,000 psi. Non-shrink grout shall be, "Euco N-S" by the Euclid Chemical Company, "Sikagrout 212" by Sika Corporation, Conspec 100 Non-Shrink Non-Metallic Grout by Conspec, Masterflow 555 Grout by BASF Construction Chemicals.

C. Epoxy Grout

1. Epoxy grout shall be "Sikadur 32 Hi-Mod" by Sika Corporation, "Duralcrete LV" by Tamms Industries, or "Euco #452 Series" by Euclid Chemical, Concresive 1090 by BASF Construction Chemicals.

2. Epoxy grout shall be modified as required for each particular application with aggregate per manufacturer's instructions.

D. Epoxy Base Plate Grout

1. Epoxy base plate grout shall be Sikadur 42, Grout-Pak by Sika Corporation, or Masterflow MP by BASF Construction Chemicals.

2.02 CURING MATERIALS

A. Curing materials shall be as specified in Section 03370, Concrete Curing for cement grout and as recommended by the manufacturer for prepackaged grouts.

PART 3 - EXECUTION

3.01 GENERAL

A. The different types of grout shall be used for the applications stated below unless noted otherwise in the Contract Documents. Where grout is called for in the Contract Documents which does not fall under any of the applications stated below, non-shrink grout shall be used unless another type is specifically referenced.

1. Cement grout shall be used for grout toppings and for patching of fresh concrete.

2. Non-shrink grout shall be used for grouting beneath base plates of structural metal framing.

3. Epoxy grout shall be used for bonding new concrete to hardened concrete.

4. Epoxy base plate grout shall be used for precision seating of base plates including base plates for all equipment such as engines, mixers, pumps, vibratory and heavy impact machinery, etc.

B. New concrete surfaces to receive cement grout shall be as specified in Section 03350, Concrete Finishes, and shall be cleaned of all dirt, grease and oil-like films. Existing concrete surfaces shall likewise be cleaned of all similar contamination and debris, including chipping or roughening the surface if a laitance or poor concrete is evident. The finish of the grout surface shall match that of the adjacent concrete. Curing and protection of cement grout shall be as specified in Section 03370, Concrete Curing.

C. All mixing, surface preparation, handling, placing, consolidation, and other means of execution for prepackaged grouts shall be done according to the instructions and recommendations of the manufacturer.

D. The Contractor, through the manufacturer of a non-shrink grout and epoxy grout, shall provide on-site technical assistance upon request, at no additional cost to the Owner.

3.02 CONSISTENCY

A. The consistency of grouts shall be that necessary to completely fill the space to be grouted for the particular application. Dry pack consistency is such that the grout is plastic and moldable but will not flow.

3.03 MEASUREMENT OF INGREDIENTS

A. Measurements for cement grout shall be made accurately by volume using containers. Shovel measurement shall not be allowed.

B. Prepackaged grouts shall have ingredients measured by means recommended by the manufacturer.

3.04 GROUT INSTALLATION

A. Grout shall be placed quickly and continuously, shall completely fill the space to be grouted and be thoroughly compacted and free of air pockets. The grout may be poured in place, pressure grouted by gravity, or pumped. The use of pneumatic pressure or dry-packed grouting requires approval of the Engineer. For grouting beneath base plates, grout shall be poured form one side only and thence flow across to the open side to avoid air-entrapment.

END OF SECTION

DIVISION 04

MASONRY

SECTION 04200 - UNIT MASONRY

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.02 DESCRIPTION OF WORK

A. Extent of each type of masonry work is indicated on drawings and in schedules.

B. Types of masonry work required include:

1. Reinforced concrete unit masonry.

2. Brick or architectural concrete masonry, if shown or indicated.

1.03 QUALITY ASSURANCE

A. Fire Performance Characteristics: Where indicated, provide materials and construction which are identical to those of assemblies whose fire endurance has been determined by testing in compliance with ASTM E 119 by a recognized testing and inspecting organization or by another means, as acceptable to authority having jurisdiction.

B. Single Source Responsibility for Masonry Units: Obtain exposed masonry units of uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from one manufacturer for each different product required for each continuous surface or visually related surfaces.

C. Single Source Responsibility for Mortar Materials: Obtain mortar ingredients of uniform quality, including color for exposed masonry, from one manufacturer for each cementitious component and from one source and producer for each aggregate.

D. Mockups: Build sample panels for each type of exposed unit masonry assembly to verify selections made under sample Submittals and to demonstrate aesthetic effects.

1. Build an L-shaped mockup 48 inches long by 48 inches high by full thickness with a 24 inch leg. Mockup may be used in construction only with Engineer's approval.

1.04 SUBMITTALS

A. Product Data: Submit manufacturer's product data for each type of masonry unit, accessory, and other manufactured products, including certifications that each type complies with specified requirements.

B. Provide samples of brick or architectural concrete masonry for Owner selection.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver masonry materials to project in undamaged condition.

B. Store and handle masonry units to prevent their deterioration or damage due to moisture, temperature changes, contaminants, corrosion or other causes.

C. Store materials off the ground, under cover and in dry location.

D. Store aggregates where grading and other required characteristics can be maintained.

E. Store masonry accessories including metal items to prevent deterioration by corrosion and accumulation of dirt.

1.06 PROJECT CONDITIONS

A. Protection of Work: During erection, cover top of walls with waterproof sheeting at end of each day's work. Cover partially completed structures when work is not in progress.

B. Extend cover a minimum of 24 inches down both sides and hold cover securely in place.

C. Do not apply uniform floor or roof loading for at least 12 hours after building masonry walls or columns.

D. Do not apply concentrated loads for at least 3 days after building masonry walls or columns.

E. Staining: Prevent grout or mortar or soil from staining the face of masonry to be left exposed or painted. Remove immediately grout or mortar in contact with such masonry.

F. Protect base of walls from rain-splashed mud and mortar splatter by means of coverings spread on ground and over wall surface.

G. Protect sills, ledges and projections from droppings of mortar.

H. Cold-Weather Requirements: Do not use frozen 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. Comply with cold-weather construction requirements contained in ACI 530.

I. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.

1.07 ALLOWANCE

A. Include the allowance amount shown in Section 01210, Allowances, per thousand for face brick as specified in paragraph 2.1 of this section. This cost shall include delivery, taxes, and unloading on the project site.

B. Coordinate materials and their installation with related materials and installation to ensure that the allowance item is completely integrated and interfaced with related construction activities.

PART 2 - PRODUCTS

2.01 BRICK MADE FROM CLAY OR SHALE

A. Size: Provide 2-1/4" x 3-3/4" x 8" facing bricks.

B. Provide special molded shapes where indicated and for application requiring brick of form, size and finish on exposed surfaces which cannot be produced from standard brick sizes by sawing.

C. For sills, caps and similar applications resulting in exposure of brick surfaces which otherwise would be concealed from view, provide uncored or unfrogged units with all exposed surfaces finished.

D. Facing Brick: ASTM C 216, Grade SW, type FBS with a compressive strength of 7500 psi,

average, per ASTM C67. Color to uniform in color as selected from standard colors available.

2.02 CONCRETE MASONRY UNITS

A. General: Comply with referenced standards and other requirements indicated below applicable to each form of concrete masonry unit required. Provide special shapes where required for lintels, corners, jambs, sash, control joints, headers, bonding and other special conditions. Provide bullnose units for outside corners for interior partitions, unless otherwise indicated.

B. Integral Water Repellent for Architectural Concrete Masonry Units: Provide units made with liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength for exposed units and where indicated.

Available Products:

1. Addiment Incorporated; Block Plus W-10.
2. Grace Construction Products, a unit of W. R. Grace & Co. - Conn.; Dry-Block.
3. Master Builders, Inc.; Rheopel.

C. Concrete Block: Provide units complying with characteristics indicated below.

1. Size: Manufacturer's standard units with nominal face dimensions of 16" long x 8" high (15-5/8" x 7-5/8" actual) x thickness indicated.
2. Hollow Loadbearing Block: ASTM C 90, normal weight.
    a. Net area compressive strength of concrete masonry units shall be a minimum of 1,900 psi when tested in accordance with ASTM C140. Compressive strength of masonry (f'm) shall be a minimum of 1,500 psi in accordance with ACI 530.1 when these units are used with the mortar specified
3. Non-Loadbearing Block: ASTM C155, normal weight or use hollow loadbearing block.
4. Architectural Concrete Masonry Units: ASTM C90, normal weight, minimum net compressive strength of 1,900 psi. Provide units with integral water repellant. Color of units shall be manufacturer's standard color and texture. Type of units shall be as indicated on Drawings.
5. Special Shapes: Provide normal weight loadbearing, non-loadbearing block, and architectural concrete masonry units as required to perform work without exposing cut surfaces. Bullnose shape shall be provided on outside corners within the building and where indicated on Drawings.
6. Concrete Building Brick: Provide units complying with ASTM C 55 and characteristics indicated below for grade, type, size and weight classification.
    a. Grade: Same as indicated for concrete block.
    b. Type: Same as indicated for concrete block.
    c. Size: Non-modular Standard 2-1/4"x3-3/4"x8".
    d. Weight Classification: Normal weight.

2.03 MORTAR AND GROUT MATERIAL

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

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

C. Aggregate for Mortar: ASTM C 144, except for joints less than 1/4" use aggregate graded with 100% passing the No. 16 sieve.

D. Water: Clean and potable.

E. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with architectural concrete masonry units, containing integral water repellent by same manufacturer.

Available Products:

1. Addiment Incorporated; Mortar Tite.

2. Grace Construction Products, a unit of W. R. Grace & Co. - Conn.; Dry-Block Mortar Admixture.

3. Master Builders, Inc.; Rheomix Rheopel.

2.04 JOINT REINFORCEMENT, TIES AND ANCHORING DEVICES

A. Materials: Comply with requirements indicated below for basic materials and with requirements indicated under each form of joint reinforcement, tie and anchor for size and other characteristics:

1. Zinc-Coated (galvanized) Steel Wire: ASTM A 82 for uncoated wire and with ASTM C 641 for Class 3 (9.80 oz. per sq. ft. of wire surface). Use for masonry not exposed to exterior.

2. Hot-Dip Galvanized Steel Wire: ASTM A 82 for uncoated wire and with ASTM A 153, Class B-2 (1.5 oz. per sq. ft. of wire surface) for zinc coating applied after prefabrication into units. Use for masonry exposed to exterior and in contact with earth.

3. Zinc-Coated (Galvanized) Steel Sheet: Carbon steel with zinc coating complying with ASTM A 525, Coating Designation G90. Use for dovetail slots and where indicated.

4. Hot-Dip Galvanized Carbon Steel Sheet: ASTM A 366, Class 2 or ASTM A 635; hot-dip galvanized after fabrication to comply with ASTM A 153, Class B. Use for anchors.

5. Joint Reinforcement: Provide welded-wire units prefabricated with deformed continuous side rods and plain cross rods into straight lengths of not less than 10', with prefabricated corner and tee units, and complying with requirements indicated below:

   a. Width: Fabricate joint reinforcement in units with widths of approximately 2" less than nominal width of walls and partitions as required to provide mortar coverage of not less than 5/8" on joint faces exposed to exterior and 1/2" elsewhere.

   b. Wire Size for Side Rods: 0.1875" diameter.

   c. Wire Size for Cross Rods: 0.1875" diameter.

   d. For multi-wythe masonry provide adjustable eye-wire joint reinforcement. Ladder design with cross rods spaced not more than 16" o.c. and having one side rod for each face shell of concrete masonry back-up and adjustable wall tie with seismic clip and continuous 9 gauge wire for veneer.

6. Anchor Bolts: Provide steel bolts with hex nuts and flat washers complying with ASTM A 307, Grade A, hot-dip galvanized to comply with ASTM C 153, Class C, in sizes and configurations indicated.

7. Manufacturers: Subject to compliance with requirements, provide products of one of the following:

   a. AA Wire Products Co.

   b. Dur-O-Wall, Inc.

   c. Heckman Building Products, Inc.

   d. Hohmann & Barnard, Inc.

   e. Masonry Reinforcing Corp. of America.

   f. National Wire Products Corp.

2.05 CONCEALED FLASHING MATERIALS

A. Laminated Flashing: Manufacturer's standard laminated flashing consisting of 7 oz. per sq. ft. copper sheet bonded with asphalt between 2 layers of glass fiber cloth.

B. Products: Subject to compliance with requirements, provide one of the following:

   1. Copper Fabric Laminate Flashing:

      a. Copper Fabric; Afco Products, Inc.

      b. Copper Fabric Flashing; Sandell Mfg. Co., Inc.

      c. Copper Fabric Flashing; York Mfg., Inc.

2.06 MISCELLANEOUS MASONRY ACCESSORIES

A. Reinforcing Bars: Deformed steel, ASTM A 615, Grade 60 for bars No. 3 to No. 18.

B. Non-Metallic Expansion Joint Strips: Premolded, flexible cellular neoprene rubber filler strips complying with ASTM D 1056, Grade RE41E1, capable of compression up to 35%, of width and thickness indicated.

C. Premolded Control Joint Strips: Styrene-butadiene rubber compound complying with ASTM D 2000, Designation 2AA-805, designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

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

E. Weep Holes: Provide round Plastic tubing, medium-density polyethylene, 3/8" outside diameter by CMU or brick width long. Space as indicated on drawings.

2.07 INSULATION

A. Extruded Polystyrene Board Insulation: Rigid cellular polystyrene thermal insulation with closed cells and integral high density skin, formed by the expansion of polystyrene base resin in an extrusion process to comply with ASTM C 578, Type IV; 5-year aged r-value of 5 Btu/(hr x sf x degrees F) at 75 degrees F (24 degrees C); in manufacturer's standard lengths and

widths; thickness as indicated. Subject to compliance with requirements, provide one of the following:

1. Dow Chemical USA: Styrofoam SM/SB.
2. UC Industries: Foamular 250.
3. Minnesota Diversified Products, Inc.: Certifoam.

B. Adhesive: Type recommended by insulation board manufacturer for application indicated.

2.08 MASONRY CLEANER

A. Job-Mixed Detergent Solution: Solution of trisodium phosphate (1/2 cup dry measure) and laundry detergent (1/2 cup dry measure) dissolved in one gallon of water. Modify mixture as required to meet requirements of the architectural concrete masonry unit and face brick manufacturer.

2.09 MORTAR AND GROUT MIXES

A. General: Do not add admixtures including coloring pigments, air-entraining agents, accelerators, retarders, anti-freeze compounds or other admixtures, unless otherwise indicated. Do not use calcium chloride in mortar or grout. Water repellant admixture shall be used for masonry mortar used with architectural concrete masonry units with an integral water repellant admixture.

B. Mixing: Combine and thoroughly mix cementitious, water and aggregates in a mechanical batch mixer; comply with referenced ASTM standards for mixing time and water content.

C. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification, for type of mortar required, unless otherwise indicated. Limit cementitious materials in mortar to portland cement-lime. Type N mortar for exterior, above-grade loadbearing and non-loadbearing walls; for interior loadbearing walls; and for other applications where another type is not indicated.

D. Grout for Unit Masonry: Comply with ASTM C 476 for grout for use in construction of reinforced and nonreinforced unit masonry. Use grout of consistency indicated or if not otherwise indicated, of consistency (fine or coarse) at time of placement which will completely fill all spaces intended to receive grout. Use fine grout in grout spaces less than 2" in horizontal direction, unless otherwise indicated. Grout shall have a minimum compressive strength of 3,000 psi after 28 days.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Wetting Clay Brick: Wet brick made from clay or shale which have ASTM C 67 initial rates of absorption (suction) of more than 30 grams per 30 sq. in. per minute. Use wetting methods which ensure each clay masonry unit being nearly saturated but surface dry when laid.

B. Do not wet concrete masonry units.

C. Cleaning Reinforcing: Before placing, remove loose rust, ice and other coatings from reinforcing.

D. Thickness: Build cavity and composite walls and other masonry construction to the full thickness shown. Build single-wythe walls to the actual thickness of the masonry units, using units of nominal thickness indicated.

E. Build chases and recesses as shown or required for the work of other trades. Provide not less than 8" of masonry between chase or recess and jamb of openings, and between adjacent chases and recesses.

F. Leave openings for equipment to be installed before completion of masonry work. After installation of equipment, complete masonry work to match work immediately adjacent to the opening.

G. Cut masonry units using motor-driven saws to provide clean, sharp, unchipped edges. Cut units as required to provide continuous pattern and to fit adjoining work. Use full-size units without cutting where possible. Use dry cutting saws to cut concrete masonry units.

3.02 CONSTRUCTION TOLERANCES

A. Variation from Plumb: For vertical lines and surfaces of columns, walls and arrises do not exceed 1/4" in 10', or 3/8" in a story height not to exceed 20', nor 1/2" in 40' or more. For external corners, expansion joints, control joints and other conspicuous lines, do not exceed 1/4" in any story or 20' maximum, nor 1/2" in 40' or more. For vertical alignment of head joints do not exceed plus or minimum 1/4" in 10', 1/2" maximum.

B. Variation from Level: For bed joints and lines of exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines, do not exceed 1/4" in any bay or 20' maximum, nor 1/2" in 40' or more. For top surface of bearing walls do not exceed 1/8" between adjacent floor elements in 10' or 1/16" width of a single unit.

C. Variation of Linear Building Lines: For position shown in plan and related portion of columns, walls and partitions, do not exceed 1/2" in any bay or 20' maximum, nor 3/4" in 40' or more.

D. Variation in Cross-Sectional Dimensions: For columns and thickness of walls, from dimensions, shown, do not exceed minimum 1/4" nor plus 1/2".

E. Variation in Mortar Joint Thickness: Do not exceed bed joint thickness indicated by more than plus or minus 1/8", with a maximum thickness limited to 1/2". Do not exceed head joint thickness indicated by more than plus or minus 1/8".

3.03 LAYING MASONRY WALLS

A. Layout walls in advance for accurate spacing of surface bond patterns with uniform joint widths and to accurately locate openings, movement-type joints, returns and offsets. Avoid the use of less-than-half-size units at corners, jambs and wherever possible at other locations.

B. Lay-up walls to comply with specified construction tolerances, with courses accurately spaced and coordinated with other work.

C. Pattern Bond: Lay exposed masonry in the bond pattern shown or, if not shown, lay in running bond with vertical joint in each course centered on units in courses above and below. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 2". Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4" horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Rack back 1/2-unit length in each course; do not tooth. Clean exposed surfaces of set masonry, wet units lightly (if required) and remove loose masonry units and mortar prior to laying fresh masonry.

E. Built-in Work: As the work progresses, build-in items specified under this and other sections of these specifications. Fill in solidly with masonry around built-in items. Fill space between hollow metal frames and masonry solidly with mortar, unless otherwise indicated. Where

built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath in the joint below and rod mortar or grout into core. Fill cores in hollow concrete masonry units with grout 3 courses (24") under bearing plates, beams, lintels, posts and similar items, unless otherwise indicated.

3.04 MORTAR BEDDING AND JOINTING

A. Lay solid brick size masonry units with completely filled bed and head joint; butter ends with sufficient mortar to fill head joints and shove into place. Do not slush head joints.

B. Lay hollow concrete masonry units with full mortar coverage on horizontal and vertical face shells. Bed webs in mortar in starting courses on footings and in all courses of piers, columns and pilasters, and where adjacent to cells or cavities to be reinforced or filled with concrete or grout. For starting course on footings where cells are not grouted, spread out full mortar bed including areas under cells.

C. Set pre-cast concrete coping units in full bed of mortar with all vertical joints, slushed full. Fill dowel, anchor and similar holes solid. Rake head joints 1/2" to 3/4" and install elastomeric sealant and lead joint covers.

D. Maintain joint widths shown, except for minor variations required to maintain bond alignment. If not shown, lay walls with 3/8" joints.

E. Cut joints flush for masonry walls which are to be concealed or to be covered by other materials, unless otherwise indicated.

F. Tool exposed joints slightly concave using a jointer larger than joint thickness, unless otherwise indicated.

G. Remove masonry units disturbed after laying; clean and reset in fresh mortar. Do not pound corners or jambs to shift adjacent stretcher units which have been set in position. If adjustments are required, remove units, clean off mortar and reset in fresh mortar.

3.05 STRUCTURAL BONDING OF MULTI-WYTHE MASONRY

A. Use continuous horizontal joint reinforcement installed in horizontal mortar joints for bond tie between wythes. Install at not more than 16" o.c. vertically.

B. Corners: Provide interlocking masonry unit bond in each course at corners, unless otherwise shown.

C. For horizontally reinforced masonry, provide continuity at corners with prefabricated "L" units, in addition to masonry bonding.

D. Intersecting and Abutting walls: Unless vertical expansion or control joints are shown at juncture, provide same type of bonding specified for structural bonding between wythes, provide continuity with horizontal joint reinforcement using prefabricated "T" units.

E. Non-bearing Interior Partitions: Build full height of story to underside of solid floor or roof structure above, unless otherwise shown. Wedge non-bearing partitions against structure above with small pieces of tile, slate or metal. Fill joint with mortar after dead load deflection of structure above approaches final position.

3.06 CAVITY WALLS

A. Keep cavity clean of mortar droppings and other materials during construction. Strike joints facing cavity flush.

B. Tie exterior wythe to back-up with continuous horizontal joint reinforcing, installed in mortar joints at not more than 16" o.c. vertically.

C. Provide weep holes in exterior wythe of cavity wall located immediately above ledges and flashing, spaced 2'-0" o.c., unless other wise indicated.

3.07 CAVITY WALL INSULATION

A. On units of plastic insulation, install small pads of adhesive spaced approximately 1'-0" o.c. both ways on inside face. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as shown. Fill all cracks and open gaps in insulation with crack sealer compatible with insulation and masonry.

3.08 HORIZONTAL JOINT REINFORCEMENT

A. General: Provide continuous horizontal joint reinforcement as indicated. Install longitudinal side rods in mortar for their entire length with a minimum cover of 5/8" on exterior side of walls, 1/2" elsewhere. Lap reinforcing a minimum of 6". Cut or interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.

B. Reinforce walls with continuous horizontal joint reinforcing unless specifically noted to be omitted.

C. Provide continuity at corners and wall intersections by use of prefabricated "L" and "T" sections. Cut and bend reinforcement units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures and other special conditions.

D. Space continuous horizontal reinforcement for single wythe and multi-wythe walls at 16" o.c. vertically.

E. Reinforce masonry openings greater than 1'-0" wide, with horizontal joint reinforcement placed in 2 horizontal joints approximately 8" apart, immediately above the lintel and immediately below the sill. Extend reinforcement a minimum of 2'-0" beyond jambs of the opening except at control joints.

3.09 ANCHORING MASONRY WORK

A. General: Provide anchor devices of type indicated.

B. Anchor masonry to structural members where masonry abuts or faces structural members to comply with the following: Provide an open space not less than 1" in width between masonry and structural member, rigid materials. Anchor masonry to structural members with flexible anchors embedded in masonry joints and attached to structure. Space anchors as indicated, but not more than 24" o.c. vertically and 36" o.c. horizontally.

3.10 CONTROL AND EXPANSION JOINTS

A. General: Provide vertical expansion, control and isolation joints in masonry every 20 feet or where shown. Build-in related items as the masonry work progresses. Build-in non-metallic joint fillers where indicated.

3.11 LINTELS

A. Install steel lintels where indicated. Provide masonry lintels where shown and wherever openings of more than 1'-0" for brick size units and 2'-0" for block size units are shown without structural steel or other supporting lintels. Provide precast or formed-in-place masonry lintels. Cure precast lintels before handling and installation. Temporarily support formed-in-place lintels. For hollow concrete masonry unit walls, use specially formed U-

shaped lintel units with reinforcement bars placed as shown filled with coarse grout. Provide minimum bearing of 8" at each jamb, unless otherwise indicated.

3.12 FLASHING OF MASONRY WORK

A. General: Provide concealed flashing in masonry work at, or above, shelf angles, lintels, ledges and other obstructions to the downward flow of water in the wall so as to divert such water to the exterior. Prepare masonry surfaces smooth and free from projections which could puncture flashing. Place through-wall flashing on sloping bed of mortar and cover with mortar. Seal penetrations in flashing with mastic before covering with mortar. Extend flashings through exterior face of masonry and turn down to form drip.

B. Extend flashing the full length of lintels and shelf angles and minimum of 4" into masonry each end. Extend flashing from exterior face of outer wythe of masonry, through the outer wythe, turned up a minimum of 8", and through the inner wythe to within 1/2" of the interior face of the wall in exposed work. Where interior surface of inner wythe is concealed by furring, carry flashing completely through the inner wythe and turn up approximately 2". At heads and sills turn up ends not less than 2" to form a pan.

C. Provide weep holes in the head joints of the first course of masonry immediately above concealed flashings. Space 24" o.c., unless otherwise indicated.

D. Install reglets and nailers for flashing and other related work where shown to be built into masonry work.

E. Damp cure parging for at least 24 hours and protect until cured.

3.13 REPAIR, POINTING AND CLEANING

A. Remove and replace masonry units which are loose, chipped, broken, stained or otherwise damaged, or if units do not match adjoining units as intended. Provide new units to match adjoining units and install in fresh mortar or grout, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge any voids or holes, except weep holes, and completely fill with mortar. Point-up all joints including corners, openings and adjacent work to provide a neat, uniform appearance, prepared for application of sealants.

C. Final Cleaning: After mortar is thoroughly set and cured, clean masonry as follows: Remove large mortar particles by hand with wooden paddles and non-metallic scrape hoes or chisels. Protect adjacent concrete and non-masonry surfaces from contact with cleaner by covering them with liquid strippable masking agent, polyethylene film or waterproof masking tape. Saturate wall surfaces with water prior to application of cleaners; remove cleaners promptly by rinsing thoroughly with clear water. Use bucket and brush hand cleaning method described in BIA "Technical Note No. 20 Revised" to clean brick masonry made from clay or shale. Clean concrete unit masonry to comply with masonry manufacturer's directions and applicable NCMA "Tek" bulletins.

D. Protection: Provide final protection and maintain conditions in a manner acceptable to Installer, which ensures unit masonry work being without damage and deterioration at time of substantial completion.

E. Water Protection: Water-repellant for all exposed brick and architectural concrete masonry walls shall be as specified in Section 07175 - Water Repellants.

END OF SECTION

DIVISION 05

METALS

SECTION 05010 - METAL MATERIALS

PART 1 - GENERAL

1.01 REQUIREMENTS

A. Metal materials not otherwise specified shall conform to the requirements of this Section.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Requirements for specific products made from the materials specified herein are included in other sections of the Specifications. See the section for the specific item in question.

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. ASTM A36 Standard Specification for Structural Steel

B. ASTM A47 Standard Specification for Malleable Iron Castings

C. ASTM A48 Standard Specification for Gray Iron Castings

D. ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

E. ASTM A123 Standard Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars and Strip

F. ASTM A153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

G. ASTM A167 Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

H. ASTM A276 Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes

I. ASTM A307 Standard Specification for Carbon Steel Externally Threaded Standard Fasteners

J. ASTM A446 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) quality

K. ASTM A500 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

L. ASTM A501 Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing

M. ASTM A529 Standard Specification for Structural Steel with 42 000 psi (290 Mpa) Minimum Yield Point (1/2 in. (12.7 mm) Maximum Thickness)

N. ASTM A536 Standard Specification for Ductile Iron Castings

O. ASTM A570 Standard Specification for Hot-Rolled Carbon Steel Sheet and Strip, Structural Quality

P. ASTM A572 Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel

Q. ASTM A780 Standard Practice of Repair of Damaged Hot-Dip Galvanized Coatings

R. ASTM A924 Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process

S. ASTM A992 Standard Specification for Structural Steel Shapes

T. ASTM A666 Standard Specification for Austenitic Stainless Steel, Sheet, Strip, Plate, and Flat Bar for Structural Applications

U. ASTM B26 Standard Specification for Aluminum-Alloy Sand Castings

V. ASTM B85 Standard Specification for Aluminum-Alloy Die Castings

W. ASTM B108 Standard Specification for Aluminum-Alloy Permanent Mold Castings

X. ASTM B138 Standard Specification for Manganese Bronze Rod, Bar, and Shapes

Y. ASTM B209 Standard Specification for Aluminum-Alloy Sheet and Plate

Z. ASTM B221 Standard Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes

AA. ASTM B308 Standard Specification for Aluminum-Alloy Standard Structural Shapes, Rolled or Extruded

AB. ASTM B574 Standard Specification for Nickel-Molybdenum-Chromium Alloy Rod

AC. ASTM F468 Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use

AD. ASTM F593 Standard Specification for Stainless Steel Fasteners

1.04 SUBMITTALS

A. Material certifications shall be submitted along with any shop drawings for metal products and fabrications required by other sections of the Specifications.

1.05 QUALITY ASSURANCE

A. Owner may engage the services of a testing agency to test any metal materials for conformance with the material requirements herein. If the material is found to be in conformance with Specifications the cost of testing will be borne by the Owner. If the material does not conform to the Specifications, the cost of testing shall be paid by the Contractor and all materials not in conformance as determined by the Engineer shall be replaced by the Contractor at no additional cost to the Owner. In lieu of replacing materials the Contractor may request further testing to determine conformance, but any such testing shall be paid for by the Contractor regardless of outcome of such testing.

PART 2 - PRODUCTS

2.01 CARBON AND LOW ALLOY STEEL

A. Material types and ASTM designations shall be as listed below:

1. Structural Fabrications A992, A572 Grade 50, or A36

2.	Sheet Steel	A 570 Grade C
3.	Steel Angles and Plates	A36
4.	Bars and Rods	A 36 or A307 Grade A
5.	Pipe - Structural Use	A53 Type E or S, Grade B
6.	Tubes	A500 Grade B or A501
7.	Cold-Formed Structural Studs and Joists (18-22 gauge) Cold-Formed Structural Studs and Joists (12-16 gauge)	A 446 Grade C A 446 Grade D

B. Steel shapes, plates and bars which are to be galvanized shall be galvanized in accordance with ASTM A123. Iron and steel sheet which are to be galvanized shall be galvanized in accordance with ASTM A924. All connections for galvanized members shall use fasteners galvanized in accordance with ASTM A153 unless noted otherwise.

2.02 STAINLESS STEEL

A. All stainless steel fabrications exposed to underwater service shall be Type 316. All other stainless steel fabrications shall be Type 304, unless noted otherwise. All connections for stainless steel fabrications shall use Type 304 or 316 stainless steel fasteners. Fasteners shall be of the same alloy type as the structural members.

B. Material types and ASTM designations are listed below:

1.	Plates and Sheets	ASTM A167 or A666 Grade A
2.	Structural Shapes	ASTM A276
3.	Fasteners (Bolts, etc.)	ASTM F593

2.03 ALUMINUM

A. All aluminum shall be alloy 6061-T6, unless otherwise noted or specified herein.

B. Material types and ASTM designations are listed below:

1.	Structural Shapes	ASTM B308
2.	Castings	ASTM B26, B85, or B108
3.	Extruded Bars	ASTM B221 - Alloy 6061
4.	Extruded Rods, Shapes and Tubes	ASTM B221 - Alloy 6063
5.	Plates	ASTM B209 - Alloy 6061
6.	Sheets	ASTM B221 - Alloy 3003

C. All aluminum shall be provided with mill finish unless otherwise noted.

D. Where bolted connections are indicated, aluminum shall be fastened with Type 304 stainless steel bolts unless noted otherwise.

E. Aluminum in contact with dissimilar materials shall be insulated with an approved dielectric.

2.04 CAST IRON

A. Material types and ASTM designations are listed below:

1. Gray ASTM A48 Class 30B
2. Malleable ASTM A47
3. Ductile ASTM A536 Grade 60-40-18

2.05 BRONZE

A. Material types and ASTM designations are listed below:

1. Rods, Bars and Sheets ASTM B138 - Alloy B Soft

2.06 HASTELLOY

A. All Hastelloy shall be Alloy C-276.

PART 3 – EXECUTION (NOT USED)

END OF SECTION

SECTION 05500- METAL FABRICATIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Aluminum Stairs.

1.02 REFERENCE STANDARDS

A. Aluminum Association:

1. AA DAF-45 - Designation System for Aluminum Finishes.

B. American Architectural Manufacturers Association:

1. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum.

2. AAMA 2603 - Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels.

3. AAMA 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels.

4. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.

C. American National Standards Institute:

1. ANSI A14.3 - Ladders - Fixed - Safety Requirements

D. ASTM International:

1. ASTM B26 - Standard Specification for Aluminum-Alloy Sand Castings.

2. ASTM B85 - Standard Specification for Aluminum-Alloy Die Castings.

3. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

4. ASTM B210 - Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes.

5. ASTM B211 - Standard Specification for Aluminum and Aluminum-Alloy Rolled or Cold-Finished Bar, Rod, and Wire.

6. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

E. National Ornamental & Miscellaneous Metals Association:

1. NOMMA Guideline 1 - Joint Finishes.

1.03 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design metal stairs, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance of Stairs: Metal stairs shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

1. Uniform Load: 100 lbf/sq. ft. .

2. Concentrated Load: 300 lbf applied on an area of 4 sq. in.

3. Uniform and concentrated loads need not be assumed to act concurrently.

4. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.

5. Limit deflection of treads, platforms, and framing members to **L/240** or 1/4 inch whichever is less.

C. Structural Performance of Railings: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

1. Handrails and Top Rails of Guards:

a. Uniform load of 50 lbf/ ft. applied in any direction.

b. Concentrated load of 200 lbf applied in any direction.

c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Infill of Guards:

a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft.

b. Infill load and other loads need not be assumed to act concurrently.

1.04 SUBMITTALS

A. See Section 01300 – Submittals for submittal requirements

B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.

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

D. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.05 QUALITY ASSURANCE

A. Finish joints according to NOMMA Guideline 1.

1.06 DELIVERY, STORAGE, AND HANDLING

A. See Section 01631 – Products and Substitutions for transporting, handling, storing, and protecting products.

B. Inspection: Accept metal fabrications on-Site in labeled shipments. Inspect for damage.

C. Protect metal fabrications from damage by exposure to weather or by ground contact.

1.07 EXISTING CONDITIONS

A. Field Measurements: Verify field measurements prior to fabrication. Indicate field measurements on Shop Drawings.

PART 2 PRODUCTS

2.01 STAIR NOSINGS

A. Stair Nosings: Slip resistant checker plate or equivalent to be approved by Engineer.

2.02 MATERIALS

A. Aluminum:

1. Extruded Aluminum: ASTM B221 Alloy 6063, Temper T5.
2. Sheet Aluminum: ASTM B209 Alloy 6061, Temper T6.
3. Aluminum-Alloy Drawn Seamless Tubes: ASTM B210 Alloy 6063, Temper T6
4. Aluminum-Alloy Bars: ASTM B211 Alloy 6063, Temper T6.
5. Aluminum-Alloy Sand Castings: ASTM B26, Alloy 356.
6. Aluminum-Alloy Die Castings: ASTM B85, Alloy as required to suit application.
7. Bolts, Nuts, and Washers: Stainless steel.
8. Welding Materials: AWS D1.1; type required for materials being welded.

2.03 FABRICATION

A. Fit and shop assemble items in largest practical sections for delivery to Site.

B. Fabricate items with joints tightly fitted and secured.

C. Continuously seal joined members by continuous welds.

D. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small, uniform radius.

E. Exposed Welded Joints: NOMMA Guideline 1 Joint Finish #1.

F. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.

G. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

H. Fabrication Tolerances:

1. Squareness: 1/8 in maximum difference in diagonal measurements.

2. Maximum Offset between Faces: 1/16 in.

3. Maximum Misalignment of Adjacent Members: 1/16 in.

4. Maximum Bow: 1/8 inch in 48 in.

5. Maximum Deviation from Plane: 1/16 inch in 48 in.

2.04 FINISHES

A. Aluminum:

1. Finish coatings to conform to AAMA 611. Comply with AA DAF-45.

2. Exterior Aluminum Surfaces:

a. Exterior Hard coat Two-step anodized to clear color, to 0.0007 in thickness.

b. Organic coating to color as selected.

3. Interior Aluminum Surfaces:

a. Interior Hard coat Two-step anodized to clear color, to 0.0007 in thickness.

b. Organic coating to color as selected.

4. Apply one coat of bituminous paint to concealed aluminum surfaces in contact with cementitious or dissimilar materials.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify field conditions are acceptable and are ready to receive Work.

3.02 PREPARATION

A. Clean and strip primed steel items to bare metal and aluminum where Site welding is required.

B. Supply steel items required to be cast into concrete or embedded in masonry with setting templates to appropriate sections.

3.03 INSTALLATION

A. Install items plumb and level, accurately fitted, and free from distortion or defects.

B. Make provisions for erection stresses. Install temporary bracing to maintain alignment until permanent bracing and attachments are installed.

C. Field weld components indicated on Drawings or Shop Drawings.

D. Perform field welding according to AWS D1.1.

E. Obtain approval of Architect/Engineer prior to Site cutting or making adjustments not scheduled.

3.04 TOLERANCES

A. Maximum Variation from Plumb: ¼ in per story or for every 12 ft in height, whichever is greater, non-cumulative.

B. Maximum Variation from Level: 1/16 inch in 3 ft and 1/4 inch in 10 ft.

C. Maximum Offset from Alignment: 1/4 in.

D. Maximum Out-of-Position: 1/4 in.

3.05 FIELD QUALITY CONTROL

A. Welding: Inspect welds according to AWS D1.1.

B. Replace damaged or improperly functioning hardware.

C. After erection, touch up welds, abrasions, and damaged finishes with prime paint or galvanizing repair paint to match shop finishes.

D. Touch up factory-applied finishes according to manufacturer-recommended procedures.

3.06 ADJUSTING

A. Adjust operating hardware and lubricate as necessary for smooth operation.

END OF SECTION

SECTION 05511- ALUMINUM LADDERS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Fixed aluminum wall ladders.

B. Fasteners and installation accessories.

1.02 RELATED SECTIONS

A. Section 06100 - Rough Carpentry

B. Section 08370 - Access Hatches

1.03 REFERENCES

A. ANSI A14.3 - American National Standard for Ladders -- Fixed -- Safety Requirements; 1992.

B. ASTM B 210 - Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes; 2002.

C. ASTM B 221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2000.

D. ASTM B 308 - Standard Specification for Aluminum - Alloy T6061-T6 Standard Structural; 2002

E. OSHA 29 CFR Standard 1910.27 - Fixed ladders; Occupational Safety and Health Standards; current edition

1.04 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Product Data: Manufacturer's data sheets on each product to be used, including:

1. Preparation instructions and recommendations.

2. Storage and handling requirements and recommendations.

3. Installation methods.

C. Shop Drawings: Detailed drawings showing complete dimensions, all materials, mounting attachments, and fabrication details.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in the engineering and manufacturing of metal ladders, with not less than twenty years of experience.

1.06 WARRANTY

A. See Section 01770 - Closeout Project, for additional warranty requirements.

B. Provide manufacturer's standard limited five-year warranty against defects in materials and workmanship.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products of one of the following:

1. Alaco Ladder Co.
2. ACL Industries, Inc.
3. Jomy Products, Inc.
4. O'Keeffe's, Inc.

B. Requests for substitutions will be considered in accordance with provisions of Section 01631.

2.02 MATERIALS

A. Extruded Aluminum Profiles: ASTM B 221, ASTM B 210, ASTM B 308, Alloy 6061-T6; standard mill finish.

B. Aluminum Sheet and Plate: ASTM B 209, Alloy 6061-T6; standard mill finish.

C. Fasteners: Aluminum solid aircraft rivets rated at 300 lbs shear strength.

D. Cast fittings, connectors and rung ends: Cast Aluminum alloy 356

2.03 LADDERS

A. Ladders - General: Comply with ANSI A14.3 and OSHA regulations.

B. Fixed Wall Ladders: Extruded aluminum; serrated rungs 1-1/8 inches (29 mm) in diameter, connected to 2-7/8 inch (73 mm) side rail channels with cast aluminum rung connectors, each secured to rails by means of four solid aircraft rivets.

1. Capacity: 500 lbs (225 kg).
2. 24" Wide.

2.04 FINISHES

A. Provide all aluminum in standard mill finish.

2.05 FALL PREVENTION DEVICES

A. All ladders shall be equipped with Saf-T-Climb fall prevention device, Manufactured by Air Space Devices, Inc., Paramount, California, or equal.

B. All ladders and safety devices shall meet OSHA regulations

PART 3 - EXECUTION

3.01 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions and approved shop drawings, and in compliance with ANSI A14.3 and OSHA 1910.27.

3.03 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 05520 - HANDRAILS AND RAILINGS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Extent and dimensions of handrails and railings are indicated on Drawings and include miscellaneous handrails and railing systems not included in other Sections of these Specifications.

B. Type of handrails and railing systems in this Section is aluminum pipe handrails and railing systems.

C. Products furnished but not installed under this Section include inserts and anchors preset in masonry and concrete for anchorage of hand rails and railing systems.

1.02 RELATED WORK SPECIFIED ELSEWHERE

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

1.03 SUBMITTALS

A. Product Data: Manufacturer's technical data for products and processes used in handrails and railing systems, including finishes and grout.

B. Shop Drawings: Shop details of fabrication and installation for each type and material of handrail and railing system required including plans, elevations, sections, profiles of rails, fittings, connections, and anchors.

C. Samples: Prepare samples of each type of metal finish required on metal of same thickness and alloy indicated for final work. Where finish involves normal color and texture variations, include sample sets composed of two (2) or more units showing limits of such variations expected in completed work. Include 6" long samples of each distinctly different railing member including handrails, top rails, posts, and samples of fittings and brackets.

1.04 DEFINITIONS

A. Definitions in ASTM E 985 for railing-related terms apply to this Section.

1.05 SYSTEM DESCRIPTION

A. Structural Performance of Handrails and Railing Systems: Design, engineer, fabricate, and install handrails and railing systems to withstand the following structural loads without exceeding the allowable design working stress of the materials for handrails, railing systems, anchors, and connections. Apply each load to produce the maximum stress in each of the respective components comprising handrails and railing systems.

1. Top Rail of Guardrail Systems: Concentrated load of 200 lbf (890 N) applied at any point and in any direction and a uniform load of 50 lbf per linear foot (730 N/m) applied horizontally and concurrently with a uniform load of 100 lbf per linear foot (1460 N/m) applied vertically downward. Concentrated and uniform loads need not be assumed to act concurrently.

2. Handrails Not Serving as Top Rails: Concentrated load of 200 lbf (890 N) applied at any point and in any direction and a uniform load of 50 lbf per linear foot (730 N/m) applied in any direction. Concentrated and uniform loads need not be assumed to act concurrently.

3. Infill Area of Guardrail Systems: Horizontal concentrated load of 200 lbf (890 N) applied to 1 sq. ft. (0.09 sq. m) at any point in the system including gates, panels, intermediate rails, balusters, or other elements composing the infill area. Loads on infill area need not be assumed to act concurrently with loads on top rails.

B. Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

C. Material for rails and gates shall be a minimum of 1-1/2" diameter Schedule 40 and for posts, a minimum of Schedule 80.

1.06 QUALITY ASSURANCE

A. Single Source Responsibility: Obtain handrails and railing systems of each type and material from a single manufacturer.

B. Design Responsibility: Engage a qualified professional engineer to prepare or supervise the preparation of structural computations for handrails and railing systems to determine compliance with structural performance requirements indicated.

1.07 STORAGE

A. Store handrails and railing systems in clean, dry location, away from uncured concrete and masonry, protected against damage of any kind. Cover with waterproof paper, tarpaulin, or polyethylene sheeting; allow for air circulation inside the covering.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with requirements, provide handrails and railing systems of one of the following, or an approved equal. Handrail System shall be equal to "TUFRAIL" as manufactured by Thompson Fabricating Company.

1. Thompson Fabricating Company, Inc., Birmingham, Alabama.

2. Superior Railing Company

3. Alumaguard

2.02 METALS

A. General: Comply with standards indicated for forms and types of metals indicated or required for handrail and railing system components.

B. Aluminum: Provide alloy and temper recommended by aluminum producer or finisher for type of use and finish indicated, and with not less than the strength and durability properties of the alloy and temper designated below for each aluminum form required.

1. Extruded Bar and Shapes: ASTM B 221, 6063-T6.

2. Extruded Pipe and Tube: ASTM B 429, 6063-T6.

3. Plate and Sheet: ASTM B 209, 6061-T6.

4. Die and Hand Forgings: ASTM B 247, 6061-T6.

5. Castings: ASTM B 26, 356-T6.

2.03 MISCELLANEOUS MATERIALS

A. Nonshrink Nonmetallic Grout: Pre-mixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with CE CRD C621. Provide grout specifically recommended by manufacturer for interior and exterior applications of type specified in this Section.

B. Welding Electrodes and Filler Metal: Provide type and alloy of filler metal and electrodes as recommended by producer of metal to be welded, complying with applicable AWS Specifications, and as required for color match, strength, and compatibility in fabricated items.

C. Fasteners: Use fasteners of Type 304 stainless steel for aluminum components, unless otherwise indicated. Do not use metals which are corrosive or incompatible with materials joined.

D. Provide concealed fasteners for interconnection of handrail and railing components and for their attachment to other work except where exposed fasteners are unavoidable or are the standard fastening method for handrail and railing system indicated.

E. Provide Phillips flat-head machine screws for exposed fasteners, unless otherwise indicated.

F. Anchors and Inserts: Provide anchors of type, size, and material required for type of loading and installation condition shown, as recommended by manufacturer, unless otherwise indicated. Use nonferrous metal of hot-dipped galvanized anchors and inserts for exterior locations and elsewhere as required for corrosion resistance. Use toothed steel or expansion bolt devices for drilled-in-place anchors.

G. Galvanizing Repair Paint: High zinc dust content paint for regalvanizing welds in galvanized steel: Sherwin-Williams Zinc-Clad Galvanizing Compound #143-0255 or equal.

H. Bituminous Paint: SSPC-Paint 12 (cold-applied asphalt mastic).

I. Zinc Chromate Primer for Galvanized Metals: Sherwin-Williams Galvite, B50W3 or equal; for Ferrous Metals: Sherwin-Williams KemKromik Universal, B50Z Series or equal.

2.04 FABRICATION

A. General: Fabricate handrails and railing systems to design, dimensions and details shown. Provide handrail and railing members in sizes and profiles indicated, with supporting posts and brackets of size and spacing shown, but not less than required to comply with requirements indicated for structural performance. Handrail systems which use fittings which are glued or pop-riveted will not be acceptable.

B. Shop Assembly: Pre-assemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

C. Nonwelded Connections: Fabricate railing systems and handrails for interconnection of members by means of railing manufacturer's standard concealed mechanical fasteners and fittings unless otherwise indicated. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.

D. Welded Connections for Aluminum Pipe: Fabricate aluminum pipe handrails and railing systems for interconnection of members by concealed internal welds, which eliminate surface grinding, using manufacturer's standard system of sleeve and socket fittings.

E. Form changes in direction of railing members by bending members, insertion of prefabricated elbow fittings, radius bends, or by mitering.

F. For handrails and railing systems with nonwelded connections which are exposed to exterior or to moisture from condensation or other sources, provide weepholes or other means for evacuation of entrapped water in hollow sections of railing members.

G. Toe Boards: Where required by O.S.H.A. and where indicated on the Drawings, provide toe boards at railing systems around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details shown or, if not shown, use manufacturer's standard detail. Toe boards shall be 4" high.

H. Brackets, Flanges, Fittings and Anchors: Provide manufacturer's standard wall brackets, flanges, hinges, miscellaneous fittings and anchors for interconnection of handrail and railing members to other work, unless otherwise indicated.

I. Furnish inserts and other anchorage devices for connecting handrails and railing systems to concrete or masonry work. Fabricate anchorage devices which are capable of withstanding loadings imposed by handrails and railing systems. Coordinate anchorage devices with supporting structure.

J. For railing posts set in concrete provide preset sleeves of steel, not less than 6" long and inside dimensions not less than 2" greater than outside dimensions of post, with steel plate forming bottom closure.

K. Provide slip-fit metal sockets to receive removable railing posts. Fabricate sockets for a close fit with posts and to limit deflection of post without lateral load, measured at top, not to exceed 1/12 of post height. Design and fabricate socket covers to resist accidental dislodgement.

L. Gates: Provide gates of equal structural properties of railing system, with toe board. Hinges shall be capable of providing a swing of 180 degrees. Provide positive latching device which shall be operable from both sides of gate.

2.05 METAL FINISHES, GENERAL

A. Comply with NAAMM "Metal Finishes Manual" for recommendations and designations of finishes, except as otherwise indicated.

B. Class I Clear Anodized Finish: AA-M10C22A41 (medium satin directional textured mechanical finish; chemical etch, medium matte; 0.7 mil min. thick clear anodic coating) complying with AAMA 607.1.

PART 3 - EXECUTION

3.01 PREPARATION

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

B. Field Measurements: Take field measurements prior to fabrication.

3.02 INSTALLATION, GENERAL

A. Fit exposed connections accurately together to form tight, hairline joints.

B. Perform cutting, drilling, and fitting required for installation of handrails and railing systems. Set work accurately in location, alignment, and elevation, plumb, level, true, and free of rack, measured from established lines and levels. Do not weld, cut or abrade surfaces of handrails

and railing components which have been coated or finished after fabrication, and are intended for field connection by mechanical means without further cutting or fitting.

C. Field Welding: Comply with applicable AWS Specification for procedures of manual shielded metal-arc welding, for appearance and quality, of welds made, and for methods used in correcting welding work. Weld connections which are not to be left as exposed joints, but cannot be shop welded because of shipping size limitations. Grind exposed welded joints smooth and restore finish to match finish of adjacent rail surfaces.

D. Corrosion Protection: Coat concealed surfaces of aluminum, which will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint or zinc chromate primer.

E. Adjust handrails and railing systems prior to anchoring to ensure matching alignment at abutting joints. Space posts at 5'-0" o.c. MAX but not more than that required by design loadings.

3.03 ANCHORING POSTS

A. Anchor aluminum handrail posts to concrete with manufacturer's base flange assembly (3 anchors per base) for top and side mount brackets recommended for meeting the design criteria. Base flanges and side mount brackets will not be welded to the post but will be mechanically fastened so as to achieve a rigid construction without annealing the post. All connections to concrete will be made using stainless steel wedge anchors, which are to be sized and furnished by the handrail manufacturer as an integral part of their handrail system. Anchor post on new concrete shall be side mounted except where shown otherwise on the drawings.

B. Anchor posts to metal surfaces with manufacturer's standard fittings designed for this purpose unless otherwise indicated.

C. Provide removable railing sections as indicated, using slip-fit metal sockets. Accurately locate sockets to match post spacing.

3.04 RAILING CONNECTIONS

A. Nonwelded Connections: Use manufacturer's standard mechanical joints for permanently connecting railing components. Components that are glued or pop riveted at the joints will not be acceptable. All components must be mechanically fastened with stainless steel hardware. Use wood blocks and padding to prevent damage to railing members and fittings. Seal recessed holes of exposed locking screws using plastic filler cement colored to match finish of handrails and railing systems.

B. Welded Connections: Use fully welded joints for permanently connecting railing components by welding. Cope or butt components to provide 100 percent contact or use manufacturer's standard fittings designed for this purpose.

3.05 ANCHORING RAILING ENDS

A. Anchor railing ends into concrete or masonry with manufacturer's standard fittings designed for this purpose, unless otherwise indicated.

B. Anchor railing ends to metal surfaces with manufacturer's standard fittings using concealed fasteners, unless otherwise indicated.

C. Expansion Joints: Provide expansion joints at locations indicated or, if not indicated, at intervals not to exceed 40 feet. Provide slip-joint internal sleeve extending 2" beyond joint on either side; fasten internal sleeve securely to one side, locate joint within 6" of post.

3.06 ATTACHMENT OF HANDRAILS TO WALLS

A. General: Secure handrails to walls with manufacturer's standard wall brackets and end fittings, unless otherwise indicated.

B. For concrete and solid masonry, use drilled-in expansion shields and concealed hanger bolts, unless otherwise indicated.

C. For hollow masonry anchorage, use toggle bolts with square heads, unless otherwise indicated.

3.07 PROTECTION

A. Protect finishes of railing systems and handrails from damage during construction period by use of temporary protective coverings approved by railing manufacturer. Remove protective covering at time of Substantial Completion.

B. Restore finishes damaged during installation and construction period so that no evidence remains of correction work. Return items which cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units as required.

END OF SECTION

SECTION 05530 - GRATING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide all labor, materials, equipment and services required to furnish and install metal bar grating in accordance with the Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

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

1.03 SUBMITTALS

Comply with Section 01300 as well as the requirements specified herein.

A. Submit shop drawings to the Engineer for review before fabrication.

B. Indicate areas to receive grating, grating details and dimensions, and material specifications.

C. Show anchorage details and locations.

D. Indicate coordination with equipment suppliers where openings for such equipment are required.

1.04 REFERENCE STANDARDS

A. Design, fabrication and installation of grating shall be in accordance with Standard Specifications and Voluntary Code of Practice in Metal Bar Grating Manual, 1979 Edition, published by National Association of Architectural Metal Manufacturers, Chicago, Illinois (ANSI A 202.1).

PART 2 - PRODUCTS

2.01 DESIGN CRITERIA

Gratings shall meet or exceed the following design criteria:

A. Support uniform live load of 100 psf.

B. Deflection not to exceed span of bearing bars (in inches) divided by 360.

C. Maximum fiber stress: 12,000 psi.

2.02 BASIC DESIGN

The basic design requirements are listed below:

A. Shape: Rectangular.

B. Type Construction: Pressure locked.

C. Bar Sizes, unless otherwise shown on the Drawings:

1. Bearing Bars: 1-1/2" x 3/16".

2. Cross Bars: 1" x 1/8".

D. Maximum Bar Spacing:

1. Bearing Bars: 1-3/16" c-c.

2. Cross Bars: 4" c-c.

E. Banding Bars:

1. Same thickness as bearing bars to which they are attached.

2. At free ends: Same depth as bearing bars.

3. At supported ends: 1/8" less in depth than bearing bars.

F. Bearing and crossbars shall be flush at surface.

G. All free and supported bar ends around perimeter and around cutouts shall be banded.

H. Provide removable sections of grating with suitable end bearing where noted on the Drawings or otherwise required.

2.03 MATERIALS

A. Aluminum Grating:

The materials of construction shall meet the following requirements:

1. Bearing Bars: ASTM B 221, 6061-T6 or 6063-T6, aluminum.

2. Cross Bars: ASTM B 221 (extruded) or ASTM B 210 (drawn) aluminum.

3. All steel fasteners used with aluminum grating shall be aluminum or Type 304 stainless steel.

4. Finish: Aluminum mill finish (as fabricated).

5. Anchors: Saddle clips of manufacturer's standard design, aluminum or Type 304 stainless steel.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Grating shall be fabricated as indicated by shop drawings which have been revised to reflect actual field measurements.

B. Grating shall be set with full and uniform end bearing to preclude rocking; do not use wedges or shims.

C. Provide 1-inch minimum bearing with maximum erection clearance of 1/4-inch all around.

D. Anchor grating with saddle clips in accordance with manufacturer's recommendations or as detailed on the Drawings.

E. Provide cutouts for the passage of pipe, valve and equipment operators, conduit, stems and similar work; cutouts for circular obstructions shall be at least 2" larger in diameter than the obstruction.

F. Protect all surfaces of angles and frames to be in contact with concrete or dissimilar metals with two (2) coats of Fed. Spec. TT-V-51F Asphalt Varnish.

END OF SECTION

DIVISION 06

WOOD AND PLASTIC

SECTION 06100 - ROUGH CARPENTRY

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide all labor, materials, equipment and services for furnishing and installing the carpentry work as shown on the Drawings and specified herein.

B. The extent of rough carpentry work is shown on the Drawings and includes, but is not necessarily limited to the following:

1. Installation of wood framing, blocking and furring.

2. Installation of wood trim.

3. Installation of Doors, Windows and Hardware.

1.02 RELATED DOCUMENTS SPECIFIED ELSEWHERE

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.03 SUBMITTALS

A. Comply with all provisions of Section 01300, as well as the requirements listed herein.

B. Submittals Pertaining to Wood Preservative Data:

1. Carpentry: For information only, submit 2 copies of chemical treatment manufacturer's instructions for proper use of each type of treated material.

2. Pressure Treatment: For type specified, include certification by treating plant, stating chemicals and process used, net amount of salts retained and conformance with applicable standards. For water-borne preservatives, include statement that moisture content of treated materials was reduced to a maximum of 19% prior to shipment to project site.

1.04 QUALITY ASSURANCE

A. Installer must examine all parts of the existing structure and the conditions under which the carpentry work is to be installed, and notify the Contractor in writing of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the installation until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

B. Coordination: Fit carpentry work to other work; scribe and cope as required for accurate fit. Correlate location of furring, nailers, blocking, grounds, and similar supports to allow proper attachment of other work.

C. Delivery and Storage: Keep materials dry during delivery and storage. Protect against exposure to weather and contact with damp or wet surfaces. Stack lumber and plywood and provide air circulation within stacks.

D. Protect installed carpentry work from damage by work of other trades until Owner's acceptance of the work.

E. Factory-mark each piece of lumber and plywood to identify the type, grade, agency providing the inspection service, the producing mill and other qualities as specified herein.

PART 2 - PRODUCTS

2.01 LUMBER

A. Lumber, Standards: For each use, comply with the "American Softwood Lumber Standard" PS 20 by the U.S. Department of commerce. Nominal sizes are shown or specified; provide actual sizes complying with the minimum size requirements of PS 20 for moisture content specified for each use.

B. Provide dressed lumber, S4S, unless otherwise shown or specified.

C. Provide seasoned lumber with 19% maximum moisture content at time of dressing and complying with dry size requirements of PS 20, unless otherwise specified.

D. Framing Lumber: Where wood framing from 2" to 5" (but not including 5") in nominal thickness, and 2" or more in nominal width is shown or scheduled; provide lumber complying with grading rules which conform to the requirements of the "National Grading Rule for Dimension Lumber" of the American Lumber Standards Committee established under PS 20. For light framing (2" to 4" thick and 2" to 4" wide), provide "Stud" grade lumber for stud framing and "Standard" grade for other light framing. Design values for framing lumber shall be as follows:

	Stud Grade	Standard Grade
Extreme fiber in bending	775 PSI	575 PSI
Tension parallel to grain	450 PSI	350 PSI
Compression parallel to grain	575 PSI	900 PSI
Horizontal shear	90 PSI	90 PSI
Compression perpendicular to grain	405 PSI	390 PSI
Modulus of elasticity	1,400,000	1,400,000

E. Boards: Where lumber less than 2" in nominal thickness and 2" or more in nominal width is shown or specified, provide boards complying with dry size requirements of PS 20, with a moisture content of 19% maximum, mark boards "S-DRY".

2.02 PLYWOOD

A. Standard: For each use, comply with the requirements for "Soft wood Plywood/Construction and Industrial" PS 1 by the U.S. Department of Commerce except as otherwise specified herein. Provide plywood of any PS-1 species classification group, except where particular species is shown or specified or where PS-1 limits groups for a particular grade specified.

2.03 TRIM

A. Wood trim shall be Ponderosa Pine (C Select), Douglas Fir (C Select), Idaho White Pine (Choice), or Southern Pine (C and better) or other species complying with AWI Section 300 Custom Grade.

2.04 PRESERVATIVE TREATMENT

A. Preservative Treatment by Pressure Process: AWPA C2.

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.

B. Kiln-dry lumber after treatment to maximum moisture content of 19 percent.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

D. Application: Treat items indicated on Drawings, and the following:

1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.

2. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.

4. Wood framing members that are less than 18 inches (460 mm) above the ground in crawlspaces or unexcavated areas.

5. Wood floor plates that are installed over concrete slabs-on-grade.

2.05 ANCHORAGE & FASTENING DEVICES

A. Select proper type, size, material and finish for each application and comply with the following specification requirements:

1. Nails and Staples: FS FF-N-105.

2. Wood Screws: FS FF-S-111.

3. Bolts and Studs: FS FF-B-575.

4. Nuts: FS FF-N-836.

5. Washers: FS FF-W-92.

6. Lag Screws or Lag Bolts: FS FF-B-561.

7. Expansion Shields, Expansion Nails & Drive Screws Devices: FS FF-B-325.

8. Toggle Bolts: FS FF-B-5889.

9. Bar or Strap Anchors: ASTM A 107 Carbon Steel Bars.

PART 3 - EXECUTION

3.01 FRAMING INSTALLATION

A. Plates: Plates shall be set level and square and anchor bolted at not more than four (4) feet on centers and not more than twelve (12) inches from each end of each piece. A minimum of three anchors shall be used for each piece. All sill plates shall be preservative treated lumber.

B. Miscellaneous:

1. Blocking shall be provided as necessary for application of wallboard, wall hung accessories and other materials or building items.

2. Wood grounds shall be provided as necessary for attachment of trim, finish, and other work. Grounds shall be run in lengths as long as practicable, butt jointed, and rigidly secured in place.

END OF SECTION

SECTION 06176 - METAL-PLATE-CONNECTED WOOD TRUSSES

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following:

1. Wood roof trusses.

2. Truss accessories.

B. See Division 6 Section 06100 Rough Carpentry for supplementary framing and permanent bracing.

1.02 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide metal-plate-connected wood trusses capable of withstanding design loads indicated without exceeding TPI 1 deflection limits.

1.03 SUBMITTALS

A. Product Data: For metal-plate connectors, metal framing anchors, bolts, and fasteners indicated.

B. Shop Drawings: Show location, pitch, span, camber, configuration, and spacing for each type of truss required; species, sizes, and stress grades of lumber; splice details; type, size, material, finish, design values, orientation, and location of metal connector plates; and bearing details.

1. Include structural analysis data signed and sealed by the qualified Professional Engineer responsible for their preparation, registered in Kentucky.

C. Qualification Data: For the following:

1. Metal-plate manufacturer.

2. Fabricator.

D. Research/Evaluation Reports: For the following:

1. Metal-plate connectors.

2. Metal framing anchors.

E. Comply with all requirements of Section 01300.

1.04 QUALITY ASSURANCE

A. Metal Connector-Plate Manufacturer Qualifications: A manufacturer that is a member of TPI and that complies with TPI quality-control procedures for manufacture of connector plates published in TPI 1.

1. Manufacturer's responsibilities include preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

B. Fabricator Qualifications: Shop that participates in a recognized quality-assurance program that involves inspection by SPIB, Timber Products Inspection, TPI, or other independent testing and inspecting agency acceptable to Engineer and authorities having jurisdiction.

C. Comply with TP1 1, "National Design Standard for Metal Plate Connected Wood Truss Construction," and TPI HIB, "Commentary and Recommendations for Handling, Installing & Bracing Metal Plate Connected Wood Trusses."

D. Wood Structural Design Standard: Comply with applicable requirements in AFPA's "National Design Specifications for Wood Construction" and its "Supplement."

PART 2 - PRODUCTS

2.01 DIMENSION LUMBER

A. Lumber: DOC PS 20 and applicable rules of lumber grading agencies certified by the American Lumber Standards Committee Board of Review.

B. Grade and Species: Any species for truss chord and web members, graded visually or mechanically, and capable of supporting required loads without exceeding allowable design values according to AFPA's "National Design Specifications for Wood Construction" and its "Supplement."

2.02 METAL PRODUCTS

A. Metal Connector Plates: Fabricate connector plates to comply with TPI 1 from hot-dip galvanized steel sheet complying with ASTM A 653/A 653M, G60 (Z180) coating designation; Designation SS, Grade 33, and not less than 0.036 inch (0.9 mm) thick.

B. 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. Alpine Engineered Products, Inc.
2. CompuTrus, Inc.
3. Eagle Metal Products.
4. Jager Industries, Inc.
5. Mitek Industries, Inc.
6. Robbins Manufacturing Company.
7. TEE-LOK Corporation.
8. Truswal Systems Corporation.

C. Fasteners: Where trusses are exposed to weather, in ground contact, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.

1. Nails, Wire, Brads, and Staples: FS FF-N-105.
2. Power-Driven Fasteners: CABO NER-272.
3. Wood Screws: ASME B18.6.1.

4. Lag Bolts: ASME B18.2.1. (ASME B18.2.3.8M).

5. Bolts: 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.

D. Metal Framing Anchors: Provide framing anchors made from hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, G60 (Z180) coating designation.

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

a. Alpine Engineered Products, Inc.

b. Cleveland Steel Specialty Co.

c. Harlen Metal Products, Inc.

d. KC Metals Products, Inc.

e. Silver Metal Products, Inc.

f. Simpson Strong-Tie Company, Inc.

g. Southeastern Metals Manufacturing Co., Inc.

h. United Steel Products Company, Inc.

2. Allowable Design Loads: Meet or exceed those indicated per manufacturer's published values determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

2.03 FABRICATION

A. Assemble truss members in design configuration indicated; use jigs or other means to ensure uniformity and accuracy of assembly with joints closely fitted to comply with tolerances in TPI

1. Position members to produce design camber indicated.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install and brace trusses according to TPI recommendations and as indicated. Install trusses plumb, square, and true to line and securely fasten to supporting construction.

B. Anchor trusses securely at bearing points; use metal framing anchors. Install fasteners through each fastener hole in metal framing anchor according to manufacturer's fastening schedules and written instructions.

C. Securely connect each truss ply required for forming built-up girder trusses. Anchor trusses to girder trusses as indicated.

D. Install and fasten permanent bracing during truss erection and before construction loads are applied. Anchor ends of permanent bracing where terminating at walls or beams.

1. Install and fasten strongback bracing vertically against vertical web of parallel-chord floor trusses at centers indicated.

E. Install wood trusses within installation tolerances in TPI 1.

F. Do not cut or remove truss members.

G. Return wood trusses that are damaged or do not meet requirements to fabricator and replace with trusses that do meet requirements.

END OF SECTION

SECTION 06600 - FIBERGLASS REINFORCED PLASTIC PRODUCTS AND FABRICATIONS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals necessary to install the fiberglass reinforced plastic (FRP) grating, stair treads, handrail, ladders and structurals as shown on the drawings and as specified herein.

1.02 RELATED DOCUMENTS

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

1.03 QUALITY ASSURANCE

A. The material covered by these specifications shall be furnished by a reputable and qualified manufacturer of proven ability who has regularly engaged in the manufacture and installation of FRP systems.

B. Substitution of any component or modification of system shall be made only when approved by the Engineer.

C. Fabricator Qualifications: Firm experienced in successfully producing FRP fabrications similar to that indicated for this project, with sufficient production capacity to produce required units without causing delay in the work.

D. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.

1.04 DESIGN CRITERIA

A. The design of FRP products including connections shall be in accordance with governing building codes and standards as applicable.

B. Design of FRP live loads on grating shall not be less than 100 pounds per sq. ft. Grating deflection at the center of a simple span not to exceed 0.25 inch. Deflection in any direction shall not be more than L/180 of span for structural members. Connections shall be designed to transfer the above loads.

1.05 SYSTEM PERFORMANCE REQUIREMENTS

A. STRUCTURAL PERFORMANCE

Design, engineer, fabricate, and install the following FRP fabrications to withstand the following structural loads without exceeding the allowable design working stress of the materials involved, including anchors and connections. Apply each load to produce the maximum stress in each respective component of each FRP fabrication.

B. STAIR TREAD PERFORMANCE

Capable of withstanding a uniform load of 100 lbs per sq. ft. or a concentrated load of 300 lbs on an area of 4 sq. inches located in the center of the tread, whichever produces the greater stress.

C. PLATFORMING AND STAIR PLATFORM PERFORMANCE

Capable of withstanding a uniform load of 100 lbs per sq. ft.

D. HANDRAILS SYSTEMS PERFORMANCE

Capable of withstanding a concentrated load of 200 lbs applied at any point non-currently, vertically downward, or horizontally.

1.06 SUBMITTALS

A. Shop drawings of all FRP structural members, handrails, gratings, plate, ladders and appurtenances shall be submitted to the Engineer for approval in accordance with the requirements of Section 01300.

B. Manufacturer's catalog data showing:

1. Dimensions, spacings, and construction of grating
2. Design tables showing limits for span length and deflection under various uniform and concentrated toads
3. Materials of construction

C. Detail shop drawings showing:

1. Dimensions of grating, ladders, handrail, and structural members
2. Sectional assembly
3. Location and identification mark
4. Size and type of supporting frames required
5. Anchorage and accessory items.

D. Samples of each type of grating proposed shall be submitted for approval prior to placement of purchase orders.

1.07 SHIPPING AND STORAGE INSTRUCTIONS

A. All systems, sub-systems and structures shall be shop fabricated and assembled into the largest practical size suitable for transporting.

B. All materials and equipment necessary for the fabrication and installation of the grating, plate, handrails, stair treads, and structural shapes 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 or equipment, including damage due to over exposure to the sun. Any material which, in the opinion of the Engineer, has become damaged as to be unfit for use, shall be promptly removed from the site of work, and the Contractor shall receive no compensation for the damaged material or its removal.

C. Identify and match-mark all materials, items, and fabrications for installation and field assembly.

PART 2- PRODUCTS

2.01 GENERAL

A. Materials used in the manufacture of the FRP products 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.

B. All materials shall be of the kind and quality specified, and where the quality is not specified, it shall be the best of the respective kinds and suitable for the purpose intended.

C. All FRP products noted in 1.01 shall be manufactured using a pultruded process utilizing either an isophthalic polyester or a vinyl ester resin with flame retardant and ultra-violet (UV) inhibitor additives. A synthetic surface veil shall be the outermost layer covering the exterior surface. The FRP shapes shall achieve a flame spread of 25 or less in accordance with ASTM test method E84. (Isophthalic polyester resin is available without flame retardant and UV inhibitor additives.)

D. After fabrication, all cut ends, holes and abrasions of FRP shapes shall be sealed with a compatible resin coating to prevent intrusion of moisture.

E. FRP products exposed to weather shall contain an ultraviolet inhibitor and shall additionally receive one mil thick 1J.V. coating to shield from ultra-violet light if specified or requested.

F. All exposed surfaces shall be smooth and true to form.

G. Manufacturers:

1. Morrision Molded Fiber Glass Company (MMFG)
2. Fibergrate
3. Approved equal

2.02 GRATINGS AND TREADS

A. GENERAL

1. Grating shall be shipped from the manufacturer, palletized and banded with exposed edges protected by cardboard to prevent damage in shipment.

2. Each piece shall be clearly marked showing manufacturer's applicable drawing number.

B. DESIGN

1. The panels shall be 1-1/2" deep and sustain a deflection of no more than 0.25 inches under a uniform distributed load of 100 psf for the span lengths shown on the plans.

2. The bearing bars shall be joined into panels by passing continuous length fiberglass pultruded cross rods through the web of each bearing bars. The pultruded cross rod assembly shall consist of two cross rod spacers that have notches cut into them at 1-1/2" inches on center to fit the distance between the web of each bearing bar. A continuous fiberglass pultruded bar shaped section shall be wedged between the two cross rod spacers mechanically locking the notches in the cross rod spacers to the web of the bearing bars. Chemical bonding shall be achieved between the cross rod spacers and the bearing web and between the bar shaped wedge and the two cross rod spacers locking the entire panel together to give a panel that resists twist and prevents internal movement of the bearing bars.

3. The top surface of all panels shall have a nonskid grit affixed to the surface by a baked epoxy resin followed by a top coat of baked epoxy resin.

4. Panels shall be fabricated to the sizes shown on the drawings.

5. Hold down clamps shall be type 316L stainless steel. A minimum of 4 each per panel.

6. Color shall be gray (OSHA safety gray)

7. All bearing bars that are to be exposed to UV shall be coated (optional) with polyurethane coating of a minimum thickness of I mil if desired.

C. FABRICATION

1. The FRP grating and stair treads shall be fabricated from bearing bars and cross rod manufactured by the pultrusion process. The glass fiber reinforcement for the bearing bars shall be a core of continuous glass strand rovings wrapped with continuous strand glass mat. A synthetic surface veil shall be the outermost layer covering the exterior surfaces.

2. Fiberglass Grating and Stair Treads

   a. Fiberglass grating and stair treads shall be made from a premium grade chemical resistant, fire retardant isophthalic polyester or fire retardant vinyl ester resin system with antimony trioxide added to meet the flame rating of 25 or less in accordance with ASTM E-84 testing and meet the self-extinguishing requirements of ASTM D-635. U. V. inhibitors are added to the resin.

3. Grating with Plate

   a. Grating shall be the same as described above in this section.

   b. Plate shall be manufactured using a premium grade polyester or vinyl ester resin with fire retardant additive to meet Class I flame rating of 25 or less as tested by ASTM E-84 and meet the self-extinguishing requirements of ASTM D-635. All plate shall contain a U. V. inhibitor.

   c. Plate will be epoxy bonded to the grating, and a non-skid grit will be affixed to the top surface of the assembly by a baked epoxy resin, followed by a top coat of baked epoxy resin.

4. All cut and machined edges, holes and abrasions shall be sealed with a resin compatible with the resin matrix used in the bearing bars and cross rods.

5. All panels shall be fabricated to the sizes shown on the approved shop drawing.

2.03 STRUCTURAL SHAPES

A. Structural shapes shall be made from a premium grade polyester or vinyl ester resin with fire retardant additives to meet Class 1 flame rating of ASTM E-84 and meet the self-extinguishing requirements of ASTM D-635. All structural shapes shall contain a U.V. inhibitor.

B. Manufactured by the pultrusion process.

Structural FRP members composition shall consist of a glass fiber reinforced polyester or vinyl ester resin matrix, approximately 50% resin to glass ratio. A synthetic surface veil shall be the outermost layer covering the exterior surfaces. Continuous glass strand rovings shall be used internally for longitudinal strength. Continuous strand glass mats shall be used internally for transverse strength.

C. The following minimum mechanical properties shall apply:

Table 1 – Fiberglass Pultruded Material Properties
Minimum Ultimate Coupon Properties (UN)

Material Properties	ASTM Test Method	PSI (Mpa)
Pultruded Fiberglass Structural Shapes		
Ultimate tensile stress in longitudinal direction	D638	30,000 (207)
Ultimate compressive stress in longitudinal direction	D695	30,000 (207)
Ultimate flexural stress in longitudinal direction	D790	30,000 (207)
Ultimate short beam shear in longitudinal direction	D2344	4,500 (31)
Ultimate tensile stress in transverse direction	D638	7,000 (48)
Ultimate compressive stress in transverse direction	D695	15,000 (103)
Ultimate flexural stress in transverse direction	D790	10,000 (69)
Density (lb/in.^{3} (kg/mm^3)	D792	.060-.070 (0.00166-00194)
Water absorption (24-h immersion)	D570	0.60 Max, % by Weight
Barcol Hardness	D2583	45
Coefficient of thermal 10^{-6} in/in/°C	D696	8
Expansion, LW10^{-6} in/in/°F	_____	4.4
Thermal conductivity BTU-in/FT^2/hr/°F	C177	4
Flame Retardant Properties		
Flame resistance	FTMS 406-2023	55/30 lgn.burn.sec.
Flammability test	D 635	Self Extinguishing
Surface burning characteristics	E 84	25 maximum
Flammability class	UL 94	VO
Temperature index	UL94	130°C

2.04 HANDRAILS

A. Design:

1. The FRP handrail system shall be designed to meet the configuration and loading requirements of OSHA 1910.23, with a minimum factor of safety on loading of 2.0.

B. Material:

1. The rails and posts shall be 2"'x2"x.156" square tube manufactured by the pultrusion process. The kickplate shall be 4"xl/2" (corrugated) x .125" thick pultruded fiberglass shape. The parts may be coated with an industrial grade polyurethane paint for additional U.V. protection and wear resistance. The pultruded parts shall be made with a fire retardant resin which meets the ASTM E-84 test for a flame spread of 25 or less. The resin matrix shall be {polyester} or {vinyl ester} and shall contain a UV inhibitor. The color shall be {OSHA safety yellow} or {gray}.

2. The pultruded parts shall meeting the following minimum mechanical properties:

Properties	Test Method	Values
Tensile Stress	ASTM D638	30,000 psi
Tensile Modulus	ASTM D638	2.5×10^6 psi
Compressive Stress	ASTM D695	30,000 psi
Compressive Modulus	ASTM D695	2.5×10^6 psi
Flexural Stress	ASTM D790	30,000 psi
Flexural Modulus	ASTM D790	1.6×10^6 psi
Shear Stress	ASTM D2344	4,500 psi
Density	ASTM D792	.060 - .070 lbs/in^3
24 Hr. Water Absorption	ASTM D570	0.6% max
Coef. of Thermal Expansion	ASTM D696	4.4×10^{-6} in/in°F
Flexural Stress	Full Section	36,000 psi
Flexural Modulus	Full Section	3.7×10^6 psi

C. Fabrication Handrail System:

1. The fiberglass handrail system shall be fabricated into finished sections by fabricating and joining together the pultruded square tube using molded or pultruded components; epoxy bonded and connected as shown in the fabrication details. Where required by OSHA, fiberglass kickplate shall be attached to the handrail posts with nylon rivets. Handrail sections shall be fabricated to the size shown on the approved fabrication drawings and shall be piece marked with a waterproof tag.

D. For Side Mount:

1. Post shall be constructed with a square pultruded bottom plug. Length shall be sufficient to extend a minimum of one inch beyond the uppermost bolt hole to prevent cursing of post tubing. Bolt holes shall provide clearance of 1/16 inch for 1/2 inch diameter bolts/studs. Holes shall be on longitudinal center line of post, 1 inch from bottom of post (minimum) and not less than 3 inches apart on center. Posts shall be fastened with stainless steel anchor bolts or studs, 1/2 inch diameter extending no less than 2-1/4 inches into the concrete, or into a minimum thickness of 1/4 inch structural steel or pultruded fiberglass.

2. Post locations shall be no greater than 24 inches, nor less than 9 inches from horizontal or vertical change in handrail direction. Post centers shall be no greater than 72 inches apart on any straight run of rail or 48 inches apart on any inclined rail section.

E. Other Attachment Methods:

1. Base mount, embedded, and removable are also types of mounting procedures for handrail. Contact approved fabricator for detailed information on these connection types.

F. Installation of Handrail Sections:

1. The fabricated handrail sections shall be supplied complete with fittings by the FRP manufacturer. The components used to joint fabricated sections together may be shipped loose, to be exposed and riveted together in the filed by the Contractor, per the manufacturer's recommendations.

2. The fabricated handrail sections shall be installed as shown on the approved shop drawings. The handrail sections shall be accurately located, erected plumb and level. The sections shall be fastened to the structure as shown on the approved shop drawing.

G. Approved Fabricators:

1. Morrison Molded Fiber Glass Company (MMFG)

a. AFC Division (Chatfield, MN)
b. Bristol Division (Bristol, VA)

2. Approved equal

2.05 LADDERS AND CAGES

A. Ladders and cages shall be made from (select either Isophthalic-Polyester or Vinylester) resin.

B. All ladder and cage components shall be flame retardant per ASTM E-84 Class 1.

C. Ladder rails shall be 2 x 2 x 1/4 square tube. Ladder rungs shall be 1 inch diameter solid round.

D. Ladders and cages are to be safety yellow.

E. Ladder rungs are to penetrate inside wall of ladder rail tube and be countersunk into outside wall of ladder rail tube, providing support for the ladder rung in 4 places. This connection is to be fully bonded and with epoxy adhesives and pinned to prevent rung rotation.

F. Ladder rungs to have slip-resistant quartz epoxy grit surface.

G. Ladder stand-off brackets are to be FRP and are to be installedd at a maximum of 6'-0 on center. Ladder base mount brackets are to be FRP. All bolts are to be 316 stainless steel.

H. Ladder cages, if required per OSHA, shall be fabricated from FRP Hoops and Straps. FRP Hoops are to be 3 x 1/4 preformed FRP. Hoop spacing shall be a max. of 4'-0 on center. FRP Straps are to be 2 x 1/4 FRP and are to be spaced at 9" on center. Hoops and Straps are to be bonded with epoxy adhesives and riveted with 316 stainless steel rivets.

I. Approved Fabricators:

1. Ladder and cages shall be manufactured by Seasafe Inc., Lafayette LA, or approved equal

2.06 FALL PREVENTION DEVICES

A. All ladders shall be equipped with Saf-T-Climb fall prevention device, Manufactured by Air Space Devices, Inc., Paramount, California, or equal.

B. All ladders and safety devices shall meet OSHA regulations

PART 3 - EXECUTION

3.01 PREPARATION

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

B. Set sleeves in concrete with tops flush with finish surface elevations; protect sleeves from water and concrete entry.

3.02 INSTALLATION, GENERAL

A. Fastening to in-place construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous FRP fabrications to in-place construction; include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, and other connectors as required.

B. Cutting, fitting, and placement: Perform cutting, drilling, and fitting required for installation of miscellaneous FRP fabrications. Set FRP fabrication accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete masonry or similar construction.

3.03 ALL FRP INSTALLATION

A. All field cut and drilled edges, holes and abrasions shall be sealed with a catalyzed resin compatible with the original resin as recommended by the manufacturer. The sealing of the edges shall prevent premature fraying at the field cut edges.

B. Install items specified as indicated and in accordance with manufacturer's instructions.

3.04 INSPECTION AND TESTING

A. The Engineer shall have the right to inspect and test all materials to be furnished under these specifications prior to their shipment from the point of manufacture.

B. All labor, power, materials, equipment, and appurtenances required for testing shall be furnished by the Contractor at no cost to the Owner.

END OF SECTION

DIVISION 07

THERMAL AND MOISTURE PROTECTION

SECTION 07175 - WATER REPELLENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.02 DESCRIPTION OF WORK

A. Extent of surfaces to receive water repellant includes new exterior exposed masonry.

1.03 QUALITY ASSURANCE

A. Application: A firm with not less than 3 years of successful experience in application of water repellents of types required on substrates similar to those of this project.

1.04 SUBMITTALS

A. Product Data: Submit manufacturer's specifications, installation instructions, and general recommendations for water repellents. Include data substantiating that materials are recommended by manufacturer for applications indicated and comply with requirements.

1.05 JOB CONDITIONS

A. Weather and Substrate Conditions: Do not proceed with application of water repellant (except with written recommendation of manufacturer), when ambient temperature is less than 50 deg. F (10 deg. C); when substrate surfaces have cured for less than a period of 2 months; when rain or temperatures below 40 deg. F (4 deg. C), are predicted for a period of 24 hours, or earlier than 3 days after surfaces became wet; when substrate is frozen; at surface temperature of less than 40 deg. F (4 deg. C).

PART 2 - PRODUCTS

2.01 WEATHER SEAL SILOXANE

A. Provide manufacturer's standard "winter-clear" breathing, water repellant coating based on oligomeric alkyl-alkoxy siloxane. The water repellant shall not alter the appearance of the masonry.

B. Provide medium compound 5.0% to 6.7% solids content.

C. Manufacturer: Subject to compliance with requirements, provide products of one of the following:

1. ProSo Co., Inc. Sure Klean Weather Seal Siloxane
2. Pecora International Corp. Clear Seal 908SX
3. Harry S. Peterson Co. Iso-Flex 620 Siloxane Sealer
4. Tamms Industries Co. Hay'Di HOS

PART 3 - EXECUTION

3.01 PREPARATION

A. Test Application: Prior to performance of water repellant work, including bulk purchase/delivery of products, prepare a small application in an unobtrusive location and in a manner acceptable to Engineer, for purpose of demonstrating final effect (visual and physical/chemical) of planned installation. Proceed with work only after Engineer's acceptance of test application, or as otherwise directed.

B. Clean substrate of substances which might interfere with penetration/adhesion of water repellents. Test for moisture content, in accordance with repellant manufacturer's instructions, to ensure that surface is sufficiently dry.

C. Coordination with Sealants: Where feasible, delay application of water repellents until installation of sealants has been completed in joints adjoining surfaces to be coated with repellant.

D. Protect adjoining work, including sealant bond surfaces, from spillage or blow-over of water repellant. Cover adjoining and nearby surfaces of aluminum and glass where there is possibility of water repellant being deposited on surfaces. Cover live plant materials with drop cloths. Clean water repellant from adjoining surfaces immediately after spillage. Comply with manufacturer's recommendations for cleaning.

3.02 INSTALLATION

A. Apply a heavy saturation spray coating of water repellant on surfaces indicated for treatment using low pressure spray equipment. Comply with manufacturer's instructions and recommendations, using airless spraying procedure unless otherwise indicated.

B. Apply a second saturation spray coating, repeating first application. Comply with manufacturer's instructions for limitations on drying time between coats and after rainstorm wetting of surfaces between coats. Consult manufacturer's technical representative if printed recommendations are not applicable to project conditions.

END OF SECTION

SECTION 07200 - INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.02 DESCRIPTION OF WORK

A. Extent of insulation work is shown on Drawings and includes batt insulation and baffles for application above the ceiling.

B. Cavity wall insulation is specified in Division-4 section for unit masonry.

1.03 SUBMITTALS

A. Product Data: Submit manufacturer's product literature and installation instructions for each type of insulation and baffle.

1.04 DELIVERY, STORAGE, AND HANDLING

A. General Protection: Protect insulations from physical damage and from becoming wet, soiled, or covered with ice or snow. Comply with manufacturer's recommendations for handling, storage and protection during installation.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:

1. Owens Corning Fiberglass Corp.
2. Johns Manville Building Materials Corp.
3. Certainteed Corporation

2.02 INSULATING MATERIALS

A. General: Provide insulating materials which comply with requirements indicated for materials, compliance with referenced standards, and other characteristics.

B. Batt/Blanket Insulation: Flexible, unfaced blankets made of inorganic glass fibers bonded with formaldehyde-free thermosetting resin, complying with ASTM C 665 and with glass fiber portion classified as noncombustible when tested in accordance with ASTM C 136.

1. Thermal Resistance (R-value): 19 hr sq ft degF/Btu.
2. Surface Burning Characteristics: Flame spread index of 25 or less; smoke developed index of 50 or less; when tested in accordance with ASTM E 84 with specified facing.

3. Recycled Content: Certified by Scientific Certification Systems to contain minimum of 18 percent post-consumer and 7 percent pre-consumer recycled glass product, on average of manufacturer's products.

4. Air Erosion Resistance: Satisfactory up to 1,000 ft/min when tested in accordance with UL 181.

C. Tape: Self-adhesive vapor retarder tape with flame spread index of 25 or less, smoke developed index of 50 or less.

D. Separate Vapor Retarder: Vapor permeance not more than .2 perm (57 ng/(Pa s sq m); flame spread index of 25 or less, smoke developed index of 50 or less.

E. Insulation Baffles: Provide fabricated baffles or site fabricated baffled that provide a minimum of 1" of airspace below the roof deck. Baffled shall be made from rigid insulation.

PART 3 - EXECUTION

3.01 INSPECTION AND PREPARATION

A. Require Installer to examine substrate and conditions under which insulation work is to be performed. A satisfactory substrate is one that complied with requirements of the section in which substrate and related work is specified. Obtain installer's written report listing conditions detrimental to performance of work in this section. Do not proceed with installation of insulation until unsatisfactory conditions have been corrected.

B. Clean substrates of substances harmful to insulations or vapor retarders, including removal of projections which might puncture vapor retarders.

3.02 INSTALLATION, GENERAL

A. Comply with manufacturer's instructions for particular conditions of installation in each case. If printed instructions are not available or do not apply to project conditions, consult manufacturer's technical representative for specific recommendations before proceeding with work.

B. Extend insulation full thickness as shown over entire area to be insulated. Cut and fit tightly around obstructions, and fill voids with insulation. Remove projections which interfere with placement.

C. Apply a single layer of insulation of required thickness, unless otherwise shown or required to make up total thickness.

3.03 INSTALLATION OF INSULATION

A. Apply insulation units to substrate by method indicated, complying with manufacturer's recommendations. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

3.04 PROTECTION

A. General: Protect installed insulation from harmful weather exposures and from possible physical abuses, where possible by non-delayed installation of concealing work or, where that is not possible, by temporary covering or enclosure.

END OF SECTION

SECTION 07311 - ASPHALT SHINGLE ROOFING SYSTEM

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Granule surfaced asphalt shingle roofing.

B. Moisture shedding underlayment.

C. Associated gutters, downspouts and metal flashing.

1.02 RELATED SECTIONS

A. Section 06100 - Rough Carpentry: Plywood.

1.03 REFERENCES

A. ASTM D 3018 - Standard Specification for Class A Shingles Surfaced with Mineral Granules.

B. ASTM D 3462 - Standard Specification for Asphalt Shingles Made from Glass Felt and Surfaced with Mineral Granules.

C. ASTM D 4869 - Standard Specification for Asphalt-Saturated Organic Felt Shingle Underlayment Used in Roofing.

D. ASTM E 108 - Standard Test Methods for Fire Tests of Roof Coverings.

1.04 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Product Data: Provide manufacturer's printed product information indicating material characteristics, performance criteria, and product limitations.

C. Manufacturer's Installation Instructions: Provide published instructions that indicate preparation required and installation procedures.

D. Certificate of Compliance: Provide Certificate of Compliance from an independent laboratory indicating that the asphalt fiberglass shingles made in normal production meet or exceed the requirements of the following:

1. ASTM E 108/UL 790 Class A Fire Resistance.

2. ASTM D 3161/UL 997 Type I Wind Resistance.

E. Samples of standard color selections from manufacturer's standard products.

1.05 QUALITY ASSURANCE

A. Verify that manufacturer's label contains reference to specified ASTM standards.

1.06 WARRANTY

A. Manufacturer's Warranty: Furnish shingle manufacturer's 30 year warranty for the Work of this section.

PART 2 - PRODUCTS

2.01 MANUFACTURER

A. Provide products manufactured by one of the following:

1. CertainTeed Corporation.: "Independence"

2. GAF Building Materials Corporation: "Timberline"

2.02 ASPHALT FIBERGLASS SHINGLES

A. Conforming to ASTM D 3018 Type I - Self-Sealing; UL Certification of ASTM D 3462, UL 997 90-mph Wind Resistance, and UL Class A Fire Resistance; glass fiber mat base, ceramically colored/UV resistant mineral surface granules across entire face of shingle; three-tab type with random laminated tabs and random shadow line.

1. Weight: 300 pounds per square (100 square feet) (14.6 kg/sq m).
2. Color: As selected by Engineer from manufacturer's standards.

2.03 SHEET MATERIALS

A. Felt Underlayment: Type II, 36-inch- (914-mm-) wide, asphalt-saturated organic felt, complying with ASTM D 226 (No. 30) or ASTM D 4869.

2.04 FLASHING MATERIALS

A. Sheet Flashing: ASTM A 361/A 361M; 26 gage steel with minimum 1.25 ounces per square foot galvanized coating.

2.05 ACCESSORIES

A. Nails: Standard round wire type roofing nails, corrosion resistant; hot dipped zinc coated steel, or chromated steel; minimum 3/8 inch head diameter; minimum 11 or 12 gauge shank diameter; shank to be of sufficient length to penetrate through roof sheathing or 3/4 inch into solid wood, plywood, or non-veneer wood decking.

2.06 GUTTERS AND DOWNSPOUTS

A. Gutters: Fabricate metal gutters from 24 gage steel 6 inches wide.

B. Downspouts: Fabricate metal downspouts from 26 gage steel 2-3/4 inch x 4-1/4 inch size.

C. Finish:

1. Fluorofinish, hot dipped (1.25 oz) galvanized steel with fluorocarbon, kynar (70%) resin finish. Primer to be 0.2$\pm$ 0.05 mil. with 0.8$\pm$ 0.1 mil. exterior topcoat and interior backercoat. Minimum coating for backercoat same as primer.

2. Color of the exterior side shall be white.

2.07 RIDGE VENTS

A. Ridge Vent shall be shingle over type, 12" wide, similar to Air Vent, Inc. "ShingleVentII" ridge vent.

1. Shall provide 18 square inches of net free area per linear foot.

2. Shall be selected from Mfg. full line of standard colors.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify deck surfaces are dry and free of ridges, warps, or voids.

3.02 ROOF DECK PREPARATION

A. Follow shingle manufacturer's recommendations for acceptable roof deck materials.

3.03 INSTALLATION - PROTECTIVE UNDERLAYMENT

A. Roof Slope Between 3:12 and 4:12: Apply two layers of D 4869 underlayment over wood deck, with ends and edges weather lapped minimum 19 inches. Stagger end laps each consecutive layer. Nail in place.

3.04 INSTALLATION - METAL FLASHING

A. Weather lap joints minimum 2 inches.

1. Seal work projecting through or mounted on roofing with plastic cement and make weathertight.

3.05 INSTALLATION - ASPHALT SHINGLES

A. Install shingles in accordance with manufacturer's instructions for product type and application specified.

3.06 PROTECTION OF FINISHED WORK

A. Do not permit traffic over finished roof surface.

END OF SECTION

SECTION 07600 - FLASHING AND SHEET METAL

PART 1 - GENERAL

1.01 REQUIREMENTS

A. Furnish labor, materials, equipment and appliances required for complete execution of Work shown on Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 04200 – Unit Masonry

B. Section 07700 – Roof Specialties and Accessories

C. Section 07900 – Joint Sealers

1.03 REFERENCES SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of these specifications Work shall conform to the applicable requirements of the following documents:

1. OF-506C Flux, Soldering, Paste, and Liquid
2. ASTM A176 Stainless and Heat-Resisting Chromium Steel Plate, Sheet and Strip
3. ASTM B32 Specifications for Solder Metal
4. ASTM D1187 Test Method for Asphalt-Base Emulsions for use as Protective Coatings for Metal
5. "Architectural Sheet Metal Manual" by Sheet Metal and Air Conditioning Contractors National Association.

1.04 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, submit the following:

1. Manufacturer's literature and installation instructions.
2. Complete layout and installation Drawings and schedules with clearly indicated dimensions.
3. Color samples.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Store materials in a clean dry protected area in such manner to preclude damage by denting, warping, or other distortion.

PART 2 - MATERIALS

2.01 MATERIALS

A. Metal Flashing

1. Exposed to View: Provide prefinished 0.050 inches aluminum. Provide a full-strength Kynar 500 baked-on paint finish with a 20 year warranty.

2. Concealed from View: Provide a minimum of 22 ga. galvanized steel sheet, stainless steel sheet, or mill-finished aluminum sheet.

B. Nails, screws, rivets, bolts and other fasteners: same material as sheet metal being attached. Nails shall be 18 gauge diameter shank, 1/4 inch diameter flat head, annular-thread, diamond point, long enough to penetrate backing by at least 1 inch. Nails shall be spaced 3 inches on center unless other spacing is indicated. Exposed fasteners shall match finish of metal being fastened.

C. Reglets shall be formed of 304 series stainless steel, minimum of 0.020 inch. Reglets shall be Model CO for insertion in concrete, MA-4 for insertion in masonry as manufactured by FRY Reglet Corporation. Corners shall be factory made, mitered and sealed. Furnish reglets to proper trade in sufficient time to be incorporated into the masonry or concrete work.

D. Plastic cement shall conform to ASTM D2822.

E. Sealants shall be silicone type.

F. Sealer tape shall be polyisobutylene tape specifically manufactured for setting flanges on bituminous roofing such as Morrison and Company CL-50.

PART 3 - EXECUTION

3.01 FABRICATION

A. Shop fabricate Work to greatest extent possible. Comply with details shown and applicable requirements of SMACNA "Architectural Sheet Metal Manual" and other recognized industry standards. Fabricate for waterproof and weather resistant performance; with expansion provisions for running work, sufficient to permanently prevent leakage, and damage or deterioration of the work. Comply with material manufacturer's instructions and recommendations for forming material. Form exposed work without excessive oil-canning, buckling and tool marks, true to line and levels as indicated, with exposed edges folded back to form hems.

B. Roof penetration sheet metal work shall be provided and coordinated with the roofing system. The design and details shall conform to SMACNA "Architectural Sheet Metal Manual". Sheet metal items shall be built into roofing in strict accordance with the instructions of the roofing manufacturer.

END OF SECTION

SECTION 07700 - ROOF SPECIALTIES AND ACCESSORIES

PART 1 - GENERAL

1.01 REQUIREMENTS

A. Furnish all labor, materials, equipment and appliances required for the complete execution of Work shown on Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 06100 – Rough Carpentry

B. Section 07600 - Flashing and Sheet Metal

C. Section 07900 - Joint Sealers

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of these specifications Work shall conform to the applicable requirements of the following documents:

1. TT-P-641 (1) Primer Coating, Zinc Dust - Zinc Oxide (for galvanized surfaces
2. ASTM A 525 Specification for General Requirements for Steel Sheet, Zinc Coated (Galvanized) by the Hot-Dip Process.
3. ASTM A 526 Specification for Steel Sheet, Zinc Coated (Galvanized) by the Hot-Dip Process, Commercial Quality.
4. ASTM B 209 Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
5. Sheet Metal and Air Conditioning Contractors National Association "Architectural Sheet Metal Manual" (ASMM).
6. The Aluminum Association "Specification for Aluminum Sheet Metal Work in Building Construction."
7. American Welding Society (AWS).

1.04 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300, Submittals, submit the following:

1. Manufacturers literature and installation instructions.
2. Samples, of each material listed.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver all materials in factory packed unopened cartons and crating bearing the manufacturer's labels.

B. Store materials in clean, dry protected area in such manner to preclude damage of any nature.

C. Handle all materials with proper care to avoid denting, marring, warping or other distortions during delivery, storage and handling.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General: Provide roof specialties and accessories of design and construction compatible and approved for use with roofing manufacturer.

B. Fasteners: Provide all fasteners and attachments required to secure item to substrate and support loads required by applicable Building Code. Use only non-corrosive fasteners which are compatible with materials being joined.

C. Colors: Colors shall be selected by Owner.

2.02 GUTTERS AND DOWNSPOUTS

A. Material: 0.050 inch aluminum.

B. Design: Manufacture gutters tapered and notched to provide telescoping joint. Design gutters and downspouts to accommodate expected thermal movement.

C. Supports and Fasteners: Provide manufacturers' standard straps, brackets and fasteners. Place supports and fasteners at 36 inches on center or as recommended by the manufacturer. Finish of supports, brackets and fasteners shall match gutter and downspout.

D. Accessories: Provide end caps, flashing, trim, and other items required for a complete installation.

E. Finish: Baked on Kynar, with 20 year warranty.

PART 3 - EXECUTION

3.01 INSTALLATION - GENERAL

A. Install roof accessories and specialties in accordance with the manufacturer's instructions. Provide a complete watertight and weatherproof installation. Install with provision for expansion and contraction.

3.02 DAMAGED MATERIAL

A. Repair or replace materials damaged during installation.

3.03 ADJUSTING AND CLEANING

A. Check levels and adjust as necessary after roofing and flashing is complete.

B. Protect materials from damage by other trades. Remove protective coatings at completion of project.

END OF SECTION

SECTION 07900 - JOINT SEALERS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide all labor, materials, equipment and services for furnishing and installing the joint sealers in accordance with the Drawings and as specified herein.

B. The extent of each form and type of joint sealer is indicated on the drawings and includes but is not limited to, the following general locations:

1. Exterior wall joints.
2. Paving and sidewalk joints.
3. Joints at penetrations of walls, decks, and floors by piping and other services and equipment.
4. Joints between items of equipment and other construction.
5. Joints at windows, doors and louvers.

1.02 RELATED DOCUMENTS SPECIFIED ELSEWHERE

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.03 SUBMITTALS

Comply with the requirements of Section 01300 as well as the requirements specified herein.

A. Product Data: Submit manufacturer's technical data for each joint sealer product required, including instruction for joint preparation and joint sealer application.

B. Samples for Initial Selection Purposes: Submit manufacturer's standard bead samples consisting of strips of actual products showing full range of colors available, for each product exposed to view.

C. Certificates: Submit certificates from manufacturers of joint sealers attesting that their products comply with specification requirements and are suitable for the use indicated.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Engage an Installer who has successfully completed within the last 3 years at least 3 joint sealer applications similar in type and size to that of this project and who will assign mechanics from these earlier applications to this project of which one will serve as lead mechanic.

B. Single Source Responsibility for Joint Sealer Materials: Obtain joint sealer materials from a single manufacturer for each different product required.

C. System Performance: Provide joint sealers that have been produced and installed to establish and maintain watertight and airtight continuous seals.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to project site in original unopened containers or bundles with labels informing about manufacturer, product name and designation, color, expiration period for use, pot life, curing time and mixing instructions for multi component materials.

B. Store and handle materials to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.06 PROJECT CONDITIONS

A. Environmental Conditions: Do not proceed with installation of joint sealers under the following conditions:

1. When ambient and substrate temperature conditions are outside the limits permitted by joint sealer manufacturer or below 40 degrees F. (4.4 degrees C).

2. When joint substrates are wet due to rain, frost, condensation or other causes.

B. Joint Width Conditions: Do not proceed with installation of joint sealers when joint widths are less than allowed by joint sealer manufacturer for application indicated.

PART 2 - PRODUCTS

2.01 MATERIALS, GENERAL

A. Compatibility: Provide joint sealers, 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 testing and field experience.

B. Colors: Provide color of exposed joint sealers indicated or, if not otherwise indicated, as selected by Owner from manufacturer's standard colors.

2.02 ELASTOMERIC JOINT SEALANTS

A. Elastomeric Sealant Standard: Provide manufacturer's standard chemically curing, elastomeric sealant of base polymer indicated which complies with ASTM C 920 requirements, including those for Type, Grade, Class, and Uses.

B. Two-Part Pourable Urethane Sealant: Type M; Grade NS; Class 25; Uses T, M, A, and as applicable to joint substrates indicated, O.

C. One-Part Nonsag Urethane Sealant: Type S; Grade NS; Class 25; Uses NT, M, A, and as applicable to joint substrates indicated, O.

D. Products: Subject to compliance with requirements, provide one of the following:

1. Two Part, Pourable, Urethane Sealant:

"Chem-Calk 550"; Bostik Construction Product Division
"Pourthane"; W.R. Meadows, Inc.
"Sonolastic Paving Joint Sealant"; Sonneborn Building Products Division, Rexnord Chemical Products, Inc.

2. One-Part Nonsag Urethane Sealant:

"Chem-Calk 900"; Bostik Construction Products Division
"Vulkem 116"; Mameco International, Inc.
"Sonolastic NP 1"; Sonneborn Building Products Division, Rexnord Chemical Products, Inc.

2.03 LATEX JOINT SEALANTS

A. Acrylic-Emulsion Sealant: Manufacturer's standard, one part, nonsag, acrylic, mildew-resistant, acrylic-emulsion sealant complying with ASTM C 384, formulated to be paintable and recommended for exposed applications on interior and on protected exterior exposures involving joint movement of not more than + or - 7.5%.

B. Products: Subject to compliance with requirements, provide one of the following:

"Chem-Calk 600"; Bostik Construction Products Division
"AC-20"; Pecora Corp.
"Sonolac"; Sonneborn Building Products Division; Rexnord Chemical Products, Inc.
"Tremco Acrylic Latex Caulk"; Tremco, Inc.

2.04 JOINT SEALANT BACKING

A. General: Provide sealant backings of material and type which 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-waxing, non-extruding strips of plastic foam of material and size, shape and density to control sealant depth and otherwise contribute to producing optimum sealant performance. Provide either flexible, open cell polyurethane foam or non-gasing, closed-cell polyethylene foam, unless otherwise indicated, subject to approval of sealant manufacturer.

2.05 MISCELLANEOUS MATERIALS

A. Primer: Provide type recommended by joint sealer manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint sealer-substrate and field tests.

B. Cleaners for Nonporous Surfaces: Provide non-staining, chemical cleaner of type acceptable to manufacturer of sealant and sealant backing materials which are not harmful to substrates and adjacent nonporous materials.

C. Masking Tape: Provide non-staining, non-absorbent type compatible with joint sealants and to surfaces adjacent to joints.

PART 3 - EXECUTION

3.01 INSPECTION

A. Require Installer to inspect joints indicated to receive joint sealers for compliance with requirements for joint configuration, installation tolerances and other conditions affecting joint sealer performance.

B. Obtain Installer's written report listing any conditions detrimental to performance of joint sealer work.

C. Do not allow joint sealer work to proceed until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealers to comply with recommendations of joint sealer manufacturers and the following requirements:

1. Remove all foreign material from joint substrates which could interfere with adhesion of joint sealer, including dust; paints, except for permanent protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer; oil; grease; waterproofing; water repellants; water; surface dirt and frost.

2. Clean concrete, masonry and similar porous joint substrate surfaces, by brushing, grinding, blast cleaning, mechanical abrading, acid washing or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealers. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air.

3. Remove latence and form release agents from concrete.

4. Clean metal and other non-porous surfaces by chemical cleaners or other means which are not harmful to substrates or leave residues capable of interfering with adhesion of joint sealers.

B. Joint Priming: Prime joint substrates where indicated or where recommended by joint sealer manufacturer based on preconstruction joint sealer-substrate tests or prior experience. Apply primer to comply with joint sealer manufacturer's recommendations. Confine primers to areas of joint sealer 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 which 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 SEALERS

A. General: Comply with joint sealer manufacturer's printed installation instructions applicable to products and applications indicated, except where more stringent requirements apply.

B. Elastomeric Sealant Installation Standard: Comply with recommendations of ASTM C 962 for use of joint sealants as applicable to materials, applications and conditions indicated.

C. Latex Sealant Installation Standard: Comply with requirements of ASTM C 790 for use of latex sealants.

D. Installation of Sealant Backings: Install sealant backings to support sealants during application and at position required to produce optimum sealant movement capability.

1. Do not leave gaps between ends of sealant backings.

2. Do not stretch, twist, puncture, or tear sealant backings.

3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

E. Install joint-fillers of type indicated 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 which allow optimum sealant movement capability. Do not leave gaps between ends of joint-fillers. Do not stretch, twist, puncture or tear joint-fillers. Remove

absorbent joint-fillers which have become wet prior to sealant application and replace with dry material.

F. 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 which allow optimum sealant movement capability.

G. Tooling of Nonsag Sealants: Immediately after sealant application and prior to time skinning of 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 which discolor sealants or adjacent surfaces or are not approved by sealant manufacturer. Provide concave joint configuration per Figure 6A in ASTM C 962, unless otherwise indicated.

3.04 PROTECTION AND CLEANING

A. Protect joint sealers 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 sealers immediately and reseal joints with new materials to produce joint sealer installations with repaired areas indistinguishable from original work.

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

END OF SECTION

DIVISION 08

WINDOWS AND DOORS

SECTION 08342 - FIBERGLASS DOORS AND DOOR FRAMES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Fiberglass Reinforced Plastic (FRP) Doors.

B. Fiberglass Door Frames.

1.02 RELATED SECTIONS

A. Section 08710 – Finish Hardware.

1.03 REFERENCES

A. ASTM D 635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position.

B. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

1.04 SYSTEM DESCRIPTION

A. Design Requirements:

1. Design door opening assemblies to resist failure from corrosion in an environment of Fluoride and/or Chlorine.

2. Design door opening assemblies to have minimum fiberglass content 25 percent by weight.

B. Performance Requirements:

1. Door opening assemblies: Maximum flame spread 25 in accordance with ASTM E 84, self-extinguishing in accordance with ASTM D 635.

1.05 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Product Data: Manufacturer's printed product data indicating characteristics of products specified in this section.

C. Shop Drawings:

1. Plans: Indicate location of each door opening assembly in project.

2. Elevations: Dimensioned elevation of each type door opening assembly in project; indicate sizes and locations of door hardware, and lites and louvers, if specified.

3. Details: Installation details of each type installation condition in project; indicate installation details of glazing, if specified.

4. Schedule: Indicate each door opening assembly in project; cross-reference to plans, elevations, and details.

D. Verification Samples: Two (2) samples to verify custom color match to color chip furnished by Architect/Engineer.

1. Manufacturer's Instructions: Printed installation instructions for door opening assemblies.

2. Warranty Documents: Manufacturer's standard warranty documents, executed by manufacturer's representative, countersigned by Contractor.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer: Minimum twenty (20) years documented experience producing products specified in this section.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Packing, Shipping, Handling and Unloading:

1. Deliver doors and frames factory-assembled and pre-hung, with hardware.

2. Package door opening assemblies in wood crates having wood perimeters; label crates with the following information:

a. Manufacturer's name.

b. Architect/Engineer-designated Project Number.

c. Tag Location in accordance with door schedule.

d. Door type, color, and weight.

B. Acceptance at Site: Accept only sealed, crated, and labeled door opening assemblies at site.

C. Storage and Protection: Store door assemblies in factory packaging in dry area; store on edge and protect from damage.

1.08 WARRANTY

A. Manufacturer's Warranty: Manufacturer's 25-year warranty against failure due to corrosion from specified environment.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers include the following:

1. Ceco Door Products, KhemPro FRP

2. CHEM-PRUF Door Company.

3. Corrim Company

4. Fib-R-Dor Division of Advanced fiberglass, Inc. "Fire-Rated"

5. Tiger Door, LLC

2.02 MATERIALS

A. Fiberglass Mat: Random glass fiber mat; minimum 4.5 ounces per square foot weight of glass material.

B. Polyurethane Foam: Minimum density 4 pounds per cubic foot; maximum flame spread 25 in accordance with ASTM E 84.

C. Kraft Honeycomb Material: Phenolic resin impregnated; maximum flame spread 25 in accordance with ASTM E 84.

D. Roving: Unidirectional glass fiber mat; minimum 16 ounces per square yard weight.

E. Resins: Formulated for specified environment; maximum flame spread 25 in accordance with ASTM E 84, self-extinguishing in accordance with ASTM D 635

F. Anchors: Manufacturer's standard stainless steel screws and plastic anchors.

G. Bonding Materials: Manufacturer's standard frame-to-opening polymeric bonding system.

2.03 MANUFACTURED UNITS

A. Fiberglass Reinforced Plastic (FRP) Doors:

1. Thickness: 1-3/4 inches.

2. Thermal Insulating Value: 'R' factor 10.

3. Construction:

   Stile and Rail Structure: Manufacturer's standard edge design and reinforcements designed to accept hardware and strengthen door. Wrap edges with FRP. Exposed edges shall be finished to match face sheets.

   a. Core: Polyurethane foam for exterior doors.

   b. Core: Kraft honeycomb material for interior doors.

   c. Face sheets: Minimum of 1/8" thick FRP face plate with aminimum 25 mil gel.

   d. Sizes: Indicated on drawings.

   e. Finish: Smooth gloss surface.

   f. Color: As selected from Mfg. standard colors.

B. Fiberglass Frames:

1. Construction: Manufacturer's standard FRP frame with a 2" nominal face and a 5/8" stop, two part polyurethane coating. Frame shall be reinforced as required to properly carry weight of door on hinge side and accommodate hardware.

2. Sizes: For door sizes and frame depths indicated on drawings.

3. Finish: Smooth gloss surface.

4. Color: As selected from Mfg. standard colors.

2.04 FABRICATION

A. Fiberglass Reinforced Plastic (FRP) Doors:

1. Stile and Rail Structure:

a. Form in mold of exact door size, with gel coat layer.

b. Formulate gel coat for environment and integral color specified.

c. Form structure as single component; jointed construction at intersections of stiles and rails is prohibited.

d. Form mortise for lockset, and recess for strike plate in lock stile, at time of molding.

e. Embed reinforcements for hardware in fiberglass matrix. Coordinate reinforcements to ensure proper support for all hardware..

2. Core:

a. Foam polyurethane or honeycomb core material in place within stile/rail structure. Allow no voids within structure.

b. Form openings for lites or louvers, if specified; form to sizes and at locations indicated.

3. Face sheets:

a. Formulate gel coat with integral color specified; embed glass materials.

b. Chemically bond face sheets to stile/rail structure and core material.

B. Fiberglass Frames:

1. Form in mold of exact wall opening size, with gel coat.

2. Formulate gel coat for environment and integral color specified.

3. Form structure of fiberglass components; jointed construction at intersections of jambs, head, or intermediate members, is prohibited.

4. Form mortise for lock strike, and recess for strike plate in lock jamb, at time of molding.

5. Embed reinforcements for hinges and other indicated hardware in fiberglass matrix. Coordinate reinforcements to ensure proper support for all hardware.

C. Assemble doors and frames. Install specified hardware, using through bolts or sex screws with compression members to resist screw torque and to prevent compressing door construction.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verification of conditions:

1. Openings are correctly prepared to receive doors and frames.

2. Openings are correct size and depth in accordance with shop drawings.

B. Installer's Examination:

1. Have installer examine conditions under which construction activities of this section are to be performed and submit written report if conditions are unacceptable.

2. Transmit two copies of installer's report to Architect/Engineer within 24 hours of receipt.

3. Beginning construction activities of this section before unacceptable conditions have been corrected is prohibited.

4. Beginning construction activities of this section indicates installer's acceptance of conditions.

C. Verify that glazing has been factory-installed.

3.02 INSTALLATION

A. Install door opening assemblies in accordance with shop drawings and manufacturer's printed installation instructions, using installation methods and materials specified in installation instructions.

B. Field alteration of doors or frames to accommodate field conditions is strictly prohibited.

C. Site tolerances: Maintain plumb and level tolerances specified in manufacturer's printed installation instructions.

3.03 ADJUSTING

A. Adjust doors in accordance with door manufacturer's maintenance instructions to swing open and shut without binding, and to remain in place at any angle without being moved by gravitational influence.

B. Adjust door hardware to operate correctly in accordance with hardware manufacturer's maintenance instructions.

3.04 CLEANING

A. Clean surfaces of door opening assemblies and sight-exposed door hardware in accordance with respective manufacturer's maintenance instructions.

3.05 PROTECTION OF INSTALLED PRODUCTS

A. Protect door opening assemblies and door hardware from damage by subsequent construction activities until final inspection.

END OF SECTION

SECTION 08370 - ACCESS HATCHES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide all labor, materials, equipment, and service required for the complete installation of the access hatches as specified herein and shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Cast-in-Place Concrete: Section 03300

B. Precast Concrete: Section 03400

1.03 SUBMITTALS

A. Submit manufacturer's data and shop drawings for the materials specified herein. Comply with all requirements of Section 01300.

B. Descriptive literature, catalog cuts, and dimensional prints clearly indicating all dimensions and materials of construction, shall be submitted on all items specified herein to the Engineer for review before ordering.

C. At the time of submission, the Contractor shall, in writing, call the Engineer's attention to any deviations that the submittals may have from the requirements of the Engineer's Contract Drawings and Specifications.

1.04 ACCEPTABLE MANUFACTURERS

A. Access hatches shall be as manufactured by the Bilco Company, New Haven, Connecticut; Babcock-Davis Associates, Inc., Arlington, Massachusetts; Milcor Division Inryco, Inc., Milwaukee, Wisconsin; or approved equal.

PART 2 - PRODUCTS

2.01 ACCESS HATCH (ROOF)

A. Access hatch shall be double leaf or single leaf, as indicated on the Contract Drawings or by the Engineer, aluminum, gutter type, watertight, exterior, flush floor hatch design. Door leaves shall be 1/4 inch aluminum diamond pattern plate to withstand a live load of 300 pounds per sq. ft. Channel frames shall be 1/4 inches aluminum with an anchor flange around the perimeter. Provide 1-1/2 inch female NPT threaded aluminum drainage coupling welded under frame at right front corner for connection of drain pipe.

B. Door shall be equipped with 316 stainless steel hinges, a lockable hasp for use with a padlock, stainless steel pins, spring operator for easy operation and an automatic hold-open arm with release handle. Provide inside stainless steel snap locks with removable wrench lift handle outside. Furnish threaded aluminum plug to seal lock aperture. Hardware shall be cadmium plated.

C. Doors and frames shall be mill finish with bituminous coating applied to the exterior of the frame. Hatches shall have an odor resistant gasket.

D. Access hatches shall be furnished with a factory installed "Safe-Hatch" fall prevention system, as supplied by ITT Flygt Corporation, or Engineer approved equal. Safety grate shall be constructed of 6061-T6 aluminum and designed to withstand a live load of 300 pounds per

sq. ft. and painted with a bright safety orange color. The grating shall completely cover the opening and be in conformance with OSHA Standard 1910.23 and controlled space entry per OSHA Standard 1910.146.

E. Hatch shall have a minimum clear opening as shown on the contract drawings. Contractor shall verify that opening is sized to allow removal of largest piece of equipment in the space.

2.02 ACCESS HATCH FOR VALVE VAULT

A. Access hatch for valve vault shall be as described in section 2.01 A through D.

B. Hatch shall have a minimum clear opening as shown on the contract drawings.

2.03 ACCESS HATCH (PUMPS)

A. Pump access hatches shall be as described in section 2.01 A through D and furnished by the pump supplier, sized adequately to accommodate installation and removal of the pumps and piping.

B. Safety grating shall be capable of being used as a pump platform. The pump would be lifted from the wet well, then after closing the safety grating, the grating will be designed to be strong enough to allow the pump to be placed back on the grating to allow the Operator to wash down the pump sending runoff back into the wet well.

2.04 ACCESS HATCHES (AASHTO H-20 RATED)

A. Access hatch (h-20 rated) shall be double leaf or single leaf, as indicated on the Contract Drawings or by the Engineer, aluminum, gutter type, watertight, exterior, flush floor hatch design. Door leaves shall be 1/4 inch aluminum diamond pattern plate. Cover shall be reinforced to support AASHTO H-20 wheel loading with a maximum deflection of $1/150^{th}$ of the span. Manufacturer shall provide structural calculations stamped by a professional engineer.

B. Door shall be equipped with 316 stainless steel hinges, a lockable hasp for use with a padlock, stainless steel pins, spring operator for easy operation and an automatic hold-open arm with release handle. Provide inside stainless steel snap locks with removable wrench lift handle outside. Furnish threaded aluminum plug to seal lock aperture. Hardware shall be cadmium plated.

C. Doors and frames shall be mill finish with bituminous coating applied to the exterior of the frame. Hatches shall have an odor resistant gasket.

PART 3 - EXECUTION

3.01 GENERAL

A. Installation shall be in accordance with manufacturer's instructions.

B. Manufacturer shall guarantee against defects in material of workmanship for a period of five years.

C. Unit shall be set with slight pitch toward drain. Furnish and install 1" diameter schedule 80 PVC plastic drainage pipe and fittings to connect to gutter drainage coupling, set in concrete and run outside vault to daylight.

END OF SECTION

SECTION 08390 – PRESSURE RESISTANT DOORS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide all labor, materials, equipment, and service required for the complete installation of the pressure resistant watertight doors as specified herein and shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Cast-in-Place Concrete: Section 03300

1.03 REFERENCES

A. AISC "Specifications for Design, Fabrication, and Erection of Structural Steel Buildings"

B. AWS Structural Welding Code

C. ASME Structural Welding Code Section IX

1.04 SUBMITTALS

A. Submit manufacturer's data and shop drawings for the materials specified herein. Comply with all requirements of Section 01300.

B. Submit manufacturer's maintenance manuals for the materials. Comply with all requirements of Section 01300 Submittals and Section 01780 – Operations and Maintenance Manuals.

C. Descriptive literature, catalog cuts, and dimensional prints clearly indicating all dimensions and materials of construction, shall be submitted on all items specified herein to the Engineer for review before ordering.

D. At the time of submission, the Contractor shall, in writing, call the Engineer's attention to any deviations that the submittals may have from the requirements of the Engineer's Contract Drawings and Specifications.

1.05 QUALIFICATIONS

A. Manufacturer shall be able to provide proof of a least five successful years of manufacturing watertight manhole doors.

B. Manufacture shall be able to provide proof of successful installations of their product in a like application.

PART 2 - PRODUCTS

2.01 WATERTIGHT DOORWAY

A. Watertight door shall be Type 316 stainless steel. Door hinges shall also be Type 316 stainless steel. Gaskets shall be neoprene gasket, 25 durometer, with fully molded corners. The door shall be designed to resist hydraulic loading as shown on drawings or specified herein.

B. Door shall have a minimum clear opening as shown on the contract drawings.

2.02 DESIGN

A. Watertight door shall be designed with a minimum safety factor of 2:1.

B. The door installation (including frame and attachment to concrete) shall be watertight to pressure specified on the drawings and herein without excessive deflection.

PART 3 - EXECUTION

3.01 GENERAL

A. Installation shall be in accordance with manufacturer's instructions.

B. Manufacturer shall guarantee against defects in material of workmanship for a period of five years.

END OF SECTION

SECTION 08620 - SKYLIGHTS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide all labor, materials, equipment, and service required for the complete installation of the skylights and skylight screen as specified herein and shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Cast-in-Place Concrete: Section 03300

B. Precast Concrete: Section 03400

1.03 REFERENCES

A. OSHA 1910.23 – Guarding floor and wall openings

B. ASTM D 542: Standard Test Method for Index of Refraction of Transparent Organic Plastics

C. ASTM D 635: Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position

D. ASTM D 638: Standard Test Method for Tensile Properties of Plastics

E. ASTM 790: Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

F. ASTM D 1003: Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics

G. ASTM D 1929: Standard Test Method for Determining Ignition Temperature of Plastics

H. ASTM D 2843: Standard Test Method for Density of Smoke from the Burning or Decomposition of Plastics

1.04 SUBMITTALS

A. Submit manufacturer's data and shop drawings for the materials specified herein. Comply with all requirements of Section 01300.

B. Descriptive literature, catalog cuts, and dimensional prints clearly indicating all dimensions and materials of construction, shall be submitted on all items specified herein to the Engineer for review before ordering. This must include testing showing compliance with all OSHA requirements.

C. At the time of submission, the Contractor shall, in writing, call the Engineer's attention to any deviations that the submittals may have from the requirements of the Engineer's Contract Drawings and Specifications.

D. Samples for Selection.

1.05 DESIGN

A. Structural Criteria: Skylight and skylight screen shall be designed per OSHA 1910.23(e)(8) stating that the construction and mounting are capable of withstanding a load of at least 200 pounds applied perpendicularly at any one area on the screen. The skylight shall be of

required thickness to sustain a loading of 300 pounds per sq. ft. . The screen shall be constructed and mounted that under the prescribed loads, the screen will not deflect and break the skylight.

B. Skylight shall be able to withstand the loads, as specified on drawings and herein, without failure. Failure includes thermal stresses, structural movement, and noise and vibration.

1.06 ACCEPTABLE MANUFACTURERS

A. Skylights shall be as manufactured by Velux USA, or approved equal.

PART 2 - PRODUCTS

2.01 SKYLIGHT

A. Skylight shall have extruded aluminum retaining angle and extruded aluminum inner frame with mitered and welded corner assemblies to ensure the assembly is leakproof. Extruded aluminum allow to be 6063-T5. 100% acrylic skylight dome shall be frosted and welded in place to the retaining angle. All joints to be fit and secured utilizing welds.

B. Skylight to be mounted to concrete curb onsite. Manufacturer to provide watertight, leakproof attachment method.

C. Skylight shall be furnished with skylight screen designed to withstand a 200 pound load applied perpendicularly at any one area on the screen without deflection to the skylight in conformance OSHA Standard 1910.23.

D. Skylight shall have a minimum clear opening as shown on the contract drawings.

PART 3 - EXECUTION

3.01 GENERAL

A. Installation shall be in accordance with manufacturer's instructions.

B. Manufacturer shall guarantee against defects in material of workmanship for a period of five years.

END OF SECTION

SECTION 08710 - FINISH HARDWARE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections apply to work of this section.

1.02 WORK INCLUDED

A. This section includes the furnishing of all finish hardware to the respective trades. The hardware supplier will promptly furnish templates to all other manufacturers furnishing materials necessary to completion of this part of the work.

B. The following specifications are a guide and a description of the quality of materials required. No material of quality or weight less than that outlined in this specification will be accepted or give consideration. The Contractor shall be responsible for supplying the correct quality of all materials, whether or not specifically mentioned in this specification. Any additional items that may be required shall be furnished and be of type, quality and utility consistent with other hardware specified.

C. No consideration will be granted for any alleged misunderstanding of the material to be furnished or work to be done, it being fully under stood that the tender of a proposal carries with it the agreement to all items and conditions referred to herein or indicated on the Drawings and as scheduled, whether specifically mentioned herein or not.

D. The hardware supplier shall receive and check all hardware at his warehouse. All hardware shall be delivered to the job by the hardware supplier in one shipment. Drop shipments to the job site from the various manufacturers will positively not be permitted. All hardware shall be properly wrapped in separate packages complete with trimmings, screws, etc., (locksets packages complete in the same box), each plainly labeled and numbered to agree with the door numbers, and Contractor's typewritten schedule. The Contractor shall submit his schedules for corrections and shall obtain approval from the Engineer before proceeding with any work. The hardware supplier shall re-pack all separate boxes and packages of hardware, in cartons or cases, and attach to the outside of each case or carton a label indicating the manufacturer of the material, contents, quality, item number on hardware schedule and door number, before delivery to job site. Hardware, when required, shall be delivered to the shops of the various door manufacturers, properly marked and labeled following the same procedure outlined above for job site shipment.

E. The Contractor shall provide proper storage facilities for the finish hardware after delivery to the job site. A separate room, under lock and key, with shelves and bins as necessary to provide dry storage for all hardware items will be required.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Hinges: All hinges to be of five knuckle construction with pins and plugs concealed in the barrel. Plain bearing and ball bearing hinges to be identical in appearance. Ball bearing hinges to have fully concealed bearings and self-lubricated sleeves for lateral wear. Hinges for all doors to be brass with finish as indicated. 1-1/2 pair per door up to 90" high.

B. Locksets: All locks shall be bored type. Lock bodies and trim shall be by the same manufacturer. Levers shall have screwless shank and no attachment screws shall be visible

on either face of doors. Latch bolts shall have a minimum throw of 5/8". Back set on all locks shall be 2-3/4".

C. Closers: Except as otherwise specifically indicated, comply with the manufacturer's recommendations for size of door control unit, depending upon size of door, exposure to weather and anticipated frequency of use. Provide parallel arms for all overhead closers, except as otherwise indicated.

D. Door Stops and Holders: Door stops shall be provided on all doors to prevent the door or hardware from striking an adjacent wall or obstruction. They shall be wall type whenever possible. Do not mount floor stops on exterior concrete stoops, or where they will impede traffic. Where floor or wall stops are not appropriate, provide overhead holders. Contractor to verify if door closers will conflict with hardware selected. All door stops mounted on concrete floor or masonry walls shall be furnished with machine screws and lead expansion shields. Anchorage shall be rigid and firm before acceptance. Door holders shall be kick stops with rubber bottom surface.

E. Weatherstripping: Except as otherwise indicated, provide continuous weatherstripping at each edge of every exterior door leaf. Provide type, sizes, and profiles shown or scheduled. Provide noncorrosive fasteners as recommended by manufacturer for application indicated.

F. Thresholds: Extruded aluminum thresholds shall be furnished where called for in the hardware schedule. Thresholds shall be furnished with machine screws and lead expansion shields and shall be rigidly anchored to the floor.

2.02 FINISHES

Finish on all hardware hereafter specified unless specifically noted otherwise, shall be US32D (Satin Stainless Steel).

PART 3 - EXECUTION

3.01 MOUNTING

All hardware shall be firmly and rigidly attached to the doors and frames. Door closers, specified to be surface mounted shall be thrubolted to the door with oval head bolts. All door pulls and other surface mounted items shall be thrubolted to the door with oval head bolts, except push and kick plates. Outswinging doors shall have hinges with non-removable pins.

3.02 APPLICATION

Application - finish hardware shall be installed using mechanics skilled in this type of work. Installation shall be in a neat workmanship manner, in accordance with the approved hardware and door schedule. All items of hardware shall be secure and free working in the manner intended. Hardware shall not be applied until the painting is finished. After hard ware is installed, the General Contractor shall cover all exposed surfaces of push plates, pulls, locksets, etc., with a suitable covering, such as masking tape and polyethylene trim, to protect the hardware from scratches, abrasion, and tarnishing. This is to be left on until the building is completed and ready for final inspection. Upon completion of application the Contractor shall deliver to the Owner, or to the Owner's maintenance personnel, two (2) copies of all installation instructions, templates, wrenches, installation tools, etc., supplied by the various manufacturers and packed with the hardware, necessary for installation and maintenance.

3.03 HARDWARE SCHEDULE

A. Lists of hardware to be submitted by the Contractor shall be corrected as to quality and kind of hardware selected, but the Contractor must be responsible for all quantities and for the

hands of the locks, and must submit supplemental lists as necessary to cover any items of hardware not included in the original list.

B. The General Contractor and the hardware supplier's representative shall conduct a pre-installation meeting on the project prior to hardware installation.

C. Before an order is placed with the manufacturer for the hardware, six (6) copies of a complete schedule of the hardware, indicating the type, number, location and finish shall be submitted to the Architect/Engineer, together with such samples as may be required for approval. No hardware shall be shipped or delivered to the job until the Owner has approved the schedule and the samples. Approval of schedules and samples shall not relieve the Contractor of any responsibility for furnishing all hardware required.

D. Acceptable Manufacturers: The numbers given in the schedule are of the following first listed manufacturers.

MANUFACTURERS USED:

Hinges	**Hager**, Mckinney Stanley
Locksets, Latchsets	**Best,** Schlage, Sargent,, Corbin Russwin or equal
Closers	**LCN**, Norton, Dorma or equal
Bolts	**Ives**, Glynn Johnson or equal
Thresholds	**Reese**, National Guard or equal
Weather Stripping	**Reese**, National Guard or equal
Doorstops	**Glynn Johnson**, Ives or equal
Door Holders	**Glynn Johnson**, or equal

HARDWARE:

SEE SHEET A-101

END OF SECTION

DIVISION 09

FINISHES

SECTION 09961 - HIGH PERFORMANCE PAINTS AND COATINGS - WASTEWATER

PART 1- GENERAL

1.01 DESCRIPTION OF WORK

A. Provide all labor, materials, equipment and services for furnishing and installing the finishes as indicated on drawings and schedules, and as herein specified.

B. Work includes painting and finishing of interior and exterior exposed items and surfaces throughout project, except as otherwise indicated. Surface preparation, priming and coats of paint specified are in addition to shop-priming and surface treatment specified under other sections of work.

C. Work includes field painting of exposed bare and covered pipes and ducts (including color coding), and of hangers, exposed steel and iron work, and primed metal surfaces of equipment installed under mechanical and electrical work, except as otherwise indicated. In addition, the Contractor shall provide for the use of deep tone colors to be applied in selected areas as wall graphics, stripes and visual accents. The areas and colors shall be selected by the Architect-Engineer and shall not exceed 15% of the total wall surface area to be painted.

D. "Paint" as used herein means all coating systems materials, including primers, emulsions, enamels, stains, sealers and fillers, and other applied materials whether used as prime, intermediate or finish coats.

E. Surfaces to be Painted: Except where natural finish of material is specifically noted as a surface not to be painted, paint exposed surfaces whether or not colors are designated in "schedules". Where items or surfaces are not specifically mentioned, paint the same as similar adjacent materials or areas. If color or finish is not designated, Architect-Engineer will select these from standard colors or finishes available.

F. Following categories of work are not included as part of field- applied finish work.

1. Pre-Finished Items: Unless otherwise indicated, do not include painting when factory-finishing or installer-finishing is specified for such items as (but not limited to) toilet enclosures, prefinished partition systems, acoustic materials, architectural woodwork and casework, and finish mechanical and electrical equipment, including light fixtures, switchgear, and distribution cabinets.

2. Concealed Surfaces: Unless otherwise indicated, painting is not required on surfaces such as walls or ceilings in concealed areas and generally inaccessible areas, furred areas, pipe spaces, and duct shafts.

3. Finished Metal Surfaces: Unless otherwise indicated, metal surfaces of anodized aluminum, stainless steel, chromium plate, copper, bronze and similar finished materials will not require finish painting.

4. Operating Parts: Unless otherwise indicated, moving parts of operating units, mechanical and electrical parts, such as valve and damper operators, linkages, sinkages, sensing devices, motor and fan shafts will not require finish painting.

G. Following categories of work are included under other sections of these specifications.

1. Shop Priming: Unless otherwise specified, shop priming of ferrous metal items is included under various sections for structural steel, metal fabrications, hollow metal work and similar items.

2. Unless otherwise specified, shop priming of fabricated components such as architectural

woodwork, wood casework and shop-fabricated or factory-built mechanical and electrical equipment or accessories is included under other sections of these Specifications.

H. Do not paint over any code-required labels, such as Underwriters' Laboratories and Factory Mutual, or any equipment identification, performance rating, name, or nomenclature plates.

I. PVC plastic process piping shall not be painted, but shall be stenciled and labeled or tagged for identification surfaces. Each type of process piping using PVC pipe shall be installed using the same color pipe.

J. Repainting of existing structures, tanks, piping, and all other existing items shall not be part of this Contract unless otherwise noted or altered by this work. Areas that have been directly altered or damaged by construction shall be repainted to match existing conditions using the appropriate painting system. Repainting shall include the entire length of a system including piping, equipment, and accessories. Walls and structural items altered shall be painted for their entire length and height.

1.02 RELATED DOCUMENTS

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

1.03 SUBMITTALS

A. Product Data: Submit manufacturer's technical information including paint label analysis and application instructions for each material proposed for use. Provide MSDS sheets for each item submitted.

B. Samples: Prior to beginning work, submit color chips for surfaces to be painted. Use representative colors when preparing samples for review. Submit samples for Architect-Engineer's review of color and texture only. Provide a listing of material and application for each coat of each finish sample.

1.04 QUALITY ASSURANCE

A. Single Source Responsibility: Provide primers and other undercoat paint produced by same manufacturer as finish coats. Use only thinners approved by paint manufacturer, and use only within recommended limits.

B. Coordination of Work: Review other sections of these Specifications in which prime paints are to be provided to ensure compatibility of total coatings systems for various substrates. Upon request from other trades, furnish information or characteristics of finish materials provided for use, to ensure compatible prime coats are used.

1.05 DELIVERY AND STORAGE

A. Deliver materials to job site in original, new and unopened packages and containers bearing manufacturer's name and label, and following information:

1. Name or title of material.

2. Fed. Spec. number, if applicable.

3. Manufacturer's stock number, batch number, and date of manufacturer.

4. Manufacturer's name.

5. Contents by volume, for major pigment and vehicle constituents.

6. Thinning instructions.

7. Application instructions.

8. Color name and number.

B. Store materials not in actual use in tightly covered containers. Maintain containers used in storage of paint in a clean condition, free of foreign materials and residue. Protect from freezing where necessary. Keep storage area neat and orderly. Remove oily rags and waste daily. Take all precautions to ensure that workmen and work areas are adequately protected from fire hazards and health hazards resulting from handling, mixing and application of paints.

1.06 JOB CONDITIONS

A. Apply water-base paints only when temperature of surfaces to be painted and surrounding air temperatures are between 50 degrees F (10 degrees C) and 90 degrees F (32 degrees C), unless otherwise permitted or restricted by paint manufacturer's printed instructions.

B. Apply solvent-thinned paints only when temperature of surfaces to be painted and surrounding air temperatures are between 45 degrees F (7 degrees C) and 95 degrees F (35 degrees C), unless otherwise permitted or restricted by paint manufacturer's printed instructions.

C. Do not apply paint in snow, rain, fog or mist, or when relative humidity exceeds 85%, or to damp or wet surfaces, unless otherwise permitted or restricted by paint manufacturer's printed instructions. Painting may be continued during inclement weather if areas and surfaces to be painted are enclosed and heated within temperature limits specified by paint manufacturer during application and drying periods.

D. Paint only when the surface temperature is at least 5 degrees F above the dew point, unless otherwise permitted by paint manufacturer's printed instructions.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

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

1. Tnemec Company, Inc. (Tnemec)

2. The Sherwin-Williams Company

3. Carboline

2.02 MATERIALS

A. Material Quality: Provide best quality grade of various types of coatings as regularly manufactured by acceptable paint materials manufacturers. Materials not displaying manufacturer's identification as a standard, best-grade product will not be acceptable.

B. Proprietary names used to designate colors or materials are not intended to imply that products of named manufacturers are required to exclusion of equivalent products of other manufacturers.

C. Color Pigments: Pure, non-fading, applicable types to suit substrates and service indicated.

1. Lead content in pigment, if any, is limited to contain not more than 0.06% lead, as lead metal based on the total non-volatile (dry-film) of paint by weight.

2.03 COLORS AND FINISHES

A. Surface treatments and finished are shown under "Painting Systems" below. All substrates scheduled under "Painting Systems" shall be painted whether or no shown on the drawings, or in schedule as not requiring the painting system scheduled below.

B. Color Selection

The Owner may select colors from the standard or custom colors available, in addition to color coding of all of the piping and ducts.

All exterior exposed concrete surfaces (including cast-in-place, prestressed concrete, and C.M.U.) shall be painted "Keeneland Green". Color swatch to be provided and approved by Owner.

C. After approval of submittals and prior to beginning work, the Engineer will furnish color schedules for surfaces to be painted listed in the painting systems below.

D. Color Coding

In general, and unless otherwise specified, all color coding of piping, ducts, and equipment shall comply with applicable standards of ANSI A13.1 and OSHA 1910.144.

PART 3 - EXECUTION

3.01 INSPECTION

A. Applicator must examine areas and conditions under which painting work is to be applied and notify Contractor in writing of conditions detrimental to proper and timely completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Applicator and coating manufacturer.

B. Starting of painting work will be construed as acceptance of surfaces and conditions within any particular area.

C. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions otherwise detrimental to formation of a durable paint film.

3.02 SURFACE PREPARATION

A. General: Perform preparation and cleaning procedures in accordance with paint manufacturer's instructions and as herein specified, for each particular substrate condition.

1. Provide barrier coats over incompatible primers or remove and re-prime as required. Notify Architect-Architect-Engineer in writing of any anticipated problems in using the specified coating systems with substrates primed by others.

2. Remove hardware, hardware accessories, machined surfaces, plates, lighting fixtures, and similar items in place and not to be finish-painted, or provide surface-applied protection prior to surface preparation and painting operations. Remove, if necessary, for complete painting of items and adjacent surfaces. Following completion of painting of each space or area, reinstall removed items.

3. Clean surfaces to be painted before applying paint or surface treatments. Remove oil and grease prior to mechanical cleaning per SSPC SP-1. Program cleaning and painting so that contaminants from cleaning process will not fall onto wet, newly-painted surfaces.

4. Abrasives for blasting shall be sharp, washed, salt free, angular, and free from feldspar or other constituents that tend to breakdown and remain on the surface.

5. Concrete floors shall be dry as indicated by testing in accordance with ASTM D4263, Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.

B. Cementitious Materials: Per ASTM D4261, Standard Practice for Surface Cleaning Concrete Unit Masonry for Coating, prepare cementitious surfaces of concrete block to be painted by removing efflorescence, chalk, dust, dirt, grease, oils, and by roughening as required to remove glaze. Per ASTM D4262, Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces, determine alkalinity of surfaces to be painted by performing appropriate tests. If surfaces are found to be sufficiently alkaline to cause blistering and burning of finish paint, correct this condition before application of paint. Test the surface for moisture and do not paint over surfaces where moisture content exceeds that permitted in manufacturer's printed directions. Concrete surfaces shall be prepared in accordance with SSPC-13 – Concrete Surface Preparation. Prepare concrete to remove contaminants, open bugholes, surface voids, air pockets, and other subsurface irregularities. Do not expose underlying aggregate. Use dry, oil-free air for blasting operations. Surface texture after blasting shall be similar to that of medium grit sandpaper. Remove residual abrasives, dust, and loose particles by vacuuming or blowing with high pressure air.

C. Wood: Clean wood surfaces to be painted of dirt, oil, or other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sandpaper smooth those finished surfaces exposed to view, and dust off. Scrape and clean small, dry, seasoned knots and apply a thin coat of white shellac or other recommended knot sealer, before application of priming coat. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood-filler. Sandpaper smooth when dried.

1. Prime, stain, or seal wood required to be job-painted immediately upon delivery to job. Prime edges, ends, faces, undersides, and backsides of such wood, including cabinets, counters, cases, paneling.

2. When transparent finish is required, use spar varnish for backpriming.

D. Ferrous Metals: Clean ferrous surfaces, which are not galvanized or shop-coated, of oil, grease, dirt, and other foreign substances by solvent cleaning per SSPC SP-1. Mechanical cleaning shall be in accordance with SSPC-SP6 Commercial Blast Cleaning specifications for non-immersion surfaces and SSPC-SP10 Near White Metal Blast Cleaning for immersion in potable or non-potable water.

E. Galvanized Surfaces: Clean free of oil and surface contaminants with non-petroleum based solvent.

F. Shop Primed Surfaces: Prepare shop-applied prime coats wherever damaged or bare as required by other sections of these Specifications. Clean and touch-up with same type shop primer.

3.03 MATERIALS PREPARATION

A. Mix and prepare painting materials in accordance with manufacturer's directions.

B. Maintain containers used in mixing and application of paint in a clean condition, free of foreign materials and residue.

C. Stir materials before application to produce a mixture of uniform density, and stir as required

during application. Do not stir surface film into material. Remove film and, if necessary, strain material before using.

3.04 APPLICATION

A. General: Apply paint in accordance with manufacturer's directions. Use applicators and techniques best suited for substrate and type of material being applied.

1. Painting requirements, surface treatments, and finishes, are indicated in "schedules" of the contract documents and as noted in Paragraph 3.11 hereinafter.

2. Provide finish coats which are compatible with prime paints used.

3. Apply additional coats when undercoats, stains or other conditions show through final coat of paint, until paint film is of uniform finish, color and appearance. Give special attention to insure that surfaces, including edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.

4. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Paint surfaces behind permanently- fixed equipment or furniture with prime coat only before final installation of equipment.

5. Paint interior surfaces of ducts, where visible through registers or grilles, with a flat, non-specular black paint.

6. Paint back sides of access panels, and removable or hinged covers to match exposed surfaces.

7. Finish exterior doors on tops, bottoms and side edges same as exterior faces, unless otherwise indicated.

8. Sand lightly between each succeeding enamel or varnish coat.

9. Omit first coat (primer) on metal surfaces which have been shop-primed and touch-up painted, unless otherwise indicated.

B. Scheduling Painting: Apply first-coat material to surfaces that have been cleaned, pretreated or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration. Allow sufficient time between successive coatings to permit proper drying. Do not recoat until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and application of another coat of paint does not cause lifting or loss of adhesion of the undercoat.

C. Minimum Coating Thickness: Apply materials at not less than manufacturer's recommended spreading rate, to establish a total dry film thickness (DFT) as indicated or, if not indicated, as recommended by coating manufacturer. Coatings to be in immersion or a severe environment shall be tested for dry film thickness. Testing shall be accomplished by methods recommended by coating manufacturer. Record DFT for each 100 square feet of surface area using the average of three readings within each 100 square feet. Additional coats of paint shall be applied where minimum DFT is not achieved.

D. Mechanical and Electrical Work: Painting of mechanical and electrical work is limited to those items exposed in mechanical equipment rooms and in occupied spaces.

1. Mechanical items to be painted include, but are not limited to, the following:

a. Piping, pipe hangers, supplementary steel and supports except galvanized surfaces.

b. Heat exchangers.

c. Tanks.

d. Ductwork, insulation.

e. Motor, mechanical equipment, and supports.

f. Accessory items.

2. Electrical items to be painted include, but are not limited to, the following:

a. Conduits and fittings except galvanized surfaces.

b. Switchgear.

c. Hanger and support except galvanized surfaces.

E. Prime Coats: Apply prime coat of material which is required to be painted or finished, and which has not been prime coated by others. Recoat primed and sealed surfaces where there is evidence of suction spots or unsealed areas in first coat, to assure a finish coat with no burn- through or other defects due to insufficient sealing.

F. Pigmented (Opaque) Finishes: Completely cover to provide an opaque, smooth surface of uniform finish, color, appearance and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness or ther surface imperfections will not be acceptable. Holiday test coated steel in immersion areas in accordance with NACE International RP 0188-90.

G. Transparent (Clear) Finishes: Use multiple coats to produce glass-smooth surface film of even luster. Provide a finish free of laps, cloudiness, color irregularity, runs, brush marks, orange peel, nail holes, or other surface imperfections. Provide satin finish for final coats, unless otherwise indicated.

H. Completed Work: Match approved samples for color, texture and coverage. Remove, refinish or repaint work not in compliance with specified requirements.

3.05 FIELD QUALITY CONTROL

A. The right is reserved by Owner to invoke the following material testing procedure at any time, and any number of times during period of field painting:

1. Engage services of an independent testing laboratory to sample paint being used. Samples of materials delivered to project site will be taken, identified and sealed, and certified in presence of Contractor.

2. Testing laboratory will perform appropriate tests for any or all of following characteristics: Abrasion resistance, apparent reflectivity, flexibility, washability, absorption, accelerated weathering, dry opacity, accelerated yellowness, recoating, skinning, color retention, alkali resistance and quantitative materials analysis.

B. If test results show that material being used does not comply with specified requirements, Contractor may be directed to stop painting work, and remove non-complying paint; pay for testing; repaint surfaces coated with rejected paint; remove rejected paint from previously painted surfaces if, upon repainting with specified paint, the two coatings are non-compatible.

3.06 CLEAN-UP AND PROTECTION

A. Clean-Up: During progress of work, remove from site discarded paint materials, rubbish, cans and rags at end of each work day.

B. Upon completion of painting work, clean window glass and other paint-spattered surfaces. Remove spattered paint by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces.

C. Protection: Protect work of other trades, whether to be painted or not, against damage by painting and finishing work. Correct any damage by cleaning, repairing or replacing, and repainting, as acceptable to Architect-Architect-Engineer. Provide "Wet Paint" signs as required to protect newly-painted finishes. Remove temporary protective wrappings provided by others for protection of their work, after completion of painting operations. At completion of work of other trades, touch-up and restore all damaged or defaced painted surfaces.

3.07 PAINTING SYSTEMS

Product names and numbers are based on Tnemec products.

A. Ferrous Metals - Structural, Tanks, Pipes and Equipment

1. Exterior, Non-Immersion

		Dry Mils
Sur. Prep.:	SSPC-SP6 Commercial Blast Cleaning	
1st Coat:	1 PurplePrime	2.5 - 3.5
2nd Coat:	N 69 High-Build Epoxoline II	2.0 - 3.0
3rd Coat:	1074- Endura-Shield	2.0 - 3.0

2. Interior, Non-Immersion

Sur. Prep.:	SSPC-SP6 Commercial Blast Cleaning	
1st Coat:	1 PurplePrime	2.5 - 3.5
2nd Coat:	N 69 High-Build Epoxoline II	4.0 - 6.0
Finish Coat:	N 69 High-Build Epoxoline II	2.0 - 3.0

3. Immersion, Potable or Non-Potable Water

Sur. Prep.:	SSPC-SP10 Near-White Blast Cleaning	
1st Coat:	1 PurplePrime	2.5 - 3.5
2nd Coat:	N 69 High-Build Epoxoline II	4.0 - 6.0
3rd Coat:	N 69 High-Build Epoxoline II	4.0 - 6.0

		Dry Mils

4. Factory Primed Interior (Refer to Piping Specifications)

Sur. Prep.:	Surface shall be clean and dry	
Int. Coat:	N 69 High-Build Epoxoline II	2.0 - 3.0
Finish Coat:	N 69 High-Build Epoxoline II	2.0 - 3.0

5. Factory Primed, Exterior (Refer to Piping Specifications)

Sur. Prep.:	Surface shall be clean and dry	
1st Coat:	N69 Epoxoline II	4.0 – 6.0
2nd Coat:	1074- Endura-Shield	2.0- 3.0

6. Primed Steel (Doors, Frames, etc.)

Touch up:	1 Purpleprime	
1st Coat:	N 69 High-Build Epoxoline II	2.0 - 3.0
2nd Coat:	N 69 High-Build Epoxoline II	2.0 - 3.0

7. Hydrogen Sulfide Exposed

Sur. Prep:	SSPC-SP5	
1st Coat:	435 Perma-Glaze	15.0 - 20.0
2nd Coat:	435 Perma-Glaze	15.0 - 20.0

B. Galvanized Steel - Pipe and Miscellaneous Fabrications

1. Exterior, Non-Immersion

Sur. Prep.:	SSPC-SP1 Solvent Cleaning and Etch	
1st Coat:	N69 Epoxoline II	2.0 - 3.0
2nd Coat:	1074-Color Endura-Shield	2.0 - 3.0

2. Interior, Non-Immersion (Doors, Frames, etc.)

Sur. Prep.:	SSPC-SP1 Solvent Cleaning and Etch	
One Coat:	N69 Epoxoline II	2.0 - 3.0
2nd Coat:	N 69 High-Build Epoxoline II	2.0 - 3.0

3. Immersion, Potable or Non-Potable Water

Sur. Prep.:	SSPC-SP1 Solvent Cleaning followed by abrasive blast	
1st Coat:	N69 Epoxoline II	3.0 - 5.0
2nd Coat:	N69 Epoxoline II	4.0 - 6.0

C. Porous Masonry - Concrete Masonry Units

1. Interior

Sur. Prep.:	Surface shall be clean and dry	
1st Coat:	130 Envirofill	80 - 100 sf/gal.
(Spray & Back Roll to Fill Porosity)		
2nd Coat:	84 Ceramlon ENV	4.0 - 6.0
3rd Coat:	84 Ceramlon ENV	4.0 - 6.0

D. Cast-In-Place Concrete

Dry Mils

1. Concrete Walls & Precast Concrete Ceilings (Interior)

Sur. Prep.: Abrasive Blast (SSPC-SP13) Fill bugholes and voids with coating manufacturer's epoxy filler.

1st Coat:	N69 Epoxoline II	4.0 - 6.0
2nd Coat:	N69 Epoxoline II	4.0 - 6.0

2. Concrete Walls, Tanks and Basins (Exterior, Exposed)

Sur. Prep.: Abrasive Blast (SSPC-SP13, Severe Service) Fill bugholes and voids with coating manufacturer's epoxy filler

1st Coat:	Series 156 Enviro-Crete	125 sf/gal.
2nd Coat:	Series 156 Enviro-Crete	200 sf/gal.

3. Concrete Floors (Interior, Heavy Traffic and Chemical Exposure)

Sur. Prep.: SSPC-SP 13/NACE 6

Primer:	237 Power-Tread, double broadcast	1/8 inch
1st Coat:	280 Tneme-Glaze	6.0 – 8.0
2nd Coat:	290 CRU	2.0 – 3.0

4. Chemical Containment Areas

Sur. Prep.:	Abrasive Blast (SSPC-SP13, Severe Service) Fill bugholes and voids with recommended coating manufacturer's epoxy filler.	
1st Coat:	201 Epoxoprime	6.0 - 8.0
2nd Coat:	275 Stranlock	25.0 – 40.0
Finish Coat:	282 Tneme-Glaze	8.0 – 12.0

5. Concrete Tanks & Basins (Hydrogen Sulfide Exposed)

Sur. Prep.:	Abrasive Blast (SSPC-SP13, Severe Service)	
1st Coat:	218 MortarClad or 219 MortarCast	1/8" to 1/4"
2nd Coat:	434 Perma-Shield H2S	125 mils
3rd Coat:	435 Perma-Glaze	15.0 - 20.0

E. Wood

Interior or Exterior

Sur. Prep.:	Surface shall be clean and dry	
1st Coat:	151-1051 Elasto-Grip FC	1.0 - 1.5
2nd Coat:	29 Tufcryl	2.0 - 3.0 - 3.5
3rd Coat:	29 Tufcryl	2.0 - 3.0

F. Insulated Pipe

Sur. Prep.:	Surface shall be clean and dry	
1st Coat:	6-Color Tneme-Cryl	2.0 - 3.0
2nd Coat:	6-Color Tneme-Cryl	2.0 - 3.0

Dry Mils

G. Gypsum Board

1. Interior Drywall - Architectural

Sur. Prep.:	Surface shall be clean and dry	
1st Coat:	151-1051 Elasto-Grip FC	1.0 - 1.5
2nd Coat:	6-Color Tneme-Cryl	2.0 - 3.0

2. Interior Drywall - Severe Exposure

Sur. Prep.:	Surface shall be clean and dry	
Prime Coat:	151-1051 Elasto-Grip FC	1.0 - 1.5
1st Coat:	113 H.B. Tneme-Tufcoat	2.0 - 3.0
2nd Coat:	113 H.B. Tneme-Tufcoat	2.0 - 3.0

H. PVC Piping – Do Not Paint

I. Aluminum Windows, Doors, Handrails & Grating – Do Not Paint

J. Fiberglass Reinforced Plastic Doors & Windows – Do Not Paint

3.08 PIPING COLOR CODE

To facilitate identification of piping in plants and pumping stations it is recommended that the following color scheme be utilized:

WATER LINES	
Raw Water	Olive Green
Settled Water	Light Blue
Filtered or Finished Water	Dark Blue
CHEMICAL LINES	
Acid	Red
Ammonia	White
Caustic	Yellow w/ green band
Chlorine	Yellow
Coagulant	Orange
Fluoride	Light Blue w/ red band
Polymer	Orange w/ green band
WASTE LINES	
Overflow (Backwash waste)	Light Brown
Sewer (Sanitary or Other)	Dark Gray
OTHER	
Compressed Air	Dark Green
Other Lines	Light Gray

3.09 STENCILING

A. The Contractor shall supply all materials and labor necessary for stenciling of legends on pipes. The legend shall show the name of the contents. Review by the Architect-Engineer of legends will be required. Names shall be "plainly visible". Arrows showing direction of flow shall also be stenciled on pipes. The legends shall be located not more than 10 feet apart and, in general, at each valve and piece of equipment. The size and location of the legend shall be in general accordance with ANSI A13.1-1981 "Scheme for the Identification of Piping Systems". All visible piping 6" in diameter and larger shall be color-coded and stenciled. "Stick-on" labels are not acceptable.

3.10 PLASTIC IDENTIFICATION MARKERS

A. All visible piping 3/4" and greater and less than 6" which is accessible for maintenance operations shall be color-coded and identified with semi-rigid plastic identification markers equal to SETMARK Pipe Markers as manufactured by Seton Name Plate Corporation, New Haven, Conn.; T & B/Westline, Los Angeles, California; or equal. Direction of flow arrows are to be included on each marker, unless otherwise specified.

B. Each marker background is to be appropriately color coded with a clearly printed legend to identify the contents of the pipe in conformance with the "Scheme for the Identification of Piping Systems" (ANSI A 13.1 - 1981).

C. For pipes under 3/4" O.D. (too small for color bands and legends), brass identification tags 1-1/2" in diameter with depressed 1/4" high black-filled letters above 1/3" blackfilled numbers shall be fastened securely at specified locations.

D. All electrical conduits, which are accessible for maintenance operations, shall be identified with semi-rigid identification markers similar to those specified above.

E. Each marker background is to be color-coded with a clearly printed legend to identify the conductor. Size of markers and sizes of lettering to generally conform with the "Scheme for

Identification of Piping Systems" (ANSI A 13.1 - 1981)

F. Locations for pipe and electrical markers to be as follows:

1. Adjacent to each valve and fitting (except on plumbing fixtures and equipment).
2. At each branch and riser take-off.
3. At each pipe passage through wall, floor and ceiling construction.
4. At each pipe passage to underground.
5. On all horizontal pipe runs-marked every 25 feet.

3.11 PAINT SCHEDULE

All items at the Project site shall be painted in accordance with these Specifications and Drawings. The following paint schedule is provided only to assist the Owner and Contractor in selection of the appropriate paint system and is not intended to be a complete list of items to be painted. All exterior exposed concrete surfaces (including cast-in-place, prestressed concrete, and C.M.U.) shall be painted "Keeneland Green".

Repainting of existing structures, tanks, piping, and all other existing items shall be part of this Contract.

A. Paint Application Schedule

Location and/or Description	System
1. Pump Station	
a. Interior Block Walls	C.1
b. Drywall Ceiling	G.2
c. Aluminum/FRP Doors and Frames, Exterior	Do not Paint
d. Aluminum/FRP Doors and Frames, Interior	Do not Paint
e. Overhead Door Frames	A.6
f. Cast-in-Place Concrete Walls/Floors	Do not paint
g. Cast-in-Place Concrete – Containment Area	A.5
h. Exterior, Non-Immersion	A.1, A.5
i. Ferrous Metals – Interior, Non-Immersion	A.2, A.4
j. Ferrous Metals – Immersion	A.3
k. Wood	E.1
l. Aluminum Hatches	Do not Paint
m. Pumps	Do not paint
n. Pipes/Valves Interior, Non-Immersion	A.2, A.4

o.	Pipes/Valves - Immersion	A.3
p.	Pipes/Valves - Exterior, Non-Immersion	A.1, A.5
q.	Electrical conduit, Cabinets, and equipment	Do not paint

END OF SECTION

DIVISION 10

SPECIALTIES

SECTION 10440 - SPECIALTY SIGNS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Section Includes: Extent of specialty signs as shown on Drawings, on Signage Schedule, and as specified herein.

1. Note: Cast metal plaque, handicapped access signs, and exterior freestanding signs are required unless not indicated under "Forms of Specialty Signs" below.

B. Forms of specialty signs required include the following:

1. Panel signs.

2. Cast metal plaques.

3. Exterior freestanding signs.

C. Related Documents: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to Work of this Section.

1.02 SUBMITTALS

A. Shop Drawings: Submit Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:

1. Drawings for fabrication and erection of specialty signs. Include the following:

a. Plans, elevations, and large-scale details of sign wording and lettering layout.

b. Anchorages and accessory items indicated.

c. Location template Drawings for items supported or anchored to permanent construction.

d. Furnish full-size rubbings for metal plaques.

2. Submit manufacturer's technical data and installation instructions for each type of sign required.

3. Submit samples of each sign form and material showing finishes, colors, surface textures, and qualities of manufacturer and design of each sign component including graphics.

4. Prior to beginning plaque fabrication review process, the Contractor shall coordinate the text size and content with the Engineer. Prior to plaque fabrication, the Contractor shall submit a full size plaque rubbing to the Engineer for final review.

1.03 QUALITY ASSURANCE

A. Uniformity of Manufacturer: For each sign form and graphic image process indicated, furnish products of a single manufacturer.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:

1. Panel Signs, and Exterior Freestanding Signs:

   a. ABC Signing Division of Nelson-Harkins Industries.

   b. Andco Industries Corp.

   c. APCO Graphics, Inc.

   d. Architectural Graphics, Inc.

   e. ASI Sign Systems, Inc.

   f. Charleston Industries, Inc.

   g. DGS Corp.

   h. Diskey Sign Corporation.

   i. Mohawk Sign Systems.

   j. Spanjer Brothers, Inc.

   k. The Supersine Company.

2. Plaques:

   a. A.C. Davenport and Son.

   b. Andco Industries, Inc.

   c. A.R.K. Ramos Manufacturing Company, Inc.

   d. ASI Sign Systems, Inc.

   e. Matthews.

   f. Metal Arts, Division of L&H Manufacturing Co.

   g. Metallic Arts.

   h. Spanjer Brothers, Inc.

   i. The Southwell Company.

   j. The Supersign Company.

2.02 MATERIALS

A. Fiberglass (Exterior Signs): Provide molded seamless thermosetting glass-fiber-reinforced polyester panels in sizes and thicknesses indicated, with a minimum tensile strength of 15,000 psi when tested in accordance with ASTM D 638, and a minimum flexural strength of 30,000 psi when tested in accordance with ASTM D 790.

B. Cast Acrylic Sheet: Provide cast (not extruded or continuous cast) methacrylate plastic sheet, in sizes and thicknesses indicated; with a minimum flexural strength of 16,000 psi when tested in accordance with ASTM D 790, a minimum allowable continuous service temperature of 176 degrees F (80 degrees C), and of the following general types:

1. Opaque Sheet: Where sheet material is indicated as "opaque," provide colored opaque acrylic sheet in colors and finishes indicated or, if not indicated, as selected by ENGINEER from manufacturer's standards.

C. Aluminum Sheet: Provide aluminum sheet of alloy and temper recommended by the aluminum producer or finisher for the type of use and finish indicated, and with not less than the strength and durability properties specified in ASTM B 209 for 5005-H15.

D. Aluminum Extrusions: Provide aluminum extrusions of alloy and temper recommended by the aluminum producer or finisher for type of use and finish indicated, and with not less than the strength and durability properties specified in ASTM B 221 for 6063-T5.

E. Bronze Castings: Provide bronze castings, copper Alloy UNS C83600, complying with the requirements of ASTM B 584. Casting shall be free from pits, scale, sand holes, or other defects.

1. Border Style: 1/4-inch single line with beveled edge.

2. Background: Leatherette.

3. Letters: Polished face – raised 1/8- inch.

4. Material: Cast bronze.

5. Size: 24" x 30"

6. Text: Size, style, and content shall be selected by Engineer (for bidding purposes only, text can cover as much as 60 percent of the total plaque surface).

7. Quanity: One (1).

8. Finish: As indicated in "Finish" article.

9. Color(s): As selected by Engineer.

F. Fasteners: Unless otherwise indicated, used concealed fasteners fabricated from metals that are noncorrosive to either the sign material or the mounting surface.

G. Anchors and Inserts: Use nonferrous metal or hot-dipped galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use toothed steel or lead expansion bolt devices for drilled-in-place anchors. Furnish inserts, as required, to be set into concrete or masonry work.

H. Provide posts for all exterior signs. Posts shall be 2" x 3 ¼" aluminum, durandic finish, color selected by Engineer.

2.03 FABRICATION

A. Graphic Image Process:
   1. Graphic Content and Style: Provide sign copy to comply with the requirements indicated for sizes, styles, content, positions, finishes and colors of letters, numbers, symbols, and other graphic devices as Scheduled at end of this Specification. Handicap access bathrooms shall have 1-1/4-inch-high lettering.

   2. Interior Panel Signs: Fabricate panel signs to comply with the requirements indicated for materials, thicknesses, finishes, colors, designs, shapes, sizes, and details of construction.

      a. Frames for Panel Signs: Fabricate frames from a continuous piece of extruded aluminum angle, 1/8-inch thick by 1/2-inch deep. Duranodic finish in a color selected by ENGINEER, square corners with no sharp edges, 1/8-inch backup plate, prepared for mechanical fastener mounting, and frame size to allow 1/16 inch reveal around sign insert.

      b. Raised Sign Panels: Signs shall be 1/8-inch-thick acrylic plastic with 1/32-inch raised letters and Grade 2 Braille complying with Americans with Disabilities Act (ADA) of 1990. Letters shall be of a contrasting color with their background. Braille shall be of an integral color and material with their background. Braille tags shall not be used.

B. Cast Metal Plaques: Fabricate cast plaques to comply with requirements specified for metal, border style, background texture, and finish. Produce castings free from pits, scale, and sand holes or other defects. Hand tool and buff borders and raised copy to produce the manufacturer's standard satin polished finish. Refer to "Finish" Article for other finish requirements. Plaque to be 24 inches by 30 inches by 1/2 inch, minimum. The inscription to be placed on the plaque will be furnished by ENGINEER after approval of the plaque manufacturer, and after OWNER provides the desired names, information, and text, which will be during the later stages of the construction period.

   1. Metal: Bronze.

   2. Border Style: 1.4-inch single line with beveled edge.

   3. Background Texture: Leatherette.

   4. Background Finish: Provide dark statuary finish to comply with the requirement specified and "Finish" Article for bronze finishes except provide background texture finish specified above in lieu of mechanical finish indicated.

C. Exterior Freestanding Signs:

   1. Non-illuminated Composite Fiberglass Box-Type Panels: Provide composite box sign message panel with molded fiberglass outer shell bonded to internal reinforcing. Comply with the following requirements:

      a. Panel Face: Seamless 0.125-inch-thick molded fiberglass.

      b. Finish: Manufacturer's standard semi gloss finish with ultraviolet inhibitors.

      c. Internal Panel Structure: Extruded aluminum frame supports with impregnated honeycomb core.

      d. Corner Condition: Square corners.

2. Copy Embedded in Fiberglass Panels: Apply computer-generated adhesive graphics to panel as a masking material. Apply acrylic polyurethane background color floodcoats, 0.015-inch minimum thickness. Include ultraviolet inhibitors. Remove masking material.

3. Post shall be 2-inch by 3-1/4-inch aluminum, duranodic finish, color to be selected by ENGINEER. Letter style, helvetica medium. Size of face panels, 36-inch by 60-inch.

2.04 FINISHES

A. Colors and Surface Textures: For exposed sign material that requires selection of materials with integral or applied colors, surface textures, or other characteristics related to appearance, provide color matches indicated, or if not indicated, as selected by ENGINEER from manufacturer's standards.

B. Metal Finishes: Comply with NAAMM "Metal Finishes Manual" for finish designations and application recommendations.

C. Aluminum Finishes:

1. Baked Enamel Finish: Provide finish AA-M4xC12C42RIx (manufacturer's standard nondirectional mechanical finish including sanding and filing, cleaning with inhibited chemicals, conversion coated with an acid-chromate-fluoride-phosphate treatment, and painted with organic coating specified below).

a. Organic Coating: Provide manufacturer's standard thermosetting enamel system consisting of a prime coat and a finish coat.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Locate sign units and accessories where shown or Scheduled, using mounting methods of type described and in compliance with the manufacturer's instructions, unless otherwise indicated. If location is not shown or Scheduled, it shall be as directed by ENGINEER.

1. Install sign units level, plumb, and at the height indicated with sign surfaces free from distortion or other defects of appearance.

B. Wall-Mounted Panel Signs: Attach panel signs to wall surfaces using the methods indicated below:

1. Vinyl Tape Mounting: Use double-sided foam tape, of the thickness indicated, to mount signs to smooth non-porous surfaces. Do not use this method for vinyl-covered or rough surfaces.

2. Silicone Adhesive Mounting: Use standard liquid silicone adhesive recommended by the sign manufacturer to attach sign units to irregular, porous, or vinyl-covered surfaces. Use double-sided vinyl tape where recommended by the sign manufacturer to hold the sign in place until the adhesive has fully cured.

C. Cast Metal Plaques: Mount cast plaques using the standard fastening methods recommended by manufacturer for type of wall surface indicated.

1. Concealed Mounting: Mount the plaques by inserting threaded studs into tapped lugs on the back of the plaque. Set in pre-drilled holes filled with quick-setting cement.

D. Exterior Freestanding Signs: Signposts shall be embedded in concrete footings of depth and diameter to support panel against 100-mile per hour wind load. Install level, plumb, and at the indicated finished grade. Installation of sign units shall be as directed by ENGINEER. Repair or replace damaged units as directed by ENGINEER.

3.02 CLEANING AND PROTECTION

A. At completion of installation, clean soiled sign surfaces in accordance with manufacturer's instructions. Protect units from damage until acceptance by OWNER.

SIGNAGE SCHEDULE

BUILDING/TYPE	TEXT	QUANTITY	SIZE	STYLE	COLOR	REMARKS
SAFETY AND RESTRICTIVE SIGN						
	NON POTABLE WATER	5	10x14	AS SELECTED	AS SELECTED	Exterior
	WARNING AREA UNDER 24-HR VIDEO SURVEILLANCE	2	10 x 14	AS SELECTED	AS SELECTED	Exterior
	AUTHORIZED (PERSONNEL ONLY)	2	10 x 14	AS SELECTED	AS SELECTED	Exterior
	CONFINED SPACE ENTRY - AUTHORIZED PERSONNEL ONLY	18	10x14	AS SELECTED	AS SELECTED	Exterior
PLANT ENTRANCE						
	OWNER SELECTED	1	36 x 60	AS SELECTED	AS SELECTED	Exterior

END OF SECTION

SECTION 10441 - FIRE EXTINGUISHERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

1.02 SUBMITTALS

A. Product Data: For each type of product.

B. Warranty: Sample of special warranty.

C. Operation and maintenance data.

1.03 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period; warranty period shall be six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

2.02 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each mounting bracket indicated.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Larsen's Model MP20 Steel Cylinder fire extinguisher or comparable product by one of the following:

    a. Ansul Incorporated.

    b. Buckeye Fire Equipment Company.

    c. Guardian Fire Equipment, Inc.

    d. JL Industries, Inc.; a division of the Activar Construction Products Group.

2. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B.

B. Multipurpose Dry-Chemical Type: UL-rated 10A-120B:C nominal capacity, with monoammonium phosphate-based dry chemical in manufacturer's standard enameled container.

2.03 MOUNTING BRACKETS

A. Mounting Brackets: Manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or red baked-enamel finish.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Larsen's Model 864 mounting bracket or comparable product by one of the following:

a. Ansul Incorporated.

b. Buckeye Fire Equipment Company.

c. Guardian Fire Equipment, Inc.

d. JL Industries, Inc.; a division of the Activar Construction Products Group.

B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.

1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.

a. Orientation: Horizontal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Examine fire extinguishers for proper charging and tagging.

1. Remove and replace damaged, defective, or undercharged fire extinguishers.

B. Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.

1. Mounting Brackets: 54 inches above finished floor to top of fire extinguisher.

C. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated, with appropriate fasteners.

END OF SECTION

DIVISION 11

EQUIPMENT

SECTION 11133 - SUBMERSIBLE SUMP PUMPS

PART 1 - GENERAL

1.01 REQUIREMENTS

A. The Contractor shall furnish and install submersible non-clog sump pumps at the locations shown on the Drawings and as specified herein. All pumps shall be supplied by the same manufacturer.

B. Equipment shall be provided in accordance with the general requirements of these contract documents.

1.02 OPERATING CONDITIONS AND PERFORMANCE REQUIREMENTS

A. Sump Pump Schedule:

Item	Sump Pump
Arrangement	Duplex
Design Capacity (gpm)*	96
Total Dynamic Head (ft.)	31
Motor Horsepower	3
Max. Pump Speed (rpm)	3,450
Min. Size of Solids (in.)	¾"
Discharge Diameter (in.)	3"
Area Classification	Class 1, Division 1, Group D

1.03 SUBMITTALS

A. The following items shall be submitted with the Shop Drawings in accordance with, or in addition to the submittal requirements specified in Section 01300, Submittals:

1. Equipment and motor nameplate data
2. Complete electrical schematic wiring diagram drawings.
3. Copies of certified shop test reports.
4. Spare Parts List
5. Field test results.
6. Certificates of installation.
7. Operation and Maintenance Manuals

1.03 WARRANTY AND GUARANTEE

A. Warranty and Guarantee shall be as specified in Section 01782 with the exception that the warranty period shall be for two (2) years.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. The pumps shall be submersible grinder sewage pumps as manufactured by Myers, Zoeller, KSB Amarex or approved equal.

2.02 MATERIALS

A. Pump Construction - The lifting cover, stator housing, and volute casing shall be close grained cast iron conforming to ASTM A48-Class 25 through 35. All exposed nuts, bolts, washers, and other fastening devices shall be Type 304 stainless steel.

B. Casing shall be completely open from suction to discharge with no wearing rings or impeller faceplates required. All internal case clearances shall be equal to the inlet diameter so that all materials which will pass through the inlet can pass through the pump.

C. Impeller shall be of either the flow through or recessed design. The impeller shall be secured to the motor shaft per manufacturers recommendations.

D. Shafting shall be constructed of high grade carbon steel, Grade 1045 (minimum), for the pump and motor, and sufficiently large in diameter to transmit safely the maximum torque developed by the drive unit and of such a design as to provide a rigid support for the impeller and to prevent excessive vibration. The shaft shall be suitably heat-treated, turned, ground, and polished over its entire length. The shaft shall be protected from wear through the seal box by a removable hardened 416 stainless steel shaft sleeve with seal to prevent leakage under the sleeve.

E. Shaft Seal for the pump and motor shaft shall utilize a mechanical seal. The mechanical seal shall consist of carbon and ceramic seal faces running in an oil-filled chamber to provide constant lubrication, BUNA N or ethylene propylene flexible members, brass or stainless steel metal parts and 18-8 stainless steel spring.

F. Bearings shall be of the anti-friction ball or roller type. Bearings shall be heavy-duty, permanently oil lubricated which will carry all radial and axial thrust loads. Bearings shall have a minimum AFBMA L-10 life of 30,000 hours under worst possible operating conditions.

2.03 ELECTRICAL AND CONTROL REQUIREMENTS

A. All electrical appurtenances shall be rated for installation in classified areas as indicated in the Sump Pump Schedule.

B. Motors shall conform to all applicable parts of Section 16220. The pump motor shall be designed for 480 volt, 60 Hertz, three-phase operation. See sump pump schedule for motor horsepower. Motors shall be mounted on each pump and shall conform to the latest applicable NEMA, IEEE, and ANSI standards for submersible service. The motors shall be rated for continuous duty with a minimum service factor of 1.15.

1. The pump motor shall be squirrel-cage induction type, housed in a watertight chamber.

2. The stator winding and stator leads shall be moisture resistant.

3. Insulation shall be manufacturer's premium grade Class F insulation rated 155 degrees Celsius, 40 degrees Celsius ambient plus 115 degrees Celsius rise. The stator shall be dipped and baked three times in Class F varnish and shall be heat-shrink fitted into the stator housing.

4. The use of bolts, pins, or other fastening devices requiring penetration of the stator housing shall not be allowed.

5. The motor shall be guaranteed for continuous unsubmerged duty, capable of sustaining a minimum of ten (10) starts per hour without overheating.

6. The motor shall be provided with pre-lubricated radial and thrust bearings which are designed to carry the entire load which may be imposed upon it under all operating conditions.

7. All motors shall be of nationally known manufacture and shall be housed in enclosures specifically designed for submersible pump application.

C. The cable entry water seal design shall insure a watertight and submersible seal.

1. The junction chamber, containing the terminal board, shall be sealed from the motor by elastomer compression O-ring seal.

2. Connection between the cable conductors and stator leads shall be made with threaded compressed type binding post permanently affixed to a terminal board and thus perfectly leak proof.

D. Power and control cables between the pumps and the control panel shall be provided by the pump manufacturer who shall be responsible for reviewing the electrical drawings as necessary to determine the required cable length. All pumps for the same application shall be provided with the same length of cable. No splices shall be allowed unless specifically called for in the electrical drawings. Cable shall be hypalon jacketed SPC cable suitable for submersible pump applications and shall be sized according to NEC and ICEA standards. Stainless steel strain relief connectors shall be furnished for all cables.

E. Float switches shall be provided with the pump controls. Float switches shall comply with requirements specified under Division 17, Control and Information System. Float switches shall be set and shall operate according to the sump pump schematic and installation details shown on the Drawings and as specified herein. Float switches to be installed in classified areas shall be intrinsically safe and suitable for use in the classified area as specified in the Sump Pump Schedule.

2.04 SPARE PARTS

A. Spare parts shall be provided in accordance with these contract documents and shall include the following for each size pump:

Two (2) - sets of seals, "O" rings
One (1) – spare pump

PART 3 - EXECUTION

3.01 SHOP TESTING

A. Shop testing shall be in accordance with applicable standards and with the following additional requirements:

1. Prior to shipment, Manufacturer shall submit certified pump curve for each pump for approval.

3.02 FIELD TESTING

A. Field testing shall be in accordance with Section 01400 and these contract documents.

END OF SECTION

SECTION 11252 - VERTICAL MOUNTED SCREEN

PART 1 - GENERAL

1.01 SCOPE OF WORK

The Contractor shall furnish, install and place into satisfactory operating condition, one (1) vertical mount deflection screens. Each screen shall consist of a screen frame, bar rack assembly, cleaning carriage assembly, overflow weir, hydraulic power pack, external supports and controls, and all other appurtenances required or shown on the drawings.

1.02 DESIGN CRITERIA

Number of screens	1	
Designed for a peak flow Q_{max} of:	7.3	MGD
Total unobstructed open screening area:	8.5	sf
Bar Screen opening:	4	mm
Max Screen length:	9.3	ft
Screen height:	3	ft
Max velocity through open area at peak flow:	5	ft/s

1.03 SUBMITTALS

A. Copies of all materials required to establish compliance with these specifications shall be submitted for review. Submittals shall include at least the following:

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with each paragraph check-marked to indicate specifications compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. I deviation from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. **Failure to include a copy of the marked-up specifications sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.**
2. Certified general arrangement drawings showing all important details including materials of construction, dimensions, loads on supporting structures, and anchor bolt locations.
3. Descriptive literature, bulletins and/or catalogs of the equipment.
4. Complete data on motors and gear reducers.
5. Wiring diagrams and electrical schematics for all control equipment to be furnished.

1.04 EXPERIENCE AND QUALIFICATON

A. To show evidence of being able to provide the quality of equipment and services described in this specification, the equipment supplier shall submit their quality system ISO 9001 certification. The quality procedures shall provide for a means of qualifying all sub-vendors and shall specify that the fabrication facility is a critical vendor and shall require inspection. The quality system shall be audited by a third party independent inspector. Certification shall remain in effect throughout the project startup.

B. Due to the special importance of proper functioning of the equipment specified in this section to the satisfactory operation of the entire treatment system, the Contractor shall demonstrate in

writing, to the satisfaction of the Owner at the time of the shop drawing submittal that the manufacturer has produced the specified type and size of equipment for CSO service that has been in successful operation for a minimum period of five years prior to the bid date.

C. In the event the Contractor elects to install equipment whose manufacturer cannot comply with the above experience requirement, then the Contractor shall submit with shop drawings, appropriate bonds or deposits guaranteeing replacement of the equipment in the event of a failure for a period of three years after warranty: Such three-year period shall start upon termination of the Contractor's basic warranty and guarantee obligations under the Contract.

D. During such three-year period the Contractor shall repair, modify or replace the equipment in a manner acceptable to the Owner, if in the opinion of the Owner, the operation of the equipment is unsatisfactory.

1. Normal wear or malfunctions due to neglect or abuse will not be considered justifiable reasons for unsatisfactory operation.

2. In the event the Owner determines the operation of the equipment to be unsatisfactory during this three year period and the Contractor fails to correct the deficiencies within six months from the time the Contractor is first notified in writing that such deficiencies exist, the Owner will make the necessary repair or replacement and deduct such costs from the aforementioned bonds or deposits of the Contractor.

PART 2 PRODUCTS

2.01 MANUFACTUER

A. The mechanical screening equipment manufacturer and model shall be the following:

1. WesTech CleanFlo™ ROMAG Screens Model RSW 8x2/4.

2.02 GENERAL DESIGN

A. Functional Description: The influent stream to be screened will be introduced to the screen during wet weather event. Solids will be retained in the normal wastewater channel and will be carried away with the wastewater to a downstream treatment facility. Screened overflow will be discharged as outfall to a receiving body of water.

B. Materials of Construction: All wetted parts shall be constructed from high strength plastic or stainless steel. Electrical devices, motor and power packs shall be of the manufacturer's standard materials.

C. Shop Surface Preparation/Coating: All welds shall be cleaned and passivated to remove weld spatter, slag and discoloration. Electrical devices, motor and power packs shall be provided with the manufacturer's standard coating system.

2.03 FINE SCREEN ASSEMBLY

A. Frame: The screen frame shall be a rectangular support structure that provides stability for the screen, the required mounting surface for the bar rack assembly, and the guiding surfaces for the traveling cleaning carriages.

1. The unit frame shall be designed to be anchored at the base and sides of the screen. The frame will be a welded construction, fabricated of formed stainless sheet and plate from type 304L stainless steel.

2. One side member will be drilled and tapped for mounting of the stationary end of the bar rack assembly.

3. A machined mounting block will be welded to the opposite side member for mounting of the tensioning end of the bar rack assembly.

B. Control Weir:

1. The control weir shall be fastened to the discharge side of the screen to provide the desired water elevation and flow velocity through the screen.
2. The weir shall be constructed of type 304L stainless steel.

C. Bar Rack Assembly:

1. The bar rack assembly will consist of parallel stainless steel bars secured to the screen frame with specially designed end blocks. Spacing between each bar will be 4 mm (0.16 inch).

2. Each bar will be made of minimum 4 mm (0.16 inch) type 304L stainless steel and will be continuous from one end of the screen to the other. Designs without continuous bars will not be allowed.
3. The end sections of each bar will be designed to facilitate the removal of solids from the bar rack. A hole will be drilled at both ends of each bar to allow the bars to be secured to the end blocks.

4. Modular end blocks will be made from type 304L stainless steel. Each end block will be machined to secure a set of bars to the screen frame. Bars will be fastened to each end block with a stainless steel pin connection. Modular end blocks will be stacked to provide the necessary screen height.

5. Stationary end blocks will be provided at the fixed end of the bar rack assembly. These end blocks will be fastened directly to the screen frame.

6. Tensioning end blocks will be provided at the opposite end of the bar rack assembly. Tensioning end blocks will be a floating-type connection to be tensioned after securing the frame to the concrete structure. As torque is increased on the bolts, the tension end blocks will be pulled, creating the required pre-tension on the bars.

7. Designs which do not incorporate a bar tensioning feature are specifically excluded.

D. Cleaning Carriage Assembly:

1. The cleaning carriage will consist of sets of cleaning tines mounted on a traveling carriage assembly. Travel of the carriage assembly will be provided by a hydraulic cylinder. Each set of cleaning tines will travel forward and backward across a section of the screen length. The travel distance of each set of cleaning tines will overlap the travel distance of the adjoining set. The shape of the tines will be designed to move accumulated solids forward during forward travel of the carriage, and to allow accumulated solids to pass over during backward travel of the carriage assembly. The travel distance overlap and tine shape will allow solids to be transported to the end of the screen.

2. The carriage assembly will consist of tine support members fastened together by cross-member angles. Slide blocks mounted on the carriage assembly will guide the travel of the carriage.

3. Each tine support member will be fabricated of type 304L stainless steel angles welded to each side of a type 304L stainless steel structural tube. The flanking angles will provide a mounting surface for the cleaning tines. Mounting tabs will be welded to the tube for attachment of the cross-member angles.

4. The cross-member angles will be structural angles made of type 304L stainless steel. Both cross-member angles will be fastened to the top and bottom of all tine support members to provide an integral carriage assembly. A mounting bracket will be welded to the top cross-member to provide a clevis-type mount for the rod end of the hydraulic cylinder.

5. Slide blocks made of UHMW polyethylene will be fastened to the top and bottom cross-member angles.

E. Cleaning Tines:

1. Cleaning tines will be provided in replaceable sections. The standard cleaning tine section will be machined from a block of UHMW polyethylene.

2. The end cleaning tine sections will consist of individual tines fastened to a UHMW PE mounting block. Each individual tine will be made of alloy bronze. The extended shape of the end tine will push accumulated solids past the end of the bars.

F. Overflow Weir:

1. A stainless steel overflow weir will be fastened to the top of the screen frame. It will provide protection of the hydraulic cylinder and ensure that emergency overflow water flows smoothly over the top of the screen into the outfall channel.

2. The overflow weir, fabricated of type 304L stainless steel, will extend the length of the screen. In the width direction, the shroud will extend beyond the cleaning carriage assembly.

G. Hydraulic Cylinder

1. A stainless steel hydraulic cylinder will be mounted above the carriage assembly. The housing of the cylinder will be secured to the screen frame, while the rod end will be pinned to the clevis bracket on the top cross-member of the carriage assembly.

2. The piston rod will be made of hard chrome plated carbon steel. The rod end will be supplied with an eye bolt fitted with a bronze bushing. The rod end will be connected to the clevis bracket with a stainless steel pin, secured by two (2) cotter pins.

H. Hydraulic Hoses and Carrier Conduit

1. Hydraulic hoses will be constructed of synthetic rubber with double wire braid reinforcement and synthetic rubber cover. Hydraulic hoses will have a nominal inside diameter of 0.5-inch.

2. Manufacturer to provide four (4) 48 inch hydraulic hoses with stainless steel JIC fittings on each end.

3. The Contractor shall coordinate with the manufacturer to provide additional hose of adequate length to connect the hydraulic power pack to the mechanical screen. This field hydraulic hose, rated for a working pressure of 4,250 PSI, shall be Parker 302 or Engineer approved equal. Hydraulic hose shall be No-Skive SAE 100R2 Tper AT, ½-inch I.D., 7-inch minimum bend radius, rated for -40° F to 212° F. Field hydraulic hose buried and in structure shall be routed through continuous smooth bore stainless steel pipe (Or polyethylene carrier pipe continuous, smooth wall, and without joints for the entire length). All pipe bends shall be long radius sweeps exceeding the allowable radius bend of the hydraulic hose. End fittings will be #8 JIC female swivel.

4. The Contractor shall supply proper hydraulic hose clamp system as manufactured by Hydro-Craft, Hydac, or approved equal. Hydraulic hoses need to be supported and secured to prevent hose vibration, movement, and abrasion from rubbing on any surface which may cause premature failure.

5. Hydraulic Conduit: The contractor shall provide two inch (2-inch) type 304L stainless steel hydraulic conduit for each pair of hydraulic hose from the power pack to the mechanical screen.

6. Contractor shall provide watertight seals for the annular space between the 2-inch sst conduits and the hydraulic hoses at the equipment building housing the power pack and at the mechanical screen. Seals shall be OZ-Gedney, CSBI-200P-1, conduit sealing bushings, segmented with sleeves, pressure rings, grommets, screws, clamps and all accessories.

I. Hydraulic Power Pack.

1. The hydraulic cylinder will be driven by a remote- mounted hydraulic power pack. The hydraulic power pack will be mounted indoors protected from freezing temperatures and weather conditions. The hydraulic power pack will include the following:

    1. Hydraulic gear pump
    2. Replaceable suction filter
    3. 5 HP, 1800 RPM, 230/460 volt, 3 Phase, 60 Hz, TEFC, severe duty electric motor
    4. 10 gallon capacity oil reservoir
    5. 0-3000 psi pressure gauge
    6. Pressure transducer, 4-20 mA, NEMA 4 enclosure.
    7. Pressure limiting/relief valve
    8. Directional control valves, 4 way, 3 position, double solenoid, spring return to all ports, Burna seals, 120 VAC coils, ½" NPT conduit box rated for NEMA 4.
    9. Replaceable oil filter
    10. Filler/breather cap with strainer
    11. Combination Oil Level Low/Temperature switch, snap action switching element for oit level low and high temperature, NEMA 4 enclosure.
    12. The hydraulic pressure of the cleaning carriage cylinder will be monitored by a pressure transducer which will produce an analog signal that will be sent to the PLC in the control panel.
    13. The oil reservoir will be constructed of welded carbon steel and provided with a gasket bolt-on lid.
    14. Hydraulic fluid shall be supplied and as recommended by the screening manufacturer.
    15. Viscosity @ 40°C shall be no less than 26.9 centistokes.
    16. Viscosity @ -40°C shall be no less than 85.0 centistokes.

J. External Supports:

1. External supports will be furnished by the equipment supplier to provide structural stability for the screen.

2. The supports will be made from type 304L stainless steel structural tubing. Support locations, lengths and means of attachment shall be as per the manufacturer's recommendations.

K. Spare Parts: The following spare parts will be furnished:

1. Two (2) Cleaning Tine Sections (Standard)
2. Two (2) Cleaning Tine Section (End)
3. Two (2) oil filters
4. One (1) spare ultrasonic level controller and sensor

2.04 ANCHORAGE AND FASTENERS:

A. Anchor Bolts: All anchor bolts shall be a minimum of 1/2 inch diameter and made of type 304L stainless steel. The equipment supplier shall furnish all anchor bolts, nuts, and washers required for the equipment.

B. Fasteners: All fasteners shall be type 18-8 stainless steel. The equipment supplier shall furnish all fasteners required for the assembly of the equipment.

2.05 CONTROLS

A. Control Devices: All controls necessary for the fully automatic operation of the screen shall be provided. The equipment supplier shall furnish all electrical items specifically called for in this specification section. The Contractor shall supply all other electrical items, and interconnecting wiring of proper size, including all conduit and supports required to place the equipment into service.

B. Ultrasonic Level Controller: A 120V controller shall be provided in a windowed NEMA 4X polycarbonate enclosure suitable for wall mounting, to receive and interpret a 4-20mA scaled signal from an upstream and downstream transducer. The controller shall have 6 internal relays and provide an LCD display and handheld programmer for use interface.

C. Ultrasonic Level Transducer: One (1) ultrasonic level transducer shall be provided with type 304 stainless steel mounting brackets and expansion anchors. Each sensor shall have an ETFE housing with an integral sensor to provide compensation for acoustic variations due to temperature. Each sensor shall have a range of 1-33 ft and be supplied with a 30 ft integral cable. Interconnecting cable between the sensors and the ultrasonic level controller must be 3-wire shielded cable, run through a separate raceway.

D. Control Panel: A 460 volt primary control panel will be provided in a NEMA 12 wall mount control panel. A 460 volt main disconnect switch, a non-reversing motor starter, and a 460 to 120 volt step down transformer will be provided in the panel. The panel will contain the following logic devices for proper operation of the equipment:

1. Indicating Lights, push-to-test LED type:

    1. Oil Temperature FAULT
    2. Low Oil Level FAULT
    3. Screen RUNNING
    4. Carriage Stroke Reduced FAULT
    5. Carriage Blocked FAULT
    6. Loss of Pressure Signal FAULT
    7. Motor Overload FAULT
    8. High Screen Level FAULT

2. Pushbuttons:

    1. EMERGENCY STOP
    2. FAULT RESET

3. Programmable Logic Controller, Allen Bradley MicroLogix 1400 or CompactLogix with Operator Interface Unit, Allen Bradley Panelview C400. Ethernet port is required.

4. Elapsed Time Meter.

5. Contact outputs for connection to SCADA:

1. Motor running.
2. Motor overload.
3. High oil temperature.
4. Low oil level.
5. E-stop.
6. Carriage stroke reduced.
7. Carriage blocked.
8. Loss of pressure signal.

6. Analog outputs to WWS Control Panel
   1. Diversion Structure Level

7. Inputs from WWS Control Panel
   1. Screen system Inhibit – to stop operation of the screen regardless of level.

E. SEQUENCE OF OPERATION

1. Screen Hand Operation: When the screen selector switch is in the Hand position, the screen will run continuously forward and backward. Turning the screen selector switch to Off will return to home position and stop the unit.
2. Screen Automatic Operation: When the screen selector switch is in the Auto position and when not inhibited by the WWS CP, the screen will cycle on demand by the level sensor or repeat cycle timer. After the level sensor condition has cleared, the screen shall continue to run for an off delay time to prevent excessive starting and stopping of the unit. The repeat cycle timer shall reset after the screen is called to run by the level sensor. During each stop, the carrier will return to its home position.
   a. Upper level sensor initiates travel of assembly
   b. Assembly travels continuously until lower level sensor detects a low water level. Assembly continues to run 0 to 15 minutes (as set by the off-delay timer).
   c. In order to ensure that the screen is operational a the time of a rain event, it is automatically put into operation every week for 5 minutes. If a failure occurs, an alarm will be reported.
3. Fault Conditions:
   a. Excessive motor current will trip the starter overload relays, immediately stop the power pack motor, and illuminate the alarm indicating light. This fault must be reset by depressing the motor starter overload reset internal to the control panel.
   b. Momentary motor over current will trip the current monitor, immediately stop the drive motor, and illuminate the alarm indicating light. Pushing the reset pushbutton will reset this fault.
   c. High Oil Temperature. If the oil temperature exceeds 140° F, the high temperature will close, the screen will shut down and the illuminate the High Oil Temperature fault light. When the oil temperature cools below 140° F, the screen starts again. The high temperature fault light remains illuminated until acknowledged.
   d. Low Oil Level. If the oil level in the reservoir drops below the low level switch, the switch will close, the screen will shut down and illuminate the Low Oil Level fault light.
   e. Carriage Stroke Reduced Fault. The pressure transducer mounted on the hydraulic power pack will continuously monitor the operating pressure of the unit. The pressure transducer will output a 4-20 mA signal. If the pressure spikes five (5) times in 10 second (adjustable) period, the screen will shut down and illuminate the Carriage Stroke Reduced Fault light.

f. Carriage Blocked Fault. If the preset maximum pressure measured by the pressure transducer is maintained for longer than 30 seconds, the screen will shut down and illuminate the Carriage Blocked Fault light.

g. Loss of Pressure Signal Fault. If the control panel does not receive a 4-20 mA signal from the pressure transducer for 2 minutes the screen will shut down and illuminate the Loss of Pressure Signal Fault.

h. High Screen Level Fault. If the water level during a bypass condition exceeds a pre-set level, the screen will shut down and illuminate the High Screen Level Fault.

i. All faults may be reset by pressing the FAULT RESET push button after the cause of the fault is corrected.

PART 3 EXECUTION

3.01 GENERAL

A. The equipment shall be installed properly to provide a complete working system. Installation shall follow the supplier's recommendations. Take great care to keep the hydraulic tubing for the hydraulic power pack free from debris during installation.

B. Contractor shall coordinate with the screen manufacturer to provide the exact dimensions of the screen openings required for proper installation.

C. The concrete dimensions and tolerances, and concrete finish as shown on the Contract Drawings are required for the proper installation and operation of the screening system. No deviations will be permitted from the dimensions and tolerances on the approved drawings.

3.02 HYDRAULIC HOSE OR TUBING INSTALLATION

A. All turns shall be made with long radius bends and not 90 degrees. Hose and tube connections shall be JIC fittings.

B. Do not use Teflon Tape on any connection for hydraulic piping. Use only pipe dope suitable for use with hydraulic oil.

C. Provide a continuous fall in tubing from the power pack to the screen. No high spots in the tubing are allowed, which can trap air. If high spots are unavoidable, provide air bleed devices at each high point in the line.

D. Secure tubing and hoses to prevent movement.

E. Flush hydraulic lines to prevent dirt and metal shavings from fouling the hydraulic system. Cap all ends to prevent dirt from contaminating tubing lines. Upon completion of all field tubing, but before connection to control components, clean the tubing system by circulating oil continuously at a rate of not less than 12 fps. Filter the hydraulic oil through a 2 micron filter for a period of not less than 24 until the filter fails to retain any particulate material during a filter run o not less than 1 hour duration, whichever is the greater period of time.

F. Proper precautions should be taken to avoid contamination of hydraulic lines and equipment during storage and installation.

3.03 MANUALS

The equipment supplier shall furnish copies of operation and maintenance manuals which will be retained at the installation site to assist plant operators. The manual shall include the supplier's erection and assembly recommendations, a complete parts list, and a list of recommended spare parts.

3.04 SHOP ASSEMBLY

The equipment specified herein shall be completely factory assembled and inspected prior to shipment.

3.05 FIELD SERVICES

A. The equipment supplier shall provide the service of a qualified representative for three (3) trips and four (4) days to inspect the equipment installation, assist in start-up, and instruct plant personnel in the proper operation and maintenance of the equipment.

B. Perform operating tests to demonstrate the units turn on and off based on the required level sensor settings and that the equipment operates without excessive vibration. Make adjustments required to place equipment in proper operating condition. Submit report of test results.

END OF SECTION

SECTION 11285 - SLIDE GATES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Gates shall be furnished with all necessary accessories for a complete installation and shall be the latest standard products of a manufacturer regularly engaged in the production of equipment of this type. All slide gates shall be furnished by the same manufacturer.

B. Electrical actuators shall comply with Section 16225.

1.02 SUBMITTALS

A. Descriptive literature, catalog cuts, and dimensions\al prints clearly indicating all dimensions and materials of construction, shall be submitted on all items specified herein. Detailed wiring diagrams and information shall be submitted on the electric actuators.

B. Comply with the requirements of Section 01300.

PART 2 - PRODUCTS

2.01 MANUFACTURER

A. Gates shall be Series 25 (Channel Gates) and Series 20 (Sluice Gates) as manufactured by H. Fontaine Ltd., Waterman, or approved equal.

2.02 STAINLESS STEEL SLUICE GATES

A. Gates and operators shall be supplied with all the necessary parts and accessories indicated on the Drawings, specified herein, or otherwise required for a complete properly operating installation and shall be the latest standard product of a manufacturer regularly engaged in the production of stainless steel water control gates.

B. Except as modified or supplemented herein, all gates and operators shall conform to the applicable requirements of AWWA C501 (latest edition).

C. Gates shall be substantially watertight under the design head conditions (maximum design head shall be taken as the height of the slide unless otherwise specified). Leakage shall not exceed 0.05 gallon per minute per foot of seal periphery under the design seating head and 0.10 gallon per minute per foot of seal periphery for the design unseating head of under 20 feet. For an unseating head of 20 feet or more, the maximum allowable leakage shall not exceed the rate per foot of perimeter specified by the following equation:

Gallon per minute per foot of perimeter = 0.10 + [0.0025 x (unseating head in feet – 20)]

The gate's sealing system shall have been tested through a cycle test in an abrasive environment and should show that the leakage requirements are still obtained after 25,000 cycles with a minimum deterioration. Certification of this testing shall be provided to the Engineer or Owner upon request.

D. Gates shall be self-contained of the rising stem configuration. Self contained gates shall be provided with a yoke made of structural members or formed plates. The maximum deflection shall be 1/360 of the gate's span.

E. Gate frames shall be constructed of structural members or formed plate welded to form a rigid one-piece frame. The frame shall be suitable for mounting on a concrete wall at the end

of a pipe opening. The frame configuration shall be of the flush-bottom type and shall allow the replacement of the tope and side seals without removing the gate frame from the wall.

F. The slide shall consist of a flat plate reinforced with formed plates or structural members to limit its deflection to 1/720 of the gate's span under the design head.

G. The guides shall be made of UHMWPE and shall be of such length as to retain and support at least two-thirds (2/3) of the vertical height of the slide in the fully open position.

H. The side seals for gates shall be made of UHMWPE of the self-adjusting type. A compression cord shall ensure contact between the UHMWPE guide and the gate in all positions. The sealing system shall maintain efficient sealing in any position of the slide and let the water flow only below the slide plate. The bottom seal shall be made of resilient neoprene set into the bottom member of the frame and shall form a flush-bottom.

I. 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 lb. effort on the crank or handwheel. The stem shall have a slenderness ratio (L/R) less than 200. The threaded portion of the stem shall have machined cut threads of the Acme type. Where an electric operator is used, the stem design force shall not be less than 1.25 times the output thrust of the electric motor in the stalled condition. For stems in more than one piece and with a diameter of 1¾ inches and larger, the different sections shall be joined together by solid couplings. Stems with a diameter smaller than 1¾ inches shall be pinned to an extension tube. The couplings shall be grooved and keyed and shall be of greater strength than the stem.

J. Gates having width equal to or greater than two (2) times their height shall be provided with two (2) lifting mechanisms connected by a tandem shaft.

K. Stem guides shall be fabricated from type 304L stainless steel and shall be equipped with an UHMWPE bushing. Guides shall be adjustable and shall be spaced in accordance with the manufacturer's recommendation. The L/R ratio shall not be greater than 200.

L. Rising stem gates shall be provided with a clear polycarbonate stem cover. The stem cover shall have a cap and condensation vents as well as clear mylar position indicating tape. The tape shall be field applied to the stem cover after the gate has been installed and positioned.

M. Manual operators shall be provided by the gate manufacturer and shall be crank or handwheel operated as indicated in the Schedule. Each operator shall be designed to operate the gate under the maximum specified seating and unseating heads by using a maximum effort of 40 lb. on the crank or handwheel, and shall be able to withstand, without damage, an effort of 80 lb.

N. All bearing 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. The crank shall be removable and fitted with a corrosion resistant rotating handle. The maximum crank radius shall be 15 inches and the maximum handwheel diameter shall be 24 inches.

O. Materials for the gate shall be as follows:

Part	Material
Frame, Yoke, Stem Guides, Slide, Stem Extension	Stainless Steel ASTM A-276, Type 304L
Side Seals, Stem Guide Liner	UHMWPE ASTM D-4020
Bottom seal	Neoprene ASTM D-2000, Grade 2 BC-510
Compression cord	Nitrile ASTM D-2000 M6BG 708, A14, B14, EO14, EO34
Threaded stem	Stainless Steel ASTM A-276, Type 303 MX
Fasteners	ASTM F593 and F594, GR1 for Type 304 and GR2 for Type 316
Pedestal, Handwheel, Crank	Tenzaloy aluminum
Gasket (between frame and wall)	EPDM ASTM 1056
Stem Cover	Polycarbonate ASTM A-707
Lift Nut	Manganese bronze ASTM B584 Alloy 432

E. Refer to Section 16225 – Electric Valves/Gate Actuators for actuator requirements.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Sluice gates shall be installed in accordance with the manufacturer's recommendations.

END OF SECTION

SECTION 11290 - INTERIOR PROCESS PIPING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide all labor, materials, equipment and services required to furnish and install all plant process piping as shown on the Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Interior Process Valves: Section 11295

B. Water Piping: Section 02505

C. Valves: Section 02515

D. Piping furnished with equipment is included in the specific equipment item.

1.03 SUBMITTALS

A. The Contractor shall comply with the requirements of Section 01300 of these specifications.

B. A notarized certification shall be furnished for all pipe and fittings which verifies compliance with all applicable specifications.

PART 2 - PRODUCTS

2.01 DUCTILE IRON PIPE/DUCTILE IRON FITTINGS

A. Unless otherwise noted or required, all inside ductile iron piping shall be flanged pipe with threaded flanges in accordance with AWWA C 115. All piping flanges shall have ring gaskets, 1/8-inch thick.

B. All exposed iron pipe to be field painted shall be furnished with an external coating of rust inhibitive primer, such as Tnemec Series 1 OmniThane, Sherwin-Williams Corothane I GalvaPac, or equal. Pipe manufacturer shall be responsible for compatibility of shop applied coatings with the field paint systems and products specified in Division 9, Section 09961. Do not apply asphalt or bituminous coatings on pipe to be painted.

C. Protecto 401 Ceramic Epoxy Interior Lining

1. Condition of ductile iron prior to surface preparation

   All ductile pipe and fittings shall be delivered to the application facility without asphalt, cement lining, or any other lining on the interior surface. Because removal of old linings may not be possible, the intent of this specification is that the entire interior of the ductile iron pipe and fittings shall not have been lined with any substance prior to the application of the specified lining material and no coating shall have been applied to the first six inches of the exterior of the spigot ends.

2. Lining Material

   The standard of quality is Protecto 401™ Ceramic Epoxy. The material shall be an amine cured novolac epoxy containing at least 20% by volume of ceramic quartz pigment. Any request for substitution must be accompanied by a successful history of lining pipe and fittings for sewer service, a test report verifying the following properties,

and a certification of the test results.

a. A permeability rating of 0.00 when tested according to Method A of ASTM E-96-66, Procedure A with a test duration of 30 days.

b. The following test must be run on coupons from factory lined ductile iron pipe:

(1) ASTM B-117 Salt Spray (scribed panel) - Results to equal 0.0 undercutting after two years.

(2) ASTM G-95 Cathodic Disbondment 1.5 volts @ 77°F. Results to equal no more than 0.5 mm undercutting after 30 days.

(3) Immersion testing rated using ASTM D-714-87.

i. 20% Sulfuric acid—No effect after two years.

ii. 140°F 25% Sodium Hydroxide—No effect after two years.

iii. 160°F Distilled Water—No effect after two years.

iv. 120°F Tap Water (scribed panel)—0.0 undercutting after two years with no effect.

(4) ASTM G-22 90 Standard practice for determining resistance of Synthetic Polymeric materials to bacteria. The test should determine the resistance to growth of Acidithiobacillus Bacteria and should be conducted at 30 degrees centigrade for a period of 7 days on a minimum of 4 panels. The growth must be limited only to trace amounts of bacteria.

c. An abrasion resistance of no more than 3 mils (.075 mm) loss after one million cycles using European Standard EN 598: 1994 Section 7.8 Abrasion Resistance.

3. Application

a. Applicator

The lining shall be applied by a certified firm with a successful history of applying linings to the interior of ductile iron pipe and fittings.

b. Surface Preparation

Prior to abrasive blasting, the entire area to receive the protective any substance that can be removed by solvent, shall be solvent cleaned to remove those substances. After the surface has been made free of grease, oil or other substances, all areas to receive the protective compounds shall be abrasive blasted using sand or grit abrasive media. The entire surface to be lined shall be struck with the blast media so that all rust, loose oxides, etc., are removed from the surface. Only slight stains and tightly adhering oxide may be left on the surface. Any area where rust reappears before lining must be re-blasted.

c. Lining

After surface preparation and within 12 hours of surface preparation, the interior of the pipe shall receive 40 mils nominal dry film thickness. No lining shall take place when the substrate or ambient temperature is below 40°F. The surface also must be dry and dust free. If flange pipe or fittings are included in the project, the lining shall not be used on the face of the flange.

d. Coating of Bell Sockets and Spigot Ends

Due to the tolerances involved, the gasket area and spigot end up to 6 inches back from the end of the spigot end must be coated with 6 mils nominal, 10 mils maximum using Protecto 401™ Joint Compound. The Joint Compound shall be applied by brush to ensure coverage. Care should be taken that the Joint Compound is smooth without excess buildup in the gasket seat or on the spigot ends. Coating of the gasket seat and spigot ends shall be done after the application of the lining.

e. Number of Coats

The number of coats of lining material applied shall be as recommended by the lining manufacturer. However, in no case shall this material be applied above the dry thickness per coat recommended by the lining manufacturer in printed literature. The maximum or minimum time between coats shall be that time recommended by the lining material manufacturer. To prevent delamination between coats, no material shall be used for lining which is not indefinitely recoatable with itself without roughening of the surface.

f. Touch-Up and Repair

Protecto 401™ Joint Compound shall be used for touch-up or repair in accordance with manufacturer's recommendations.

4. Inspection and Certification

a. Inspection

All ductile iron pipe and fitting linings shall be checked for thickness using a magnetic film thickness gauge. The thickness testing shall be done using the method outlined in SSPC PA-2 Film Thickness Rating.

The interior lining of all pipe barrels and fittings shall be tested for pinholes with a non-destructive 2,500 volt test. Any defects found shall be repaired prior to shipment.

Each pipe joint and fitting shall be marked with the date of application of the lining system along with its numerical sequence of application on that date and records maintained by the applicator of his work.

b. Certification

The pipe or fitting manufacturer must supply a certificate attesting to the fact that the applicator met the requirements of this specification, and that the material used was as specified.

5. Handling

Lined pipe and fittings must be handled only from the outside of the pipe and fittings. No forks, chains, straps, hooks, etc. shall be placed inside the pipe and fittings for lifting, positioning, or laying. The pipe shall not be dropped or unloaded by rolling.

Care should be taken not to let the pipe strike sharp objects while swinging or being off loaded. Ductile iron pipe should never be placed on grade by use of hydraulic pressure from an excavator bucket or by banging with heavy hammers.

D. Ductile iron fittings shall conform to AWWA C 110 with flanges faced and drilled 125-pound. Fittings shall have interior lining and exterior coating same as the pipe.

2.02 POLYVINYL CHLORIDE (PVC) PLASTIC PRESSURE PIPE

A. PVC Pressure Pipe, 3" and Smaller: Polyvinyl chloride plastic pipe shall be ASTM D 1785 Schedule 80 or F441 CPVC, Schedule 80 with solvent weld joints. Fittings shall be ASTM D 2467 Schedule 80 socket type. All socket type connections shall be made with PVC solvent cement complying with ASTM D 2564 PVC solvent cement shall be furnished from the same supplier as the PVC pipe. Provide socket-threaded adapters for connection to threaded appurtenances where required.

2.03 WALL PIPE AND SLEEVES

A. All wall pipe shall be furnished with cast or welded collar water stops in the positions shown on the Drawings. Welding of water stop collars on pipe shall be accomplished by the wall pipe manufacturer in their shop. All centrifugally cast wall pipe shall be ductile iron meeting the requirements of AWWA C151 for the pipe barrel, conforming to the pressure rating of the pipeline in which installed, and in no case be lighter than Class 53.

B. All statically cast wall pipe shall be ductile iron meeting the requirements of AWWA C110 for fittings. Mechanical joint end and cast-on flange end wall pipe shall conform to AWWA C110 and threaded flange wall pipe shall conform to AWWA C115. Where flanged or mechanical joint bell ends are flush with the wall, they shall be drilled and tapped for stud bolts which are to be of 300 Series stainless steel.

C. The length of all wall pipe shall be not less than the thickness of the wall in which installed. Wall pipe shall have the same pressure rating as connecting pipe. All wall pipe shall be AWWA C401 lined. The outside of wall pipes shall be left uncoated and shall be field primed for painting on the portion exposed, uncoated where embedded and field coated with standard bituminous coated where buried.

D. Contractor may have the option to install wall pipe flush face-to-face of wall in lieu of the dimensioned length wall pipe shown on the Drawings, in order to eliminate form penetrations. This option will be subject to Engineer's review at each wall pipe location and covers both flanged and mechanical-joint bell-end wall pipe. Embedded flanged and MJ bell-end bolt holes shall be tapped for stud bolts; tapped bolt holes in embedded flanges shall be plugged for protection during concrete pouring.

E. All pipe wall sleeves shall be plain end galvanized steel pipe of diameter noted on Drawings and length to fit flush face-to-face of wall.

2.04 INTERLOCKING LINK PIPE SEALS

A. In all locations indicated on the Drawings, interlocking link pipe seals shall be used in lieu of lead packing a pipe wall sleeve. Seals shall be modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall sleeve. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and nut. After the seal assembly is positioned in the sleeve, tightening of the bolts shall cause the rubber sealing elements to expand and provide an absolutely water-tight seal between the pipe and wall sleeve. Seals shall be "Link-Seal" as manufactured by Thunderline Corporation, Wayne, Michigan, or approved equal.

B. The Contractor shall determine the required diameter of each individual wall opening according to the manufacturer's recommendations before ordering and installing the seal. Pipe shall be accurately centered in the sleeve and the link seals shall be sized, installed and tightened in accordance with the manufacturer's instructions.

2.05 COUPLINGS AND ADAPTERS

A. Flexible couplings shall be of the sleeve type with a middle ring, two round-wedge shaped rubber gaskets at each end, two following rings together and compress the gasket against the pipe. Flexible couplings shall be steel with minimum wall thickness of the middle ring or sleeve installed on pipe being 5/16-inch for pipe smaller than 10 inches, 3/8-inch for pipe 10 inches or larger. The minimum length of the middle ring shall be 5-inches for pipe sizes up to 10 inches and 7 inches for pipe 10 inches to 30 inches. The pipe stop shall be removed. Gaskets shall be suitable for 250 psi pressure rating or at rated working pressure of the connecting pipe. Couplings shall be harnessed and be designed for 250 psi.

B. Flanged adapters shall have one end suitable for bolting to a pipe flange and the other end of flexible coupling similar to that described hereinbefore. All pressure piping with couplings or adapters shall be harnessed with full threaded rods spanning across the couplings or adapters. The adapters shall be furnished with bolts of an approved corrosion resistant steel alloy, extending to the adjacent pipe flanges. Flanges on flanged adapter (unless otherwise indicated or required) shall be faced and drilled ANSI B16.1 Class 125.

C. Flexible couplings and flanged adapters shall be as manufactured by Dresser, Rockwell, or equal, per the following, unless otherwise specified and/or noted on the Drawings:

1. Steel couplings for joining same size, plain-end, steel, cast iron, and PVC plastic pipe -

Dresser	Smith-Blair
Style 253 (2"-15") Style 38/138 (18" & above)	411

2. Transition couplings for joining pipe of different outside diameters-

Dresser	Smith-Blair
Style 162 (4"-12") Style 62 (2"-24")	413 steel (2"-24") 415 steel (6"-48") 433 cast (2"-16") 435 cast (2"-12")

3. Flanged adapters for joining plain-end pipe to flanged pipe, fittings, valves and equipment.

Dresser	Smith-Blair
Style 227 cast (3"-12") Style 128 steel (3"-48" D.I. Pipe) Style 128 steel (2"-96" steel pipe)	912 cast (3"-12") 913 steel (3"-24" D.I. Pipe)

2.06 FLANGED JOINTS

A. Flange bolts and nuts shall be ASTM A 307, Grade B and shall have hexagonal heads. All bolts, nuts and studs for flanged pipe in submerged locations shall be of 300 Series stainless steel. The flanges shall be drawn together until the joint is perfectly tight, with bolts of a length such that they will not project greater than 1/4-inch from the nut nor fall short of the end of the nut when drawn up. No washers shall be used. Gaskets shall be carefully fabricated prior to installation and must be suitable for pressure rating for the pipe for which it is used.

B. All flanges (unless otherwise indicated or required) shall be faced and drilled ANSI B16.1 125-pound for ductile iron and ANSI B16.5 150-pound for steel.

C. At the Contractor's option, and at no additional expense to the Owner, the following patented SBR flange gaskets or approved equal may be substituted for standard sheet packing ring gaskets in ductile iron flanged pipe:

1. TORUSEAL by American Cast Iron Pipe Company

2. FLANGE-TYTE by United States Pipe & Foundry Company

When using such gaskets, flange bolts shall be torqued to manufacturer's recommended torque values.

PART 3 - EXECUTION

3.01 INSTALLATION OF PIPING

A. Materials shall be new and of the best grade and quality; workmanship shall be first class in every respect.

B. Each piece of iron pipe and each fitting shall be plainly marked at the foundry with class number and weight.

C. Where indicated on the Drawings, plain-end pipe shall be joined by means of flanged adapters or flexible couplings which shall be Rockwell, Dresser, or equal.

D. All pipe couplings shall be designed to safely withstand the operating pressure of the lines in which they are installed. All couplings shall be shop primed with an approved rust inhibitive primer.

E. Taps and connections to piping shall be made as required to connect equipment, sample lines, etc., and where otherwise shown on the Drawings.

F. Piping shall be installed straight and true, parallel or perpendicular to walls, with approved offsets around obstructions. Standard pipe fittings shall be used for changing direction of piping. No mitered joints or field fabricated pipe bends are permitted unless accepted by the Engineer.

G. All piping, fittings, valves and other accessories shall be thoroughly cleaned of dirt, chips and foreign matter before joint connections are made.

H. All plastic pipe shall be adequately supported and braced. Support spacing shall not exceed the recommendations of the Plastics Pipe Institute.

I. Teflon tape shall be used on all plastic pipe threaded connections.

J. Field cut male threads on plastic pipe shall be made with plastic pipe threading dies.

K. The annular space of plain wall sleeves shall be packed tight with lead wool to within 3/4" of wall face and then patch grouted flush to wall face with non-staining nonshrink grout, Masterflow 713 by Master Builders, Sonogrout by Sonneborn-Contech, or equal.

L. All pipe sleeves passing through walls or floors of chlorine feed and storage areas shall be provided with gas tight seals.

M. All pipe threads shall conform to ANSI B2.1.

N. Piping shall be erected to provide for expansion and contraction.

O. Screwed or soldered unions shall be provided in all small piping as required to permit convenient removal of equipment, valves and piping accessories from the piping system.

P. Dielectric insulating couplings or brass adapters shall be used whenever the adjoining materials being connected are of dissimilar material such as connections between copper tubing and steel pipe.

Q. All inside piping shall be color coded, stenciled and label tagged for identification as specified in Division 9.

3.02 HANGERS AND SUPPORTS

A. It shall be the Contractor's responsibility to furnish a complete system of pipe supports, to provide expansion joints and to anchor all piping. The pipe support system shall be installed complete with all necessary inserts, bolts, nuts, rods, washers, miscellaneous steel, and other accessories. The Contractor shall submit shop drawings on the pipe supporting system, including type and size of supports, applied hanging loads at each hander support location, product data indicating safe hanging loads for each hanger, and details on thrust anchorage and all their locations.

B. In some instances, expansion joints have been shown on the drawings, but no attempt has been made to indicate every expansion joint for piping included under this portion of the specifications. Portions of the piping are shown on the detail drawings. Some of the piping, however, is shown only on the schematics.

C. Reaction Anchorage and Blocking

All piping exposed in interior locations and subject to internal pressure in which flexible connectors are used shall be blocked, anchored, or harnessed, as shown on the drawings, or as directed by the Engineer to preclude separation of joints.

D. Pipes with centerlines less than 6 feet from the floor shall be supported from below. Pipe support spacing shall not exceed 6 feet on center. Expansion Joints for ductile iron shall not exceed 80 feet on center. Expansion joints for plastic shall not exceed 30 feet. Unless otherwise shown or authorized by the Engineer, piping running parallel to walls shall be placed approximately 1½ inch out from the face of wall and at least three inches below ceiling.

E. Pipe Supports

1. Pipes support from underneath shall have pipe saddle supports with cast iron stanchion saddle with U-Bolts. Assemblies shall be Grinnell Figure 259, Elcen Figure or approved equal.

2. Pipe hangers shall be clevis style, galvanized, Grinnell Figure 260, or approved equal.

3. Pipe hangers shall be Anvil Figure C-211 Stainless Steel, or approved equal.

E. Concrete Inserts

1. Concrete inserts shall be provided at locations to support piping where structural steel supports are not readily available. Inserts shall be located so that the total load on any insert does not exceed the manufacturer's recommended maximum load. The location of all inserts shall be approved by the Engineer.

2. Where it is necessary to anchor supports to hardened concrete or complete masonry, expansion anchors of the type described in the anchor bolt and expansion anchors section shall be used. All expansion anchors shall be sized as required for the service with minimum safety factor of five.

3. Individual concrete inserts shall be Grinnell 282, Unistrut M26, or equal. Continuous concrete inserts shall be Unistrut P-3200 Series, Fee and Mason, or equal.

F. Brackets and Anchors

1. For suspended piping, anchors shall be centered, as closely as possible, between expansion joints, and between elbows and expansion joints. Anchors shall hold the pipe securely and shall be sufficiently rigid to force expansion and contraction movement to take place at expansion joints and elbows.

2. Thrust Anchors: Anchorage shall be provided as required to resist thrust due to changes in diameter or direction, or dead ending of pipelines. Anchorage shall be required wherever bending stresses exceed the allowable for the pipe.

3. Brackets and anchors shall be installed as required. They shall be Unistrut P-1000 Series with all parts galvanized, Grinnel 199 painted with rust inhibitive primer, or equal, or fabricated steel meeting ASTM A36, and be painted with a rust inhibitive primer.

G. Guides

Pipe guides shall be provided adjacent to sliding expansion joints in accordance with the recommendations of the National Association of Expansion Joint Manufacturers.

H. Anti-Seize Compounds

An anti-seize compound shall be applied to all nuts and bolts.

I. Contact between dissimilar metals shall be prevented.

J. In all cases where piping is in contact with a concrete or metal pipe support, a 1/8-inch thick teflon, neoprene rubber, or plastic strip shall be placed under all piping at the point of bearing. Each strip shall be cut to fit the entire area of contact between pipe and support and shall be neat.

K. Location

1. In general, the piping work under this contract shall be done in accordance with the arrangements shown on the drawings. The runs of piping are, in part, diagrammatic and the Contractor shall without extra cost run the piping as directed by the Engineer at the time of installation, so as to best fit the conditions in the building, and so that no piping shall pass through beams or other structural members in such a way as to impair their strength.

2. Special care shall be exercised to keep all piping in the building in locations as shown on the drawings and to install the risers and horizontal runs so as to occupy a minimum space.

3. Changes in runs and location to meet field conditions shall be done at no extra cost to the Owner.

4. All horizontal lines carrying liquids shall be pitched to facilitate draining and all low points shall be provided with 3/4 inch hose bibs suitable for the material being handled, located so that the entire system can be drained.

5. Expansion joint locations shall coincide with building control joints and as shown on the drawings.

L. All piping, valves, hanger, and supports shall be painted in accordance with Division 9.

3.03 TESTING

A. See Section 02351 – Sewage Collection Lines and Section 02352 – Sewage Force Mains for testing requirements for all interior process piping.

END OF SECTION

SECTION 11295 - INTERIOR PROCESS VALVES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide all labor, materials, equipment and services required to furnish and install all new valves as shown on the Drawings and/or specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Water Piping: Section 02505
B. Valves: Section 02515
C. Interior Process Piping: Section 11290
D. Valves furnished with equipment are included with equipment specifications.

1.03 SUBMITTALS

A. Descriptive literature, catalog cuts, and dimensional prints clearly indicating all dimensions and materials of construction, shall be submitted on all items specified herein to the Engineer for review before ordering. Comply with provisions of Section 01300.

B. At the time of submission, the Contractor shall, in writing, call Engineer's attention to any deviations that the submittals may have from the requirements of the Engineer's Contract Drawings and Specifications.

PART 2 - PRODUCTS

2.01 PLUG VALVES

A. All plug valves shall be eccentric plug valves unless otherwise specified.

B. Valves shall be of the non-lubricated eccentric type with flanged ends faced and drilled per ANSI B16.1 125 lb.

C. Valve bodies shall be flushing body type and made of ASTM A126 Class B cast iron. Valves shall be furnished with a 1/8" welded overlay seat of not less than 95% pure nickel. Seat area shall be raised, with raised surface completely covered with weld to insure that the plug face contacts only nickel. Screwed-in seats shall not be acceptable.

D. Plugs shall be made of ductile iron and have a cylindrical seating surface eccentrically offset from the center of the plug shaft. The interference between the plug face and body seat, with the plug in the closed position, shall be externally adjustable in the field with the valve in the line under pressure. Plug shall be resilient faced with neoprene or hycar, suitable for use with sewage.

E. Valves shall have replaceable sleeve type bearings and grit seals at the upper and lower journals.

F. Valve shaft seals shall be of the multiple V-ring type and shall be externally adjustable and repackable without removing the bonnet or actuator from the valve under pressure. Valves utilizing O-ring seals or non-adjustable packing shall not be acceptable.

G. Valve pressure ratings shall be 175 psi through 12" and 150 psi for 14" through 72". Each valve shall be given a hydrostatic and seat test with test results being certified when required by the specifications.

H. Manually operated valves 4-inch and larger shall have a worm gear actuator, stainless steel input shaft and handwheel operator. Manually operated valves 3-inch and smaller shall have a lever operator. All gearing shall be enclosed in a semi-steel housing and be suitable for running in a lubricant with seals provided on all shafts to prevent entry of dirt and water into the actuator. The actuator shaft shall be stainless steel and the quadrant shall be supported on permanently lubricated bronze bearings. Actuators shall clearly indicate valve position and an adjustable stop shall be provided to set closing torque and to provide seat adjustment to compensate for change in pressure differential or flow direction change. All exposed nuts, bolts and washers shall be stainless steel.

I. Any cylinder actuators shall be equipped with 2-inch square operating nuts to allow manual valve operation in case of supply failure.

J. Valves shall provide drip tight shutoff up to the full pressure rating. Valves shall be provided with adjustable limit stops and rotate 90 degrees from fully opened to fully closed.

K. Valves located 6 feet or more above the floor shall be furnished with chain wheel operators.

L Valves shall have rectangular port openings for throttling service, and shall open to 100% of the corresponding pipe diameter.

M. Plug valves shall be as manufactured by DeZurik, or approved equal.

2.02 CHECK VALVES

A. The valve is a counterweighted, rubber seated check valve with attached cushion chamber whose function is to permit flow in only one direction, close tightly when its discharge side pressure exceeds its inlet pressure, and to close without a slam or bang.

B. The swing check valve shall be constructed with heavy cast iron or cast steel body with a bronze or stainless steel seat ring, a non-corrosive shaft for attachment of weight and lever, and complete non-corrosive shockless chamber.

C. It shall absolutely prevent the return of water, oil or gas back through the valve when the inlet pressure decreases below the delivery pressure. The valve must be tight seating, and must be shockless in operation. The seat ring must be renewable.

D. The cushion chamber shall be attached to the side of the valve body externally and so constructed with a piston operating in a chamber that will effectively permit the valve to be operated without any hammering action. The shock absorption shall be by air, and the cushion chamber shall be so arranged that the closing speed will be adjustable to meet the service requirements.

E. The valve disc shall be of cast iron or cast steel and shall be suspended from a non-corrosive shaft which will pass through a stuffing box and be connected to the cushion chamber on the outside of the valve.

F. All material and workmanship shall be first class throughout and the purchaser reserves the right to inspect this valve before shipment.

G. The valves will be Golden-Anderson Industries, Inc. Fig. No. 250-D, 125# or equal.

2.03 SEWAGE COMBINATION AIR VALVE

A. Sewage Combination Air Valves shall be installed at the high points of the force main and at various locations as shown on the Contract Drawings.

B. Air valves shall be automatic float operated valves designed to exhaust air during the filling of a piping system and close upon liquid entry. The valve shall open during draining or if a

negative pressure occurs. The valve shall also release accumulated air from a piping system while the system is in operation and under pressure.

1. The valve seat shall provide complete shut off to the full valve pressure rating.

2. Valves shall incorporate a full port orifice, a seal plug assembly, and an upper and lower float to provide a rolling resilient seal.

3. The seal shall be a one-piece design and include a large orifice and a small orifice and each shall open or close as needed to allow release or intake of air as the demand on the system regulates.

4. Valve shall be designed to intake or discharge a minimum of 100 SCFM of air with a 3.5-psi differential pressure.

C. Materials

1. Valve cover, lower float, stem, washer, spring, nuts and bolts: 316 Stainless Steel.

2. Upper float: Foamed polypropylene.

3. O-rings: Buna-N.

4. Seal plug assembly and base and body: 316 Stainless Steel.

D. All Sewage Combination Air Valves on the force main shall be ARI model no. D-025 as manufactured by A.R.I. Flow Control Accessories, Kfar Charuv, Israel, or equal. Sizes shall be based on the pipeline diameter as noted herein:

Pipe Diameter	3" – 8"	10" – 16"	18" – 20"	24" – 48"
Air Valve Size	2"	3"	4"	6"

2.04 SLIP-IN INLINE CHECK VALVES

A. Slip-in inline check valves shall be installed at the locations as shown on the Contract Drawings.

B. Check valves are to be all rubber with a slip in cuff connection. The entire check valve shall be one-piece body reinforced as required, manufactured with no metal, mechanical hinges or fasteners which fits within the inside diameter of the pipe with no voids between the outside diameter of the valve and the inside diameter of the pipe. The port area shall conform with the pipe for full sealing, allowing the flow in one direction, while preventing reverse flow. The saddle area of the valve must be flat, it must not produce voids that can collect debris.

C. The check valve shall only cover 10% of the open area of the pipe when fully open.

D. Manufacturer must have flow test data from accredited hydraulics laboratory.

E. Company name, plant location, valve size, and serial number must be on the check valve.

2.05 VALVE OPERATORS

A. Valve operators shall be as shown on the plans and specified herein and in Section 2.05.

B. Valves located six (6) feet or more from floor level shall be furnished with chain wheel operators or chain level operators. Chains shall extend to within four (4) feet off the floor. All NRS floor stands and geared operators shall be indicating type.

2.06 VALVE ACTUATORS

A. Comply with Section 16225.

PART 3 - EXECUTION

3.01 INSTALLATION

A. All valves shall be installed in accordance with the manufacturer's recommendations.

END OF SECTION

SECTION 11310 - NON-CLOG SUBMERSIBLE SEWAGE PUMPS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide all labor, materials, equipment, delivering, installing, testing, incidentals, and placing into service the submersible sewage pumps and all appurtenances as shown on the Drawings and more fully described hereinafter.

B. Unless otherwise specified the pump manufacturer shall furnish each pumping unit complete with drive motor and all other components and shall be entirely responsible for the compatibility in all respects of all components furnished.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Submittals: Section 01300

B. Operating & Maintenance Manuals: Section 01780

C. Interior Process Piping: Section 11295

D. Variable Frequency Drives: Section 16446

E. Electrical: Division 16

1.03 MANUFACTURER

A. The pumping units shall be provided by a single manufacturer with a minimum of five (5) year's experience in designing and manufacturing pumping equipment of similar type, size and capacity. The pumps shall be manufactured by the Xylem Corporation Flygt Division, Sulzer-ABS, KSB or approved equal.

B. Replacement Parts Capability: The manufacturer shall have the ability to promptly furnish any and all interchangeable replacement parts as may be needed at any time within the expected life of the pumps. Upon request, the Contractor shall submit evidence of the proposed manufacturer's ability to promptly fill replacement orders.

C. Quality Assurance: All pumping units shall be of approved design and make products of manufacturers who have built equipment of similar type, size and capacity.

D. Additional Submittals: The Contractor shall submit, upon request, any additional information that the Engineer may deem necessary to determine the ability of the proposed manufacturer to produce the specified equipment.

E. Manufacturer Information: All manufacturer information required by the specifications shall be submitted by the Contractor within thirty (30) calendar days of the date of receipt of the Notice to Proceed.

Any additional information or data, specifically requested by the Engineer, concerning manufacturer's capabilities (especially relating to requirements described hereinbefore), shall be submitted by the Contractor within fourteen (14) calendar days of the receipt of the written request thereof, unless otherwise specified.

Approval of manufacturers or suppliers will not be given until all information required by the specifications or requested by the Engineer has been submitted and acceptable.

F. Disqualification of Manufacturer:

1. Poor performance of similar pumping equipment now in operation under the specified conditions of service and pump rating constitute grounds for disqualification of the pump manufacturer, supplier, or both, unless such poor performance has been corrected.

2. Failure to successfully comply with the provisions of subparagraphs A through F, inclusive, will constitute grounds for disqualification of pump manufacturer.

1.04 SUBMITTALS

A. General: The Contractor shall comply with the provisions of the specifications regarding submittals, unless otherwise specified herein.

B. At the time of submission, the Contractor shall, in writing, call the Engineer's attention to any deviations that the submittals may have from the requirements of the Engineer's Contract Drawings and Specifications.

C. The Contractor shall provide a notarized certification indicating that all piping products meet the required Specifications.

D. Descriptive literature, catalog cuts, and dimensional prints clearly indicating all dimensions and materials of construction shall be submitted on all items specified herein to the Engineer for review and approval before ordering.

E. Content of Submittals: The following shall be included in submittals as a minimum. However, any additional information or data shall be added if and whenever requested by the Owner or the Engineer. Where applicable, submit separate data for each pump.

1. Descriptive Literature:

a. Dimensions

b. Materials of Construction (including required coating).

c. Performance Data.

1) Pump Impeller Size

2) GPM

3) TDH

4) BHP

5) RPM

6) Performance curves showing pump operation including shutoff head, operating point, and run-out.

7) Performance curves showing overall pump efficiencies.

8) Weight of pump

9) Horsepower rating of pump motor

2. Installation Information: Submit installation drawings and information for pump connections, connecting piping and valves, electrical connections, and auxiliary equipment.

   The Contractor shall submit all other drawings, material lists and other information specified, requested and/or necessary to show complete compliance with all details of the contract documents.

3. Test and Inspection Reports: A written report shall be submitted to the Engineer documenting testing and or inspection results.

4. Operation and Maintenance Manual: Manual shall contain all information necessary for proper operation and maintenance of pumping units, as well as the location of the nearest permanent service headquarters.

1.05 TESTS

A. Shop Tests:

1. The pumps shall be fully tested at the manufacturer's factory before shipment at their rated speed, capacity, and head, and at such other conditions of head and capacity to establish that each has met all guarantees on the characteristic curves submitted. Five (5) certified copies of the results of these tests are to be sent to the Engineer. Also included with the test curves shall be a certified bill of material list depicting quality of construction. Such tests shall be accomplished at the manufacturer's facility prior to shipment.

2. The pumping units will be accepted upon the basis of the certified copies of the shop test and be subject to a four-hour field test of each unit. This test will be for the purpose of determining if each pumping unit will operate under installed conditions within a reasonable degree of correlation with the shop tests.

B. Field Tests:

1. The Contractor shall give at least two (2) week's notice to the Owner when the field tests are to be accomplished so that the Owner may have a representative present at the said tests.

2. The field tests shall be made by the Contractor in the presence of and as directed by the Engineer. Testing shall be done in accordance with the Hydraulic Institute Standards and shall meet the requirements of ANSI/HI 14.6 to acceptance grade 1U.

3. Field tests shall be made on each pumping unit. During the test, each pump shall be run at maximum rated speed for at least three (3) rates of flow corresponding to minimum rate, design rate, and maximum rate of flows specified as evidenced by the corresponding total head shown by the pump gages; simultaneous ammeter readings shall be taken. Variation of the rate of flow shall be made by throttling the discharge valve (where applicable). The rated motor nameplate current and power shall not be exceeded at any rate of flow within the specified range.

4. Before any pump is rotated, the Contractor shall make certain that no debris is present in suction well, pumps or pipelines. Any internal damage done to equipment while starting up shall be assumed to be caused by debris and shall be replaced at the Contractor's expense. No pump shall be rotated under power unless submerged with liquid.

5. When water can be pumped, the Contractor shall commence pumping and shall have representatives from the pump manufacturer to start the pumps. When flow conditions

are favorable, the Contractor or pump manufacturer shall in the presence of the Engineer, run a series of tests to establish the adequacy of the pumping units.

6. Field tests shall also conform to Part 3, Paragraph 3.03 as specified hereinafter.

C. Failure of Tests:

1. Any defects in the equipment or failure to meet the guarantees or requirements of the specifications shall be promptly corrected by the Contractor by replacements or otherwise. The decision of the Engineer as to whether or not the Contractor has fulfilled his obligations under the Contract shall be final and conclusive. If the Contractor fails or refuses to make these corrections or if the improved equipment, when tested, shall fail again to meet the guarantees of specified requirements, the Owner notwithstanding its having made partial payment for work and materials which have entered into the manufacture of said equipment, may reject said equipment and order the Contractor to remove it from the premises at his own expense.

2. In case the Owner rejects said equipment, then the Contractor hereby agrees to repay to the Owner all sums of money paid to him for said rejected equipment on progress certificates or otherwise on account of the lump sum prices herein specified, and upon the receipt of said sum of money the Owner will execute and deliver to the Contractor a bill of sale of all its rights, title, and interest in and to said rejected equipment; provided, however, that said equipment shall not be removed from the premises of the Owner until the Owner obtains from other sources the equipment to take the place of the rejected. The Owner hereby agrees to obtain said other equipment within a reasonable time and the Contractor agrees that the Owner may use the equipment furnished by him without rental or other charge until said other new equipment is obtained.

D. Responsibility During Test: The Contractor shall be fully responsible for the proper operation of equipment during tests and instruction periods and shall neither have nor make any claim for damage which may occur to equipment prior to the time when the Owner formally takes over the operation thereof.

E. Manufacturer's Representative: For all pumping units, the Contractor shall furnish the services of accredited representatives of the pump manufacturer who shall supervise the installation, adjustment, and field tests of each pumping unit and give instructions to the operating personnel. As one condition necessary to acceptance of any pumping unit, the Contractor shall submit a certificate from the manufacturer, stating that the installation of the pumping unit is satisfactory, that the unit is ready for operation, and that the operating personnel have been suitably instructed in the operation, lubrication, and care of the unit.

1.06 GUARANTEE PERIOD

A. After successful completion of tests and trials under operating conditions on all equipment, the Contractor shall guarantee all equipment, materials and workmanship from undue wear and tear, from mechanical and electrical defects, and from any failure whatever except those resulting from proven carelessness or deliberate actions of the Owner, for a minimum of one (1) year. This one (1) year minimum shall not replace a standard manufacturer's guarantee if it exceeds one (1) year.

1.07 PUMP WARRANTY

A. The Contractor guarantees and warrants that during the first one year of operation, the pumps will operate satisfactorily and continuously according to the pump schedule specified herein, and that after due notice has been given by the Owner, he or the pump manufacturer will proceed, within a reasonable time, to adjust, regulate, repair and renew at his own expense or perform such work as is necessary to maintain the guaranteed capacities, efficiencies and performances.

PART 2 - PRODUCTS

2.01 NON-CLOG SUBMERSIBLE SEWAGE PUMPS

A. Pump Requirements:

Each pump shall be designed to operate continuously at the intersection of the pump curve and the minimum system curve with available net positive suction head as indicated without cavitation and without requiring throttling to prevent cavitation or overloading the motor.

Submersible sewage pumps shall be explosion proof, Class I, Division 1, Group D construction except when indicated on the schedule.

B. Pump Design:

The pump(s) shall be automatically and firmly connected to the discharge connection, guided by no less than two parallel guide bars extending from the top of the station to the wet well mounted discharge connection. The design shall be easily removable, requiring no bolts, nuts or other fasteners to remove. There shall be no need for personnel to enter the wet-well. Each pump shall be fitted with a stainless steel chainof adequate strength and lenth to permit raising the pump for inspection and removal. Sealing of the pumping unit to the discharge connection shall be accomplished by a machined metal-to-metal watertight contact or O-ring watertight contact. The entire weight of the pump/motor unit shall be borne by the pump discharge elbow. No portion of the pump/motor unit shall bear on the sump floor directly or on a sump floor mounted stand. Each pump shall be fitted with 316 stainless steel lifting cable. The working load of the lifting system shall be 50% greater than the pump unit weight.

Power and pilot cable supports shall be provided and consist of a wire braid sleeve with attachment loops or tails to connection to the under side of the access frame.

C. Pump Construction:

Major pump components shall be of gray cast iron, ASTM A-48, Class 35B, with smooth surfaces devoid of blow holes or other casting irregularities. All exposed nuts or bolts shall be a minimum AISI type 304 stainless steel. 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.

Sealing design shall incorporate **metal-to-metal or O-ring contact** between machined surfaces. Pump/Motor unit mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile or Viton rubber O-rings. Joint sealing will be the result of controlled compression of rubber O-rings in two planes and O-ring contact of four sides without the requirement of a specific bolt torque limit. Rectangular cross-sectioned rubber, paper or synthetic gaskets that require 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.

D. Cooling System:

Each pump/motor unit shall be provided with an integral cooling system. The motor water jacket shall encircle the stator housing and shall be of cast iron, ASTM A-48, Class 35B. The water jacket shall thus provide heat dissipation for the motor regardless of whether the motor unit is submerged in the pumped media or surrounded by air. After passing through a classifying labyrinth, the impeller back vanes shall provide the necessary circulation of the cooling liquid, a portion of the pumpage, through the cooling system. Two cooling liquid

supply pipes, one discharging low and one discharging high within the jacket, shall supply the cooling liquid to the jacket. An air evacuation tube shall be provided to facilitate air removal from within the jacket.

Any piping internal to the cooling system shall be shielded from the cooling media flow allowing for unobstructed circular flow within the jacket about the stator housing. Two cooling liquid return ports shall be provided. The internals to the cooling system shall be non-clogging by virtue of their dimensions. Drilled and threaded provisions for external cooling and, seal flushing or air relief are to be provided. The cooling jacket shall be equipped with two flanged, gasketed and bolted inspection ports of not less than 4" diameter located 180° apart. The cooling system shall provide for continuous submerged or completely non-submerged pump operation in liquid or in air having a temperature of up to 40°C (104°F), in accordance with NEMA standards. Restrictions limiting the ambient or liquid temperatures at levels less than 40°C are not acceptable.

or

The unit shall be provided with a closed loop cooling system adequately designed to allow the motor to run continuously under full load while in an unsubmerged or minimally submerged condition. A cooling jacket shall surround the stator housing, and an environmentally safe non-toxic propylene glycol solution shall be circulated through the jacket by an axial flow circulating impeller attached to the main motor shaft. The coolant shall be pumped through an integrated heat exchanger in the base of the motor whenever the motor is running, allowing excess heat to be transferred to the process liquid. Cooling systems that circulate the pumped medium through the cooling jacket, or those that use a toxic cooling liquid shall not be acceptable. The use of external heat exchangers, fans, or the supply of supplemental cooling liquid shall not be accepted.

E. Cable Entry Seal:

The cable entry seal design shall preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall consist of dual cylindrical elastomer grommets, flanked by stainless steel washers, all having a close tolerance fit against the cable outside diameter and the cable entry inside diameter. The grommets shall be compressed by the cable entry unit, thus providing a strain relief function. The assembly shall provide ease of changing the cable when necessary using the same entry seal. **The cable entry junction chamber and motor shall be sealed from each other, which shall isolate the stator housing from foreign material gaining access through the pump top. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable.**

F. Motor:

The pump motor shall be a NEMA B design, induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber. The stator windings shall be insulated with moisture resistant Class H insulation rated for 180°C (356°F). The motor shall be inverter duty rated in accordance with NEMA MG 1, Part 3. The stator shall be heat-shrunk or press fitted into the stator housing. The use of bolts, pins or other fastening devices requiring penetration of the stator housing is not acceptable.

The motor shall be specifically designed for submersible pump usage and designed for continuous duty pumping media of up to 40°C (104°F) with an 80°C temperature rise and capable of at least 15 evenly spaced starts per hour without overheating. The rotor bars and short circuit rings shall be made of cast aluminum. Thermal switches shall be embedded in the stator end 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 shall be sealed off from the stator housing and shall contain a terminal board for connection of power and

pilot sensor cables using threaded compression type terminals. The use of wire nuts or crimp-type connectors is not acceptable. The motor and the pump shall be produced by the same manufacturer.

The motor service factor (as defined by the NEMA MG1 Standard) 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 and no-load characteristics.

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 at least 65 feet.

The motor horsepower shall be adequate so that the pump is non-overloading throughout the entire pump performance curve from shut-off through run-out.

G. Pilot Cable:

The pilot cable shall be designed specifically for use with submersible pumps and shall be type SUBCAB (Submersible Cable).

H. Bearings:

The pump shaft shall rotate on at least three grease-lubricated bearings. The upper bearing, provided for radial forces, shall be a single roller bearing. The lower bearings shall consist of at least one roller bearing for radial forces and one or two angular contact ball bearings for axial thrust.

The minimum ABMA L_{10} bearing life shall be 50,000 hours at any point along the usable portion of the pump curve at maximum product speed.

The lower bearing housing shall include an independent thermal sensor to monitor the bearing temperature. If a high temperature occurs, the sensor shall activate an alarm and shut the pump down.

I. Mechanical Seal:

Each pump shall be provided with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies. The lower seal shall be independent of the impeller hub. The seals shall operate in a lubricant reservoir that hydrodynamically lubricates the lapped seal faces at a constant rate. The lower, primary seal unit, located between the pump and the lubricant chamber, shall contain one stationary and one positively driven rotating corrosion resistant **tungsten-carbide or silicon-carbide** seal ring.

The upper, secondary seal unit, located between the lubricant chamber and the motor housing, shall contain one stationary and one positively driven rotating corrosion resistant **tungsten-carbide or silicon carbide** seal ring. Each seal interface shall be held in contact by its own spring system. The seals shall require neither maintenance nor adjustment and shall be capable of operating in either clockwise or counter clockwise direction of rotation without damage or loss of seal. For special applications, other seal face materials shall be available.

Should both seals fail and allow fluid to enter the stator housing, a port shall be provided to direct that fluid immediately to the stator float switch to shut down the pump and activate an alarm. Any intrusion of fluid shall not come into contact with the lower bearings.

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. No system requiring a pressure differential to offset pressure and to effect sealing shall be used.

Each pump shall be provided with a lubricant chamber for the shaft sealing system. The lubricant chamber shall be designed to prevent overfilling and to provide lubricant expansion capacity. The drain and inspection plug, with positive anti-leak seal shall be easily accessible from the outside. The seal system shall not rely upon the pumped media for lubrication. The motor shall be able to operate continuously while non-submerged without damage while pumping under load.

Seal lubricant shall be FDA Approved, nontoxic.

J. Pump Shaft:

Pump and motor shaft shall be a single piece unit. The pump shaft shall be the extension of the motor shaft. Couplings shall not be acceptable. The pump shaft shall be of carbon steel ASTM A 572 Grade 50 or Stainless Steel AISI 420 and shall be completely isolated from the pumped liquid.

K. Impeller:

The impeller(s) shall be of gray cast iron, Class 35B,semi-enclosed, dynamically balanced, multiple vaned, double shrouded non-clogging design having long throughlets 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" diameter solid, per Ten State Standards. All impellers shall be coated with an acrylic dispersion zinc phosphate primer.

L. Wear Rings:

A wear ring system shall be used to provide efficient sealing between the volute and suction inlet of the impeller. Each pump shall be equipped with a Nitrile rubber coated steel, cast iron, or brass ring insert that is drive fitted to the volute inlet.

This pump shall also have a stainless steel impeller wear ring heat-shrink fitted onto the suction inlet of the impeller.

M. Volute:

Pump volute(s) shall be single-piece gray cast iron, Class 35B, non-concentric design with smooth passages large enough to pass any solids that may enter the impeller. Minimum inlet and discharge size shall be as specified.

N. Protection:

All stators shall incorporate thermal switches in series to monitor the temperature of each phase winding. Should high temperature occur, the thermal switches shall open, stop the motor and activate an alarm in the control panel.

A lower bearing temperature sensor shall be provided. The sensor shall directly contact the outer race of the thrust bearing providing for accurate temperature monitoring.

A leakage sensor shall be provided to detect water in the stator chamber. The Float Leakage Sensor (FLS), a small float switch, shall be used to detect the presence of water in the stator chamber. When activated, the FLS will stop the motor and activate an alarm. USE OF VOLTAGE SENSITIVE SOLID STATE SENSORS SHALL NOT BE ALLOWED.

The thermal switches, FLS and the lower bearing temperature monitor shall be connected to a MAS (Monitoring and Status) monitoring unit. The MAS shall be designed to be mounted in the motor control center.

O. Pump Discharge Flange:

The pump discharge-mating flange shall be as shown on the drawings.

P. Pump Intake

A flared fitting (8") shall be located on the pump intake as shown on the drawings.

2.02 PUMPING REQUIREMENTS

A. Pumps shall be manufactured by Xylem Corporation, Flygt Division, and KSB shall comply to the following characteristics:

No. of Pumps	Shut-Off Head (Min) (Ft)	Design Point #1	Design Point #2	Design Point #3	Static Head (Ft.)	Max. Speed (RPM)	Motor HP/Max Each Pump
		2 pumps running	1 pump running	1 pump running			
		Flow (GPM)	Flow (GPM)	Flow (GPM)			
3 (2 operational, 1 back up)	75	Head (Ft.)	Head (Ft.)	Head (Ft.)	46.8 Ft.	1200 RPM	60 HP
		5070 GPM	2535 GPM	1520 GPM			
		55.8 Ft.	53.5 Ft.	49.5 Ft.			

B. Power supply shall be 480 volts, 3-Phase, 60 Hz, 4 wire service.

C. Motors shall be 460 volt, 3 phase, 60 Hz.

D. Each pump shall be operated by VFD – see Specifications Division 16.

E. Pump models shall be as follows, or approved equal

1. Xylem Corporation – Flygt NP 3202 MT 3~640
2. Sulzer – ABS – XFP 201J – CB2 PE 430/4
3. KSB - KRT K 200-400/406XG-S

2.03 PUMP ACCESSORIES AND OTHER

A. All pumps and controls shall be completely wired at the factory for power and control and shall be color-coded. All wiring outside the control cabinet shall be rigid conduit. All

accessory equipment shall be permanently wired with suitable disconnecting means and overload protection.

B. All pump motors shall be provided with stator temperature sensor switches and stator housing leak detector.

C. The pump/motor assembly shall be suitable for use in Class I, Division 1, Group D hazardous locations.

D. Contractor shall be responsible for supply of appropriate lengths of lifting chain, submersible power cable, and MG Hi conductor submersible cable.

E. Access hatches for wet well and valve pit shall be as specified in Section 08370 of these specifications. Minimum dimensions shall be as noted on the Drawings, pump manufacturer shall size and provide access hatches for each pump.

PART 3 - EXECUTION

3.01 PREPARATION

A. Coordinate with other trades, equipment and systems to the fullest extent possible.

B. Take all necessary measurements in the field to determine the exact dimensions for all work and the required sizes of all equipment under this contract. All pertinent data and dimensions shall be verified by the Contractor.

3.02 INSTALLATION

A. Installation shall be in strict accordance with the manufacturer's instructions and recommendations in the locations shown on the Drawings. Anchor bolts shall be set in accordance with the manufacturer's recommendations and setting plans.

B. The Contractor shall also provide from the submersible pump supplier the service of a qualified start-up engineer (factory representative) who has had prior on-site start-up experience to assist in performing start-up, checkout and initial operation services of the pumping units. The start-up engineer shall also instruct the Owner's personnel on the operation and maintenance procedures for the station. Qualified supervisory services, including manufacturers' engineering representatives, shall be provided for a minimum of 4 man-days to insure that the work is done in a manner fully approved by the respective equipment manufacturer. The pump manufacturer's representatives shall specifically supervise the installation of the pump and the alignment of the connection piping. If there are difficulties in the start-up or operation of the equipment due to the manufacturer's design or fabrication, additional service shall be provided at no cost to the Owner. Services of the manufacturer's representatives and training shall be provided when the first pump is started, with follow-up visits upon start-up of each subsequent pump.

C. A certificate from each equipment manufacturer shall be submitted stating that the installation of his/her equipment is satisfactory, that the equipment is ready for operation and that the operating personnel have been suitably instructed in the operation, lubrication and care of each unit.

3.03 FIELD TESTS

A. During the field tests, observations shall be recorded of head, capacity, and motor input. All defects or defective equipment revealed by or noted during the tests shall be corrected or replaced promptly at the expense of the Contractor, and if necessary, the tests shall be repeated until results acceptable to the Engineer are obtained. The Contractor shall furnish

all labor, piping, equipment, and materials necessary for conducting the tests. A report of the field tests shall be submitted to the Engineer.

B. After installation of the pumping equipment, and after inspection, operation, testing and adjustment have been completed by the manufacturer's representative, each pump shall be given a running test in the presence of the Engineer, such tests as necessary to indicate that the pumps, motors, and drives generally conform to the efficiencies and operating conditions specified and its ability to operate without vibration or overheating. The pumps and motors shall operate at the specified capacities in the range of heads specified without undue noise or vibration. Any undue noise or vibration in the pumps or motors, which is deemed objectionable by the Engineer, will be sufficient cause for rejection of the units.

C. A thirty-day operating period of the pumps will be required before acceptance. If a pump performance does not meet the Specifications, corrective measures shall be taken or the pump shall be removed and replaced with a pump which satisfies the conditions specified. All test procedures shall be in accordance with Hydraulic Institute Standards certified results of tests shall be submitted. If pumps are accepted after thirty-day operating period, the Owner will pay all electric cost for the operation period. If the pumps are not accepted the Contractor will be responsible for the costs. Without a rain event, the operation of the facility for testing will be activated using the throttling gate within the diversion structure.

D. Provide, calibrate and install all temporary gauges and meters, shall make necessary tapped holes in the pipes, and install all temporary piping and wiring required for the field acceptance tests. Written test procedures shall be submitted to the Engineer for approval 30 days prior to testing.

3.04 TRAINING

A. A factory representative shall provide a minimum of eight (8) person-hours of training to the Owner's operations staff concerning the recommended operation and maintenance of the equipment. Training shall be performed after substantial completion of the project with the use of operating equipment.

END OF SECTION

DIVISION 13

SPECIAL CONSTRUCTION

SECTION 13200 - PRESTRESSED CONCRETE STORAGE TANK

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This section specifies the design and construction of an AWWA D110 Type II, wire-wound prestressed concrete storage tank with galvanized steel diaphragm complete including all reinforcing, concrete work, accessories, disinfection and testing directly related to the tank.

B. The tank contractor is responsible for furnishing all labor, materials, tools and equipment necessary to design and construct the prestressed concrete storage tank as indicated on the drawings and as described in this specification.

1.02 REFERENCES

A. ACI 301/301M-10 – Specifications for Structural Concrete for Buildings.

B. ACI 305R-10 – Guide to Hot Weather Concreting.

C. ACI 306R-10 – Guide to Cold Weather Concreting.

D. ACI 347R-04 – Guide to Formwork for Concrete.

E. ACI 350/350R-06 – Code Requirements for Environmental Engineering Concrete Structures and Commentary.

F. ACI 350.3-06 – Seismic Design of Liquid-Containing Concrete Structures and Commentary.

G. ACI 372R-03 – Design and Construction of Circular Wire- and Strand-Wrapped Prestressed Concrete Structures.

H. ACI 506R-05 – Guide to Shotcrete.

I. ACI 506.2-95 – Specification for Materials, Proportioning, and Application of Shotcrete.

J. ACI SP4: Formwork for Concrete.

K. ANSI/AWWA C652-11 – Disinfection of Water Storage Facilities.

L. ANSI/AWWA D110-04 – Wire- and Strand-Wound, Circular, Prestressed Concrete Water Tanks.

M. ASCE Standard 7-10 – Minimum Design Loads for Buildings and Other Structures.

N. ASTM A416/A416M-12a – Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.

O. ASTM A615/A615M-12 – Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.

P. ASTM A653/653M-11 – Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc Iron Alloy Coated (Galvannealed) by Hot Dip Process.

Q. ASTM A821/A821M-10 – Standard Specification for Steel Wire, Hard Drawn for Prestressing Concrete Tanks.

R. ASTM A882/A882M-04(2010) – Standard Specification for Filled Epoxy-Coated Seven-Wire Prestressing Strand.

S. ASTM A884/A884M-12 – Standard Specification for Epoxy Coated Steel Wire and Welded Wire Reinforcement.

T. ASTM A1064/A1064M-12 – Standard Specification for Carbon Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.

U. ASTM C31/C31M-12 – Standard Practice for Making and Curing Concrete Test Specimens in the Field.

V. ASTM C33/C33M-13 – Standard Specification for Concrete Aggregates.

W. ASTM C39/C39M-12a – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.

X. ASTM C143/C143M-12 – Standard Test Method for Slump of Hydraulic-Cement.

Y. ASTM C172/C172M-10 – Standard Practice for Sampling Freshly Mixed Concrete.

Z. ASTM C231/C231M-10 – Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.

AA. ASTM C881/C881M-10 – Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.

BB. ASTM D1056-07 – Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.

CC. "Earthquake Induced Sloshing in Tanks with Insufficient Freeboard" by P.K. Malhotra, Structural Engineering International, IASBSE, 3/2006 pp 222-225.

1.03 SUBMITTALS

A. Prequalification Data: Provide prequalification data prior to the bid in accordance with Section 1.05 B. of this specification.

B. Shop Drawings: Provide shop drawings with a minimum size of 18" x 24" with a complete plan, elevation, and sectional views showing critical dimensions as follows:

1. Size, location and number of all reinforcing bars.

2. Thickness of all parts of the tank structure including floor, core wall, dome, 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. Concrete placement sequence for the slab of the storage tank, including the construction joint layout, shall be submitted for approval.

C. Concrete Data: Submit concrete design mixes including ingredient proportions, minimum cementitious content, and water/cementitious ratio in accordance with Section 2.02 and 2.03 of this specification.

D. Design Data: Submit all structural calculations for the tank, signed and sealed by a Professional Engineer in accordance with Section 1.05 A.3 of this specification.

E. Coating Data: Submit color charts for review by the Engineer and Owner. Once a color is chosen, submit actual drawdown samples for final approval prior to application of coating.

F. Test Reports: Submit concrete strength reports for 7-day and 28-day breaks taken in accordance with the requirements of Section 3.03 A.1.

G. Warranty Document: Submit warranty document in Owner's name in accordance with Section 1.06 A. of this specification.

H. Cleaning and Disinfection Plan: Submit a cleaning and disinfection plan which complies with Section 3.04 of this specification.

I. 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 ANSI/AWWA D110 Type II wire-wound, circular prestressed concrete 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 twenty (20) dome-covered 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, wall, and roof 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 ANSI/AWWA D110 Type II wire-wound, circular prestressed concrete 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 diaphragm design and epoxy injection procedure shall have been used in the twenty tanks required in Section 1.04 A.1 of this specification.

B. Prequalification:

1. All tank construction companies must be prequalified and meet the criteria stated in Section 1.04 A.1 of this specification to be considered an acceptable tank builder.

2. A complete prequalification package shall be submitted to the Engineer for consideration 14 days prior to the date set for receipt of bids. The prequalification submittal shall include the following items:

a. Complete construction drawings showing the principal sizes, thicknesses, reinforcing size and spacing for all structural members including: floor, wall, dome shell and dome edge.

b. Complete construction drawings showing the layout and details of the structural foundation slab, including rock anchors to resist buoyancy.

c. Complete details of other structural appurtenances as required by the project drawings showing principal sizes, thickness and reinforcing sizes and spacing.

d. Complete design calculations which address applicable loads provided in Section 1.07 B. of this specification.

e. Complete experience record for the tanks used to meet the experience requirement of Section 1.04 A. of this specification that have been designed and built in the tank construction company's own name. The record shall include the size of the tank, name, address and telephone number of the Owner, the year of construction and the name and telephone number of the Engineer for the project.

f. Construction schedule which details the duration for tank construction.

3. The following are preapproved as acceptable tank construction companies:

   a. The Crom Corporation, Gainesville, Florida.

   b. Precon Corporation, Newberry, Florida.

1.05 WARRANTY

A. Provide a warranty document for workmanship and materials on the complete structural portion of the tank for a five-year period from the 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.

1.06 DESIGN CRITERIA

A. The design shall be in conformance with applicable portions of American Concrete Institute (ACI) 372R Design and Construction of Circular Wire- and Strand-Wrapped Prestressed Concrete Structures, ANSI/AWWA D110 Wire- and Strand-Wound, Circular, Prestressed Concrete Water Tanks, American Concrete Institute (ACI) 350-06 Code Requirements For Environmental Engineering Concrete Structures, and currently accepted engineering principles and practices for the design of such structures.

B. The following loadings shall be utilized in the design:

1. Capacity: 1.8 Million Gallons

2. Dimensions: 95 feet Inside Diameter
   33.95 feet Water Depth at Sidewall

3. Fluid Loads: Shall be the weight of all liquid when the reservoir is filled to capacity. The unit weight of the liquid material shall be 63 lbs/ft^3.

4. Roof Live Loads: Consideration shall be given to all applicable roof design loads in accordance with ANSI/AWWA D110, Section 3.03 and ASCE 7. The minimum roof live load for the structure shall be 20psf uniform load or 300 pound concentrated load.

5. Dead Loads: Consideration shall be given to all permanent imposed loads including concrete and steel.

6. Buoyancy: Structure and foundation shall be designed to resist buoyant forces from the 100 yr flood elevation of 882.70 ft. Design criteria for passive rock anchors are provided in specification 02490 and the Geotechnical Report.

7. Seismic Loads: Seismic forces and moments resulting from seismic accelerations of the tank dome and wall shall be calculated in accordance with ACI 350.3 or ANSI/AWWA D110. Seismic induced sloshing water need not be considered due to the improbability that the tank will contain water at the same time as a seismic event.

8. Soil Pressure: Earth loads shall be referenced in the Geotechnical Report and applied using rational methods of soil mechanics. Soil pressure shall not be used in the design of the core wall to counteract hydraulic loads or provide residual compression in the wall.

9. Differential Backfill Loads: Forces from differential backfill loads shall be considered in the design and shall be based on the at-rest coefficient. Passive resistance shall not be used to resist differential backfill loads.

10. Wind Loads: Wind loads shall be considered in the design in accordance with ASCE 7.

C. Structural Floor: The design of the floor for the prestressed concrete tank shall conform to the following:

1. Concrete structural floor shall contain a minimum reinforcing steel amount equal to 0.50% of the gross cross sectional area. Reinforcing steel shall be placed orthogonally and distributed with at least 2/3 of the total minimum area required in the top face and 1/3 of the total minimum area in the bottom face.

2. Concrete sections that are 24 inches or greater in thickness may have the minimum percentage of reinforcing based on a 12 inch concrete layer at each face.

3. Minimum reinforcing bar size shall be #5 bar.

4. Maximum spacing of reinforcing steel for the structural floor shall be 12 inches.

5. Concrete structural floor shall be designed to resist bending moments and shears induced by loadings required in Section 1.06B. Moments and shears shall be calculated based on rational analysis utilizing an influence area derived from the rock anchor spacing plus 2 times the rock anchor spacing tolerance. In no case shall the dimensions and reinforcing steel for the concrete structural floor be less than the following:

   a. Minimum floor thickness: 12 in.
   b. Minimum top reinforcing steel: #6@10"o.c.
   c. Minimum bottom reinforcing steel: #5@12"o.c.

6. Radial and circumferential steel shall be added to the top and bottom mats of reinforcing steel at the edge of the structural floor to account for edge effects in the circular plate.

D. Core wall:

1. The wire-wound, prestressed concrete tank core wall shall be designed as a thin shell cylindrical element using shotcrete and an embedded, mechanically bonded, galvanized steel shell diaphragm.

2. The design of the core wall shall take into account appropriate edge restraint. To compensate for bending moments, shrinkage, differential drying, and temperature stresses, the following minimum reinforcing steel shall be incorporated into the design:

   a. The top 2' of core wall shall have not less than 1% circumferential reinforcing.

   b. The bottom 3' of core wall shall have not less than 1% circumferential reinforcing.

c. Inside Face:

(1) The inside face of the core wall shall utilize the diaphragm as effective reinforcing.

(2) Additional vertical and horizontal reinforcing steel bars shall be used as required by design computations.

d. Outside Face:

(1) Vertical reinforcing steel in the outside face of the core wall shall be: minimum of #4 bars at 12" center to center.

(2) Additional vertical and horizontal reinforcing steel bars shall be used as required by design computations.

3. The minimum core wall thickness shall be 3½".

4. Reinforcing steel used in the core wall shall be designed using a maximum allowable design tensile stress, f_s, of 18,000 psi.

5. Allowable compressive stress in the core wall due to initial prestressing force, f_{gi}, shall be:

a. 1250 psi + 75t 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 2025 psi.

6. Allowable compressive stress in the core wall due to final prestressing force, f_g, shall be:

a. 1250 psi + 75t psi/in. with 0.45 f'_g maximum (where f'_g is defined as compressive strength required for final prestressing force and *t* is the thickness of the core wall in inches).

b. Maximum of 2000 psi.

E. Dome:

1. The dome roof shall be constructed of reinforced concrete and shall be circumferentially prestressed.

2. Dome shell reinforcement shall consist of reinforcing bars or welded wire fabric meeting ASTM A1064/A1064M, not galvanized. Bolsters for wire fabric and reinforcing bars shall be plastic. Wire ties shall be galvanized.

3. The dome ring girder shall be prestressed with sufficient wire to withstand the dome dead load and design live loads. The ring girder shall have cross section suitable to accept the applied prestressing forces.

4. The high water level in the tank shall be permitted to encroach on the dome shell no higher than the upper horizontal plane of the dome ring girder.

5. Overflow outlets or the overflow pipe shall be capable of providing an overflow open area three times the area of the largest influent pipe.

6. Overflow outlets plus the dome ventilator shall be capable of providing an open area three times the area of the largest pipe.

7. The dome shall be designed as a free-span, spherical thin shell with one-tenth rise in accordance with the following:

a. Typical Dome Design: The typical dome thickness and steel reinforcement shall meet the requirements of ANSI/AWWA D110.

b. In all cases, the thickness of the dome shall be no less than 3".

c. Dome Edge Design: The dome edge and upper wall shall be designed to resist the moments, thrusts, and shears that occur in this region due to dome and wall prestressing and loading conditions. The design of the edge region shall conform to the following:

(1) Dome Edge Thickness:

(a) A determination of the buckle diameter shall be made, as defined by:

$$d_b = 2.5 \cdot \sqrt{r_d \cdot t_d}$$ rounded up to the next foot

Where: d_b = buckle diameter in feet

r_d = dome radius in feet

t_d = typical dome thickness in feet

(b) Dome edge thickening shall begin at a radial location on the dome, defined as s_2 which is at least one buckle diameter away from the tank wall.

(c) A springline haunch shall be provided, which extends radially from the inside face of the tank wall to radial location s_1 which is defined as:

$$s_1 = 0.6 \cdot \sqrt{1.5 \cdot r_d \cdot t_d}$$ rounded up to the next foot

Where: s_1 = distance from inside face of wall to haunch in feet

s_2 = distance from inside face of wall to typical dome thickness in feet.

This springline haunch shall begin at the inside face of the tank wall with a springline thickness as required by paragraph (f) below and shall end at radial location s_1 with the following thickness:

$$t_{d1} = 1.33 \cdot t_d$$

Where: t_{d1} = minimum thickness at s_1 in feet

t_d = typical dome thickness in feet at one buckle diameter from tank wall

(d) Beginning at s_1 and continuing to s_2 the dome shell shall have a uniform straight line taper.

(e) Parameters (b), (c), and (d) above are not required for domes where the calculated typical dome thickness is less than 75% of the actual typical dome thickness.

(f) Sufficient concrete thickness at the springline of the dome shall be provided so that no more than 2' of the springline haunch is considered in calculating the effective dome edge ring cross sectional area. Compressive stress in this area shall not exceed 1000 psi when subjected to initial prestressing, offset by dead load only.

(2) Dome Edge Steel Reinforcement:

(a) Throughout the dome edge, the percentage of steel reinforcement, both radially and circumferentially, shall be no less than 0.25% of the gross cross sectional area of concrete.

(b) Along the dome edge, steel reinforcement shall be distributed between the upper and lower layers unless finite element analysis calculations indicate that tensile stress does not exist in the concrete along the bottom face of the dome edge. In that case, only top bars are required radially and circumferentially. In addition, radial and circumferential reinforcing bars will not be required along the bottom face of the dome edge where the calculated typical dome thickness is less than 75% of the actual typical dome thickness.

(c) Where reinforcing bars are required in the bottom layer, they shall be placed near the tank wall to insure adequate development at the intersection between dome and wall.

(d) In all cases, the percentage of circumferential steel reinforcement in the effective dome ring shall be no less than one percent of the gross cross sectional area of concrete. The effective dome ring is defined as ¼ of the haunch length not to exceed 2'.

(e) Where bottom dome edge steel reinforcement is required, vertical steel reinforcement along the inside face of the tank wall shall be no less than 0.5% of the cross sectional area of wall shotcrete.

F. Prestressing:

1. Circumferential prestressing of the tank shall be achieved by the application of cold-drawn, high-carbon steel wire complying with ASTM A821/A821M Type B, placed under high tension.

2. 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.

3. The prestressing design shall conform to the following minimum requirements:

a. Working stress for the tank wall, fs, shall be a maximum of 115,000 psi.

b. Working stress for the dome ring, fsd, shall be a maximum of 120,000 psi.

c. The allowable design tensile stress in the prestressing wire before losses, fsi shall be 145,600 psi or no greater than 0.63 fu, where fu is defined as the ultimate strength of the wire.

d. Areas to be prestressed will contain not fewer than 10 wires per foot of wall for 8 gauge and 8 wires per foot of wall for 6 gauge.

e. 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.

G. Wall Openings:

1. 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.

2. Unbanded strips shall have a vertical dimension of no more than 36" unless an axi-symmetric shell analysis is performed to account for compressive forces plus shear and moments caused by displacement of the prestressing wires into adjacent bands.

H. Foundation

1. The foundation shall be designed by the tank manufacturer in accordance with Section 02490 – Soil and Rock Anchors, Section 02222 – Excavation, Section 02223 – Structural Fill and Embankment and in accordance with the recommendations set forth in the geotechnical reports and addenda in Section 00032 – Geotechnical Data.

PART 2 PRODUCTS

2.01 PERFORMANCE

A. Performance of the materials used in the tank construction shall conform to the minimum requirements of this specification.

B. Substitutions to the materials in this specification may only be made if submitted in writing and approved by the engineer.

2.02 CONCRETE

A. Concrete shall conform to ACI 301/301M.

B. All concrete shall utilize Type I/II Portland cement.

C. A maximum of 25% of cementitious material may be fly ash.

D. Admixtures other than air-entraining and water reducing admixtures will not be permitted unless approved by the engineer.

E. Coarse and fine aggregate shall meet the requirements of ASTM C33/C33M.

F. Concrete mixes used in the construction of the tank shall conform to the following:

Mix	Compressive Strength (psi)	Minimum Cement Content (lbs)	Maximum Aggregate Size (in)	Maximum W/C Ratio	Air Content (%)	Slump (in)
Floor	4000	560	¾	0.45		4"+/-1"
Dome	4000	600	⅜	0.45		4"+/-1"

2.03 SHOTCRETE

A. Shotcrete shall conform to the requirements of ACI 506.2 except as modified herein.

B. All shotcrete mixes shall utilize Type I/II cement.

C. A maximum of 25% of cementitious material may be fly ash.

D. All shotcrete in contact with diaphragm or prestressing wire shall be proportioned to consist of not more than three parts sand to one part Portland cement by weight. All other shotcrete shall be proportioned to consist of not more than four parts sand to one part Portland cement by weight.

E. Admixtures will not contain more than trace amounts of chlorides, fluorides, sulfides or nitrates.

F. Shotcrete mixes used in the tank construction shall conform to the following:

Mix	Compressive Strength (psi)	Maximum W/C Ratio	Air Content (%)	Slump (in)	Fiber Reinforcement (lbs/cyd)
Core Wall	4000	0.42		-	-
Covercoat	4000	0.42		-	

2.04 PRESTRESSED REINFORCEMENT

A. The prestressing wire shall conform to the requirements of ASTM A821/A821M, Type B.

B. The prestressing wire size shall be 0.162" (8 gauge), 0.192" (6 gauge) or larger, but no larger than 0.250".

C. The ultimate tensile strength, fu shall be, 231,000 psi or greater for 8 gauge wire, 222,000 psi or greater for 6 gauge.

D. Splices for horizontal prestressed reinforcement shall be ferrous material compatible with the reinforcement and shall develop the full strength of the wire.

2.05 NON-PRESTRESSED REINFORCEMENT

A. Non-prestressed mild reinforcing steel shall be new billet steel meeting the requirements of ASTM A615/A615M-12 with a minimum yield strength, f_y, of 60,000 psi.

B. Welded wire reinforcing shall be plain wire conforming to the requirements of ASTM A1064/A1064M with a minimum yield strength, f_y, of 65,000 psi.

2.06 GALVANIZED STEEL DIAPHRAGM

A. The galvanized steel diaphragm used in the construction of the core wall shall be 26 gauge with a minimum thickness of 0.017 in. conforming to the requirements of ASTM A653/A653M. Weight of zinc coating shall be not less than G 90 of Table 1 of ASTM A653/A653M.

B. The diaphragm shall be formed with re-entrant angles and erected so that a mechanical key is created between the shotcrete and diaphragm.

C. The diaphragm shall be continuous from bottom to top of wall; horizontal joints or splices will not be permitted.

D. All vertical joints in the diaphragm shall be rolled seamed, crimped and sealed watertight using epoxy injection.

E. In all tanks designed to use a waterstop at the floor/wall joint, the steel shell diaphragm shall be epoxy bonded to the waterstop.

2.07 PVC WATERSTOPS, BEARING PADS AND SPONGE FILLER

A. Plastic waterstops shall be extruded from an elastomeric plastic material of which the base resin is virgin polyvinyl chloride.

B. The profile and size of the waterstop shall be suitable for the hydrostatic pressure and movements to which it is exposed.

C. Bearing pads used in floor/wall joints shall consist of neoprene, natural rubber or polyvinyl chloride.

D. Sponge filler at the floor/wall joint shall be closed-cell neoprene.

2.08 EPOXY

A. Epoxy Sealants:

1. Epoxy used for sealing the diaphragm shall conform to the requirements of ASTM C881/C881M.

2. Epoxy used for sealing the diaphragm shall be, Type III, Grade 1, and shall be a 100% solids, moisture insensitive, low modulus epoxy system.

3. When pumped, maximum viscosity of the epoxy shall be 10 poises at 77°F.

4. The epoxy sealants used in the tank construction shall be suitable for bonding to concrete, shotcrete, PVC and steel.

B. Bonding Epoxy:

1. Epoxy resins used for enhancing the bond between fresh concrete and hardened concrete shall conform to the requirements of ASTM C881/C881M.

2. Epoxy resins shall be a two-component, 100% solids, moisture-insensitive epoxy and shall be Type II, Grade 2.

2.09 SEISMIC RESTRAINT CABLES

A. When required by design, seismic restraint cables shall be seven-wire strand conforming to ASTM A416/A416M.

B. The strand shall be protected with a fusion-bonded, grit-impregnated epoxy coating conforming to ASTM A882/A882M.

C. The minimum yield strength of the seven-wire strand shall be 270,000 psi.

2.10 TANK ACCESSORIES

A. Minimum of three, 2' 0" x 4' 4" rectangular Type 316 stainless steel wall manhole for access to the interior of the tank. The cover and the bolts shall also be of Type 316 stainless steel. The wall manhole shall be designed to resist hydraulic loading without excessive deflection.

B. Exterior ladder shall be fabricated from 6061-T6 and 6063-T6 aluminum with Type 316 stainless steel fasteners and shall conform with all applicable OSHA standards. The ladder shall have an aluminum safety cage and lockable security gate and/or a safety climbing device as required to meet applicable OSHA standards. A rest platform is required on the exterior ladder.

C. Roof hatch cover and roof ventilator shall be fabricated from fiberglass with Type 316 stainless steel fasteners.

D. Through-wall pipe sleeves shall be Type 316 stainless steel sleeves with neoprene modular seal units using stainless steel tightening bolts.

E. The total open area of the precast concrete "eyebrows" shall be equivalent to the cross section area of the largest influent or effluent pipe diameter multiplied by a safety factor of four. A minimum of three concrete eyerbrows is required.

F. Pipe brackets shall be provided as designed per tank manufacturer.

2.11 COATINGS

A. Exterior coating system shall consist of one of the following:

1. Two coats Tnemec Series 156 Enviro-Crete Modified Waterborne Acrylate.

2. Two coats Thoroseal Waterproof Cement-Based Coating.

PART 3 EXECUTION

3.01 EXAMINATION

A. All subgrade elevations shall be verified prior to starting tank construction.

3.02 INSTALLATION

A. Floor:

1. The subgrade shall be prepared by fine grading to ensure proper placement of reinforcing steel with proper bottom cover.

2. A 6-mil polyethylene vapor-barrier shall be placed after subgrade preparation has been completed.

3. Form and screed boards shall be of proper thickness and sufficiently braced to ensure that the floor is constructed within proper thickness tolerances.

4. Plate bolsters shall be used to support reinforcing steel in the construction of the floor to ensure positive control of placement of reinforcing steel.

5. The floor shall be vibratory screeded to effect consolidation of concrete and proper encasement of floor reinforcing steel.

6. The floor shall be water cured for a minimum of 7 days after casting.

7. The floor shall receive a light broom finish.

B. Core Wall:

1. The wall shall be constructed in a predesigned manner utilizing diaphragm and layers of shotcrete with each conforming to the following:

a. Diaphragm Erection:

(1) The diaphragm shall be protected against damage before, during, and after erection. Nail or other holes shall not be made in the diaphragm 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 epoxy sealant which complies with Section 2.08 Epoxy.

b. Shotcrete:

(1) 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.

(2) Each shotcrete layer shall be broomed prior to final set to effect satisfactory bonding of the following layer.

(3) No shotcrete shall be applied to reinforcing steel or diaphragm that is encrusted with overspray.

(4) No less than ⅛" thick shotcrete shall separate reinforcing steel and prestressing wire.

(5) The diaphragm shall be encased and protected with no less than 1" of shotcrete in all locations.

(6) The interior shotcrete shall receive a light broom finish.

c. Curing:

(1) Interior and exterior portions of the shotcrete wall shall be water cured for a minimum of 7 days or until prestressing is completed.

C. Epoxy Injection:

1. Epoxy injection shall be carried out from bottom to top of wall using a pressure pumping procedure.

2. Epoxy injection shall proceed only after the diaphragm has been fully encased, inside and outside, with shotcrete.

D. Dome:

1. All concrete shall be consolidated by means of a vibrator for proper encasement of reinforcing steel and welded wire fabric.

2. All surfaces at the joint between the wall and the dome shall be coated with bonding epoxy which complies with Section 2.08 Epoxy.

3. Plastic bolsters shall be used to support reinforcing steel and welded wire reinforcement to ensure positive control on placement of steel.

4. The exterior surface of the dome shall receive a light broom finish.

5. The dome shall be water cured for a minimum 7 days after casting or until dome band prestressing is completed.

E. Prestressing:

1. 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.

2. 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 force 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.

3. 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.

4. 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 design and as shown on approved drawings.

5. 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.

6. 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.

7. When multiple layers of wire are required, shotcrete cover between layers shall be no less than ⅛" thick.

F. Covercoat:

1. 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. Horizontal sections of the wall shall form true circles without flat areas, excessive bumps or hollows.

3. The covercoat shall receive a sliced trowel finish.

G. Wall Openings:

1. All wall pipes, sleeves and manholes passing through the wall shall be sealed to the diaphragm by epoxy injection.

H. Coatings:

1. All coatings shall be applied a minimum of 28 days after final application of concrete or shotcrete.
2. All application procedures for coatings shall be in accordance with manufacturer's recommendations.

3.03 FIELD QUALITY CONTROL

A. Inspection and Testing:

1. Concrete and Shotcrete Testing:

a. Compression Tests:

(1) Compression test specimens shall be taken during construction from the first placement of each class of concrete specified herein and at intervals thereafter as selected by the Engineer to insure continued compliance with these Specifications. At least one set of test specimens shall be made for each 50 yards of concrete/shotcrete placed. Each set of test specimens shall be a minimum of 5 cylinders.

(2) Compression test specimens for concrete/shotcrete shall conform to ASTM C172/C172M for sampling and ASTM C31/C31M for making and curing test cylinders. Test specimens shall be 6-inch diameter by 12-inch high or 4-inch diameter by 8-inch high cylinders.

(3) Compression test shall be performed in accordance with ASTM C39/C39M. Two test cylinders will be tested at 7 days and two at 28 days. The remaining cylinder will be held to verify test results, if needed.

b. Air Content Tests:

(1) Air content tests shall conform to ASTM C231/C231M (Pressure Method for Air Content).

(2) Tests for air content shall be made prior to concrete placement and whenever compression test specimens are made.

c. Slump Tests (For concrete only, no slump test for shotcrete):

(1) Slump tests shall be made in accordance with ASTM C143/C143M.

(2) Slump tests shall be made whenever compression test specimens are made.

d. All testing will be paid for by the Owner, unless it is testing required of defective work.

2. Hydrostatic Testing:

a. The tank shall be tested for watertightness upon completion. The structure shall be filled with potable water from Kentucky American Water Company supply. The Contractor will be responsible for purchasing water, metering, and coordination in accordance with KAWC guidelines. All costs associated with the testing shall be included in the Bids.

b. The testing for watertightness shall be completed as described in Section 03300 – 3.11

3.04 CLEANING

A. The interior of the tank shall be cleaned to remove debris, construction items, and equipment prior to testing.

END OF SECTION

DIVISION 15

MECHANICAL

SECTION 15010 - GENERAL MECHANICAL PROVISIONS

PART 1 - GENERAL

1.01 SYSTEM DESCRIPTION

A. Consult Plans and Specifications in Division 15.

B. Drawings:

1. Drawings are schematic and show approximate locations of ducts, piping and equipment. Coordinate and field verify exact locations with other trades.

2. Obtain Engineer's approval for significant deviations from drawing locations and layout.

3. The Engineer reserves the right to make minor changes in the location of mechanical work or equipment prior to roughing-in without additional cost.

4. Examine the Contract Documents and immediately report any error, discrepancy or omission. The Engineer will determine which interpretation shall take precedence where two or more conflicting statements occur. Otherwise, the Contractor is responsible for the more stringent (or expensive) interpretation. In general, schedules, wherever they appear, supersede specifications, and specifications supersede plans.

5. Contractor shall make use of all data in all Contract Documents and shall verify this information at the building site. All Drawings of the Contract set are hereby made a part of these Specifications and shall be consulted by Contractor and his work adjusted to meet the conditions shown thereon.

1.02 QUALITY ASSURANCE

A. Materials, equipment and installation shall meet the requirements of the following as applicable:

1. American Gas Association (AGA)

2. American National Standards Institute (ANSI).

3. American Society for Testing and Materials (ASTM).

4. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).

5. American Society of Mechanical Engineers (ASME).

6. National Fire Protection Association (NFPA).

7. Sheet Metal and Air-Conditioning Contractor's National Association (SMACNA).

8. Underwriters Laboratories (UL).

B. All equipment shall bear the label of an approved independent testing laboratory (e.g. UL), where such standards exist.

C. All equipment shall be supplied with integral fusing as required for compliance with its listing.

D. Performance of work shall be in strict accordance with the best common practices of the trades involved, in a thorough, substantial, neat, and workman-like manner by competent, qualified workmen. No trainees or apprentice workmen shall be allowed at the job site unless

under the direct, continuous supervision of a qualified journeyman. All work on HVAC, plumbing, fire protection or electrical systems shall be supervised and performed by individuals properly licensed, where required by state law, or as otherwise indicated in these Documents.

1.03 REGULATORY REQUIREMENTS

A. The work in this Division shall meet the requirements, as applicable, of the following Codes and regulatory bodies:

1. Kentucky Building Code (KBC).
2. Kentucky Department for Natural Resources and Environmental Protection.
3. Kentucky Department of Public Protection and Regulation, Department of Housing, Buildings, and Construction (State Fire Marshal, Plumbing Div., Building Code Enforcement).
4. Life Safety Code - NFPA 101.
5. Local Building Codes and Health Department.
6. Local Utility Regulations.
7. ANSI 17.1 Elevator Code as adopted by KBC.
8. Americans with Disabilities Act (ADA) - Where referenced, product design and installation shall meet minimum requirements of the Act.

B. Conformity with code requirements shall be maintained whether or not official inspections, fees or certificates are required due to project not falling under scope or jurisdiction of regulatory agencies.

1.04 REFERENCES

A. With regard to this Project and these Contract Documents, the following specific definitions shall apply:

1. "Furnish": To purchase and deliver products to the project site and prepare for installation.
2. "Install": To take furnished products, assemble, erect, secure, connect and place into operation.
3. "Provide": To furnish and install.
4. "Products": Includes materials, systems, equipment and accessories, as specified.
5. "Work": The providing of products for any or all of the entire Contract.
6. "Project": The sum total of all work by all parties, to be accomplished as directed in the Contract Documents.
7. "Documents", "Contract Documents": All Plans, Specifications, addenda, bid packages and any other enclosures, agreements or instruments specifically included in the Contract.
8. "Division(s)": Means the generally accepted subdivisions of the Specifications, usually according to the CSI scheme of organizing construction documents, such as Division 15 -

Mechanical, Division 16 - Electrical, etc. Also refers to all work covered within the referenced Division(s) of the Specifications.

9. "Section(s)": Means the subdivisions of the "Division" of construction specifications, such as, under Division 15, Section 15010 - General Mechanical Provisions, etc. Also refers to all work covered within the referenced Section(s) of the Specifications.

10. "Engineer", "Architect", "E/A", "A/E": The engineering, architectural or architectural/engineering firm with design authority for the Project.

11. "Contractor": Means the General Contractor and also the Plumbing, Fire Protection, Controls, HVAC or any other Mechanical Contractor, individually or collectively.

12 "Concealed": Embedded in or installed behind walls, within partitions, above ceilings, in trenches, in tunnels and crawl spaces. Areas above lay-in ceilings, in crawl spaces or in service tunnels and trenches, other than stand-up utility tunnels, chases or vaults, may be considered concealed with reference to appearance or finish but not concealed with respect to accessibility. Check for specific exceptions.

13. "Exposed": Not installed underground or "concealed" as defined above. Generally, systems in all mechanical spaces, including mechanical or boiler rooms, stand-up or walk-thru chases and utility tunnels or vaults shall be considered to be exposed with respect to finish or accessibility requirements.

14. "Equivalent" or "Equal": In the opinion of the Engineer, acceptably comparable in concept, form, quality, performance and compatibility with the design.

15. "Mechanical": May refer to all mechanical trades, including HVAC, plumbing, fire protection, or may refer to HVAC work as opposed to say plumbing, the difference being necessarily taken from context.

16. "Plans", "Drawings": Mean all information presented in a drawing or graphical format, which have been included in the Contract, including but not limited to plans, sections, elevations, details, diagrams, schedules, notes, legends and addenda thereto.

17. "Specifications": Means all information pertaining to performing the Work, presented in text format and in the accepted organization of Divisions and Sections and in the addenda thereto.

18. "Addendum", "Addenda": Means information published after the original distribution of Documents (but before the Bid Opening), which may contain changes to Drawings, Specifications or the bidding process. Such information carries the same weight as if originally included in the Documents.

B. Abbreviations and Symbology:

1. Refer to the following references for any abbreviations, acronyms or symbols not defined in the Contract Documents:

   a. ASHRAE Fundamentals Handbook, current edition, chapter on Abbreviations and Symbols.

2. The following abbreviations may be used throughout the mechanical Documents. Refer also to legends or symbol lists on Drawings and to architectural abbreviations. Note that all abbreviations are not necessarily used.

A, AMP	Ampere	AAE	Automatic Air Eliminator
AV	Air Vent		
AAV	Automatic Air Vent	ABV	Above

AC	Alternating Current Air Conditioning	ACCU	Air Cooled Condensing Unit
AD	Access Door	ADDL	Additional
ADJ	Adjustable Adjacent	ARL	Above Roof Level
A/E	Architect/Engineer	AFF	Above Finished Floor
AHU	Air Handling Unit	ALT	Altitude Alternate
AL	Aluminum		
ALTN	Alternate	ANOD	Anodized, Anode
AP	Access Panel	APPROX	Approximate
ARCH	Architect(ural)	ATM	Atmosphere
AUTO	Automatic	AV	Acid Vent
AVG	Average	AW	Acid Waste
AWG	American Wire Gauge	AWT	Average Water Temperature
AFD	Adj. Freq. Drive		
BDD	Backdraft Damper	BD	Board
BEL	Below	BHP	Brake Horsepower
BLDG	Building	BOD	Bottom of Duct
BOP	Bottom of Pipe (Elevation)	(Elevation) BRK	Break, Breaker
BRKT	Bracket	BRZ	Bronze, Braze
BS	Bird Screen	BSMT	Basement
BTU	British Thermal Unit	BTUH BFP	BTU/HR Backflow Preventer
CAP	Capacity	CB	Catch Basin
CC	Center to Center	CD	Ceiling Diffuser
CEIL	Ceiling	CENT	Central
CFH	Cubic Feet/Hour	CFM	Cubic Feet/Minute
CHG	Charge, Change	CG	Ceiling Grille
CI	Cast Iron	CKT	Circuit
CLG	Cooling	CLO	Closet
CLR	Clear	CO	Carbon Monoxide
CO	Cleanout	CO2	Carbon Dioxide
COL	Column	COMP	Compound Compressor (ed)
CONC	Concrete		
COND	Condensate, Condensation Condenser	CONFIG CONN CONST	Configuration Connection Construction
CONT	Control(s), Continuous	CONTR COP	Contractor Coefficient of Performance,
CPLG	Coupling		Copper
CT	Cooling Tower	CU	Copper, Condensing Unit, Cubic
CTR	Center		
CUH	Cabinet Unit Heater	CIRC	Circular
CW	Cold Water	CWR	Chilled Water Return
CWS	Chilled Water Supply	CR	Ceiling Register
D	Depth, Diameter Differential	dB	Decibels
		DOUB	Double
DB	Dry Bulb	DC	Direct Current
DCW	Domestic Cold Water	DD	Direct Drive
		DDC	Direct Digital Control
DET	Detail		
DF	Drinking Fountain	DG	Door Grille

DHW	Domestic Hot Water	DHWR	Domestic Hot Water Return
DI	Double Inlet		
DIA	Diameter	DIFF	Diffuser
DIM	Dimension	DISC	Disconnect
DISCH	Discharge	DL	Door Louver
DN	Down	DP	Double Pole
DS	Downspout	DT	Double Throw
DW	Double Width	DWG	Drawing
DWH	Domestic Water Heater	DWV	Drain, Waste and Vent
DR	Drain	DHBC	See HBC
E	East	EA	Each, Entering Air
EER	Energy Efficiency Ratio		Exhaust Air
		EF	Exhaust Fan
		EGW	Ethylene Glycol/ Water Mixture
EL	Elevation		
ELEC	Electric	EMD	End of Main Drip
EMER	Emergency	ENTR	Entrance
ENT	Entering	EQUIP	Equipment
EQ	Equal, Equivalent	ET	Entering Temperature
EVAP	Evaporative		Expansion Tank
EW	Eye Wash	EWC	Electric Water Cooler
EWH	Electric Wall Heater		
EWT	Entering Water Temperature	EXH	Exhaust
		EXIST	Existing
EXP	Expansion, Exposed, Explosion	EXT	Exterior, External, Extruded
		EAT	Entering Air Temperature
EDB	Entering Dry Bulb		
EWB	Entering Wet Bulb	ESP	Ext.Static Pres.
F	Fahrenheit Temperature	FCU	Fan/Coil Unit
		FD	Floor Drain
FDN	Foundation		Fire Damper
FE	Fire Extinguisher	FEC	Fire Extinguisher Cabinet
FF	Fouling Factor	FH	Fire Hydrant
FHC	Fire Hose Cabinet	FIG	Figure
FIN	Finish	FL, FLR	Floor
FLA	Full Load Amps	FLEX	Flexible
FLUOR	Fluorescent	FOR	Fuel Oil Return
FOS	Fuel Oil Supply, Suction	FP	Fire Protection
		FPF	Fins Per Foot
FPH	Frost-Proof Hydrant	FPM	Feet Per Minute
		FPS	Feet Per Second
FPT	Female Pipe Thread	FR	Frame
		FT	Feet
FTR	Finned Tube Radiation	FVC	Fire Valve Cabinet
		FSD	Fire/Smoke Damper
FCV	Flow Cont. Valve		
GA	Gauge	GAL	Gallon
GALV	Galvanized	GI	Grease Interceptor
GL	Glass	GND, GRD	Ground
GPD	Gallons Per Day	GPH	Gallons Per Hour
GPM	Gallons Per Minute	GR	Grade, Grille
H	Height, Horizontal	HB	Hose Bib

HT, HGT	Height	HD	Head
HIGH	Height	HDWE	Hardware
HEX	Hexagonal	HOA	Hand/Off/Automatic
HORIZ	Horizontal	HP	High Pressure
HPR	High Pressure Steam Condensate Return		Horsepower
			Heat Pump
		HPS	High Pressure Steam
HI	High		
HR	Hour	HS	Hair Strainer
HTG	Heating	HTR	Heater
HUH	Horizontal Unit Heater	HVAC	Heating, Ventilating and Air Conditioning
HVY	Heavy		
HW	Hot Water	HWR	Heating Hot Water Return
HWS	Heating Hot Water Supply	HZ	Hertz = CPS = Cycles/Sec.
HBC	Ky. Dept. of Housing, Buildings, Const.		
ID	Inside Diameter, Inside Dimension	ID	Identification
		IDENT	Identification
IFB	Integral Face and Bypass Damper	IN	Inches
		INCAND	Incandescent
IN.Hg	Inches of Mercury	INSUL	Insulation
INJ	Injection, Injector	IN.W.C.,	
IND	Indirect Drain	IN.W.G.	Inches of Water column
IR	Infrared		
INV	Invert	IMC	International Mechanical Code
JT	Joint		
KIT	Kitchen	KV	Kilovolt
KVA	Kilovolt Amps	KW	Kilowatt
KWH	Kilowatthour	KBC	Ky. Bldg. Code
L	Long, Louver, Latent	LB, #	Pound
LFS	Low Fire Start	LG	Length
LAT	Leaving Air Temperature Latent	LAV	Lavatory
		LIQ	Liquid
LP	Low Pressure Liquified Petroleum (Gas)	LPR	Low Pressure Steam Condensate Return
LPS	Low Pressure Steam	LT	Light, Leaving Temperature
LTG	Lighting		
LWT	Leaving Water Temperature	LVG	Leaving
		LDB	Leaving Dry Bulb
LWB	Leaving Wet Bulb	LO	Low
MA	Milliampere	MACH	Machine
MAN	Manual	MATL	Material
MAV	Manual Air Vent	MAX	Maximum
MBH	Thousand BTU Per Hour	MD	Manual Damper
		MECH	Mechanical
MET	Metal	MEZZ	Mezzanine
MFR	Manufacturer	MH	Manhole
MIN	Minimum, Minute	MISC	Miscellaneous
MK	Mark	MO	Motor-Operated

MOD	Motorized Damper Modulating	Month	
MPH	Miles Per Hour		
MPR	Medium Pressure Steam Condensate Return	MPS	Medium Pressure Steam
MPT	Male Pipe Thread		
MS	Motor Starter	MT	Mount
MTD	Mounted	MTG	Mounting
MV	Millivolt	MW	Megawatt
MCC	Motor Control Ctr.		
N	North, Neutral	NC	Noise Criteria Normally Closed
NEUT	Neutral		
NIC	Not In Contract	NO	Normally Open Number
NOM	Nominal		
NPSH	Net Positive Suction Head	NTS	Not To Scale
O2	Oxygen	OA	Outside Air
OBD	Opposed Blade Damper	OD	Outside Diameter Outside Dimension
OC	On Center (s)	OPN	Operation
OPP	Opposite	OPNG	Opening
OVHD	Overhead	OZ	Ounces
P	Pressure, Pump	PD	Pressure Drop
PERF	Perforated	PH	Phase
PIV	Post Indicator Valve	PL	Plate, Property Line
PLBG	Plumbing	PNEU	Pneumatic
PNL	Panel	PPM	Parts Per Million
PR	Pair	PRELIM	Preliminary
PRES	Pressure	PRI	Primary
PRV	Pressure Regulating Valve	PSC	Permanent Split Capacitor
PSF	Pounds Per Square Foot	PSI	Pounds Per Square Inch
PSIG	Pounds Per Square Inch, Gauge	PT	Plaster Trap Point
PVC	Polyvinyl chloride	Ø	Phase
PCR	Pumped Condensate Return	POC	Point of Conn.
QT	Quart	QTY	Quantity
QUAL	Quality	QX	Heat Exchanger
R	Thermal or Electrical Resistance, Radius	RA	Return Air
RAD	Radius		
RCP	Reinforced Concrete Pipe		
RD	Roof Drain		
RECIRC	Recirculating	RECOV	Recovery
RED	Reducing	REG	Register Regulator
REINF	Reinforced		
REQD	Required	REV	Revised, Revision
RH	Relative Humidity	RM	Room
RND, Ø	Round	RPM	Revolutions Per Minute
RPS	Revolutions Per Second	RWC, RWL	Rainwater Conductor
RG, RAG	Return Air Grille	RPZ	Reduced Pressure Zone (BFP)
RF	Return Fan		
RECT	Rectangular		

S	South, Sensible	SA	Supply Air
SAN	Sanitary	SCH	Schedule
	SCHED	Schedule(d)	
SCR	Silicon-Controlled Rectifier	SD	Smoke Detector Storm Drain
SEC	Secondary	SECT	Section, Sector
SENS	Sensible	SERV	Service
SF	Square Feet Supply Fan	SGL SG, SAG	Single Supply Air Grille
SH	Sheet	SHT	Sheet
SING	Single	SIM	Similar
SOL	Solenoid	SP	Static Pressure Space Single Pole
SPEC(S)	Specification(s)		
SP.GR.	Specific Gravity		
SQ	Square	STRUCT	Structural
SS	Stainless Steel Sanitary Sewer or Storm Sewer (See Legend)	ST SWP	Sound Trap, Single Throw Steam Working Pressure
STD	Standard	STL	Steel
STM	Steam	STOR	Storage
STR	Straight	STRL	Structural
SUP	Support(ed)	SUSP	Suspend(ed)
SW	Switch	SYS, SYST	System
T	Temperature, Total	T&B	Top and Bottom Testing & Balancing
TAB	Testing Adjusting & Balancing	TOT	Total
TD	Temperature Difference	TDH	Total Dynamic Head
TEFC	Totally Enclosed Fan Cooled	TEMP	Temperature Temporary
TERM	Terminal	THK	Thick
THRU	Through	TYP	Typical
TG, TAG	Transfer Grille		
U	Overall Heat Transfer Coefficient	UC	Undercut
		UGND	Underground
UH	Unit Heater	UR	Urinal
UTIL	Utility, Utilities	UV	Ultraviolet Unit Ventilator
V	Volts, Vent Vertical, Velocity	VAC	Vacuum
VCP	Vitrified Clay Pipe	VEL	Velocity
		VENT	Ventilat(or), (ion), (e)
VERT	Vertical		
VOL	Volume	VSP	Vitrified Sewer Pipe
VTR	Vent Thru Roof		
VUH	Vert. Unit Heater	VSD, VFD	Variable Speed Drive
W	Waste, Water Watt, West, Width	W/	With
		WB	Wet Bulb
WC	Water Column Water Closet	WOG	Water, Oil or Gas
WG	Water Gauge	WH	Wall Hydrant
WL	Water Level	WO	Waste Oil

W/O	Without	WP	Working Pressure
WSHP	Water Source Heat Pump	WT	Weight
		WTR	Water
XFMR	Transformer	XBRA	Cross Bracing
XT	Expansion Tank	XFER	Transfer
XA	Transfer Air		
YD	Yard	YH	Yard Hydrant
YR	Year		
Z	Impedence		

C. Organizational Acronyms

AABC	Associated Air Balance Council
ACGIH	American Conference of Governmental Industrial Hygienists
ADC	Air Diffusion Council
AEE	Association of Energy Engineers
AFBMA	Antifriction Bearing Manufacturers Association
AGA	American Gas Association
AMCA	Air Movement and Control Association
ANSI	American National Standards Institute
ARI	Air-Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	American Society Mechanical Engineers
ASPE	American Society of Plumbing Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
BOCA	Building Officials & Code Administrators International, Inc. (ICC)
CISPI	Cast Iron Soil Pipe Institute
CS	Commercial Standards (sometimes known as commodity standards') produced by the U.S. Department of Commerce
FM	Factory Mutual System
FS	Federal Specification
IBR	Hydronics Institute
ICC	International Code Council
IRI	Industrial Risk Insurers (Formerly FIA)
MIL	Military Specifications
MSS	Manufacturer's Standardization Society of the Valves and Fitting Industry
NBS	National Bureau of Standards
NEBB	National Environmental Balancing Bureau
NEC	National Electrical Code (NFPA)
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Administration or Occupational Safety and Health Act
PS	Product Standard, produced by U.S. Department of Commerce
SMACNA	Sheet Metal and Air Conditioning Contractor's National Association
SFPE	Society of Fire Protection Engineers
UL	Underwriters Laboratories, Inc.

D. Technique:

1. HVAC Metal Duct Standards - SMACNA

2. Industrial Duct Construction - SMACNA

3. Industrial Ventilation - ACGIH

4. Welding Pressure Piping - ASME

1.05 SUBMITTALS

A. Refer to Division 1 for submittal procedures and references.

B. Otherwise, submit 8 to 12 copies of information to the Engineer for approval. Check each Specification Section for all items to be included

C. Submit all required items within sixty (60) days of Contract date or Notice to Proceed, whichever is later, unless otherwise specifically instructed. Approval of the Engineer must be obtained to submit later on any item.

D. Submittals are required for all items of mechanical equipment and products provided by the Contractor which are called out in individual sections of the specifications. In general, do not submit product data on pipe, pipe fittings, sheet metal, sleeves, lubrication or packing unless specifically directed in these Contract Documents, but do submit schedules listing materials to be used.

E. All drawings or other material submitted on sheets larger than 8 1/2" X 11" (or 11" X 17" foldout) shall be submitted as one set of paper sepia or mylar sepia reproducibles and one set of blueline prints. Corrections and approvals will be indicated on the sepias and returned to the Contractor for copying and distribution.

F. Submittals shall be referenced correctly to the appropriate Sections of the Specifications.

G. Manufacturer's catalog cuts, instead of complete shop drawings, may be submitted for all standard cataloged equipment, provided that the item required to meet the project specifications is not modified in any way from the standard catalog version of said item. Cuts shall be clearly marked to indicate the version of said item, including the exact size, type, rating, capacity, accessories, etc., of the item to be furnished. Do not use the term "furnished by others" or similar designations, as this may imply that the item is not being provided in the Contract.

H. No faxed (Facsimile Transmitted) material will be accepted for submittals and all drawings and text shall be clear original printed material or low-generation copies with no blurred, blotched or unreadable areas.

I. Bind shop drawings/catalog cuts in folders with a title sheet and identification on front of the folder. Allow space for Contractor, Architect and Engineer review stamps.

J. All submittals must bear the dated, handwritten signature of the Contractor and his stamp of approval before being considered for review.

K. See additional requirements in individual Sections of these Specifications.

1.06 SAMPLES AND MOCK-UPS

A. Samples of any product called for by individual sections of the specifications shall be delivered to the Engineer at the time of submittal on that item. Submittals, in those cases, will not be approved until the samples have been examined.

B. Where called for in the specifications, the Contractor shall construct a sectional mock-up of equipment installations using actual equipment or equipment cabinets of the type to be used for purposes of checking appearance, fit of piping, ductwork, controls or structural elements.

Mock-ups shall be inspected and approved by the Engineer prior to release for shipment of the material in question.

1.07 CERTIFICATES, LICENSES AND FEES

A. The Contractor shall pay all fees, stand all required inspections, obtain all necessary licenses, and obtain all required certificates for the work at his own expense.

B. Certificates requiring display shall be suitably framed and mounted in the mechanical room or other appropriate location. Copies of the certificate shall be included in each copy of the maintenance and operating manuals.

C. Certificates not requiring display shall be delivered to the Engineer for transmittal to the Owner, and copies of the certificate shall be included in each copy of the maintenance and operating manuals.

1.08 PROJECT RECORD DOCUMENTS

A. Record Drawings

1. Comply with Division 1 for record document procedures and requirements.

2. Maintain and protect one complete set of drawing prints on job site to record any deviations from Contract drawings.

3. Neatly and correctly enter with multicolored pencils any deviations on drawings and keep drawings available for inspection.

   a. Record locations of concealed ducts, piping and valves.

   b. Record Addendum and Change Order items.

4. Record deviations made necessary to incorporate equipment different from base equipment specified.

5. Drawings shall be available at the site at all times for inspection by the Engineer during normal project working hours.

6. At completion of Project and before final approval, make any final corrections to drawings, certify to the accuracy of each print by signature thereon and deliver same to Engineer for approval and drafting.

7. Underground site utilities shall be located by survey. Actual inverts and elevations shall be recorded.

1.09 MAINTENANCE AND OPERATING MANUALS

A. Submit four (4) bound copies, 8-1/2" x 11", in hard back 3-ring binders to the Engineer for review and obtain receipt for delivery.

B. Format of the manual shall be as follows:

1. First page, Each Volume: Title of Project, Owner, Address, Date of Submittal, Name and Address of Contractor, Name of Engineer.

2. Second page, Each Volume: Index of manual contents.

3. First section: A copy of each shop drawing and reviewed submittal with an index at the beginning of the section. Include operating and maintenance instructions, wiring/control diagrams, spare parts lists for each type of equipment.

4. Second section: A list of all major equipment used on the job, together with supplier's name and address and servicing agency's name and address.

5. Third section: Copies of Contractor and manufacturer warranties.

6. Fourth section: Test and balance reports, construction test reports, start-up reports, water treatment reports.

7. Fifth section:

a. Include a list of any special keys, tools and wrenches required for operation.

b. Include a list of all lubrication procedures, special lubricants and equipment.

c. Include a list of all tagged valves with tag number, valve description, location, and function. Include a revised flow chart, obtained from the Engineer to show valve identification.

C. No faxed (Facsimile Transmitted) material will be accepted for M & O submittals and all drawings and text shall be clear original printed material or low-generation copies with no blurred, blotched or unreadable areas.

D. Final payments cannot be made and Project cannot be closed out until Maintenance and Operating Manuals have been approved.

1.10 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Arrange deliveries of products in accordance with construction schedules to avoid conflict with work and site conditions.

1 Deliver products in undamaged condition, in manufacturer's original containers or packaging, with identifying labels intact and legible.

2. Immediately on delivery, inspect shipments to assure compliance with the requirements of the Contract Documents and approved submittals, and that products are properly protected and undamaged.
3. Provide equipment and personnel to handle products by methods to prevent soiling and damage to products or packaging.

B. Store products in accordance with manufacturer's instructions with seals and labels intact and legible.

1. Store fabricated products above the ground, on blocking or skids, prevent soiling or staining. Cover products which are subject to deterioration with impervious sheet coverings. Provide adequate ventilation to avoid condensation.

2. Arrange storage in a manner to provide easy access for inspection. Make periodic inspections of stored products to assure that products are maintained under specific conditions, and free from damage or deterioration.

3. Provide substantial coverings as necessary to protect installed products from damage. Remove when no longer needed.

1.11 ENVIRONMENTAL REQUIREMENTS AND EXISTING CONDITIONS

A. Locate existing utilities prior to beginning work. Reroute or replace existing utilities where necessary to permit installation of the work. Provide adequate means of protection during work operations. Repair existing utilities damaged during work operations to the satisfaction of the utility owner and at Contractor's expense.

B. Should uncharted or incorrectly charted piping or other utilities be encountered during work operations, notify the Engineer immediately for procedure directions. Cooperate with utility companies in maintaining active utilities in operation.

C. Contractor shall not remove or disturb any known or suspected existing hazardous materials in buildings, above ground or underground, except work performed in compliance with EPA requirements, as instructed in this Contract, including, but not limited to, asbestos, lead-based paints, PCB's and radioactive materials. If such materials are encountered during the course of the Work, the Engineer shall be immediately notified and the materials shall be avoided.

D. All materials removed from the site including scraps, construction materials, excavated or demolished materials shall be disposed of in a legal manner.

1.12 WARRANTY

A. The Contractor shall guarantee all work, both labor and products against defects and failure under normal use for the period of one year from the official date of Substantial Completion, the date of official acceptance by the Owner or the date of occupation by the Owner of the complete project area, whichever is earliest. The Contractor shall leave the entire installation in complete working order and free from any and all defects in materials, workmanship or finish. He shall repair or replace at his own expense any part that may develop defects due to faulty material or workmanship during construction and the warranty period and shall guarantee also to repair or replace with like materials any existing work of the building or equipment which is damaged during the repairing of such defective apparatus, materials or workmanship. The signing of the Contract for this Work, covered by these Documents of which they shall become a part, shall become a written guarantee on the part of the Contractor to carry out all the provisions of this Division of these Specifications.

B. Refer to Division 1 for other specific requirements.

C. Refer to each Section of Division 15 for additional requirements.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS, STANDARD PRODUCTS AND SUBSTITUTIONS

A. All material and equipment shall be new and in good condition. Refer to Division 1 for additional requirements.

B. Design is based upon a specific make and model of equipment. However, except where noted, the specifications are not intended to limit competition or the Contractor's option to use alternate products of equivalent concept, quality, and performance.

C. Products of alternate manufacturers listed may be substituted without approval prior to the Bid, if they are regularly catalogued items and meet the criteria of equivalence in concept, quality, and performance in the opinion of the Engineer. It is recommended that the opinion of the Engineer be solicited prior to the bid if there are any questions. This opinion does not guarantee approval of the submittals at a later time. In the case where the equipment is unfamiliar to the Engineer, all vendors desiring to furnish equipment other than that specified must submit, in addition to ordinary shop drawings, a complete verification specification for the substituted equipment along with catalogs, literature, wiring diagrams, piping diagrams, and a list of similar sized installations where the proposed equipment is installed. This information may be required to be presented immediately after the Bid and lack of information or of qualifications, as judged by the Engineer, may result in a Bid not being accepted.

D. All products which require submittals, whether design basis or otherwise accepted, must be formally approved by the Engineer before shipment to the job.

E. The Contractor is responsible for any and all costs for changes to the mechanical work or the work of other trades necessitated by the optional substitution of approved alternate equipment. Approval of alternate equipment or modifications to the plans by the Engineer are not to be construed as relief from this responsibility. In the case of significant modification to the design, the Contractor may also be required to pay for the cost of design review and/or redesign by the Engineer.

F. Listing: The successful bidder shall furnish to the Engineer within one hour of the Bid opening, or as indicated in bidding instructions, a list of all major items of mechanical equipment to be provided, indicating the manufacturer and the general type. List shall include all items of major equipment such as boilers, chillers, towers, pumps, tanks, air handlers, packaged equipment, controls, plumbing fixtures, or other items to which whole Sections of Specifications are devoted. Do not include piping, sheet metal, small specialty items or the like unless specifically requested. In addition, a list of all Subcontractors to be involved in the project shall be furnished to include, in addition to the prime mechanical contractor, as a minimum, the plumbing, pipe fitting, sheet metal, controls, water treatment, thermal balancing, insulating, fire protection and asbestos removal subcontractors, as utilized in the project. Any list of required items included in the Bid Form, Instructions to Bidders or other Bid documents shall supercede these items. Changing manufacturers or subcontractors after the listing will not be acceptable, unless initiated by the Owner or the Engineer. Final acceptance of the bids is contingent upon submission and approval of these lists.

2.02 QUANTITIES AND COMPLETENESS

A. Items may be referred to as singular or plural on drawings and specifications. Contractor is responsible for determining quantity of each item.

B. All components required for the complete installation and legal, proper and safe operation of equipment and systems indicated in the Documents shall be provided by the Contractor. Optional accessory items shall be included only as specified.

2.03 TESTING AND CERTIFICATION

A. Conduct tests and adjustments of equipment as specified and necessary to verify performance requirements. Submit test data to the Engineer. Pay all fees involved in required testing of equipment.

B. Provide necessary personnel and testing instruments required to perform test(s) of installation.

C. Refer to individual Sections for additional requirements.

D. Submit copies of all test reports, manufacturer's certifications and inspection reports to the Engineer. Include copies of each in each copy of the Maintenance and Operating Manual (Section 15010, Paragraph 1.10).

2.04 NOISE AND VIBRATION

A. Equipment shall be free of unusual or excessive noise and vibration in the opinion of the Engineer. No amount of rattling of loose, improperly isolated or ill-fitting parts will be acceptable. Vibration transmitted to the structure shall be reasonable and within recognized and specified limits.

2.05 HAZARDOUS MATERIALS

A. No materials or products containing known regulated hazardous materials shall be used in the Project, including asbestos, paint containing lead or products containing PCB's in amounts grater than current standards allow.

B. No solder containing lead shall be used on the Project.

C. Chemical products used in the construction process or for water treatment purposes shall be used in a manner in complete compliance with all OSHA and EPA regulations and guidelines. Formal Material Safety Data (MSD) Sheets shall be provided for each product used and shall be posted in the work area most accessible to the place of use of the product. In addition, MSD sheets shall accompany and be attached to water treatment products from the time they arrive on site through the end of Warranty.

PART 3 - EXECUTION

3.01 TEMPORARY SERVICES

A. Refer to Division 1 for specific requirements, responsibilities and methods for temporary water service, sanitation, heat and ventilation.

3.02 COORDINATION

A. The Contractor is responsible for sequencing of the work and coordination with all trades to prevent delays in the project. No extras will be allowed for changes made necessary by interference of work between trades.

B. Carefully check and coordinate location and level of all pipes, ducts, etc. Run preliminary levels and check with all trades so that conflicts in all locations may be avoided. Contractor shall rough sketch sections through the corridors or other tight mechanical/electrical spaces when requested to do so, in order to show that any possible conflicts have been resolved among all the trades. Where conflicts occur, if any, the following preference schedule shall be followed:

1. Recessed electrical light fixtures.
2. Sanitary and storm drainage piping on critical grade.
3. Ductwork.
4. Large HVAC or domestic water mains.
5. Sprinkler piping.
6. Communications wireway
7. Small HVAC piping.
8. Domestic water piping.
9. Electric and communications conduits.

C. Ductwork or Heating Main: No ductwork or heating main shall have preference over plumbing lines below plumbing fixtures, or over electrical conduits above or below electric switchgear and panels. No piping conveying fluids shall be installed directly over electrical equipment.

D. Unless otherwise indicated, coordinate all work with the arrival of materials on the site to prevent unnecessary delays between demolition or other preliminary phases of work and the installation of new materials. Periods of abandonment of work area, once work has begun shall be avoided unless necessary to allow other trades to complete their work.

E. The storage of materials on site shall be minimized. Materials delivered to the site far in advance of construction, and/or exposed to weather, mud or construction abuse for long periods, will not be eligible to be included in pay requests, and will be accepted for use in the project at the time of construction based upon condition at that time. Generally, rusted, beat-up products, including large equipment, will not be accepted for use.

3.03 INSPECTIONS

A. The Engineer or his representative may inspect the work at any time and for any reason, but, generally, inspections will be arranged to coordinate with phasing of the work and with regularly scheduled Project meetings. The Engineer will attempt to accommodate the Contractor where possible, but in general, it is the Contractor's responsibility to schedule the work in such a manner that inspections are not required more often than the regular meetings, except for substantial completion and final inspections.

B. No work shall be permanently concealed (underground, behind drywall or masonry, or any other inaccessible location) without being inspected by the Engineer or his representative, unless specific permission is granted to do so by the Engineer.

C. In general, piping and ductwork must be inspected by the Engineer or his representative before insulation is applied, unless specific permission to do otherwise is given by the Engineer.

D. The Contractor shall supply lights, ladders, tools, equipment and assistance to the Engineer, as required, for performing inspections and verifying the operation of mechanical systems.

3.04 CONCRETE WORK

A. Provide all concealed concrete work required for Division 15, including but not limited to pipe and duct anchors, foundations and encasement, inertia bases, and pads. Coordinate with other divisions.

B. Equipment pads, slabs and bases exposed to view and not part of the building structure (see architectural/structural plans) shall be provided by the Contractor. Coordinate with other divisions. The Contractor shall locate, dimension and furnish sleeves and anchors as required.

C. Concrete shall conform to Division 3 requirements.

3.05 PROTECTION

A. Protect equipment and materials during construction from damage from water, dirt, welding and cutting, spatters, paint droppings, etc., by use of shield and drop cloths. Damaged equipment or materials shall be repaired or replaced by the Contractor. Rusting, corroded or damaged materials or equipment is not acceptable, whether installed or not.

B. Products stored outside or in unheated spaces shall be covered with water-proof drop cloths or tarpaulins. Condensation shall be prevented by heating and ventilating. Method shall be acceptable to the Engineer. (See Section 15010, Paragraph 1.11).

C. During construction, maintain all materials and equipment in an orderly manner.

D. Protect floors from soiling and damages caused by tools, chips, cutting oil, pipe compound, paint and the like.

E. The Contractor shall use OSHA-approved ladders and lifts for Division 15 work. Workmen shall not be allowed to stand or sit on the unprotected surfaces of insulation, equipment jackets, conduit, control panels or any other location not intended for traffic.

3.06 CUTTING AND PATCHING

A. Avoid cutting of concrete, masonry and other finished work by use of sleeves and inserts.

B. Perform cutting and patching required for installation of the work. Methods and procedures shall be acceptable to the Engineer. Obtain written permission before any cutting.

C. Cut holes through concrete, brick, tile, etc., when necessary, by rotary core drilling or masonry saw.

D. Damages, patches, or work in areas previously finished under the work of other Divisions shall be repaired at the expense of the Contractor and to the satisfaction of the Engineer.

3.07 CLEANING

A. Upon completion, ductwork, piping and equipment shall be thoroughly cleaned of dirt, grease, rust and oil, primed where necessary, and left ready for painting. Vacuum clean the inside and outside of fan plenums, air handling units and equipment cabinets. Vacuum clean coils and comb out damaged fins.

B. Clean galvanized piping and ductwork in exposed areas with diluted acetic acid.

C. Clean copper piping in exposed areas with emery cloth and solvent.

D. Clean gauges, thermometers, traps, strainers and fittings.

E. Install new filters in throwaway and replaceable filter frames. Properly clean permanent filters.

F. Upon completion of Work, the Contractor shall remove all resulting rubbish, debris, and surplus materials from the premises, together with all disused instruments and equipment

and shall leave the site in a neat, clean, and acceptable condition as approved by Engineer. Contractor shall maintain Work areas of existing facilities in a reasonably clean condition on a daily basis, and shall not allow debris to create operational or safety problems for the Owner.

3.08 PAINTING AND FINISHING

Painting shall meet the requirements of Section 09961.

3.09 ACCESS

A. Equipment has been chosen to properly fit into the physical spaces provided and indicated, allowing ample room for access, servicing, removal and replacement of parts, etc. Adequate space shall be allowed for clearance in accordance with Code requirements. Physical dimensions and arrangements of equipment to be installed shall be subject to Engineer approval. Submit shop drawings of equipment layout for approval where it does not comply with plans.

B. Space Requirements: In the preparation of Drawings, a reasonable effort has been made to include all equipment manufacturer's recommendations. Since space requirements and equipment arrangement vary according to manufacturer, the responsibility for initial access and proper fit rests with the Contractor. The final arrangement of equipment and service connections shall allow the unit to be serviced. This shall include space to pull motors, filters, coils, tubes, etc. Contractor shall demonstrate that proper access has been provided to inspectors.

3.10 CONSTRUCTION DIRT, DUST AND NOISE CONTROL

A. All cutting or drilling of concrete, masonry, steel or wood shall be performed with absolute control of dirt and dust resulting from the cutting or drilling operation. Workers performing operations or in the immediate vicinity shall wear OSHA approved protective equipment.

B. The Contractor is required to minimize construction noise levels in all locations adjacent to or in occupied areas.

C. The Owner reserves the right to prevent use of any tools which cause detrimental vibration or noise.

3.11 TRAINING

A. Training and instruction to the Owner shall be provided for all Division 15 equipment, systems and controls. See individual Sections for additional specific requirements. Contractor shall submit a training agenda to the Engineer for approval, prior to Substantial Completion, including a proposed schedule, all items to be covered and who is to make the presentations. If the Owner chooses to decline training, or any part thereof, the Contractor will credit the Project for the cost of any unused hours of training and instruction. Contractor shall keep record of attendance at the training sessions and submit to the Engineer upon completion.

B. Instruction shall be based upon material in the Maintenance & Operating Manuals, described above, which shall be approved by the Engineer, prior to the training. Any supplemental information required shall be provided by the Contractor.

C. Training and instruction to the Owner shall be video recorded at the Contractor's expense, in DVD format, and the original and one copy shall be submitted to the Engineer for approval, prior to Project Closeout. Video is not required to be made by professional photographers, but shall show technical competence, with clear pictures and sound, and useable for future personnel training by the Owner.

3.12 LEAKS

A. During the time period from date of Contract until termination date of the guarantee, Contractor shall be responsible for damages to the building, grounds, walks, roads, piping systems, insulation, electrical systems, refrigeration, heating, ventilating and air conditioning systems, building equipment, furniture, and other building contents caused by leaks in piping systems or equipment being installed or having been installed by him. All repair work shall be done as directed by, and in a manner satisfactory to the Engineer and at no cost to the Owner.

END OF SECTION

SECTION 15015 - SLEEVES AND PENETRATIONS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Provide sleeves for all piping passing through walls, partitions, beams, floors, and roof in new masonry and concrete construction above grade or in basements. Holes through existing masonry or concrete construction shall be core drilled.

B. Use sleeves where round or oval duct openings are required through exposed walls, smoke or fire walls, and equipment room walls.

C. The Contractor is responsible for correct location, size, and delivery of the sleeves so as not to delay construction. If sleeves are not properly installed and cutting and patching becomes necessary, it shall be done at no expense to the Owner by parties approved by the Engineer. Contractor shall undertake no cutting or patching without first securing the Engineer's written approval.

D. Provide seals and collars for rectangular duct penetrations of walls and floors. Coordinate openings with other divisions.

E. Provide flashings or pitch pockets where required around structural roof curbs or frames (See Section 15090 - Hangers, Supports and Anchors) for mechanical equipment.

F. Provide flashings or curbs for piping or duct penetrations of the roof.

PART 2 - PRODUCTS

2.01 SLEEVE MATERIAL

A. Sleeves up thru 8" diameter shall be Schedule 40 steel pipe, machine cut, and galvanized.

B. Sleeves, 10" diameter and larger, shall be fabricated from 10 gauge steel sheet, continuously welded seams and galvanized.

C. A pipe sleeve shall be one size larger than the size of pipe it serves, or 1/2" all around. Insulated pipe shall have sleeves 1/2" or larger all around than insulation, except for penetration of fire-rated assemblies. Sleeves set in concrete floors shall extend 1 1/2"- 2" above the finished floor.

2.02 WATERTIGHT SEALS

A. Provide for outside and underground wall and floor penetrations.

B. "Linkseal" by Thunderline Corporation or approved equivalent as alternate to above. Provide correct sleeve size to match.

2.03 ESCUTCHEONS (Except Refrigerant Piping)

A. Provide heavy chrome-plated or nickel-plated plates of approved pattern on pipe passing through walls and ceilings in finished areas. Escutcheons shall be chrome-plated steel plates with concealed hinges. Pattern shall be approved by the A/E, and shall be firmly held on pipe by springs or set screws.

2.04 FLASHINGS

A. Provide galvanized, stainless steel, or copper flashings and storm collars or counter-flashings for pipes and ducts penetrating the roof or outside walls.

B. Provide seamless lead flashings or previously approved alternate flashings for plumbing vents which are in compliance with the plumbing code of the project jurisdiction.

C. For all other piping penetrations, furnish minimum 4 pound lead or 16 oz. copper flashing assembly with minimum 8" skirt, and permaseal waterproofing compound.

PART 3 - EXECUTION

3.01 SLEEVE INSTALLATION

A. Size sleeves to provide 1/2" minimum clearance all around passing pipe or pipe insulation. Insulation shall be continuous through sleeves unless prohibited by Code.

B. Fill space around ducts and pipes in sleeves in exposed areas and through slabs, fire walls and partitions with non-flammable sealing compound equal to Dow Corning Silicone RTV Foam.

C. Close off all openings around rectangular ducts through walls with sheet metal collars and sealing compound.

D. Sleeves in above grade floors of equipment rooms, and utility rooms shall extend 2" above floor and be cut flush with underside of floor construction.

E. Sleeves through walls shall be cut flush with each surface.

F. Install sleeves plumb and true to line, grade and position.

G. Unused sleeves shall be plugged and finished to match adjacent surface.

H. Sleeves and seals are not required on ducts passing through walls above ceilings, except for fire walls, if the penetrations are neatly cut. Rough, jagged or oversized penetrations will be provided with sleeves and patched.

I. Sleeving is not required for piping passing through underground foundation walls and footings except as required for sealing method.

J. Pipe sleeves penetrating outside walls shall be packed with insulating material, sealed and made waterproof. Option: Watertight seals specified above. Check for details.

K. Where a pipe passes through a sleeve, no joint in the pipe (or its insulation) shall touch the sleeve or be inside it.

L. Install all roof curbs and flashings required for mechanical equipment, including repair of existing roofs. For new work coordinate roof penetrations with Division 7 Sections rented to roofing.

M. Extend all pipes a minimum of 12" above finished roof line.

END OF SECTION

SECTION 15022 - LUBRICATION AND PACKING

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Lubricate all equipment with correct grade, type and quantity of lubrication before placing equipment into service.

B. Damages caused by not providing proper lubrication shall be repaired at the Contractor's expense.

PART 2 - PRODUCTS

2.01 LUBRICANTS

A. Provide manufacturer's recommended specific lubricants.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Each shaft or valve stem containing a packing gland shall be checked for condition and examined for proper packing.

B. Maintain all lubrication and packing seals during construction, and assure that all are operating properly at the time of final acceptance.

C. When filling systems initially for hydrostatic pressure tests, adjust valve packing glands to fingertight, and allow packing to absorb water for 5 minutes prior to tightening packing nuts.

D. All rotating pieces of equipment shall be properly lubricated prior to start-up. Damage to shafts, bearings, seals, etc., caused by lack of proper lubrication or over-lubrication shall be repaired by the Contractor. Items requiring factory start-up shall have their lubrication verified by the manufacturer's representative.

E. Where necessary, provide means for lubricating all bearings and other machine parts. If a part requiring lubrication is concealed or inaccessible, extend a lubrication tube with suitable fitting to an accessible location and suitably identify it.

F. A list of all Division 15 items requiring periodic lubrication shall be included in the bound reference manuals prepared at the end of the job. List shall include equipment identification, lubricant type required, special tools, if any, required for application and manufacturer's recommendations for period (Section 15010).

END OF SECTION

SECTION 15060 - PIPE AND PIPE FITTINGS - GENERAL

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Pipe, fittings, and connections.

B. Unless otherwise indicated in the Documents, these specifications cover all mechanical piping on the Project, including site work. Should specifications for site mechanical piping appear in other Divisions of the Specifications, they shall supercede this Section for the exterior portion of the work only and the work of this Section shall only include piping to five ft. outside the building for those systems so specified.

1.02 RELATED WORK, AS INCLUDED

A. Section 15080: Piping Specialties - General

B. Section 15090: Hangers, Supports and Anchors

C. Section 15095: Expansion Compensation and Vibration Isolation.

D. Section 15100 - Valves

E. Section 15410 - Plumbing Piping

F. Section 15535 - Refrigeration Piping and Specialties

1.03 REFERENCES

A. Note that any one reference may not apply to a given portion of the work. See other Sections for piping types required for each system. References shall always be assumed to mean the current or most recent edition, unless otherwise indicated.

1. ANSI/ASME SEC. - Boilers and Pressure Vessels VIIID Code, Rules for Construction of Pressure Vessels, with addenda.
2. ANSI/ASME SEC. - Boilers and Pressure Vessels Code, IX Welding and Brazing Qualifications, with addenda.
3. ANSI/ASME B1.1 - Unified Screw Threads
4. ANSI/ASME B2.1 - Pipe Threads (Except Dry Seal)
5. ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, 25, 125, 250, and 800 pounds
6. ANSI/ASME B16.3 - Malleable-Iron Threaded Fittings Class 150 and 300.
7. ANSI/ASME B16.4 - Cast Iron Threaded Fittings, Class 125 and 250.
8. ANSI/ASME B16.5 - Steel Pipe Flanges and Flanged Fittings
9. ANSI/ASME B16.9 - Factory-Made Wrought Steel Buttwelding Fittings
10. ANSI/ASME B16.11 - Forged Steel Fittings, Socket Welded and Threaded
11. ANSI/ASME B16.18 - Cast Copper Alloy Solder-Joint Pressure Fittings

12. ANSI/ASME B16.20 - Ring-Joint Gaskets and Grooves for Steel Pipe Flanges
13. ANSI/ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges
14. ANSI/ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings
15. ANSI/ASME B16.24 - Bronze Pipe Flanges and Flanged Fittings
16. ANSI/ASME B16.25 - Buttwelding Ends for Pipe, Valves and Fittings.
17. ANSI/ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes
18. ANSI/ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder-Joint Drainage Fittings - DWV
19. ANSI/ASME B18.2.1 - Square Head Bolts and Screws
20. ANSI/ASME B18.2.2 - Square and Hex Nuts
21. ANSI/ASME B31.1 - Power Piping
22. ANSI/ASME B31.5 - Refrigeration Piping
23. ANSI/ASME B31.9 - Building Services Piping
24. ANSI/ASME B36.10 - Welded and Seamless Wrought Steel Pipe
25. ANSI/ASME Z49.1 - Safety in Welding and Cutting
26. ANSI/ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc- Coated, Welded and Seamless
27. ANSI/ASTM A74 - Cast Iron Soil Pipe and Fittings
28. ANSI/ASTM A105 - Forgings, Carbon Steel, For Piping Components
29. ANSI/ASTM A106 - Seamless Carbon Steel Pipe for High-Temperature Service
30. ANSI/ASTM A120 - Pipe, Steel, Black and Hot-Dipped Zinc-Coated (Galvanized), Welded and Seamless, for Ordinary Uses
31. ANSI/ASTM A126 - Gray Iron Castings for Valves, Flanges and Pipe Fittings
32. ANSI/ASTM A135 - Pipe, Steel, Black, Electric Resistance Welded
33. ANSI/ASTM A194 - Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service
34. ANSI/ASTM A197 - Cupola Malleable Iron
35. ANSI/ASTM A216 - Steel Casings, Carbon, Suitable for Fusion Welding, For High Temperature Service
36. ANSI/ASTM A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
37. ANSI/ASTM A307 - Carbon Steel Externally and Internally Threaded Standard Fasteners

38. ANSI/ASTM A395 - Ferritic Ductile Iron Pressure Retaining Castings for Use at Elevated Temperatures

39. ANSI/ASTM A795 - Specification for Black and Hot-dipped Zinc Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Prevention Use

40. ANSI/ASTM B32 - Solder Metal, 95-5 (Tin-Antimony - Grade 95-5TA).

41. ANSI/ASTM B36.10M - Wrought Steel Pipe

42. ANSI/ASTM B75 - Seamless Copper Tube

43. ANSI/ASTM B88 - Seamless Copper Water Tube

44. ANSI/ASTM B140 - Flexible Metal Hose

45. ANSI/ASTM B251 - General Requirements for Wrought Seamless Copper and Copper Alloy Tube

46. ANSI/ASTM B280 - Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

47. ANSI/ASTM B813 - Fluxes for Soldering Applications of Copper and Copper Alloy Tube

48. ANSI/ASTM C14 - Concrete Sewer, Storm Drain, and Culvert Pipe

49. ANSI/ASTM C443 - Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets

50. ASTM C564 - Rubber Gaskets for Cast Iron Soil Pipe and Fittings

51. ASTM C700 - Vitrified Clay Pipe, Extra Strength, Standard Strength and Perforated

52. ANSI/ASTM D1784 - Rigid Poly Vinyl Chloride (PVC) Compounds and Chlorinated Poly Vinyl Chloride (CPVC) Compounds

53. ANSI/ASTM D1788 - Rigid Acrylonitrile-Butadiene-Styrene (ABS) Plastics

54. ANSI/ASTM D2104 - Polyethylene (PE) Plastic Pipe, Schedule 40

55. ANSI/ASTM D2146 - Polypropylene Plastic Molding and Extension Materials

56. ANSI/ASTM D2235 - Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings

57. ANSI/ASTM D2564 - Solvent Cements for Poly Vinyl Chloride (PVC) Plastic Pipe and Fittings

58. ANSI/ASTM D2657 - Heat Joining of Thermoplastic Pipe and Fittings

59. ANSI/ASTM D2680 - Acrylonitrile-Butadiene-Styrene (ABS) Composite Sewer Piping

60. ANSI/ASTM D2729 - Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings

61. ANSI/ASTM D2751 - Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings

62. ANSI/ASTM D2855 - Practice for Making Solvent-Cemented Joints with Poly Vinyl Chloride (PVC) Pipe and Fittings

63. ANSI/ASTM D3033 - Type PSP Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings

64. ANSI/ASTM D3034 - Type PSM Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings

65. ANSI/ASTM D3138 - Solvent Cements for Transition Joints Between Acrylonitrile-Butadiene-Styrene (ABS) and Poly Vinyl Chloride (PVC) Non-Pressure Piping Components.

66. ANSI/ASTM D3212 - Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

67. ANSI/ASTM D3309 - Specification for Special Listed Polybutylene (PB) Pipe

68. ANSI/ASTM F437 - Specification for Schedule 80 Chlorinated Polyvinyl Chloride (CPVC) Threaded Fittings.

69. ANSI/ASTM F438 - Specification for Schedule 40 Chlorinated Polyvinyl Chloride (CPVC) Socket Type Fittings.

70. ANSI/ASTM F439 - Specification for Schedule 80 Chlorinated Polyvinyl Chloride (CPVC) Socket Type Fittings.

71. ANSI/ASTM F442 - Specification for Special Listed Chlorinated Polyvinyl Chloride (CPVC) Pipe

72. ANSI/AWS A5.8 - Brazing Filler Metal (Class BCuP-3 or BCuP-4)...

73. ANSI/AWS D.1.1 - Structural Welding Code, Steel.

74. ANSI/AWS D10.9 - Specification for qualification of Welding Procedures and Welders for piping and Tubing.

75. ANSI/AWWA C105 - Polyethylene Encasement for Gray and Ductile Cast Iron Piping for Water and Other Liquids

76. ANSI/AWWA C111 - Rubber Gasket Joints for Ductile Iron and Gray-Iron Pressure Pipe and Fittings

77. ANSI/AWWA C151 - Ductile Iron Pipe, Centrifugally Cast 0in Metal Molds or Sand Lined Molds, for Water or Other Liquids

78. ANSI/AWWA C606 - Grooved and Shouldered Type Joints

79. The Copper Development Association Publication: Copper Tube Handbook

80. NFPA 51B - Standard for Fire Prevention in Use of Cutting and Welding Processes

81. CISPI No. 301 - Cast Iron Soil Pipe and Fittings for Hubless Cast Iron Sanitary System

82. FS WW-P-521 - Pipe Fittings, Flange Fittings, and Flanges: Steel and Malleable Iron (Threaded and Butt Welding) Class 150

83. ASTM C1053 - Borosilicate Glass Piping Systems.

84. ASTM D2447 - Polypropylene Chemical-Resistant Pipe

1.04 QUALITY ASSURANCE

A. Codes and regulations referred to are minimum standards. Where the requirements of these Specifications or Drawings exceed those of the codes and regulations, the Drawings or Specifications govern.

B. Piping systems shall meet requirements of ANSI/ASME B31.9, Building Services Piping, ASME Boiler and Pressure Vessel Code, State Plumbing Code, State Boiler Code and Kentucky Building Code.

C. All plumbing work shall be accomplished by or under the direct supervision of a licensed plumber.

D. All fire protection work shall be accomplished by or under the direct supervision of a licensed sprinkler installer.

E. Welding Materials and Procedures: Conform to ASME Code and AWS standards referenced above. Employ certified welders in accordance with ASME Section 9, ANSI/AWS D1.1., ANSI/AWS D10.9 and Boiler Inspection Section, State Fire Marshal. Welders shall be certified under the rules of the National Certified Pipe Welding Bureau and qualified by either the National Certified Pipe Welding Bureau or an independent testing laboratory for the procedures used on this Project.

1.05 SUBMITTALS

A. In general, do not submit on ordinary pipe and fittings, except as noted in these Specifications. Submit on specialties per Section 15080.

B. See individual piping Sections for additional submittal requirements.

C. Submit a letter certifying that welders and welding procedures meet the requirements of AWS D10.9, Level AR-3.

PART 2 - PRODUCTS

2.01 GENERAL

A. Provide pipe and tubing systems of types called for in the individual piping system Sections of the Specifications. Provide materials and products meeting the standards referenced in those Sections and in Paragraph 1.03 above.

B. Provide work meeting the requirements referenced in this Section 15060 - Pipe and Pipe Fittings (General), and Sections 15080 - Piping Specialties (General), 15090 - Hangers, Supports and Anchors, 15095 - Expansion Compensation and Vibration Elimination, 15100 Valves.

C. Provide all new materials in good condition, unless otherwise indicated in the Documents. Rusted, dented, bent or otherwise damaged pipe and fittings will not be accepted and shall be removed from the site as soon as discovered.

D. Provide piping system components with appropriate identification, rating or approval labels, stamps or symbols as required by Code or to show compliance with the requirements of these Documents. Unlabeled pipe, valves missing appropriate markings or any other non-identifiable items shall not be installed.

2.02 PRESSURE/TEMPERATURE RATINGS

A. Pressure/temperature ratings of all components and accessories shall meet or exceed design conditions for the system in which they are installed. All piping components, joints, valves, accessories and specialties shall be designed for operating conditions of not less than that

indicated in individual piping Sections of the Specifications and shall be designed to withstand continuous use at the following conditions as a minimum:

1. Domestic Cold Water (DCW, MU): 150 psig at 125 deg. F.

2. Domestic Hot Water (DHW, HMU) and recirculated water (DRW): 150 psig and 250 deg. F.

3. Fire water service and distribution (F, FP): 175 psig and 125 deg. F.

4. Hydronic heating piping (HWS, HWR, HCWS, HCWR): 125 psig SWP and 250 deg. F.

5. Water source heat pump, heat recovery and condenser water lines (HPWS, HPWR, CWS, CWR, HRS, HRR): 125 psig and 140 deg. F. Drainage spec piping may be used for tower open returns where allowed by notes.

6. Chilled water lines (CHWS, CHWR): 125 psig and 100 deg.F.

7. Low Pressure Steam (LPS), Low Pressure Return (LPR), Pumped Condensate Return (PCR): 125 psig SWP and 250 deg. F.

8. Medium and High Pressure Steam and Return (MPS, HPS, MPR, HPR): 150 psig and 350 deg. F.

9. Fuel Oil Supply, Return and Vent lines in general (FOS, FOR, FOV): 125 psig 250 deg. F. Some burner piping requires 350 psig or more.

2.03 PIPE AND FITTINGS

A. Where no detailed specification of pipe or fittings is given for a type of system, either in the Specifications or the Drawings, use the following general recommendations for material type.

1. Steel Pipe: ANSI/ASTM A53 Grade B, black; galvanized; Schedule 40 or as indicated. Steel Pipe Fittings: ANSI/ASME B16.3 or ANSI/ASTM A126. Weld fittings for black steel pipe shall be Tube Turns, Bonney Forge, Capital, or WFI, black steel butt welded type ASTM A234 Grade WPB of a service class to match the adjacent pipe, except that connections to valves shall be made with ASTM A105 welding neck flanges. Flanges shall have ASTM A307 Grade B bolts with hexagon heads and nuts and shall be provided with gaskets as specified and insulating sleeves where required.

2. Cast Iron Soil Pipe: ANSI/ASTM A74; coated; standard weight or as indicated. Cast Iron Pipe Fittings: ANSI/ASTM A74; ASTM C564, rubber gasket joints; ANSI/AWWA C606, grooved and shouldered joints; ANSI/AWWA C111, rubber gasket joints.

3. Hubless Cast Iron Soil Pipe: CISPI 301.

4. Ductile Iron Water Pipe: ANSI/AWWA C151, Class 50, cement-lined, bituminous coated.

5. Copper Water Tube: ASTM B88, Type K soft temper underground direct bury, Type K hard drawn for underground prefab systems, Type L hard drawn in building; Types M, DWV only as indicated. Wrought Copper and Brass Pipe Fittings: ANSI/ASME B16.22, pressure fittings or ANSI/ASME B16.29, drainage fittings. Solder shall be 95/5 tin antimony or tin/silver alloy type. Flux shall be non-acid type, approved by solder manufacturer.

6. Concrete Pipe: ASTM C14, Class 3. Concrete Pipe Fittings: ASTM C443

7. ABS Plastic Pipe: ANSI/ASTM D1788. ABS Pipe Fittings: ANSI/ASTM D2751. Solvent for ABS Jointing: ASTM D2235

8. ABS Plastic Sewer Pipe: ANSI/ASTM D2751. ABS Pipe Fittings: ANSI/ASTM D2751. Solvent for ABS Jointing: ASTM D2235

9. PVC Plastic Pipe: ANSI/ASTM D1784, Schedule 40 or 80; SDR 26, ASTM D2241; Pipe Fittings: ANSI/ASTM D2729. Solvent for PVC Jointing: ANSI/ASTM D2564. Solvent for Joining ABS to PVC: ANSI/ASTM D3138, non-pressure.

10. PVC Plastic Sewer Pipe: ASTM D3033, Type PSP or D3034, Type PSM. Solvent for PVC Jointing: ANSI/ASTM D2564. Solvent for Joining ABS to PVC: ANSI/ASTM D3138, non-pressure.

11. Polyethylene Sewer Pipe: ANSI/ASTM D2104, Schedule 40. Heat fusion for joining polyethylene: ANSI/ASTM D2657

12. Polypropylene Sewer Pipe: ANSI/ASTM D2146. Heat fusion for joining polypropylene: ANSI/ASTM D2657

13. Glazed Vitreous Clay Pipe: ASTM C700 standard strength.

2.04 UNIONS, COUPLINGS AND JOINTS

A. Unions - Pipe Size Under 2 inches: 150 psi bronze ground joint malleable iron for threaded ferrous piping; bronze for copper or brass pipe soldered joints. No wrought copper unions shall be used above 3/4" pipe size.

B. Unions - Pipe Size Over 3 inches: 150 psi forged steel or cast iron slip-on, or weld neck flanges for ferrous piping; bronze flanges for copper or brass piping; synthetic rubber gaskets for gas service.

C. Unions - Pipe Sizes 2 and 2 1/2 inch: Either of the types in A. and B.

D. Dielectric Unions: Vogt, Dart, Capitol or approved equal dielectric insulated unions for all copper to ferrous metal connections.

E. Dielectric flanges: Provide flange insulation kit for each copper to ferrous joint or as otherwise shown. Include electrically insulating gaskets, inserts and washers as required for complete isolation.

F. Couplings: Threaded steel pipe - Provide malleable iron sleeve coupling with right hand pipe thread on each end, standard or extra heavy as required for service.

G. Couplings: Copper pipe - Provide copper sleeve coupling with shoulder, socket sized for sweat connection or brazing.

H. Welded Joints: Provide joints in steel pipe executed by a properly certified pipe welder. Provide welding as required per Part 3 of this Section.

I. Grooved and Shouldered Pipe Ends: Malleable iron housing clamps to engage and lock, designed to permit some angular deflection, contraction and expansion; C-shape composition sealing gasket, steel bolts, nuts and washers; galvanized couplings for galvanized pipe.

PART 3 - EXECUTION

3.01 GENERAL

A. Joints in pipe and tubing shall be cut square with tubing or pipe cutter. Ends shall be reamed. Remove burrs. Bevel plain end ferrous pipe.

B. Remove filings, dust, scale and dirt, inside and outside, before assembly. Open ends of pipelines or equipment shall be properly capped or plugged during construction, until installation, to keep dirt and other foreign materials out of system.

C. Remove welding slag, splatter or foreign material from pipe and fitting materials before assembly and after joining.

D. Pipe shall be cut accurately to measurements established at the job site and worked into place without springing or forcing, and properly clearing all windows, doors, and other openings.

E. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted without written approval. Supports shall be attached only to structural framing members and concrete slabs. Supports shall not be anchored to metal decking unless approved in writing. Where supports are required between structural framing members, suitable intermediate metal framing shall be provided and approved by the Engineer. Supports shall conform to Section 15090 - Hangers, Supports and Anchors.

F. Changes in direction shall be made with fittings unless otherwise indicated. Bent pipe showing kinks, wrinkles, flattening or other malformations will not be accepted.

G. Provide reducing fittings for changes in pipe sizes. Reducers (increasers) shall be concentric unless eccentric fittings are indicated or required for proper drainage.

H. Pipes shall be installed to permit free expansion and contraction without damage to joints or hangers. Expansion in the piping shall be accommodated by means of expansion loops and offsets or by expansion joints as indicated in the Documents. Refer to Section 15095 - Expansion Compensation and Vibration Elimination.

I. Flanges and unions shall be faced true. Flanges shall be provided with gaskets suitable for the fluid used and made square and tight. Except where copper tubing is used, unions or flange joints shall always be provided in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, valves, and other similar items unless such items have integral flanges or unions.

3.02 COPPER PIPE CONNECTIONS

A. Form hot soldered joints in copper, brass, or bronze fittings with 95-5 solder for plumbing. Do not use for refrigeration or fuel lines. 50-50 solder or other lead-bearing solder shall not be used. Joints shall be soldered, using flux, with solder applied and drawn through the full fitting length. Excess solder shall be wiped from joint before solder hardens.

B. Joints for copper-copper, copper-brass, copper-bronze, shall be brazed where shown with specific alloy filler indicated (ANSI/AWS A5.8). During all brazing operations, the tubing and fitting being brazed shall have a continuous purge of dry nitrogen at a rate which will preclude oxidation of the tubing and fitting. All tubing and fittings shall be properly cleaned prior to brazing. All copper tubing joints that are assembled on the job site shall be assembled with fittings.

C. Joints for copper tubing may be made with flare fittings where indicated.

D. Work into place without forcing or springing.

3.03 STEEL PIPE CONNECTIONS - THREADED

A. Screw joint steel piping up to and including 1-1/2 inch, unless otherwise indicated. Weld piping 3 inch and larger, including branch connections. Screw or weld 2 or 2-1/2 inch piping.

B. Die cut screwed joints with full cut standard taper pipe threads, using cutting oil appropriate for operation.

C. Assemble with teflon paste joint compound applied to male threads only, unless otherwise indicated. Non-toxic compound shall always be used for water service piping.

3.04 STEEL PIPE CONNECTIONS - WELDED

A. Screw joint steel piping up to and including 1-1/2 inch, unless otherwise indicated. Weld piping 3 inch and larger, unless otherwise indicated, including branch connections. Screw or weld 2 or 2-1/2 inch piping.

B. Welding procedures shall be in accordance with ANSI/ASME B31.9 for the service involved. Welds shall be full penetration type, accomplished by proper beveling and spacing of pipe ends. Where backing rings are specified herein, root pass shall penetrate into the backing ring.

C. No field fabrication of jointed fittings, mitering or notching pipe to form elbows and tees or direct welding of pipe to pipe will be allowed unless specifically shown, except for buttwelding of properly aligned and prepared straight pipe sections.

D. Provide factory weld fittings for all turns in pipe. Weld bends may be field cut to proper angle as required for fit.

E. Provide manufactured weld tee fittings for branches from a main line which are main size or one size less for up to 6" pipe and for main size or up to two sizes less for 8 inch and larger mains, unless otherwise indicated. Take-off or saddle fittings such as "Weld-o-lets", "Thread-o-lets", "Latrolets", "Sweepolets", and "Elbolets" and the like may be used for smaller branch piping unless otherwise indicated. Do not project branch pipes or take-off fittings inside the main pipe.

F. Field and shop bevels shall be in accordance with the standards specified herein and shall be done by mechanical means or flame cutting. Where beveling is done by flame cutting, surfaces shall be cleaned of slag, scale and oxidation prior to welding.

G. Before welding, the component parts to be welded shall be aligned so that no strain is placed on the weld when finally positioned. Height shall be aligned so that no part of the pipe wall is offset by more than 20% of the wall thickness. Flanges and branches shall be set true. This alignment shall be preserved during the welding operations. Connections larger than 6" shall be made with backing rings at welds.

H. Where the temperature of the component parts being welded reaches 32°F or lower, the material shall be heated to approximately 100°F for a distance of 3' on each side of the weld before welding, and the weld shall be finished before the material cools to 32°F.

I. Welders shall stamp each weld with their personal symbol or code number.

J. A random sample of completed pipe field welds may be chosen by the Engineer for non-destructive testing by an independent testing agency, not to exceed 5% of the total welds on the project. Costs for testing shall be borne by the Contractor. Test criteria shall be as specified by ANSI/ASME B31. If any of the tested welds are unsatisfactory, additional welds may be chosen for testing at the Contractor's expense. Defective welds shall either be cut out and rewelded or ground down to base metal and rewelded. All reworked welds shall be tested as specified herein.

3.05 STEEL PIPE CONNECTIONS - GROOVED

A. Groove type coupling system may be used wherever this piping type is specified as an option in the individual piping Sections listed in Paragraph 1.02.

3.06 PLASTIC PIPE CONNECTIONS

A. Use joint primer with dye (Oatey Purple Primer or equal) for all PVC or CPVC solvent welded joints. Follow manufacturer's recommendations in the use of primer.

B. Form solvent joints in PVC pipe and fittings to ANSI/ASTM D2855.

C. Form heat fusion joints in polyethylene and polypropylene pipe and fittings to ASTM D 2657.

3.07 VITREOUS PIPE CONNECTIONS

A. Joints for Bell and Spigot Pipe: Lead and oakum or patented Neoprene gasketing system.

B. Joints for Plain End Pipe: Neoprene gasket and clamp system.

END OF SECTION

SECTION 15080 - PIPING SPECIALTIES

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Strainers.

B. Gauges.

C. Test plugs.

D. Thermometers.

E. Vacuum breakers.

1.02 RELATED WORK

A. Section 15060 - Pipe and Pipe Fittings.

B. Section 15100 - Valves.

C. Section 15410 - Plumbing Piping.

D. Section 15535 - Refrigeration Piping and Specialties

1.03 SUBMITTALS

A. Submit shop drawings and product data under provisions of Sections 01300 and 15010. Include component sizes, rough-in requirements, service sizes, temperature and pressure ratings, performance data and finishes. Include product description, model and dimensions. Submit proposed ranges of gauges and thermometers for each service.

B. Submit operation and maintenance data under provisions of Sections 01780 and 15010. Include manufacturer's installation and application instructions, assembly views, lubrication and service instructions, and replacement parts list.

PART 2 - PRODUCTS

2.01 STRAINERS

A. Mueller Steam, Keckley, Sarco or approved equal per Section 15010.

B. 2½" and below: Screwed-cast iron for 175 psig working pressure, Y pattern, with bronze, monel metal or 18-8 stainless steel perforated screen; 20 mesh for steam and 0.045 inch diameter perforations for liquid.

C. 2½" and above: Flanged-iron body for 175 psig working pressure, Y pattern, with bronze, monel metal or 18-8 stainless steel perforated screen; 0.045 inch diameter perforations for steam and 0.125 inch for liquids.

D. For high pressure steam (HPS), strainers shall be cast steel, rated for 300 psi and 500 deg.F.

E. Strainer element shall be removable without disconnecting piping.

2.02 GAUGES

A. Trerice, Ashcroft, Marsh, Marshalltown or approved equal per Section 15010.

B. Pressure, vacuum or compound gauges: 4 1/2 " diameter face, brass Bourdon tube type; aluminum, steel or phenolic case; 1/4" NPT bottom connection; dials black figures on white background, graduated as required for service and identity labeled; nonshatterable safety glass, and pressure blowout back in case of explosion. Range to suit application.

2.03 TEST PLUGS (P/T PLUGS)

A. Sisco BNO-25, Pete's Plug or equal per Section 15010.

B. Test plugs: ¼-inch MPT, brass body and cap, with Nordel self-closing valve cores, suitable for 250 deg. F. water, installed in water piping where shown.

C. Provide extended units for insulated piping as required.

2.04 THERMOMETERS

A. Trerice, Ashcroft, Marsh, Marshalltown or approved equal per Section 15010.

B. Dial thermometers: 3½" - 5" diameter adjustable angle face; mercury vapor tension or gas actuated; stainless steel, aluminum or black steel case, glass lens, black figures on white background, graduated with range as required, guaranteed to be accurate within one scale division; recalibration adjustment feature; adjustable angle head and capillary. Provide range suitable to the application.

C. Provide minimum 1/2" NPT separable brass well and heat conducting paste.

2.05 VACUUM BREAKERS

A. Johnson, Hoffman, Sarco or approved equal per Section 15010.

B. Use spring-loaded types unless otherwise indicated.

C. Brass body, stainless steel spring and ball, EPR "O" ring, Johnson VB-8 series, 3/4" or as indicated, opening pressure 5"-25" water.

D. Provide swing check valve only where indicated, per Section 15100.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install all items in accordance with manufacturer's instructions. In case of conflict, notify Engineer at once.

B. Provide blowoff ball valve for each wye-pattern water strainer, full size of tapping, with reducer, hose connection and cap.

C. Provide blowoff gate valve for each wye-pattern steam or condensate strainer, full size of tapping, with reducer, hose connection and cap.

D. Provide 1/4" lever-handled brass gauge cock and snubber on all pressure gauge installations except steam, unless otherwise indicated. All gauge faces shall be upright.

E. Provide straight or angled pigtail siphon and needle valve, on all steam pressure gauge installations. Trim components shall match temperature and pressure ratings of piping.

F. Provide wells for all thermometers. Mount wells in piping deep enough to contact flow stream directly but not far enough to disturb flow. See details on Drawings. Use aluminum temperature-conducting paste (Honeywell or equal) in all thermometer wells to ensure contact with bulbs. Adjust the face of all adjustable angle thermometers to be visible from the floor and tighten locking screws or nuts for a rigid installation. Avoid excessive twisting or movement of thermometer heads.

G. Provide P/T plugs with caps at all points indicated. Mount P/T plug in such position as to allow insert thermometer to be placed in fluid stream.

H. Install vacuum breakers in the horizontal or vertical top outlet positions only, unless otherwise shown, and then only in the positions for which the valves are rated.

END OF SECTION

SECTION 15090 - HANGERS, SUPPORTS, AND ANCHORS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Provide support and hangers for all piping, piping system components, and ductwork.

B. Provide pads, curbs, supports, anchors, frames and hangers for all equipment.

C. Provide steel angles and channels between structural members, framework and reinforcement as necessary to support piping and equipment.

1.02 RELATED WORK

A. Section 15060 - Pipe and Pipe Fittings.

B. Section 15095 - Expansion Compensation and Vibration Elimination.

C. Section 15810 - Ductwork.

D. Division 3 - Concrete.

E. Division 5 – Metals

1.03 QUALITY ASSURANCE

A. Meet the requirements of the following:

1. MSS SP 58 Pipe Hangers and Supports - Material, Design and Manufacture.
2. MSS SP 69 Pipe Hangers and Supports - Selection and Application.
3. ANSI Code for Pressure Piping.
4. Hangers and supports shall have a stress safety factor of 5.

1.04 SUBMITTALS

A. Submit manufacturer's product data for the following:

1. Hangers.
2. Supports.
3. Inserts.
4. Anchors.
5. Structural Curbs.

1.05 COORDINATION

A. Obtain Engineer's approval before welding, drilling or cutting any structural members.

B. Coordinate runs of piping and locate equipment to utilize structural members.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Products are based on Grinnell as a standard, unless specified otherwise.

B. Optional manufacturers: Automatic Sprinkler, Elcen, F & S, Fee & Mason, or Michigan.

2.02 STRUCTURE ATTACHMENT DEVICES

A. Riser clamp, steel: Grinnell Fig. 261. Provide masonry or concrete bearing.

B. Riser clamp, copper: Grinnell Fig. CT-121, copper plated. Provide masonry or concrete bearing.

C. Top beam clamp: Grinnell Fig. 227 with Fig. 157 extension.

D. Bottom beam clamp: Grinnell Fig. 229. (Use only where top clamps are not possible. Obtain approval from Architect).

E. Side beam bracket: Grinnell Fig. 202. (For wood construction only).

F. Horizontal traveler: Grinnell Fig. 170.

G. Concrete inserts: Grinnell Fig. 282, galvanized.

H. Concrete fasteners: Phillips "Red Head".

I. Copper tube strap: Grinnell Fig. 9124.

J. Pipe strap: Grinnell Fig. 262.

K. Pipe hanger flange: Grinnell Fig. 153.

L. Bottom channel clamp: Grinnell Fig. 226 with 157 extension. (Obtain approval from Engineer prior to use.)

M. Bottom beam/joist C clamp: Grinnell Fig. 87 with retaining clip and locknut (for use with pipes 2" and smaller, obtain approval from Engineer prior to use).

N. Sway Strut: Anvil Figure C-211, or approved equal

2.03 HANGERS AND ACCESSORIES

A. Adjustable copper tubing ring: Grinnell Fig. CT-99, copper plated.

B. Adjustable swivel split ring: Grinnell Fig. 104, black finish.

C. Adjustable pipe ring, plastic coated: Grinnell Fig. CT-99c, plastic coated.

D. Heavy adjustable clevis: Grinnell Fig. 260, black finish.

E. Lightweight adjustable clevis: Grinnell Fig. 65, black finish.

F. Pipe roll stand: (base supported): Grinnell Fig. 271, cast iron roll.

G. Adjustable pipe roll: Grinnell Fig. 181.

H. Pre-engineered spring hanger: Grinnell Figs. B-268, 82, or 98.

I. Insulated pipe saddle: Hot lines - high density precompressed fiberglass support segment with 18 ga. galvanized steel shield. Cold lines - provide "Foamglass" pipe insulation with jacket and 18 ga. galvanized steel shield. Insulation thickness shall be same as specified in 15900.

2.04 HANGER RODS AND ACCESSORIES

A. Provide plated steel threaded rods. Size according to 3.02 following.

B. Provide all necessary couplings, turn buckles, nuts, washers, and accessories for a complete installation.

2.05 TRAPEZE COMPONENTS

A. Horizontal trapeze member: Unistrut P-2700 series channel, standard or heavy duty according to load.

B. Trapeze clamp: Unistrut two piece bolted pipe clamp; steel for steel pipes, copper for copper pies.

2.06 EQUIPMENT SUPPORTS

A. Provide 3 x 3 x 1/4 angles or heavier, if required, spanning 3 structural joists to support hung equipment.

B. Provide channels (strength as required) to span between beams. Weld to beams. Obtain approval of Engineer before proceeding.

2.07 ROOF SUPPORTS

A. If not furnished with the equipment or otherwise detailed, provide 8" high support curbs of proper length to support piping and equipment. Curbs shall span 3 joists when supporting equipment. Curbs shall be Pate ES-1A, galvanized steel with wood nailer.

PART 3 - EXECUTION

3.01 PIPE SUPPORT METHODS

Condition	Support Method
Uninsulated copper pipe, horizontal hung	Adjustable copper tubing ring and hanger rod
Uninsulated copper pipe, horizontal bottom support	Copper tube strap. Provide necessary angle braces
Uninsulated copper pipe, vertical	Copper tube strap to walls with anchors. Riser clamp, copper at floors.
Uninsulated metal drain pipe horizontal hung	Heavy adjustable clevis, hanger rod.
Uninsulated metal drain pipe vertical	One hold clamp (at walls). Riser clamp, steel (at floors).
Insulated pipe horizontal, hung	Insulation pipe saddle, heavy adjustable clevis, hanger rod.

Condition	Support Method
Insulated pipe horizontal, bottom support	Insulated pipe saddle, pipe roll stand.
Insulated pipe horizontal, hung with movement	Adjustable pipe roll hanger and with rod.
Insulated pipe vertical	Pipe strap to walls. Appropriate riser clamp, with sleeve at floors.
Bottom of storm and waste stacks at slab on grade floors	Concrete pipe foundation, poured after pipe is in place

Notes:

1. Install pipe saddles as pipe is installed.
2. Trapeze hangers may be used for multiple horizontal hung pipe runs. Trapeze consists of hanger rods, horizontal trapeze member, and trapeze clamps. Each pipe individually attached to trapeze.

3.02 SUPPORT SPACING AND HANGER ROD DIAMETERS

A. Cast iron, ductile iron, and copper pipes:

Pipe Size	Maximum Vertical And Horizontal Support Spacing	Rod Diameter
½", ¾"	5'	3/8"
1", 1¼ "	6'	3/8"
1½ ", 2"	9'	3/8"
2½", 3"	10'	½"
4", 5"	10'	5/8"
6", 8"	10'	¾"

Notes:

1. Maximum support spacing for horizontal cast iron drain and vent lines is one support at each joint. (i.e., 5' spacing for 5' lengths, 10' spacing for 10' lengths).
2. Provide additional supports at turns, valves, concentrated loads, connections to equipment and where necessary for proper alignment.

B. Plastic pipe:

1. All fluid filled services: Follow Paragraph A above. Maximum support spacing on horizontal lines shall be 4 ft.
2. Drain and vent lines: Support 4 ft. maximum centers with 3/8" diameter hanger rods.

3.03 STRUCTURE ATTACHMENT METHODS

Condition	Support Method
Hanger rod to steel bar joist or truss	Top beam clamp
Hanger rod to steel beam (corrugated metal deck above)	Top beam clamp
Hanger rod to steel beam (concrete deck above, temporary form)	Bottom beam clamp

Hanger rod to precast or existing concrete deck	Concrete fasteners, pipe hanger flange
Hanger rod to new cast-in-place concrete deck	Concrete insert
Hanger rod to wood beam	Side beam bracket, lag bolt to beam (use bolt through entire beam when load exceeds manufacturer's recommended load for lag bolt application)
Hanger rod to any structure at elbows with significant lateral movement	Horizontal traveler
Hanger rod to any structure at risers with significant vertical movement	Pre-engineered spring hanger
Hanger rod to any structure at risers from vibrating equipment	Pre-engineered spring hanger

Notes:

1. Do not install hangers from metal roof deck.
2. Avoid drilling concrete by using inserts.
3. Explosive powder driven fasteners are allowed.
4. In wood construction: Where pipe is parallel to, and hanging form joists, rafters, or beams, bolt angles to side of members vertically, bolt horizontal angles to vertical angles, attach hanger rods to horizontal angles.
5. Check structural and mechanical details for methods of support.

3.04 VIBRATING EQUIPMENT

A. In-line pump support: Contractor shall provide a calibrated spring-hanger when recommended and approved by the pump manufacturer. The spring shall support the pump at approximately the center of gravity and shall reduce the piping load to less than 10% of the weight of the pump at room temperature.

B. Support piping at pumps and equipment from floor, ceiling, or walls, so that piping weight is not supported from pumps or equipment.

3.05 WET AREA AND EXTERIOR SUPPORTS

A. Use nonferrous, galvanized steel, plated steel or plastic coated steel supports and hangers in kitchens, locker rooms, shower rooms, and in exterior applications.

3.06 ANCHOR BOLTS

A. Furnish and install anchors bolts for all equipment placed on concrete equipment pads or on concrete slabs.

B. Bolts shall be of the size and number recommended by the manufacturer of the equipment and shall be located by means of suitable templates.

C. When equipment is placed on vibration isolators, the equipment shall be secured to the isolators and the isolator secured to the floor, pad, or support as recommended by the vibration isolation manufacturer.

3.07 SEISMIC REQUIREMENTS

A. Provide seismic restraints to all mechanical systems (equipment, pipes, ducts, etc.) in accordance with the latest edition of SMACNA Guidelines for Seismic Restraints and Mechanical Systems, where called for in individual sections of the specifications.

3.08 ADDITIONAL REQUIREMENTS

A. Properly support pipe to maintain required alignment, slopes, and expansion capabilities.

B. Piping and ductwork shall be supported independently from the building inner structure. Where interferences occur, provide trapeze type hangers or other suitable supports for each system. Locate hangers and supports where they will not interfere with access to air device boxes, fire dampers, valves, and other appurtenances requiring servicing.

1. Ceiling grid systems shall not be supported from ductwork, conduits, heating or plumbing lines and vice versa.

C. Refer to Section 15095 for vibration isolation requirements for ductwork and piping.

END OF SECTION

SECTION 15100 – VALVES

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Gate valves.

B. Globe or angle valves.

C. Check valves.

D. Plug cocks.

E. Butterfly valves.

F. Ball valves.

G. Drain valves.

1.02 RELATED WORK

A. Section 15060 - Pipe and Pipe Fittings (General)

B. Section 15080 - Piping Specialties (General)

C. Section 15410 - Plumbing Piping

D. Section 15535 - Refrigeration Piping and Specialties

1.03 REFERENCES

A. AWWA C500 - Gate Valves, 3 through 48 inch NPS, for Water and Sewer Systems.

B. MSS SP-67 - Butterfly Valves.

C. MSS SP-70 - Iron Body Gate Valves.

D. MSS SP-71 - Iron Body Check Valves.

E. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves.

F. MSS SP-85 - Iron Body Globe and Angle Valves.

G. MSS SP-110 - Ball Valves.

1.04 SUBMITTALS

A. Submit copies of valve ordering schedule for approval before ordering valves.

B. Submit detailed shop drawings under provisions of Sections 01300 and 15010. Clearly indicate make, model, location, type, trim, size, pressure rating and optional features.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Provide valves of same manufacturer throughout where possible.

B. Provide valves with manufacturer's name and pressure rating clearly marked on outside of body.

C. Provide valves as manufactured by Stockham, Lunkenheimer, Crane, Powell, Kennedy, Hammond, Nibco, Watts, Grinnell, Homestead, Conbraco, Keystone, Mueller or approved equal.

2.02 VALVE CONNECTIONS

A. Provide valves suitable to connect to adjoining piping as specified for pipe joints. Use valve sizes same as pipe.

B. Valves 2 inches and smaller shall be threaded type, unless otherwise shown. Use threaded adapters for sweat copper construction. Do not use sweat-type valves.

C. Valves 3" and larger (4" and larger on Domestic Water) shall be flange connected type, unless otherwise shown.

D. Valves 2 1/2" (or 3" on Domestic Water) may be either screwed or flanged.

E. Use grooved body valves with mechanical grooved jointed piping, where indicated.

F. Provide butterfly valves with tapped lug body, unless otherwise indicated.

2.03 VALVES - GENERAL

A. Unless otherwise indicated in individual piping Sections, valves shall meet the following minimum standards:

B. Unless otherwise indicated, use Class 125 valves suitable for minimum 125 psig WSP and 400 degrees F. Valves for fire protection shall be suitable for 175 psig WOG (See Section 15310).

C. For smaller domestic water piping, screwed gate, globe and check valves with supply pressures over 100 psi shall be valved with Class 150. For lower pressures, Class 125 may be used. For Larger lines, AWWA cast iron valves shall be used, rated 200 or 150 psig non-shock c.w.

D. For HVAC piping, including low pressure steam, all screwed gate, globe and check valves shall be Class 150. Larger valves shall be cast iron Class 125.

E. Spring-loaded or silent-type check valves shall be used on all pump discharge applications.

F. For pumped sump, sewage and storm drain lines larger than 2", a swing check with outside lever and spring shall be used. 3" and above should be AWWA type.

G. Provide rising stem (R.S.) or outside screw and yoke (O.S.& Y.) valves unless otherwise designated. Buried valves, or valves in shallow pits or manholes, shall be non-rising stem (N.R.S.).

2.04 SCREWED-CONNECTION VALVES FOR GENERAL SERVICE

A. Ball Valves: Valves shall be rated 125 psi SWP and 400 psi non-shock WOG, minimum, 2-pc., end-loaded, cast bronze bodies, TFE seats, standard port, separate packnut with adjustable stem packing, anti-blowout stems and stainless steel, chrome-plated brass or bronze ball. Provide 3-piece cartridge and/or full port design where indicated. Valve ends shall have full ANSI threads and be manufactured to comply with MSS-SP110. Lever operator shall be plated and/or polymer-coated. Where piping is insulated, ball valves shall be equipped with 2" extended handles of non-thermal conductive material or provide a protective sleeve that allows operation of the valve without breaking the vapor seal or disturbing the insulation. Memory stops, which are fully adjustable after insulation is applied, shall be included where indicated. Valves for gas service shall be in compliance with NFPA 54 and listed by UL, meet the requirements of AGA and the local fuel supplier.

B. Gate Valves: Valves shall be Class 125 or 150, union bonnet, rising stem, inside screw, split wedge and manufactured in accordance with MSS-SP80. Body, bonnet and wedge shall be of bronze per ASTM B-62. Stems shall be of dezincification-resistant silicon bronze, ASTM B-371 or low-zinc alloy, B-99, non-asbestos packing and malleable or ductile iron handwheel.

C. Globe and Angle Valves: Valves shall be Class 125 or 150 and manufactured in accordance with MSS-SP80; body and bonnet are to be of bronze per ASTM B-62. Stems shall be of dezincification-resistant silicon bronze, ASTM B-371 or low-zinc alloy, B-99, non-asbestos packing, replaceable seat and TFE disc, and malleable or ductile iron handwheel.

D. Swing Check Valves: Valves shall be Y-pattern swing type manufactured in accordance with MSS-SP80, Class 125 or 150, bronze ASTM B-62 body with TFE seat disc.

E. Silent Check Valves: Bronze body, spring loaded, teflon ball or disc, screwed ends, 125 or 150 psi wp.

2.05 FLANGE CONNECTED VALVES FOR GENERAL SERVICE

A. Butterfly Valves: Valves shall be lug body style, unless otherwise designated, manufactured in accordance with MSS-SP67, flanged or groove-type (where grooved piping is indicated), rated at least 200 psi non-shock cold water working pressure. Body shall be cast iron or ductile iron with 2" extended neck for insulating. Valve shall have aluminum bronze alloy disc with replaceable resilient TFE or EPDM rubber seat and seals or EPDM rubber encapsulated disc with polymer-coated body, where indicated. Stem shall be 400 series stainless steel and stem to disc fasteners shall not be exposed to flow stream. Size 2 1/2" -5" shall be lever operated with 10-position throttling plate; size 6" and larger shall have weatherproof gear operators. Lug-style shall be capable for use as isolation valves and recommended by manufacturer for dead-end service with bubble-tight shutoff at full pressure without the need for downstream flanges. Where indicated provide units rated for 250 psi bubble-tight shutoff.

B. Gate, Globe/Angle Valves: Valves to be Class 125 or 250, manufactured in accordance with MSS-SP70 (gate) or MSS-SP85 (globe/angle), flanged, bolted bonnet, OS&Y, iron body, bronze mounted (IBBM), with body and bonnet conforming to ASTM A126 Class B cast iron. Packing and gasket shall be non-asbestos.

C. Swing Check Valves: Valves shall be swing-type manufactured in accordance with MSS-SP71, Class 125 or 250, flanged ASTM A126 Class B cast iron body with bronze trim, non-asbestos gasket.

D. Silent Check Valves (Spring-Loaded): Valves shall be wafer-style, rated for 125 or 250 psig, with stainless steel spring and pin, bronze disc plates, TFE seat, body of cast iron ASTM A126 B or A48 for use with Class 125/150 or 250 flanges.

E. Ball Valves: Cast steel body, chrome plated steel ball, Teflon seat and stuffing box seals, lever handle, Class 125/150 flanges, 125 PSI SWP, 400 PSI W.O.G.

F. Gate valves 3"-48", flanged or mechanical joint, for domestic water and sewer applications shall meet AWWA C500 requirements and be rated for minimum 150 psig non-shock c.w.

G. Check valves 4" -12", flanged or mechanical joint, for domestic water or sewer applications shall be AWWA type, rated for minimum 150 psig non-shock c.w., and shall include outside lever and weight or spring for pumping applications and others indicated.

2.06 PLUG COCKS FOR WATER SERVICE

A. Iron body, brass plugs and washers, air tested, screwed ends. Rated for gas or water service as required.

B. Iron body and plug, pressure lubricated type, flanged ends. Rated for gas or water service as required.

C. Bronze body, bronze plug with square head, screwed ends. Rated for steam or water service as required.

D. Valves for gas service shall be in compliance with NFPA 54 and listed by UL, meet the requirements of AGA and the local fuel supplier.

2.07 DRAIN VALVES

A. Plumbing Systems: 3/4" Bronze compression stop with hose thread.

B. HVAC Systems: 3/4" bronze ball valve with hose adapter and cap.

2.08 VALVE OPERATORS

A. Provide suitable handwheels for gate, globe or angle and drain valves.

B. For butterfly valves, provide lever lock handle with toothed plate for shut-off service and infinitely adjustable handle with lock nut and memory stop for throttling service, 5" and below. Provide gear operator with indicating dial for larger valves or where chain operator is required.

C. Provide valves located more than 7 feet from floor in equipment room areas with chain operated sheaves. Extend chains to about 5 feet above floor and hook to clips arranged to clear walking aisles.

D. Provide one plug cock wrench for every ten plug cocks sized 2 inches and smaller, minimum of one. Provide each plug cock sized 2-1/2 inches and larger with a wrench, with set screw.

2.09 BYPASS VALVES

A. Provide on all high pressure steam valves, 2 1/2" and larger, and on other valves where indicated, a pair of tapped bosses or flanged bosses with a bypass globe valve of the same rating as the line valve, piped with stem parallel to main valve.

B. Sizes of bypass globe valves shall be the same as the recommended maximum tapped hole size set by MSS SP-45 for the particular line valve.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install valves with stems between upright and horizontal, not inverted or below horizontal.

B. Install gate valves for shut-off and isolating service, to isolate equipment, parts of systems, or vertical risers.

C. Install globe or angle valves for throttling service and control device or meter by-pass.

D. Provide spring-loaded check valves on discharge of condensate pumps, condenser water, and water circulating or booster pumps.

E. Use plug cocks for gas service, AGA rated.

F. Use plug cocks in water or steam systems for throttling service. Use non-lubricated plug cocks only when shut-off or isolating valves are also provided.

G. Provide drain valves at main shut-off valves, and low points of piping and apparatus.

H. Provide brightly colored foam covers for the stems of all normally open O.S.&Y. valves below 7' AFF.

END OF SECTION

SECTION 15195 - NATURAL GAS PIPING

PART 1 GENERAL

1.01 SCOPE

A. Provide natural gas piping and appurtenances as indicated on the Drawings and as specified herein. The gas piping to the generator shall be 3" in size.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Divisions 0 and 1 Specification Sections, apply to this Section. Section 15010 - Mechanical General Conditions shall also apply to this section.

B. Section 16620 – Standby Power Generator System

1.03 REFERENCES

A. The piping system and appurtenances shall comply with the Kentucky Building Code, the Kentucky Plumbing Code, and the KY Fuel/Gas Code (NFPA 54).

B. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

C. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

D. ASME INTERNATIONAL (ASME)

E. ASTM INTERNATIONAL (ASTM)

F. MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

G. SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

1.04 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections. There shall be a single, complete submittal for this Section.

B. Product Data: Submit for approval on all equipment furnished under this Section. This shall include piping, equipment connectors, valves, warning and identification tape, and accessories.

C. Certificates – Submit welders' qualifications (including polyethylene welding qualifications). Submit a copy of a certified ASME B31.8 qualification test report for each welder and welding operator. Submit the assigned number, letter, or symbol that will be used in identifying the work of each welder.

D. Manufacturer's Instructions - Submit manufacturer's installation instructions for all equipment and, for piping, submit the manufacturer's visual joint appearance chart.

1.05 QUALITY ASSURANCE

A. Welder's Qualifications - Comply with ASME B31.8. The steel welder shall have a copy of a certified ASME B31.8 qualification test report. Contractor shall also conduct a qualification test. Submit each welder's identification symbols, assigned number, or letter, used to identify work of the welder. Affix symbols immediately upon completion of welds. Welders making defective welds after passing a qualification test shall be given a requalification test and, upon failing to pass this test, shall not be permitted to work under this Contract.

B. PE Welder's Qualifications - Prior to installation, Contractor shall have supervising and installing personnel trained by a PE pipe manufacturer's sponsored course of not less than one week duration, or present proof satisfactory to the Engineer that personnel are currently working in the installation of PE gas distribution lines.

C. Safety Standards – Comply with 49 CFR 192 (for natural gas).

1.06 DELIVERY, STORAGE, AND HANDLING

A. Handle, transport, and store plastic pipe and fittings carefully. Plug or cap pipe ends during transportation or storage to minimize dirt and moisture entry. Do not subject to abrasion or concentrated external loads.

1.07 WARRANTY

A. Comply with the General Conditions of the Contract and Section 15010.

1.08 OPERATING AND MAINTENANCE MANUALS

A. Three sets of O&M instructions and manuals shall be submitted in loose-leaf 3-ring cardboard reinforced vinyl binders to the Engineer in accordance with the General Conditions.

B. Contained in each binder shall also be vendors, warranty information, vendor phone numbers, list of materials, and materials parts list.

C. General and Supplemental General Conditions shall supercede this paragraph where conflicts occur.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Conform to NFPA 54 and with requirements specified herein. Supply piping to appliances or equipment shall be at least as large as the inlets thereof.

2.02 PIPE AND FITTINGS

A. Aboveground

1. Pipe: Black steel in accordance with ASTM A 53, Schedule 40, threaded ends for sizes 2 inches and smaller; otherwise, plain end beveled for butt welding.

2. Threaded Fittings: ASME B16.3, black malleable iron.

3. Socket-Welding Fittings: ASME B16.11, forged steel.

4. Butt-Welding Fittings: ASME B16.9, with backing rings of compatible material.

5. Unions: ASME B16.39, black malleable iron.

6. Flanges and Flanged Fittings: ASME B16.5 steel flanges or convoluted steel flanges conforming to ASME BPVC SEC VIII D1. Flange faces shall have integral grooves of rectangular cross sections which afford containment for self-energizing gasket material.

2.03 SHUTOFF VALVES, BELOW GROUND

A. Not applicable on this project.

2.04 VALVES, ABOVEGROUND

A. All valves shall be lockable and shall be specifically listed by the manufacturer as suitable for gas service. Valves shall otherwise comply with the Valves section in this Specification.

2.05 PRESSURE REGULATOR

A. To be furnished and installed by the Utility.

2.06 GAS METER

A. Meter to be furnished and installed by the utility.

2.07 GAS EQUIPMENT CONNECTORS

A. Flexible Connectors: ANSI Z21.45.

B. Quick Disconnect Couplings: ANSI Z21.41.

C. Semi-Rigid Tubing and Fittings: ANSI Z21.69.

2.08 VALVE BOXES

A. Not applicable on this project.

2.09 CASING

A. Not applicable on this project.

2.10 BURIED UTILITY WARNING AND IDENTIFICATION TAPE

A. Not applicable – utility to furnish and install the underground gas piping on this project.

2.11 HANGERS AND SUPPORTS

A. Bolts and nuts shall be stainless steel. Supports shall otherwise be painted to match the piping.

2.12 WELDING FILLER METAL

A. Comply with ASME B31.8.

2.13 PIPE-THREAD TAPE

A. Antiseize and sealant tape of polytetrafluoroethylene (PTFE).

2.14 GASKETS

A. Fluorinated elastomer, compatible with flange faces.

2.15 IDENTIFICATION FOR ABOVEGROUND PIPING

A. All pipes shall be marked to show fluid/gas type and direction of flow.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install building gas piping, appliances, and equipment in accordance with NFPA 54. Install underground service distribution piping in accordance with ASME B31.8.

B. Piping - Cut pipe to actual dimensions and assemble to prevent residual stress. Within buildings, run piping parallel to structure lines. All piping shall be concealed in walls and ceilings (except in mechanical rooms and shop area ceilings) unless specifically indicated otherwise. Terminate each vertical supply pipe to burner or appliance with tee, nipple and cap to form a sediment trap. To supply multiple items of gas-burning equipment, provide manifold with inlet connections at both ends.

1. Cleanliness - Clean inside of pipe and fittings before installation. Blow lines clear using 80 to 100 psig clean dry compressed air. Rap steel lines sharply along entire pipe length before blowing clear. Cap or plug pipe ends to maintain cleanliness throughout installation.

2. Aboveground Steel Piping - Determine and establish measurements for piping at the job site and accurately cut pipe lengths accordingly. For 2 inch diameter and smaller, use threaded or socket-welded joints. For 2 1/2 inch diameter and larger, use flanged or butt-welded joints.

   a. Threaded Joints: Where possible use pipe with factory-cut threads, otherwise cut pipe ends square, remove fins and burrs, and cut taper pipe threads in accordance with ASME B1.20.1. Provide threads smooth, clean, and full-cut. Apply anti-seize paste or tape to male threads portion. Work piping into place without springing or forcing. Backing off to permit alignment of threaded joints will not be permitted. Engage threads so that not more than three threads remain exposed. Use unions for connections to valves and meters for which a means of disconnection is not otherwise provided.

   b. Welded Joints: Weld by the shielded metal-arc process, using covered electrodes and in accordance with procedures established and qualified in accordance with ASME B31.8.

   c. Flanged Joints: Use flanged joints for connecting welded joint pipe and fittings to valves to provide for disconnection. Install joints so that flange faces bear uniformly on gaskets. Engage bolts so that there is complete threading through the nuts and tighten so that bolts are uniformly stressed and equally torqued.

d. Pipe Size Changes: Use reducing fittings for changes in pipe size. Size changes made with bushings will not be accepted.

e. Painting: Paint new ferrous metal piping, including supports, in accordance with Division 9 Paint section. Do not apply paint until piping tests have been completed.

f. Identification of Piping: Identify piping aboveground with weatherproof labels. Apply labels to finished paint at intervals of not more than 50 feet. Provide two copies of the piping identification code framed under glass and install where directed.

C. Valves - Install valves approximately at locations indicated. Orient stems vertically, with operators on top, or horizontally. Provide support for valves to resist operating torque applied to PE pipes.

1. On outlet side of pressure regulator and meter, provide a union and a 3/8 inch gage tap with plug.

2. Stop Valve and Shutoff Valve - Provide stop valve on service branch at connection to main and shut-off valve on riser outside of building.

D. Pipe Sleeves –. Where piping penetrates concrete or masonry wall, floor or firewall, provide pipe sleeve poured or grouted in place. Make sleeve of steel or cast-iron pipe of such size to provide 1/4 inch or more annular clearance around pipe. Extend sleeve through wall or slab and terminate flush with both surfaces. Pack annular space with oakum, and caulk at ends with silicone construction sealant.

E. Piping Hangers and Supports – Comply with relevant plumbing and fuel/gas codes.

F. Final Connections - Make final connections to equipment and appliances using rigid pipe and fittings.

G. Unions – Provide union in piping between equipment and shutoff valve.

3.02 FIELD QUALITY CONTROL

A. Metal Welding Inspection - Inspect for compliance with NFPA 54 and ASME B31.8. Replace, repair, and then re-inspect defective welds.

B. Pressure Tests - Use test pressure of 1 1/2 times maximum working pressure, but in no case less than 50 psig. Do not test until every joint has set and cooled at least 8 hours at temperatures above 10 degrees C 50 degrees F. Conduct testing before backfilling; however, place sufficient backfill material between fittings to hold pipe in place during tests. Test system gas tight in accordance with NFPA 54 or ASME B31.8. Use clean dry air or inert gas, such as nitrogen or carbon dioxide, for testing. Systems which may be contaminated by gas shall first be purged as specified. Make tests on entire system or on sections that can be isolated by valves. After pressurization, isolate entire piping system from sources of air during test period. Maintain test pressure for at least 8 hours between times of first and last reading of pressure and temperature. Take first reading at least one hour after test pressure has been applied. Do not take test readings during rapid weather changes. Provide temperature same as actual trench conditions. There shall be no reduction in the applied test pressure other than that due to a change in ambient temperature. Allow for ambient temperature change in accordance with the relationship PF + 14.7 = (P1 + 14.7) (T2 + 460) / T1 + 460), in which "T" and "PF" represent Fahrenheit temperature and gage pressure, respectively, subscripts "1" and "2" denote initial and final readings, and "PF" is the calculated final pressure. If "PF" exceeds the measured final pressure (final gage reading) by 1/2 psi or more, isolate sections of the piping system, retest each section individually, and apply a solution of warm soapy water to joints of each section for which a reduction in pressure occurs after allowing for ambient

temperature change. Repair leaking joints and repeat test until no reduction in pressure occurs. In performing tests, use a test gage calibrated in one psi increments and readable to 1/2 psi.

C. System Purging - After completing pressure tests, and before testing a gas contaminated line, purge line with nitrogen at junction with main line to remove all air and gas. Clear completed line by attaching a test pilot fixture at capped stub-in line at building location and let gas flow until test pilot ignites. Procedures shall conform to NFPA 54 and ASME B31.8. CAUTION: Failure to purge may result in explosion within line when air-to-gas is at correct mixture.

END OF SECTION

SECTION 15784 - PACKAGED WALLMOUNT HEAT PUMP UNITS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This Section includes packaged wall-mounted heat pump units and their accessories and controls.

1.02 RELATED WORK SPECIFIED ELSEWHERE

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

1.03 SUBMITTALS

A. Product Data: Include rated capacities, weights, furnished specialties, and accessories for each model indicated.

B. Shop Drawings: Detail layout and installation of wall penetrations.

1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.

C. Maintenance Data: For equipment to include in the maintenance manuals specified in Division 1.

D. Warranty: Minimum 2 year manufacturer warranty is required.

1.04 QUALITY ASSURANCE/WARRANTIES

A. Unit performance shall be certified in accordance with ARI standard 210/240-94 for unitary air source heat pumps or latest standard.

B. Listing and Labeling: Provide electrically operated components specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

C. Comply with NFPA 70.

1.05 COORDINATION

Coordinate layout and installation of units and wall construction where unit penetrates wall or is supported by it.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

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. Bard
2. Marvaire
3. Trane

2.02 MANUFACTURED UNITS

A. Description: Packaged, self-contained, wall-mounted heat pumps with electric refrigeration system, heating, and temperature controls; fully charged with refrigerant and filled with oil. Heat pump can operate in heating or cooling mode.

B. Cabinet: 20 gauge galvanized steel painted and capable of resisting a 1000 hour salt spray exposure per ASTM B117.

1. Mounting: Wall with integral side mounting brackets.
2. Finish: Baked enamel.

C. Refrigeration System: Direct-expansion copper tube coil with aluminum fins and capillary restrictor, hermetically sealed compressor with internal spring isolation, and overload protection.

D. Air System: Forward-curved, centrifugal, indoor fans with permanent-split-capacitor motor and throwaway filters.

E. Outdoor Fan: Propeller type with separate permanent-split-capacitor motor.

F. Filter – Provide 1 inch throwaway filter.

G. Electric Resistance heating: Electric supplemental heaters shall be provided of the capacity as indicated on the Drawings. Each heater shall be equipped with an automatic reset limit switch and a one-time high temperature thermal cutout for additional safety back up protection.

2.03 CONTROLS

A. Controls: Provide remote-mounted adjustable autochangeover thermostat, corrosion resistant and waterproof.

B. Low Ambient Control to allow cooling cycle operation down to 0°F.

C. Shall include an alarm relay to provide signal upon a condition of shutdown on either high or low-pressure controls.

PART 3 - EXECUTION

3.01 INSTALLATION

Install units according to manufacturer's written instructions.

3.02 CONNECTIONS

A. Condensate Drain: Pipe to grade level. Ensure that grade is sloped away from building.

B. Electrical: Connect units to wiring systems and to ground as indicated and instructed by manufacturer.

C. Ground equipment.

3.03 CLEANING

After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.

3.04 COMMISSIONING

A. After installation, check the following:

1. Unit casing has no visible damage.
2. Compressor, air-cooled condenser coil, and fans have no visible damage.
3. Labels are clearly visible.
4. Controls are connected and operable.
5. Shipping bolts, blocks, and tie-down straps are removed.
6. Filters are installed and clean.
7. Drain line is installed correctly.

B. Lubricate bearings on fan.

C. Check fan-wheel rotation for correct direction without vibration and binding.

D. Start unit according to manufacturer's written instructions. Complete manufacturer's startup checks.

E. After starting and performance test, change filters.

- END OF SECTION -

DIVISION 16

ELECTRICAL

SECTION 16050 - BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.01 REQUIREMENT

A. Contractors bidding work under this Contract shall read and understand Division Zero and Division 1 - General Requirements. If any discrepancies are discovered between the Basic Electrical Materials and Methods and General Requirements, the above mentioned documents shall overrule this section. The Basic Electrical Materials and Methods are intended as a supplement to the above mentioned documents.

B. The Contractor shall bid as outlined in the above mentioned Specifications and shall be governed by any alternates or unit prices called for in the form of proposal.

C. Each Contractor bidding on the work included in these Specifications shall view the building site and carefully examine the contract Drawings and Specifications, so that he/she may fully understand what is to be done, and to document existing conditions.

1.02 SCOPE OF WORK

A. Work included in this section of the Specifications shall include the furnishing of all labor, material, tools, approvals, utility connection fees, excavation, backfill, and other equipment necessary to install the electrical system as shown on the Contract Drawings and as specified herein.

B. It also includes installation and connection of all electrical utilization equipment included in this Contract but furnished by other contractors or suppliers.

C. It is the general intent that all motors shall be furnished with the particular object of equipment it drives, except where a new motor is to be provided for an item of existing equipment (a replacement motor), then it shall be provided under this Division of the Specifications.

D. The Contractor shall furnish and install all conduit, wire, disconnect switches and miscellaneous material to make all electrical connections to all items of utilization equipment or wiring devices except as otherwise specified.

E. Equipment connections shall be made with flexible or rigid conduit as required. Controllers for motors, disconnect switches, and all control, protective and signal devices for motor circuits, except where such apparatus is furnished mounted and connected integrally with the motor driven equipment, shall be installed, connected and left in operating condition. The number and size of conductors between motors and control or protective apparatus shall be as required to obtain the operation described in these Specifications, and/or by the Contract Documents, and/or as shown in manufacturer furnished, Engineer reviewed Shop Drawings.

F. All devices and items of electrical equipment, including those shown on the Contract Drawings but not specifically mentioned in the Specifications or those mentioned in the Specifications but not shown on the Contract Drawings, are to be furnished under this section of the specifications. Any such device or item of equipment, if not defined in quality, shall be equal to similar Equipment and/or devices specified herein.

G. All devices and items of equipment mentioned in this section of the Specifications whether electrical or not or whether furnished under this or other Division of the Specifications, shall be installed under this Division of the Specifications, unless specifically indicated otherwise.

H. Where wiring diagrams are not shown on the Contract Drawings, they are to be provided by the supplier of the equipment served and such diagrams shall be adhered to except as herein modified.

I. The following is a list of items that may not be defined clearly on the Contract Drawings or in other parts of these Specifications. The list is meant to be an aid to the Contractor and is not necessarily a complete list of all work to be performed under this Contract:

1. Connect all motors and accessories furnished by equipment suppliers.
2. Furnish, install, and connect all motor controls.
3. Furnish, install, and connect lighting, indoor and outdoor.
4. Furnish, install, and connect power and signal lines to all instrumentation equipment, and accessories.
5. Furnish, install, and connect all electrical conduit, duct and cables.
6. Furnish, install, and connect all power distribution equipment.
7. Furnish and install standby power equipment.

1.03 SHOP DRAWINGS, DESCRIPTIVE LITERATURE, INSTALLATION, OPERATION AND MAINTENANCE INFORMATION

A. Shop Drawings including descriptive literature and/or installation, operation and maintenance instructions shall be submitted per Section 01300.

B. Shop Drawings shall be submitted on the following materials specified in this Division:

1. Conduit - all types and sizes, including liquid-tight flexible.
2. Boxes - all types and sizes.
3. Coal tar epoxy paint.
4. Wiring devices.
5. Device plates.
6. Metal framing system (Strut type channel).
7. Conduit fittings, expansion joints, support hardware.
8. Motor control equipment - including individually mounted items.
9. Power distribution equipment - including individually mounted items.
10. Adjustable speed equipment and accessories.
10. Miscellaneous spare parts and hardware.
12. Wire - all types and sizes.
13. Light fixtures - all types.
14. Wire markers, signs and labels.
15. Lightning/transient suppressors.

16. Motors.

17. Transformers.

18. Standby power equipment and accessories.

C. The Engineer reserves the right to make modifications to motor control and power distribution equipment ratings after Shop Drawing review, if the Shop Drawings are submitted prematurely (prematurely meaning submitted before all utilization equipment has been reviewed and accepted). Cost of modifications shall be the Contractor's responsibility.

1.04 SYMBOLS AND ABBREVIATIONS

A. The symbols and abbreviations general follow standard electrical and architectural practice, however, exceptions to this shall be as shown on the Contract Drawings.

1.05 COORDINATION WITH OTHER TRADES

A. The Contractor shall coordinate the electrical work with that of other trades to ensure proper final location of all electrical equipment and/or connections. The Contractor shall verify door swings to see that light switches are located properly.

1.06 CODES

A. The minimum standard for all work shall be the latest revision of the Kentucky Building Code (KBC), and the National Electrical Code (NEC). Whenever and wherever state and/or local laws or ordinances and/or regulations and/or the Engineer's design require a higher standard that the current NEC or KBC, then these laws and/or regulations and/or the design shall be followed.

B. Following is a list of other applicable Standards or Codes:

1. Kentucky Building Code	KBC
2. National Electrical Code	NEC
3. National Electrical Safety Code	NESC
4. Underwriters Laboratories, Inc.	UL
5. Factory Mutual System	FM
6. National Fire Protection Association	NFPA
7. National Electrical Manufacturers Association	NEMA
8. Occupational Safety and Health Administration	OSHA
9. Insulated Cable Engineers Association, Inc.	ICEA
10. Illuminating Engineering Society of North America	IES
11. Instrument Society of America	ISA
12. Institute of Electrical and Electronic Engineers, Inc.	IEEE
13. Certified Ballast Manufacturers Association	CBM
14. American National Standards Institute, Inc.	ANSI

15. Anti-Friction Bearing Manufacturers Association, Inc. AFBMA

16. Joint Industry Council JIC

17. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. ASHRAE

18. Federal Communications Commission FCC

19. American Society for Testing and Materials ASTM

20. American Wood Preservers Association AWPA

21. Rural Electrification Association REA

1.07 INSPECTIONS AND PERMITS

A. Inspection of the electrical system on all construction projects is required. If the local government has appointed a state licensed inspector, the Contractor shall be required to use that person to perform the inspections. If a locally mandated inspector does not exist, the Contractor shall select and hire a state licensed inspector, who has jurisdiction before any work is concealed. The Contractor shall notify the electrical inspector in writing, immediately upon notice to proceed, and a copy of the notice shall be submitted to the Engineer.

B. At the time of completion of the project, there shall be furnished to the Owner a certificate of compliance, from the agency having jurisdiction pursuant to all electrical work performed. The Engineer shall also receive a photostatic copy.

C. All costs incurred by the Contractor to execute the above mentioned requirements shall be paid by the Contractor at no extra cost to the Owner.

D. All permits necessary for the complete electrical system shall be obtained by the Contractor from the authorities governing such work. For further information, see Division 1.

1.08 STORAGE

A. All work, equipment, and materials shall be protected against dirt, water, or other injury during the period of construction.

B. Sensitive electrical equipment such as light fixtures, motor starters, controls, and panelboards, delivered to the job site, shall be protected against injury or corrosion due to atmospheric conditions or physical damage by other means. Protection is interpreted to mean that equipment shall be stored under roof, in a structure properly heated in cold weather and ventilated in hot weather. Provision shall be made to control the humidity in the storage area to 50 percent relative. The stored equipment shall be inspected periodically, and if it is found that the protection is inadequate, further protective measures shall be employed. Electrical equipment other than boxes and conduit shall not be installed until the structure is under roof with doors and windows installed.

C. No light fixtures or device plates shall be hung or installed until after painting is completed; however, temporary lighting shall be provided by the Contractor.

D. The Contractor shall not store submersible pump units in the wetwell. If it is absolutely necessary to do so, the open power cable ends are to be suspended above the maximum flood elevation or maximum expected water level. If not stored in this manner, the Contractor may be called upon to replace the pump motors and cables with new units to ensure that water has not penetrated the cable and entered the motor housing.

1.09 MATERIALS

A. All materials used shall be new and at least meet the minimum standards as established by the NEC and/or National Electrical Manufacturers Association (NEMA). All materials shall be UL listed for the application, where a listing exists. Additional requirements are found in Division 1. All equipment shall meet applicable FCC requirements and restrictions.

B. The material and equipment described herein has been specified according to a particular trade name or make to set quality standards. However, each Contractor has the right to substitute other material and equipment in lieu of that specified, other than those specifically mentioned at matching or for standardization, providing such material and equipment meets all of the requirements of those specified and is accepted, in writing by the Engineer.

C. The reuse of salvaged electrical equipment and/or wiring will not be permitted unless specified herein or indicated on the Contract Drawings.

D. All salvaged or abandoned electrical materials shall become the property of the Contractor and shall be removed from the job site upon completion of the project, unless otherwise noted on the Contract Drawings or specified herein.

1.10 ERRORS, CORRECTIONS, AND/OR OMISSIONS

A. Should a piece of utilization equipment be supplied of a different size or horsepower than shown on the Contract Drawings, the Contractor shall be responsible for installing the proper size wiring, conduit, starters, circuit breakers, etc., for proper operation of that unit and the complete electrical system at no extra cost to the Owner.

B. It is the intent of these Specifications to provide for an electrical system installation complete in every respect, to operate in the manner and under conditions as shown in these Specifications and on the Contract Drawings. The Contractor shall notify the Engineer, in writing, of any omission or error at least 10 days prior to opening of bids. In the event of the Contractor's failure to give such notice, he/she may be required to correct work and/or furnish items omitted without additional cost. Further requirements on this subject may be found in the General Requirements, Division 1.

C. Necessary changes or revisions in electrical work to meet any code or power company requirement shall be made by the Contractor without additional charge.

1.11 GUARANTEES AND WARRANTIES

A. The Contractor shall guarantee all work including equipment, materials, and workmanship. This guarantee shall be against all defects of any of the above and shall run for a period of 1 year from the date of acceptance of the work, concurrent with the one year guarantee period designated for the general construction contract under which electrical work is performed. Date of acceptance shall be considered to be the date on which all "punch list" items are completed ("punch list" is defined to be the written listing of work that is incomplete or deficient that must be finished or replaced/repaired before the Contractor receives final payment).

B. Repair and maintenance for the guarantee period is the responsibility of the Contractor and shall include all repairs and maintenance other than that which is considered as routine. (That is oiling, greasing, etc.) The Engineer shall be the judge of what shall be considered as routine maintenance.

C. Lamps shall bear the manufacturer's warranty.

1.12 TESTING

A. After the wiring system is complete, and at such time as the Engineer may direct, the Contractor shall conduct an operating test for acceptance. The equipment shall be demonstrated to operate in accordance with the requirements of these Specifications and the Contract Drawings. The test shall be performed in the presence of the Engineer or his authorized representative. The Contractor shall furnish all instruments and personnel required for the tests, as well as the necessary electrical power.

B. Before energizing the system, the Contractor shall check all connections and set all relays and instruments for proper operation. He shall obtain all necessary clearances, approvals, and instructions from the serving utility company and/or equipment manufacturers prior to placing power on the equipment.

C. Tests may be performed by the Engineer to determine integrity of insulation on wiring circuits selected by the Engineer at random.

D. Cost of utilities for testing done prior to beneficial occupancy by the Owner shall be borne by the Contractor.

1.13 CLEANUP

A. Cleanup shall be completed as soon as possible after the electrical installation is complete. All light fixtures, outlets, switches, starters, motor control centers, disconnect switches and other electrical equipment shall be free of shipping tags, stickers, etc. All painted equipment shall be left free of scratches or other blemishes, such as splattered or blistered paint, etc. All light fixture diffusers shall be clean and the interior of all motor controls, etc., shall be free of dust, dirt, wire strippings, etc. Surplus material, rubbish and equipment resulting from the work shall be removed from the job site by the Contractor upon completion of the work.

B. During construction, cover all Owner equipment and furnishings subject to mechanical damage or contamination in any way.

1.14 CUTTING AND PATCHING

A. Cutting and patching shall be held to an absolute minimum and such work shall be done only under the direction of the Engineer or Owner. The Contractor shall be responsible for and shall pay for all openings that may be required in the floors or walls, and he shall be responsible for putting said surfaces back in their original condition. Every attempt shall be made to avoid cutting reinforcing steel bars when an opening is required in a reinforced concrete wall or floor slab.

1.15 EXCAVATION AND BACKFILL

A. Excavation

1. Excavation for conduits shall be of sufficient width to allow for proper jointing and alignment of the type conduit used. Conduit shall be laid in straight lines between pull boxes and/or structures unless otherwise notes on the Contract Drawings. The cost of solid rock excavation shall be included in the lump sum bid with no extra pay allowed (unclassified).

B. Backfill

1. See the detail on the Drawings.

1.16 SLEEVES, CHASES AND OPENINGS

A. Sleeves shall be required at all points where exposed conduits pass through new concrete walls, slabs, or masonry walls. Sleeves that must be installed below grade or where subject to high water conditions must be installed watertight.

B. Wiring chases shall be provided where shown on the Contract Drawings. The Contractor shall have the option of installing chases below surface mounted panelboards provided all structural requirements are met.

C. It is the Contractor's responsibility to leave openings to allow installation of the complete, operational electrical system. Openings required but not left shall be cut as outlined under cutting and patching. The Contractor shall coordinate all holes and other openings with necessary diameters for proper firestopping.

1.17 POWER COMPANY COORDINATION

A. The Contractor is responsible for coordinating all activities onsite by the power company.

B. All power company metering equipment shall be electrically located "upstream" of any manual/automatic transfer equipment on projects requiring onsite emergency power generation equipment.

C. Any special provisions required by the serving electrical utility shall be as outlined on the Contract Drawings or as advised by the utility at the time of construction, and work required by these special provisions shall be executed with no extra cost to the Owner.

1.18 TEMPORARY ELECTRICAL POWER

A. The Contractor shall be responsible for providing temporary electrical power as required during the course of construction and shall remove the temporary service equipment when no longer required. Temporary power is also addressed in Division 1.

1.19 OVERCURRENT PROTECTION

A. Circuit breakers or fused switches shall be the size and type as written herein and shown on the Contract Drawings. Any additional overcurrent protection required to maintain an equipment listing by an authority having jurisdiction shall be installed by the Contractor at no extra cost to the Owner.

B. The Contractor shall submit to the Engineer actual nameplate data from motors shipped to the site, stating motor identification as well as characteristics. Overload relay thermal unit selection tables shall accompany the motor data. The Engineer will select thermal unit sizes from this data for use by the Contractor in ordering proper thermal units.

1.20 TRAINING

A. All manufacturers supplying equipment for this division shall provide the Owner's operations staff with training in the operation and maintenance on the equipment being furnished. The training shall be conducted at the project site by a qualified representative of the manufacturer.

B. The cost of this training shall be included in the bid price.

C. The required training shall consist of both classroom and hands-on situation. Classroom training shall include instruction on how the equipment works, its relationship to all accessories and other related units, detailed review of shop drawings, detailed presentation of written O & M instructions, troubleshooting and record-keeping recommendations. Hands-on-training shall include a review of the manufacturer's O & M instructions, check out of each operator to identifying key elements of the equipment, tear down as appropriate, calibration, adjustment, greasing and oiling points, and operating manipulations of all electrical and mechanical controls.

D. The training shall be scheduled through the Contractor with the Owner. The timing of the training shall closely coincide with startup of the equipment, but no training shall be conducted until the equipment is operational.

E. The minimum number of hours to be provided by manufacturers supplying equipment on this project shall be in accordance with the following table:

Item	Training Hours	
	Classroom	Hands-on
Standby Power System & Accessories	2	2
Variable Speed Systems	2	2
Automatic Level/Pressure Control System	1	1

F. At least 60 days prior to the training the manufacturer shall submit through the Contractor to the Engineer an outline of the training proposed for the Engineer's review and concurrence.

G. The Owner reserves the right to videotape all training sessions.

1.21 MAINTAINING CONTINUOUS ELECTRICAL SYSTEM AND SERVICE

A. Not applicable on this project.

1.22 GROUNDING AND BONDING

A. All metallic conduit, cabinets, equipment, and service shall be grounded in accordance with the latest issue of the National Electrical Code. All supporting framework and other metal or metal clad equipment or materials which are in contact with electrical conduit, cable and/or enclosures, shall be properly grounded to meet the code requirements.

1.23 RELATED SPECIFICATION DIVISIONS

A. The following divisions contain Specifications on utilization equipment, equipment accessories, and procedures related to execution of the electrical work, and are included here for the Contractor's information. Bids shall still be based on complete Contract Documents.

Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract
Division 1 - General Requirements
Division 11 - Equipment
Division 13 - Special Construction
Division 15 – Mechanical
Division 17 - Instrumentation

1.24 SERVICE ENTRANCE

A. Conductors and terminations for service entrances shall be furnished and installed by the Contractor. Voltage, phase, and number of wires shall be as shown on the Drawings. Clearances for overhead entrance wires shall be per power company, NEC, and NESC requirements.

B. Any details not shown on the Drawings or written in the Specifications pertaining to the service entrance shall be per power company requirements. It is the Contractor's responsibility to contact the utility prior to bidding and obtain any special requirements or costs they will be imposing. Those costs shall be included in the bid.

1.25 CONTRACTOR LICENSING

A. The Contractor performing the electrical work on this project shall be a licensed electrical contractor in the state of Kentucky.

1.26 ANCHORING/MOUNTING

A. Electrical conduits and/or equipment shall be rigidly supported. Anchors used shall be metallic expansion type, or if appropriate to prevent spalling concrete, epoxy set type. Plastic or explosive type anchors are prohibited.

B. All supports shall be consistent with the latest edition of the KBC and ASCE 7.

1.27 ELECTRICAL COMPONENT MOUNTING HEIGHTS

A. Unless otherwise indicated, mounting height for components shall be as defined herein. In cases of conflicts with architectural or structural aspects, the components may be relocated. If an indicated height conflicts with a code requirement, the code shall govern.

B. Mounting heights are given from finished floor elevation to the centerline of the component, unless otherwise noted.

	Component	Height	Comments
1.	Wall type light switch	4'-0"	To top of box
2.	Low wall outlet	16"	To bottom
3.	Medium height wall outlet	4'-0"	
4.	Medium height telephone outlet	4'-0"	
5.	High wall outlet or fixture	7'-0"	
6.	Wall type buzzers, horns, etc.	8'-0" Max.	Top 2" below ceiling
7.	Push-button or control stations	4'-0"	
8.	Top of panelboards or control panels	6'-6"	Maximum (except for handicapped areas)
9.	Top of telephone back boards	6'-6"	Maximum
10.	Top of switch handle on motor control center	6'-6"	Maximum
11.	Top of local motor controller	6'-0"	Maximum
12.	Top of local disconnect switch	6'-0"	Maximum
13.	Wall mount exterior light fixtures	8'-0"	or as shown
14.	Wall mount emergency light fixtures	6'-6"	Maximum to test button
15.	Wall thermostats	4'-0"	To top of thermostat

In situations where there appears to be a conflict with Americans with Disabilities Act (ADA) legislation, utilize the ADA requirements herein.

1.28 HAZARDOUS AREA CLASSIFICATIONS

The following table identifies the applicable hazardous areas for this project, and the classifications for each. All equipment used in these areas shall be UL listed for the application, and all wiring methods shall be in accordance with Chapter 5 of the National Electrical Code. All conduits to these spaces from non-hazardous areas shall be properly sealed.

Location	**Area Classification**	**Extent of Hazardous Area**
Wetwell	Class I, Division 1, Group D	Entire Wetwell
Valve Vault	Class I, Division 2, Group D	Entire Vault
Diversion Structure/ Screenings Area	Class I, Division 1, Group D	Entire Structure
Meter Vaults	Class I, Division 2, Group D	Entire Vault

Location	Area Classification	Extent of Hazardous Area
Wet Weather Storage (covered)	Class I, Division 1, Group D	Entire Structure
Electrical Building	Unclassified	Entire Building

Note: These ratings are based on no continuous ventilation and some may be rerated if continuous ventilation is provided (per NFPA 820).

1.29 RECEIPTS

A. Some sections of the Specifications call for equipment, materials, accessories, etc. to be provided and "turned over to the Owner" or like requirements. The Contractor shall obtain a receipt for each item turned over, signed by the Owner or his representative. A copy of this receipt shall be transmitted to the Engineer.

B. When a question arises concerning whether items have been turned over to the Owner, and there is no signed receipt, it may be assumed that the items were not provided.

1.30 POWER SYSTEM STUDIES

A. General

1. The Contractor shall provide Short Circuit Studies, Protective Device Evaluation Studies, Protective Device Coordination Studies, and Arc Flash Studies performed by a professional registered electrical engineer currently registered in the State of Kentucky for the entire electrical system. The studies shall be performed in accordance with 399-1997, IEEE Recommended Practice for Industrial and Commercial System Power Analysis (IEEE Brown Book). The studies shall be submitted to the Engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment for manufacture. If formal completion of the studies may cause delay in equipment manufacture, approval from the Engineer may be obtained for a preliminary submittal of sufficient study data to insure that the selection of device ratings and characteristics will be satisfactory.

2. The studies shall include all portions of the electrical distribution system from the utility company protective devices, the normal and standby power sources down to and including the 480 volt feeder protective devices for each feeder. The study shall include all low and medium voltage switchgear, MCCs, and panelboards. System connections and those which result in maximum fault conditions shall be adequately covered in the study.

3. In the event that the short circuit study requires a higher interrupting and/or withstand rating of equipment than that which is indicated in the Contract Documents, the Contractor shall furnish and install the equipment as required based on the study with no extra cost to the Owner.

4. In the event that the protective device coordination study indicates that different settings or equipment is required than that which is specified, the Contractor shall furnish and install the equipment based on the study with no extra cost to the Owner.

B. Data Collection for the Studies

1. The Contractor shall provide the required data for preparation of the studies. The preparer of the studies shall furnish the Contractor with a listing of the required data immediately after award of the Contract.

122909BR

2. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to release of the equipment for manufacture.

C. Short Circuit Study and Protective Device Evaluation Study

1. The short circuit study shall be performed with the aid of a digital computer program and shall be in accordance with the latest editions of IEEE Std. 399 and IEEE Std. 141.
2. The study input data shall include the utility company's short circuit contribution, resistance and reactance components of the branch impedances, the X/R ratios, base quantities selected, and other source impedances.

3. Short circuit close and latch duty values and interrupting duty values shall be calculated on the basis of assumed three-phase bolted short circuits at each bus, switchgear, medium and low-voltage motor control center, distribution panelboard, pertinent branch circuit panel and other significant locations through the system. The short circuit tabulations shall include symmetrical fault currents, and X/R ratios. For each fault location, the total duty on the bus, as well as the individual contribution from each connected branch, shall be listed with its respective X/R ratio.

4. A protective device evaluation study shall be performed to determine the adequacy of circuit breakers, molded case switches, automatic transfer switches, and fuses by tabulating and comparing the short circuit ratings of these devices with the calculated fault currents. Appropriate multiplying factors based on system X/R ratios and protective device rating standards shall be applied. Any problem areas or inadequacies in the equipment due to short circuit currents shall be promptly brought to the attention of the Engineer.

5. All equipment furnished shall meet the requirements of this study, with no extra cost to the Owner.

D. Protective Device Coordination Study

1. A protective device coordination study shall be performed to provide the necessary calculations and logic decisions required to select or to check the selection of power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated current transformers, and low voltage circuit breaker trip characteristics and settings.

2. The coordination study shall include all low voltage classes of equipment from the utility company service protective devices down to and including the main circuit breakers of motor control centers. The phase and ground overcurrent protection shall be included as well as settings of all other adjustable protective devices.

3. The time-current characteristics of the specified protective devices shall be drawn on log-log paper. The plots shall include complete titles, representative one-line diagram and legends, significant motor starting characteristics, complete parameters of transformers, complete operating bands of low voltage circuit breaker trip curves and fuses. The coordination plots shall indicate the types of protective devices selected, proposed relay taps, time dial and instantaneous trip settings, transformer magnetizing inrush and ANSI transformer withstand parameters, cable thermal overcurrent withstand limits and significant symmetrical and asymmetrical fault currents. All restrictions of the National Electrical Code shall be adhered to and proper coordination intervals and separation of characteristic curves shall be maintained. The coordination plots for phase and ground protective devices shall be provided on a system basis. A sufficient number of separate curves shall be used to clearly indicate the coordination achieved.

4. The selection and settings of the protective devices shall be provided separately in a tabulated form listing circuit identification, IEEE device number, current transformer ratios

and connections, manufacturer and type, range of adjustment and recommended settings. A tabulation of the recommended power fuse selection shall be provided for the medium voltage fuses where applied in the system. Any discrepancies, problem areas, or inadequacies shall be promptly brought to the attention of the Engineer.

E. Arc Flash Hazard Analysis

1. An Arc Flash Hazard Analysis shall be performed with the aid of a digital computer program in accordance with IEEE Std. 1584, "IEEE Guide For Performing Arc Flash Hazard Calculations", NFPA 70E, and OSHA 29-CFR, Part 1910 Subpart S.

2. Arc Flash Warning Labels and Bus Detail Sheets shall be produced for each bus and panelboard from the service entrance gear down to and including the 208V panelboard level. Labels shall be printed in color on adhesive backed labels. Labels shall be attached to the doors of the equipment. Each label and detail sheet shall list the following:

   a. Bus name

   b. System operating voltage

   c. Date of issue

   d. Flash hazard protection boundary

   e. Limited approach boundary

   f. Restricted boundary

   g. Prohibited boundary

   h. Incident energy level

   i. Required personal protective equipment class

      In addition, each Bus Detail Sheet shall list the following:

      1). Upstream Protective Devices Names, Type and Settings

3. Arc Flash Evaluation Summary Sheets shall be produced. Summary sheets shall list the following:

   a. Bus name

   b. Upstream protective device name, type and settings

   c. Bus line-to-line voltage

   d. Bus bolted fault

   e. Protective device bolted fault current

   f. Arcing fault current

   g. Protective device trip / delay time

   h. Breaker opening time

   i. Solidly grounded column

j. Equipment type

k. Gap

l. Arc flash boundary

m. Working distance

n. Incident energy

o. Required personal protective equipment class

4. Analyze the short circuit, protective device coordination, and arc flash calculations and highlight any equipment that is determined to be underrated or causes an abnormally high incident energy calculation. Propose approaches to reduce the energy levels. Proposed major corrective modifications will be taken under advisement by the Engineer and the Contractor will be given further instructions.

F. Study Report

1. The results of the power system studies shall be summarized in a report. The report shall be submitted to the Engineer. The report shall be submitted for review and acceptance prior to submittals for medium voltage switchgear, medium voltage motor control equipment, low voltage switchgear and switchboards, motor control centers, variable frequency drives, panelboards, and similar electrical equipment.

2. The report shall include the following sections:

a. Description, purpose, basis and scope of the study and a detailed single line diagram with "nodes" cross-referenced to the calculated values tabulated in the study report of that portion of the power system which is included within the scope of the study.

b. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties and commentary regarding same.

c. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, fuse selection, and commentary regarding same.

d. Fault current calculations including a definition of terms and guide for interpretation of computer printout.

3. Prior to commencing the work, the preparer the studies shall meet with the testing firm that will do the relay field testing and the Owner's representative at the site for a walk through of the facility to insure that existing conditions are taken into account.

4. The study shall include a detailed explanation of all software programs and procedures used to arrive at the calculated values, settings, and drawings (e.g. single line diagrams) showing fault valves at all busses.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

SECTION 16060 - SECONDARY GROUNDING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Grounding shall be done in accordance with the NEC, as described in these Specifications, and as shown on the Contract Documents.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Grounding equipment shall be Cadweld, T&B Blackburn, ITT Weaver, Copperweld Bimetallics Group, or equal.

PART 3 - EXECUTION

3.01 INSTALLATION/APPLICATION/ERECTION

A. Grounding shall utilize a supplemental driven ground rod system in a bed to achieve the design ground resistance.

B. The ground system shall be continuous with all structures on a common ground. This can be accomplished by bonding all conduits together and bonding to the ground bus at each motor control center. Bonding jumpers shall be required at all pull boxes, and at all motor casings. A separate grounding conductor shall be pulled in all conduits in addition to wire counts shown on Drawings.

C. Ground rods shall be 3/4" x 10'-0" copper clad type. Where multiple rods are driven, they shall be separated by at least 10 feet to assure maximum effect.

D. Ground resistance between ground and absolute earth shall not exceed 5 ohms.

E. All grounding and grounding electrode systems shall be as required by the NEC as for types of electrodes utilized and sizing of grounding conductor to service equipment from the electrode system. These shall include footer rebar, buried metal water pipe, buried bare copper conductor, etc.

F. All grounding electrode system connections shall be made using exothermic welds, Cadweld, or equal. No splices are allowed in the grounding electrode conductor.

G. An insulated, isolated ground shall be run from the service entrance to panels serving computers.

H. Should ground rods be impractical for use due to rocky conditions, then grounding electrode plates may be used after acceptance by the Engineer on a case by case basis.

3.02 FIELD QUALITY CONTROL

A. Testing

1. The Contractor shall be required to provide all labor, tools, instruments, and materials as necessary to perform testing of the grounding electrode system. Results shall be submitted in writing to the Engineer. The testing shall be done to determine the effectiveness of the selected grounding scheme and to see that it conforms with resistance specified (5 ohms maximum).

2. The testing should be done using a fall-of-potential method test at the point of grounding electrode conductor connection to main power distribution equipment and at each separately derived system or MCC. The test shall be performed no sooner than 48 hours after a rainfall event.

3. The written report should contain the following information:

   a. Type of ground scheme used, i.e., building steel, driven rod, mat, etc.

   b. Type of instrument used.

      1) Manufacturer

      2) Model Number

      3) Confirm fall-of-potential test

      4)* Serial Number

      5)* Where instrument was obtained

      * These 2 items are required so that the same instrument may be utilized should reproduction of the test be necessary due to unsatisfactory readings/instrument miscalibration.

   c. Ground resistance readings obtained at various test distances.

   d. Ground resistance/distance curve.

   e. Value of Grounding Electrode Resistance at knee of curve.

   f. Sketch showing setup of instrumentation and location of grounding electrode and test probes.

   g. Proposed method to achieve the specified resistance, should an unacceptable reading be obtained.

   h. Ground resistance readings obtained (if applicable) after modifications incorporated.

END OF SECTION

SECTION 16070 - SUPPORTING DEVICES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. All electric equipment shall be rigidly mounted, and installed using supporting devices as indicated on the Contract Drawings, as required by the work, and described herein.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. "Kindorf," "Unistrut," or equal.

2.02 MATERIALS

A. All mounting brackets and strut shall be aluminum. Fasteners used to mount equipment shall be stainless steel.

B. Aluminum support members shall not be installed in direct contact with concrete. Stainless steel or non-metallic "spacers" shall be used to prevent contact of aluminum with concrete.

PART 3 - EXECUTION

3.01 ANCHORING CABINETRY

A. All free standing equipment shall be anchored to its foundation using expansion bolts of the size and number recommended by the equipment manufacturer.

3.02 SEISMIC CONSIDERATIONS

A. Where indicated, seismic restraints shall be provided for electrical equipment.

END OF SECTION

SECTION 16075 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide electrical identification of equipment, boxes, and conductors as specified herein.

1.02 RELATED WORK

A. Section 16050 – Basic Electrical Materials and Methods

1.03 SUBMITTALS

A. Submittals are required for electrical identification products in accordance with Section 16010 requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Brady, Safety Sign Company, Seton or equal.

2.02 ELECTRICAL IDENTIFICATION PRODUCTS

A. Engraved, Plastic Laminated Labels and Signs: Shall be engraved stock melamine plastic laminate, 1/16 inch minimum thickness, and shall have white plate with black letters.

B. Vinyl self-adhesive signs: Shall warn of "High Voltage" (state the specific voltage). The type of labels to be used shall have orange as the basic color to conform with OSHA requirements, and letters shall be black. The labels shall be of proper size to fit flatly on the surface of the enclosure to make for a neat appearance and not interfere with the operating function of the device it is attached to.

C. Colored Adhesive Marking Tape for Wires and Cables: Self-adhesive, vinyl tape not less than 3 mils thich by 1 inch in width.

D. Conductor Labels: Shall be machine printed, heat-shrink type.

E. Underground line marking tape: Permanent, red-colored, continuous printed, not less than 6 inches wide and 4 mils thick. Tape shall have metal-backing suitable for tracing.

PART 3 - EXECUTION

3.01 EQUIPMENT LABELING

A. All starters, feeder units in panelboards, disconnects, instruments, etc. shall be marked to indicate the motor, outlet, or circuit they control. Marking is to be done with engraved laminated nameplates and shall bear the designation shown on the Contract Drawings where this information is given.

Nameplates shall be fastened to equipment with stainless steel screws, minimum of one each side. In no way shall the installation of mounting screws void the NEMA enclosure rating of the equipment in which they are installed. Nameplate background color shall be white, with black engraved letters, unless otherwise noted. Typical panelboard label:

"Panel PP1
225A 480Y/277 3PH 4W
Fed From Panel MCP"

Typical Safety Switch Label:

"AHU-5
480V 3PH
Fed From Panel PP1"

Typical Instrument label:

"PIT-501
High Service Discharge Pressure"

B. All cabinets, combination starters, panelboards, safety switches, etc., shall have additionally have vinyl self-adhesive signs applied.

C. Branch circuits in lighting panels shall be typed on a card suitable for the card frame furnished with the panel. The card shall bear the panel designation listed on the Contract Drawings where this information is given, as well as indicate what each circuit controls. The Contractor shall retype new cards for all existing panelboards modified.

D. Submersible pumps shall be furnished with a spare nameplate which shall be installed inside the MCC or starter enclosure.

E. All mechanical equipment on the project that has electrical service shall be labeled and the equipment labels must match the breaker labels. Coordinate with Divisions 2, 11, and 15.

F. Furnish and install "Authorized Personnel Only" signs by doors into all power distribution equipment rooms/buildings. Furnish and install other signs as indicated on the Contract Drawings.

3.02 BOX LABELING

A. Label each box with the voltage and circuit numbers contained.

3.03 CONDUCTOR LABELING

A. Label each conductor to match the circuit number or manufacturer's shop drawing wiring diagrams.

3.04 ARC-FLASH HAZARD LABELING

A. Electrical equipment shall be labeled with Arc-Flash hazard warning labels as required by the N.E.C. Labeling shall comply with ANSI Z535.4.

3.05 AVAILABLE FAULT CURRENT LABELING

A. Service equipment shall be labeled with the maximum available fault current and date of calculation

as required by the NEC. Contact Engineer to obtain available fault current value.

END OF SECTION

SECTION 16120 - CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. All wire and cable shall conform to the latest requirements of the NEC and shall meet all ASTM/UL specifications. Wire and cable shall be new; shall have size, grade of insulation, voltage rating and manufacturer's name permanently marked on the outer covering at regular intervals. Complete descriptive literature shall be submitted to the Engineer for review and acceptance prior to installation.

B. Building wire #12 - #1 shall be applied based on a 60 degree Celsius temperature rise. Building wire larger than #1 may be applied at its 75 degree Celsius temperature rise.

1.02 DELIVERY, STORAGE AND HANDLING

A. Wire and cable shall be suitably protected from weather and damage during storage and handling and shall be in first class condition when installed.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Building Wire (types "THWN" and "THW"-cu.) – "Southwire," "Collyer," "American," "Carol," or equal.

B. Control Cables (Shielded or unshielded) 600V max. – "Belden," "Eaton-Dekoron," "Okonite," or equal.

C. Instrumentation Cables (Shielded) 600V mx. – "Eaton-Dekoron," "Manhatton," "American," "Belden," "Okonite," or equal.

D. VFD cable for motor branch circuits from VFD's: "Belden", "Draka", "Service Wire Co", or equal.

2.02 MATERIALS

A. General

1. In general, all conductors shall be 98 percent conductive, annealed copper unless otherwise noted on the Contract Drawings.

2. Conductors shall be type THW or THWN insulation. Conductor size shall be AWG (American Wire Gauge) Standard. Minimum conductor size shall be AWG number 12 except branch circuits in excess of 75 feet from panel to first outlet not smaller than no. 10 AWG. Minimum voltage rating shall be 600 volts. Conductors for small power may be solid (i.e. lighting, receptacles), but conductors for control work shall be stranded.

3. Conductors with high temperature rated insulations and special construction shall be used where required in connecting to light fixtures or appliances that have special requirements.

B. VFD Cable

1. The cable shall be 600V/1000V rated, with stranded tinned copper conductors, shielded, suitable for use with Variable Frequency Drives.

2. The insulation shall be rated for 90 degrees Celsius Wet/Dry operating temperature.

3. Accessories (terminations) shall have ratings that are at least equal to those of the cable.

4. All cables shall be round.

5. Cable shall be suitable for use in wet/dry locations, indoors and outdoors, in cable trays, in conduits, trenches, and in underground ducts and direct burial.

6. The conductor shall be annealed stranded tinned copper per ASTM B3, B8, and B33.

7. The insulation thickness shall have a minimum average wall thickness of 30 mils. The insulation material must be XLPE with an XHHW-2 listing per UL 44. Each insulated conductor shall be identified in accordance with ICEA Method 4 color coding.

8. The insulated conductors are to be cabled together with a minimum of one ground wire. The ground wire(s) are to have a minimum circular mil area equivalent to one circuit conductor. Fillers shall be included as necessary to make the cable round.

9. The cabled assembly shall be shielded using one of two methods:

    a. Applying helically two 2-mil copper tapes. The shield shall provide 100% coverage over the assembly.

    b. Applying an 80% minimum coverage tinned copper braid shield used in conjunction with an Aluminum Foil shield tape.

10. All cables shall have a continuous overall outer sheath of Polyvinyl Chloride (PVC), suitable for 90 degree Celsius use.

11. The jacket shall be resistant to abrasion, rated for direct burial, sunlight resistant, and flame resistant in accordance with UL 1277.

12. The following permanent legend shall be clearly embossed or printed at approximately 2 foot intervals on the outer jacket for the entire length of the cable:

    a. Manufacturer's name and or Trade Mark.

    b. Number of conductors and size (-- AWG).

    c. Type of insulation (XLPE) or NEC Listed Conductor Type (XHHW-2).

    d. Voltage rating.

    e. TC-ER rating.

    f. 1000V Flexible Motor Supply Cable rating.

    g. Sequential footing marking at 2 foot intervals.

13. Only one continuous (without splices) length of cable shall be shipped on a reel. Both ends shall be waterproof sealed, secured, protected from damage, and both ends shall be available for testing.

PART 3 - EXECUTION

3.01 INSTALLATION/APPLICATION/ERECTION

A. General

1. Conductors shall be continuous from outlet to outlet and no splices shall be made except accessible in junction or outlet boxes. Wire connectors of insulating material or solderless pressure connectors, properly taped, shall be used for all splices in wiring, wherever possible.

2. Conductors shall be color coded in accordance with the following schedule:

	480/277V 3 Phase	208/240V 3 Phase	120/240, Single Phase
Phase A	Brown	Black	Black
Phase B	Orange	Red	Red
Phase C	Yellow	Blue	
Neutral (Grounded)	White or Light Gray	White or Light Gray	White or Light Gray
3-Way Tracers			Blue
Grounding	Green	Green	Green
Remote Energized Conductors (Control)			Yellow
Control	Std. Code	Std. Code	

3. Conductors shall be pulled into raceways in strict accordance with manufacturer's recommendations.

4. Ample slack conductors shall be allowed at each terminal point, and pull or junction box, to permit installation with ease and without crowding.

5. All conductors terminating at terminal blocks shall be identified with numbers and/or letters identical to circuit or control identification.

6. No conductors shall be drawn into conduits until all work which may cause wire or cable damage is completed. Wire pulling shall be accomplished utilizing machinery and accessories intended for the purpose.

7. All connections and splices shall be made in accordance with conductor manufacturer's recommendations, and as written herein.

8. In general, feeder sizes shown are based on no more than three current carrying conductors in a conduit. Multiple small branch circuit feeders may be combined in a common conduit, provided conductors are derated in accordance with NEC article 310-15.

9. Unless otherwise specifically indicated, neutrals may not be shared.

B. Feeders

1. All feeders are of the secondary type, below 600 volts, unless otherwise noted. Secondary feeder voltage shall be 480 volt, as noted in the Contract Drawings. Three phase, 4 wire for power and 208/120 volt, 3 phase, 4 wire for general lighting, unless otherwise noted. The Contractor shall furnish and install all feeders from the distribution center(s) to each of the other structures/subpanels as shown on the Contract Drawings.

2. Wire shall be factory color coded for each phase and neutral, with green used for the ground conductor. As far as practical, all feeders shall be continuous from origin to panel termination without running splices in intermediate pull boxes.

C. Control Cable

1. Control cable shall be the size and have the number of conductors shown on the control system drawings. Control cable shall be used for motor controls and monitoring only. Color coding shall be ICEA, Method 1. Control cables between buildings shall be underground in conduit of the size shown in the control system schematic. Cabling shall provide a minimum of 25 percent spare conductors. Voltage rating shall be 600 volts.

D. Instrument Cable

1. General

   a. All signal lines should be constructed of individually twisted pairs (6 to 10 twists per foot), including thermocouple extension leads. Cables should be made of twisted pairs, with all lays and pairs twisted in the same direction for maximum flexibility.

   b. Wire size is #16 AWG minimum.

   c. Stranded tinned copper conductor shall be used for all wiring other than thermocouple extension leads.

   d. Insulation resistance at 68 degrees Fahrenheit between conductors and between conductors and ground should be at least 500 megohms per 1,000 feet.

   e. Multi-pair cable should be jacketed with poly-vinyl-chloride, polyethylene or Teflon at least 0.045" thick. Voltage rating shall be 600 volts.

2. Signal Wiring

   a. Low level analog (less than 500 millivolt d-c). Use twisted pairs which may be cabled with other pairs carrying similar voltage levels. Foil wraps or equivalent shielding is required for each cable with the shield insulated from ground.

   b. High level analog (greater than 500 millivolts d-c). Use twisted pairs which may be cabled with other pairs carrying similar voltage levels and current levels less than 100 ma. Shielding is required.

   c. Analog outputs (normally 0-4 d-c or 4-20 ma). Same as b.

   d. Contact inputs - use twisted pairs and run in separate conduit.

   e. Contact outputs - same as d.

   f. Pulse inputs - same as d.

3. Signal and Shield Grounding

a. All shields must be grounded at one point only as close as possible to the signal source.

b. Thermocouples may be grounded or ungrounded.

c. Analog signals, if grounded, should be grounded as near the signal source as possible.

d. Resistance bulbs should not be grounded.

4. Signal and Wiring Separation

a. Analog signals shall be run in a separate conduit from contact or pulse signals.

b. A minimum separation of 12 inches between analog signal leads and a-c power leads should be maintained. For a-c power leads carrying 100 amps or greater, a 24 inch separation should be maintained. Parallel runs should be limited to less than 500 feet. Perpendicular runs may be as close as 6 inches.

E. Submersible pump Power Cable

1. Power cables for submersible pumps shall be of the extra hard usage type suitable for submerged duty and able to withstand common corrosive agents found in water and wastewater. They shall be provided with high grade non-magnetic stainless steel relief cable grips installed at the pump end and high grade non-magnetic stainless steel support cable grips anchored to the wet well structure where they enter the wet well. The strain relief and support cable grips shall be as manufactured by Kellems, Slater/Flexcor, or equal. Non-metallic corrosion resistant grips may be used in lieu of stainless steel if available for the cable size.

F. Ethernet Cables

1. Ethernet cables shall be Category 6 rated.

2. Ethernet cables inside VFD cabinets shall be Category 6 rated and shielded.

3.02 FIELD QUALITY CONTROL

A. Testing

1. All testing shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

a. Witness Shop Tests

1) Not required.

b. Shop Test

1) Cable and wiring shall be tested in accordance with the applicable ICEA Standards. Wire and cable shall be physically and electrically tested in accordance with the manufacturer's standards.

c. Field Tests

1) Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 1, and NETA acceptance testing specifications.

2) After installation, all wires and cables shall be tested for continuity. Testing for continuity shall be "test light" or "buzzer" style.

3) After installation, all wires and cables shall be tested for insulation levels. Insulation resistance between conductors of the same circuit and between conductor and ground shall be tested. Testing for insulation levels shall be as follows:

   - For 600V power and control cable, apply 1,000 VDC from a Megohmeter for one (1) minute for all 600V wires and cables installed in lighting, control, power, indication, alarm and motor feeder circuits. Resistance shall be no less than 100 Megohms.

   - 600V instrumentation signal cable shall be tested from conductor to conductor, conductor to shield, and conductor to ground using a Simpson No. 260 volt-ohmmeter, or approved equal. The resistance value shall be 200 Megohms or greater.

2. Low voltage wires and cables shall be tested before being connected to motors, devices or terminal blocks.

3. Voltage tests shall be made successively between each conductor of a circuit and all other conductors of the circuit grounded.

4. If tests reveal defects or deficiencies, the Contractor shall make the necessary repairs or shall replace the cable as directed by the Engineer, without additional cost to the Owner.

5. All tests shall be made by and at the expense of the Contractor who shall supply all testing equipment. Test reports shall be submitted to the Engineer.

END OF SECTION

SECTION 16130 - RACEWAYS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section of the Technical Specifications includes all raceways for accommodation of electrical conductors, communications conductors, sleeves for underground electrical installations, conduit stubs for future installations, fittings therefore and accessories.

B. All raceways shall be marked with the manufacturer's name or trademark as well as type of raceway and size. This marking shall appear at least once every 10 feet and shall be of sufficient durability to withstand the environment involved. All raceways shall be furnished and installed as outlined under Part 3 of this Specification.

C. All raceways and fittings shall be painted to match existing or surrounding surfaces except in mechanical spaces.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Tubular Raceways

1. Steel, Galvanized, Rigid, Heavy-Wall, Threaded – "Wheatland Tube Co.," "Triangle," "Allied Tube & Conduit Corp.," or equal.

2. Plastic (PVC); Type A (Thin Wall); Type 40 (or Schedule 40); Type 80 (or Schedule 80) (Heavy -Wall) – "Carlon," "Cantex," or equal.

3. Flexible Metal Conduit – "AFC," "Southwire," or equal.

4. Liquidtight Flexible Metal Conduit – "Carol Cable Co., Inc.," "Superflex," "OZ Gedney," or equal.

5. Liquid-Tight Flexible Non-Metallic Conduit - Type "LNM-P" as manufactured by Electri-Flex, Type "Ultralite" as manufactured by Southwire, Type "CNP" as manufactured by Anaconda, or equal.

6. Aluminum Conduit - "Wheatland Tube Co.", "Allied Tube & Conduit Corp.", or equal.

B. Raceway Fittings

1. Conduit fittings – "Crouse-Hinds," "Appleton," "OZ Gedney," or equal.

2. Non-metallic conduit fittings –"Carlon," "Cantex," or equal.

3. Flexible conduit fittings – "Raco," "T & B," "OZ Gedney," or equal.

2.02 MATERIALS

A. Rigid Steel Conduit

1. Rigid steel conduit and fittings shall be of mild steel piping, galvanized inside and out, and shall conform to UL standards. The conduit and fittings hall be listed and labeled by UL as well. The galvanized coating of zinc shall be of uniform thickness applied by the

hot-dipped process, and shall be applied also to the threads. It shall be further dipped in a chromic acid bath so as to chemically form a corrosion resistant protective coating of zinc chromate which has a characteristic yellow-green color. Each piece of conduit shall be straight, free from blisters and other defects, cut square, and taper reamed. It shall be delivered with plastic protectors on the threads.

B. Polyvinylchloride (PVC) Conduit

1. PVC conduit and fittings shall be Schedule 80 heavy wall, or thinwall, as indicated in these Specifications manufactured to conform to UL standards. It shall be listed and labeled by UL. It shall have at least the same temperature rating as the conductor insulation. Expansion joints shall be used as recommended by the manufacturer in published literature. PVC systems shall be 90 degrees Celsius minimum UL rated, have a tensile strength of 7,000 psi @ 73.4 degrees Fahrenheit, flexural strength of 11,000 psi and compressive strength of 8,000 psi.

C. Flexible Conduit

1. Flexible metallic conduit shall be constructed from flexibly or spirally wound elecro-galvanized steel. Connections shall be by means of galvanized malleable iron squeeze type fittings, or tomic twist-in type in sizes not exceeding 3/4 inch. Liquidtight conduit shall be light gray in color and have sealtight fittings, type UA.

2. In hazardous locations where flexible connections are required, flexible couplings UL listed for the application shall be used. The couplings shall consist of stainless steel tubing and outer braid, with insulating liner. Female end fittings shall also be stainless steel, with removable steel close nipples. Couplings shall be O-Z/Gedney, or equal.

D. Liquid-Tight Flexible Metal Conduit

1. Liquid-tight flexible conduit (LFMC) shall be galvanized steel, single strip, with a copper strip interwoven and suitable as a grounding means. LFMC shall be UL listed. LFMC shall have an extruded moisture and oil-proof PVC jacket.

2. PVC coated or stainless steel watertight connectors shall be used with liquid-tight flexible metal conduit on both ends.

E. Liquid-Tight Flexible Non-Metallic Conduit

1. Liquid-tight flexible non-metallic conduit (LFNC) shall be constructed of PVC. LFNC shall be UL listed. LFNC shall have an extruded moisture and oil-proof PVC jacket.

2. Watertight connectors shall be used with liquid-tight flexible non-metallic conduit on both ends. LFNC shall be used to connect all vibrating equipment installed in sodium hypochlorite storage and transfer areas as specified herein, and other applications as directed by the Engineer or as indicated on the drawings.

F. Aluminum Conduit

1. Aluminum conduit shall be extruded from alloy 6063 and shall be the rigid type, non-toxic, corrosion resistant, and non-staining. It shall be manufactured per UL standards as well as listed/labeled by same.

2. Fittings, boxes, and accessories used in conjunction with aluminum conduit shall be die cast, copper free type. They shall be resistant to both chemical and galvanic corrosion. All covers shall have neoprene gaskets.

3. All aluminum conduit used for this project shall be UL listed for the purpose.

G. Conduit Fittings

1. Rigid Steel Conduit Fittings

   a. Standard threaded couplings, locknuts, bushings, and elbows made only of steel or malleable iron are acceptable. Integral retractable type IMC couplings are acceptable also.

   b. Locknuts: Bonding type with sharp edges for digging into the metal wall of an enclosure.

   c. Bushings: Metallic insulating type, consisting of an insulating insert molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.

   d. Erickson (union-type) and set screw type couplings: Approved for use in concrete are permitted or use to complete a conduit run where conduit is installed in concrete. Use set screws of case hardened steel with hex head and cup point to firmly seat in conduit wall for positive ground. Tightening of set screws with pliers is prohibited.

   e. Sealing fittings: Threaded cast iron type. Use continuous drain type sealing fittings to prevent passage of water vapor. In concealed work, installed fittings in flush steel boxes with blank coverplates having the same finishes as that of other electrical plates in the room.

2. Rigid Aluminum Conduit Fittings

   a. Standard threaded couplings, locknuts, bushings, and elbows: Malleable iron, steel or aluminum alloy materials. Zinc or cadmium plate iron or steel fittings. Aluminum fittings containing more than 0.4 percent copper are prohibited.

   b. Locknuts and bushings: As specified for rigid steel and IMC conduit.

   c. Set screw fittings: Not permitted for use with aluminum conduit.

3. Expansion and Deflection Couplings

   a. Accommodate 1.9 cm (0.75 inch) deflection, expansion, or contraction in any direction, and allow 30 degree angular deflections.

   b. Include internal flexible metal braid sized to guarantee conduit ground continuity and fault currents in accordance with UL, and the NEC code tables for ground conductors.

   c. Watertight, seismically qualified, corrosion-resistant, threaded for and compatible with rigid or intermediate metal conduit.

   d. Jacket: Flexible, corrosion-resistant, watertight, moisture and heat resistant molded rubber material and stainless steel jacket clamps.

PART 3 - EXECUTION

3.01 PREPARATION

A. Exterior underground metallic conduits shall be degreased, pretreated, and coated with 2 coats of Carboline 888 epoxy, or equal. Other finishes may be acceptable upon the Engineer's review.

3.02 INSTALLATION

A. Conduit

1. All conduit shall be installed in a first class workmanship manner. It shall be installed in horizontal and vertical runs in such a manner as to ensure against trouble from the collection of trapped condensation and shall be arranged so as to be devoid of traps wherever possible. Special care shall be used in assuring that exposed conduit runs are parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceilings. No open wiring is allowed.

2. Fittings or symmetrical bends shall be required wherever right angle turns are made in exposed work. Bends and offsets shall be avoided wherever possible, but where necessary, they shall be made with an approved conduit bending machine. All conduit joints shall be cut square, reamed smooth and drawn up tight, using couplings intended for the purpose.

3. Conduits shall be securely fastened to all sheet metal outlets, junction and pull boxes with double galvanized locknuts and insulating-grounding bushings as required by the NEC. Conduit crossings in insulating roof fill will require both conduits to be secured to the roof deck, and these crossings can only be made where the insulating fill is a minimum of 3 inches deep. Runs of exposed conduit shall be supported in accordance with the NEC using cast aluminum or malleable iron one hole pipe straps with spacers to provide an air space behind the conduit. Stainless steel minerallaac, one piece conduit clamps shall be acceptable where located such that building occupants are not in danger of inadvertent contact, since this type fitting has several sharp edges. In general terms, they may be considered in areas such as on or above ceilings, or high on walls. All conduit in walls and slabs shall be securely braced, capped (wooden plugs are prohibited), and fastened to the forms to prevent dislodgement during vibration and pouring of concrete.

4. During construction, all conduit work shall be protected to prevent lodgement of dirt, plaster or trash in conduits, fittings or boxes. Conduits which have been plugged shall be entirely freed of accumulations or be replaced. All conduits in floors or below grade shall be swabbed free of debris and moisture before wires are pulled. Crushed or deformed conduit shall not be permitted.

5. Where GRS conduit penetrates a floor slab the conduit shall be painted with 2 coats of Koppers Bitumastic 300-M or equal to a point 6 inches above the penetration.

6. The final section of conduit connecting each motor or piece of utilization equipment subject to vibration shall be of the flexible type. Type "UA" shall be used in all process areas and in outdoor or wet locations. Flexible conduit to space heaters shall be long enough to allow swivel action.

7. All underground conduits entering a building shall be sealed against water/condensate entering around the conductors. Sealant shall be a UL listed duct seal.

8. In certain situations, conduit expansion joints shall be required to ensure against conduit and/or cable damage due to settling or thermal expansion and contraction. These expansion joints shall be required where required by the manufacturer or the Contract Drawings and shall be installed per manufacturer's instructions.

9. Aluminum conduits shall not be in contact with concrete surfaces. Where aluminum conduits are routed along concrete surfaces, they shall be installed with one hole cast straps with clamp-backs to space the conduit ¼" away from concrete surface. Where aluminum conduit passes through concrete, CMU or brick walls, the penetration shall be made such that the aluminum conduit does not come in contact with concrete, CMU,

brick or mortar. All penetrations shall meet or exceed the UL design standards. Aluminum conduit shall not be used in a concrete encasement, floor or ductbank.

10. Unless specifically identified on the Drawings as "Direct Buried," all conduits in the earth, including conduits below slabs-on-grade, shall be concrete encased. Joints in conduit shall be staggered so as not to occur side by side. Rigid non-metallic (PVC) conduit shall be connected to metallic conduit at the point where it leaves the ground, with the transition to metal conduit occurring inside the concrete encasement and coated for corrosion-prevention. Metallic conduit may transition to non-coated conduit after exiting the encasement.

11. It is the general intent that boxes for light fixtures, switches, receptacles, etc. in or on the building be flush mounted with concealed conduit to the device, except in areas designated to have all conduit installed exposed.

12. All metal raceway systems shall be grounding conductive, solidly bonded throughout and grounded in accordance with NEC requirements and/or as noted on the Contract Drawings. In addition, all raceway systems shall be provided with separate grounding conductors.

13. Minimum conduit size shall be 3/4 inch. Minimum burial depth shall be 30".

14. Wire pulling shall be facilitated by the use of a UL approved pulling compound in pulls over 30 feet in length or where there are 2 or more 90 degree bends. Only polypropylene, nylon, or manila pulling ropes will be permitted. Standard industry recognized wire pulling equipment shall be used.

15. All conduits entering and leaving instrument enclosures shall be sealed around the wires with UL listed duct seal.

16. All conduits for emergency lighting systems shall be separate from other building power conduits.

17. Areas of use for each type of conduit:

Location	Schedule 80 PVC	Aluminum
Electrical Room – Exposed		X
Electrical Room – Concealed in Wall	X	X
Valve Vault – Exposed Only		X
Exterior Exposed		X
Exterior Underground, Underslab, or In Slab	X	
Exterior Underground Service Entrance (Primary and Sec.)	X	

18. All conduit shall have an insulated ground wire pulled to all equipment and receptacles.

19. All raceway runs are shown diagrammatically to outline the general routing of the raceway. The installation shall be made to avoid interference with pipes, ducts, structural members or other equipment. Should structural or other interference prevent the installation of the raceways, or setting of boxes, cabinets, or the electrical equipment, as

indicated in the Drawings, deviations must be approved by the Owner, and after approval, shall be made without additional charges and shown on the Record Drawings.

20. Assure conduit installation does not encroach into the ceiling height head room, walkways, or doorways.

21. No conduit shall be run exposed across roofs without first obtaining permission from the Engineer.

22. Conduit may be run inside concrete slabs as long as the slab is at least 6-inches thick and conduit will have at least 1 2-inches of cover on both sides.

23. Runs of flexible conduit above accessible ceilings shall be limited to 10 ft. Runs of exposed flexible conduit shall be limited to 5 ft. All runs of flexible conduit shall be supported in accordance with NEC requirements.

24. Sealing fittings shall be installed where conduits pass from non-hazardous locations to hazardous locations and as required by Chapter 5 of the NEC. See section 16050 for hazardous area classifications.

END OF SECTION

SECTION 16131 - BOXES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Outlet and junction boxes shall be furnished and installed where indicated on the Contract Drawings, and\or as required by the work in accordance with the NEC.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Boxes – "Wiegmann," "Appleton," "Raco," "Crouse-Hinds," "Hoffman," "Robroy Industries," "Spring City," "Carlon," or equal.

2.02 GENERAL

A. All junction and/or pull boxes for dry (non-corrosive) areas shall be of code gauge sheet metal construction, of the inside dimensions as required by code, with covers.

B. Outlet boxes for wet or damp locations shall be cast metal, rust and corrosion resistant (NEMA 4X), with at least 5-1/2 full threads for each (bossed) conduit opening, and shall be suitable for flush or surface mounting as required with drilled external, cast mounting extensions (bossed to provide at least 1/8" between back of box and mounting surface for drainage). Box covers shall be hinged or cap screw retained as required, of the same material as the box and provided with stainless steel (rustproof) hardware.

C. Junction and/or pull boxes for out-of-doors use or indoor process areas, not mounted in concrete may be sheet metal (NEMA 4X), waterproof, rustproof, rain and sleetproof, with hinged covers and latches and provided means of locking by means of keyed locks, tamper-resistant screws or padlocking as required and with clamping cap-screws top and bottom door edges to provide firm contact with gasketing. All gaskets shall be molded (unbroken) neoprene or butyl rubber.

D. NEMA 4X junction and/or pull boxes shall be stainless steel.

E. Underground junction or pull boxes shall be constructed of reinforced concrete cast-in-place or pre-fabricated as detailed on the Contract Drawings.

F. Junction boxes for use in wet-wells and other hazardous areas shall be watertight, rustproof and corrosion resistant, and explosionproof with threaded conduit openings (5-1/2 full threads - minimum) and provided with rustproof hardware.

G. Explosionproof sealing fittings shall be furnished and installed in accordance with NEC requirements.

PART 3 - EXECUTION

3.01 INSTALLATION, APPLICATION, AND ERECTION

A. General

1. Outlets shall be installed in the locations shown on the Contract Drawings. The Contractor shall study the general building plans in relation to the space surrounding each outlet, in order that his work may fit the other work required by these Specifications.

When necessary, the Contractor shall relocate outlets so that when fixtures or other fittings are installed, they will be symmetrically located according to room layout and will not interfere with other work or equipment.

2. All supports for outlet boxes shall be furnished and installed by the electrical trades.

B. Concealed Work

1. All outlet boxes shall be standard galvanized steel type at least 2 inches deep, single or gang type of size to accommodate devices shown. Exceptions shall be noted on the Contract Drawings.

2. Standard deep type outlet boxes (concrete rings with appropriate covers) shall be used in floor slab construction so concealed conduits entering sides of boxes can clear reinforcing rods.

3. Outlet boxes for concealed telephone and signaling systems shall be the 4-inch square type, unless otherwise noted or required by the telephone company.

4. Boxes for use in masonry construction shall be 2-1/2 inches deep for 4-inch block and 3-1/2 inches deep for 6- and 8-inch block. Through wall boxes are prohibited for outlets opposite each other.

C. Exposed Work

1. Outlet or junction boxes for use with exposed aluminum conduit shall be copper free, cast aluminum type.

D. Pull Boxes

1. Pull boxes for exterior underground work are shown on the Contract Drawings and are the minimum number required. Others may be added at the Contractor's option, but no extra pay shall be allowed. Interior pull boxes are not shown but shall be used as needed. Pull box types are as follows:

Exterior - Per detail on the Contract Drawings.

Interior - Interior pull boxes in dry areas shall be of code gauge steel of not less than the minimum required by the NEC and shall be provided with hinged covers. In wet areas or pipe galleries, they shall be rated watertight, of stainless steel, cast aluminum, PVC, fiberglass, or equal. Hardware shall be stainless steel.

E. Openings in Electrical Boxes

1. All openings in electrical equipment, enclosures, cabinets, outlet and junction boxes shall be by means of welded bosses, standard knockouts, or shall be sawed, drilled, or punched with tools specially made for the purpose. The use of a cutting torch is prohibited. Unused openings shall be plugged per the NEC.

END OF SECTION

SECTION 16140 - WIRING DEVICES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Wiring devices shall be installed where indicated on the Contract Drawings.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. "Hubbell," "Eagle," "General Electric," "Wiremold," "P&S," "Leviton," "Daniel Woodhead," or equal.

2.02 EQUIPMENT

A. Receptacles

1. Twin-convenience - outlet (interior) – "Hubbell" cat. no. 5362, or equal.

2. Twin-convenience - outlet (exterior) – "Hubbell" cat. no. 5362 with Taymac Corporation or Intermatic, Inc. safety outlet enclosure.

3. Special purpose outlet - Per equipment requirements.

4. Ground fault interrupting receptacles shall be required where shown on the Contract Drawings, and shall be indicated by the abbreviation "GFI" beside the circuit symbol on the Contract Drawings. They shall be rated 20 amps (125 volts) and shall be of the duplex, feed through type, capable of protecting all downstream receptacles on the same circuit. They shall be UL listed and interrupt the current between 4-6 milliamps of ground fault leakage. Appropriate plates shall be furnished and installed. The 20 ampere rating shall apply not only to device internals but to the faceplate as well.

B. Plates and Covers

1. Furnish and install plates of the appropriate type and size for all wiring and control devices, signal and telephone outlets.

2. All plates on flush and surface mounted boxes shall be of 302 stainless steel (nonmagnetic) with rounded or beveled edges, except where weatherproof covers are shown. All device plate screws shall be nylon or stainless steel with countersunk heads. Plates shall be installed vertically and with an alignment tolerance of 1/16 inch. Device plates shall be of the one-piece type, of suitable shape for the devices to be covered. Plates shall have a smooth finish with no crevices to collect dirt. Oversize plates are not acceptable.

3. Covers for boxes serving equipment where flexible conduit is to be tapped into cover plates shall be sheet metal drilled for conduit. Gaskets shall be required as well as all special adapters for mounting.

C. Wall Switches (Tumbler Type)

1. Single pole (interior) – "Hubbell" cat. no. 1221, or equal.

2. Single pole (exterior) – "Hubbell" cat. no. 1222, or equal, and Hubbell 1795 or equal plate.

3. Outside receptacles shall be labeled for the purpose.

PART 3 - EXECUTION

3.01 INSTALLATION/APPLICATION/ERECTION

A. Wall Switches

1. Wall switches shall be mounted at a height as indicated in Section 16050, unless otherwise noted on the Contract Drawings.

B. Receptacles

1. Outlets shall be located as shown on the Contract Drawings. Where located in special interior finishes, they shall be properly centered. Boxes shall be of the type noted and accepted for the specific installation.

2. Furnish and install receptacle circuits where called for on the Contract Drawings and/or by these Specifications. Circuits shall be installed in conduit from panel to receptacle, with flush mounted boxes except as noted on the Contract Drawings.

3. Receptacles and lighting circuits shall not be combined on the same overcurrent device. For runs over 75 feet or for 30 amp receptacles, minimum wire size shall be AWG No. 10.

4. Receptacles for specific devices (i.e., air conditioner), shall be rated at the correct voltage and amperage for that unit.

5. The minimum free length of conductor at each box for the connection of a fixture, switch or receptacle shall be 8 inches. All connections shall be made mechanically and electrically secure.

6. Receptacles shall be duplex type, rated at 20 amps, 125 volts, brown colored, unless otherwise noted. Mounting height shall be as specified for low outlets in Section 16050. All receptacles shall be of the grounding type.

7. Receptacles over workbenches or countertops or at medium or high mountings shall be mounted so that the grounding slot is below the neutral and hot. All other receptacles shall be mounted with the grounding slot above the neutral and hot.

8. Exterior weatherproof receptacles, shall be weatherproof while in use. This requirement shall apply on all outdoor units and on others as indicated on the Drawings. Covers shall be all-aluminum heavy duty type.

END OF SECTION

SECTION 16150 - WIRE CONNECTIONS AND CONNECTING DEVICES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Wire connection and connecting devices shall be as herein specified.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Connectors, Lugs, etc. – "T & B", "Anderson", "Burndy", or equal.

B. Termination and splice connectors – "3M Scotchlok", "Anderson", "T & B", "Burndy", or equal.

2.02 MATERIALS

A. Wire Splicing and Terminations (600 Volts and Below)

1. Electrical Terminal and Splice Connectors (#22 - #4 AWG)

   a. Terminals and splice connectors from #22 - #4 AWG shall be compression types with barrels to provide maximum conductor contact and tensile strength. Performance, construction, and materials shall be in conformance with UL standards for wire connectors and rated for 600 volts and 105 degrees Celsius.

   b. Connectors shall be manufactured from high conductivity copper and entirely tin plated. Terminal barrels shall be serrated on the inside surface and have a chamfered conductor entry. Terminals shall have funnel entry construction to prevent strand fold-back. All barrels shall be brazed seam or seamless construction.

   c. Spade type terminals shall be sized for the appropriate stud and shall be locking type that snap firmly onto studs with a close fit for maximum retention. Spade type terminals shall be insulated with an insulation suitable for maintaining a high dielectric strength when crimped and be made form nylon, PVC, or equal.

2. Electrical Lugs and Connectors (#6 AWG - 1000 Kcmil)

   a. Lugs and splice connectors from #6 AWG - 1000 Kcmil shall be compression types with barrels to provide maximum conductor contact and tensile strength. They shall be manufactured from high conductivity copper and entirely tin plated. They shall be crimped with standard industry tooling. The lugs and connectors must have a current carrying capacity equal to the conductors for which they are rated and must also meet all UL requirements. All lugs above 4/0 AWG shall be 2 hole lugs with NEMA spacing. The lugs shall be rated for operation through 35 KV. The lugs shall be of closed end construction to exclude moisture migration into the cable conductor.

3. Twist-on Wire Connectors (#22 AWG - #10 AWG)

   a. All twist-on wire connectors must have a corrosion resistant spring that is free to expand within a steel jacket. The steel jacket must be insulated with a flexible vinyl jacket capable of withstanding 105 degrees Celsius ambient temperatures and of sufficient length to cover wires that are inadvertently overstripped.

   b. Each connector size must be listed by UL for the intended purpose and color coded to assure that the proper size is used on the wire combinations to be spliced. The

connectors must be compatible with all common rubber and thermoplastic wire insulations.

4. Solderless/re-usable lugs shall be used only when furnished with equipment such as control panels, furnished by others, where specification of compression type lugs is beyond the Contractor's control. In the event their use is necessary, the Contractor shall be responsible for assuring that they are manufactured to NEMA standards, with proper number and spacing of holes and set screws.

PART 3 - EXECUTION

3.01 INSTALLATION, APPLICATION, & ERECTION

A. Insulation of Splices and Connections

1. Connections/splices with a smooth even contour shall be insulated with a conformable 7 mil thick vinyl plastic insulating tape which can be applied under all weather conditions and is designed to perform in a continuous temperature environment up to 105 degrees Celsius. The tape shall have excellent resistance to abrasion, moisture, alkalies, acids, corrosion, and varying weather conditions (including sunlight). The tape shall be equal to Scotch 33+ and shall be applied in conformance with manufacturer's recommendations. In addition, it shall be applied in successive half-lapped layers with sufficient tension to reduce its width to 5/8 of its original width. The last inch of the wrap shall not be stretched.

2. Connections/splices with irregular shapes or sharp edges protruding shall be first wrapped with 30 mil rubber tape to smooth the contour of the joint before being insulated with 33+ insulating tape specified in the previous paragraph. The rubber tape shall be high voltage (69 KV) corona-resistant based on self-fusing ethylene propylene rubber and be capable of operation at 130 degrees Celsius under emergency conditions. The tape must be capable of being applied in either the stretched or unstretched condition without any loss in either physical or electrical properties. The tape must not split, crack, slip, or flag when exposed to various environments. The tape must be compatible with all synthetic cable insulations. The tape must have a dissipation factor of less than 5 percent at 130 degrees Celsius, be non-vulcanizing, and have a shelf life of a least 5 years. The rubber tape shall be applied in successive, half-lapped wound layers and shall be highly elongated to eliminate voids. Other manufacturer's recommendations on installation shall be adhered to. The rubber tape shall be equal to Scotch 23 or 130C electrical splicing tape.

3. Splices made in wet or damp locations shall be made submersible and watertight with special kits made for the application and compatible with type of cables employed.

B. Connection Make-up

1. Connections of lugs to bus bars, etc., shall be made up with corrosion resistant steel bolts having non-magnetic properties with matching nuts, and shall utilize a Belleville spring washer (stainless steel) to maintain connection integrity. Connections shall be torqued to the proper limits. Prior to bolting up the connection, electrical joint compound shall be brushed on the contact faces of the electrical joint.

2. All motor lead connections shall be made up to match the type of lead furnished on the motor. If the lead is not lugged, then twist-on wire connectors may be used. To prevent possible vibration problems, twist-on connectors shall be taped after installation.

3. All lugged motor lead connections (excluding motors over 200 horse-power) shall be made up using ring tongue compression lugs with proper size stainless steel nuts and bolts. Belleville type spring shall be used to maintain tension on the connections. The

connections shall then be insulated using the procedure described for irregular shapes, utilizing rubber tape in conjunction with vinyl electrical tape.

4. At the time of final inspection, the Engineer may request the Contractor to disassemble 3 randomly selected motor lead connections in the Engineer's presence, to assure conformance with these Specifications.

5. The Contractor shall include all necessary tools, materials, and labor in his bid for disassembly of the connections and for remaking them with new insulating materials after inspection.

END OF SECTION

SECTION 16170 – SAFETY SWITCHES

PART 1 – GENERAL

1.01 SCOPE OF WORK

A. Provide horsepower-rated, quick-make, quick-break, safety switches provided with the number of poles and fuses as required.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS/EQUIPMENT

A. Safety switches shall be as manufactured by General Electric, Square D Company, Eaton, or equal.

B. Switches shall be NEMA Type HD, single-throw, externally operated, non-fused or fused with Class R fuse clips.

C. Switches shall have arc shields, shall be of enclosed construction and fusible or non-fusible as indicated. Switches shall be rated for either 250-volt AC or 600-volt AC service as required.

D. All switches shall be capable of interrupting locked rotor current of motor which it serves.

E. Enclosures shall be NEMA-1 for interior non-process area use and NEMA-4X for exterior and process area use unless noted otherwise.

F. Provide dual-element Bussman type FRN (250 volt) or type FRS (600 volt) fuses for any fusible safety switch serving a motor circuit.

G. For non-motor loads, provide dual element Bussman type LPN (250 volt) or type LPS (600 volt).

H. All switches shall be capable of being padlocked in either the "On" or "Off" position.

I. Safety switches shall be UL listed and shall conform to NEMA Standards. NEMA 4X enclosed safety switches where called for shall be stainless steel.

J. NEMA 1 enclosed switches shall be phosphate coated as equivalent, code gauge steel with baked enamel finish.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Provide non-fusible switches at remote motor locations as indicated on drawings.

B. Mount switches to walls or to equipment enclosures with a minimum of 4 bolts using toggle anchors for masonry construction, Phillips "Red Head" anchors for poured concrete construction and bolts, jumbo washers, lock washers and nuts for equipment enclosure mounting.

C. All safety switches to be identified with nameplates per Section 16075.

END OF SECTION

SECTION 16220 - MOTORS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Motors are to be furnished with driven equipment except where otherwise noted on the Contract Drawings or elsewhere in this Division of the Specifications. All motors shall conform to the following Specifications and any special requirements of the driven equipment. Special requirements of the driven equipment shall take precedence over these Specifications should a discrepancy occur. Starting torque and slip ratings shall conform to the requirements of the driven equipment.

B. Polyphase motors shall be of the squirrel cage induction type and single phase of the capacitor start-induction run type except as otherwise noted. Conduit boxes shall be tapped for the size conduit shown on the Contract Drawings.

C. All motors shall be manufactured and installed in accordance with applicable NEMA standards and NEC provisions, latest revisions.

1.02 DELIVERY, STORAGE, & HANDLING

A. All electrical motors shall be protected against the accumulation of moisture, dust and debris and physical damage during the course of installation of the job.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Motors – "General Electric", "Westinghouse", "U.S. Motors", "Gould Century", "Lincoln", "Baldor", "Marathon", "Reliance", "Magnatek", "Siemens", or equal.

2.02 EQUIPMENT

A. Motors 200 Horsepower and Under for Service Under 600 Volts

1. Ratings and Electrical Characteristics

a. Time: All motors shall be rated for continuous duty.

b. Temperature: Based on NEMA standards for a maximum ambient temperature of 40 degrees Celsius and an altitude of 3,300 feet or less, according to service factor and insulation class employed.

c. Voltage: All single phase motors shall be rated 115/208/230 volts and all polyphase motors 230/460 volts. Submersible polyphase motors to be operated at 460 volts may take exception to the dual voltage requirement. All motors shall be capable of normal operation at balanced voltages in the range of ±10 percent from rated winding voltage.

d. Frequency: All a-c motors shall be rated for 60 Hz. operation. All motors shall be capable of normal operation at frequencies 5 percent above or below the nominal rating of 60 Hz.

e. Horsepower: Horsepower of the motors shall be as given in the Specification Division on the driven equipment or as shown on the Contract Drawings. Submersible motors shall be allowed to be furnished even though the horsepower

rating may not be in accordance with standard NEMA assignments. In many cases, the horsepower specified is a minimum requirement and certain alternate manufacturers may require larger horsepower motors. The larger motor shall be furnished at no extra cost to the Owner.

f. Locked Rotor Current: Locked rotor current shall be in accordance with NEMA standards.

g. Efficiency and Power Factor: Efficiency and power factor shall be given consideration during Shop Drawing review. The ratings at full, 3/4, and 1/2 load shall be compared to similar motors manufactured by acceptable suppliers listed in these Specifications. Excessive variation shall be considered grounds for rejection.

h. Speed: Synchronous speed of motors shall correspond to standard NEMA ratings. Actual speed shall be as given in the Specification Division on the driven equipment. Slip shall not exceed 5 percent at full load.

i. Service Factor: The service factor shall be 1.15 unless requirements of the driven load necessitate a higher service factor. The service factor for inverter duty rated motors shall be 1.0.

j. Insulation Class: Insulation shall be NEMA Class F, except as otherwise noted. Submersible motors shall be Class F, and inverter duty motors to be operated at variable speed shall be Class H. Motors shall operate at a Class B rise at nameplate horsepower loading regardless of Insulation Class.

k. Design Level: Motors shall be NEMA design B, except as otherwise noted.

l. Enclosure: Motors for process equipment 2 HP and smaller shall be totally enclosed. All motors for process equipment larger than 2 HP shall be TEFC (totally enclosed fan cooled), suitable for use indoors or outdoors, except as otherwise noted. Totally enclosed non-ventilated (or air-over) motors may be used for ventilators and other auxiliary equipment that by virtue of the load are provided with more than adequate ventilation. ODP (open dripproof) motors may be used for ventilators where the motor is outside the air stream yet still protected from the weather. Division 15 of the Specifications and the HVAC Contract Drawings will detail the type of enclosure required for ventilators. Submersible motors shall be air or oil filled and of watertight construction. Motors used in classified atmospheres shall be properly rated for that hazard.

m. Frame Size: Frame designations shall be in accordance with NEMA standards.

n. Winding Overtemperature Sensors: All motors 15 horsepower and over shall be provided with motor winding thermostats. The devices shall be hermetically sealed, snap-acting thermal switches, actuated by a thermally responsive bi-metallic disk. A minimum of 1 per phase is required, with switches wired into the control circuit of the starter to provide deenergization should overheating threaten. All submersible motors shall be equipped with motor winding thermostats.

o. All submersible pump/motor assemblies shall be equipped to detect presence of moisture and alarm at the controller.

p. Motors specified for operation with variable frequency drives shall be inverter duty and shall be designed to output 100 percent of nameplate horsepower under continuous duty service without exceeding the temperature rise specified herein when controlled by the actual drives furnished. Inverter duty motors shall be designed to operate down to 10% of full load speed without the need for a line powered cooling fan.

2. Mechanical Characteristics

a. Integral Horsepower Motor Construction

1) Motor frames for horizontal motors shall be cast iron, heavy fabricated steel, or cast aluminum (alloy 356 or 360). A steel insert ring shall be set into the aluminum alloy endshield when cast to minimize wear of the bearing support. **Aluminum alloy motors shall not be used in areas where exposed to chlorine gas.**

2) Motor frames for vertical motors shall be cast iron, heavy fabricated steel, or extruded aluminum (alloy 6063-T4 or 6063-T6). Endshields for vertical motors **must** be cast iron.

3) If an aluminum frame is used, the endshields and/or all other steel hardware must be plated with zinc or cadmium and coated with grease before assembly to minimize the galvanic action between the steel and aluminum.

4) Motor frames and endshields shall be of such design and proportions as to hold all motor components rigidly in proper position and provide adequate protection for the type enclosure employed. Lifting lugs of all motors shall conform to NEMA standards.

5) Windings shall be random or form wound, adequately insulated and securely braced to resist failure due to electrical stresses and vibration. If the windings are aluminum, there shall be a cold welded aluminum-copper transition joint at the termination of the windings to permit the use of standard copper to copper connection techniques by the electrician and to prevent galvanic action between the copper power wires and the aluminum windings.

6) The motor shaft shall be made of high grade machine steel or steel forging of size and design adequate to withstand the load stresses normally encountered in motors of that particular rating. Bearing journals shall be ground and polished.

7) Rotors shall be made from high grade steel laminations adequately fastened together and to the shaft. Rotor cage windings may be cast aluminum of bar type construction with brazed end rings.

8) Integral horsepower motors shall be equipped with cone, roller, or ball bearings made to AFBMA standards, Grade 1 and shall be of ample capacity for the motor ratings. The bearing housing shall be large enough to hold sufficient lubricant to minimize the need for frequent relubrication (ten years normal operation without lubrication), but facilities shall be provided for adding new lubricant and draining out old lubricant without motor disassembly. The bearing housing shall have long, tight running fits or rotating seals to protect against the entrance of foreign matter into the bearings or leakage of lubricant out of the bearing cavity.

9) See the specification division relating to each piece of motor driven equipment for additional motor requirements to those listed above.

b. Fractional Horsepower Motor Construction

1) Motor and shell shall be rigid welded steel designed to maintain accurate alignment of motor components and provide adequate protection. End shields shall be reinforced, lightweight, die cast aluminum. Windings shall be of varnish insulated wire with slot insulation of polyester film and baked on bonding treatment to make the stator winding strongly resistant to heat, aging, moisture, electrical stresses, and other hazards. Motor shafts shall be made from high grade, cold rolled, shaft steel with drive shaft extensions carefully machined to

standard NEMA dimensions for shaft coupled drive connection. Bearings shall be carefully selected precision ball bearings with extra quality, long life grease and large reservoir providing 10 years normal operation without relubrication, AFBMA Grade 1.

c. Submersible Motor Construction

1) See Equipment Specifications.

3. Tests, Nameplates, and Shop Drawings

a. Tests

1) Tests shall be required on integral horsepower motors only. A factory certified test report of "electrically duplicate motors previously tested" shall be supplied on all motors under 200 horsepower. The test shall be certified by the factory and shall contain a statement to the effect that complete tests affirm the guaranteed characteristics published in the manufacturer's catalogs or descriptive literature.

2) Tests will be in accordance with IEEE test procedures.

b. Nameplates

1) Each motor shall have a permanently affixed nameplate of brass, stainless steel, or other metal of durability and corrosion resistance. The data contained on the nameplate shall be in accordance with NEMA standards.

c. Shop Drawings

1) Shop Drawings shall consist of motor dimensions, nameplate data from each motor and tests as outlined above. Also included shall be efficiency and power factor at 100, 75, and 50 percent load. Operation, maintenance, and lubrication information (including bearing catalog numbers) shall be submitted with Shop Drawings for review.

4. Efficiency Requirements

a. The following motor full load efficiency requirements shall be met as a minimum for totally enclosed 3 phase integral horsepower motors, per NEMA test methods:

Horsepower	Nominal 3600 RPM (Minimum %)	Nominal 1800 RPM (Minimum %)	Nominal 1200 RPM (Minimum %)
1	75.5	82.5	80.0
1.5	82.5	84.0	85.5
2	84.0	84.0	86.5
3	85.5	87.5	87.5
5	87.5	87.5	87.5
7.5	88.5	89.5	89.5
10	89.5	89.5	89.5
15	90.2	91.0	90.2
20	90.2	91.0	90.2
25	91.0	92.4	91.7
30	91.0	92.4	91.7
40	91.7	93.0	93.0

Horsepower	Nominal 3600 RPM (Minimum %)	Nominal 1800 RPM (Minimum %)	Nominal 1200 RPM (Minimum %)
50	92.4	93.0	93.0
60	93.0	93.6	93.6
75	93.0	94.1	93.6
100	93.6	94.5	94.1
125	94.5	94.5	94.1
150	94.5	95.0	95.0
200	95.0	95.0	95.0

Open Motors where specified shall also comply with NEMA efficiency minimums.

b. Motors shall be energy efficient type to comply with NEMA Premium specification.

PART 3 - EXECUTION

3.01 INSTALLATION/APPLICATION/ERECTION

A. Installation of motors shall comply with motor manufacturer's instructions as well as applicable NEMA recommendations and requirements of the driven equipment OEM (original equipment manufacturer).

B. Motors shall be aligned to acceptable tolerances and shall not vibrate excessively.

C. Motors shall not be energized until they have been accepted by the OEM start up personnel.

END OF SECTION

SECTION 16225 - ELECTRIC VALVE & GATE ACTUATORS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide valve & gate actuators as indicated on the Contract drawings and as specified herein. The actuators shall be factory-installed onto the valves/gates and tested and shall be shipped as a complete assembly.

1.02 RELATED WORK

A. Division 15 - Valves

1.03 SUBMITTALS

A. Shop drawing approval is required. Valve and actuator submittal shall be combined into a single submittal. Include complete wiring diagrams and electrical information.

B. Operation and Maintenance Manuals shall be submitted.

1.04 QUALITY ASSURANCE

A. Actuators shall comply with AWWA C540.

1.05 WARRANTY AND SERVICE

A. Minimum one-year warranty is required on all actuators from the date of substantial completion. Provide extended warranty if necessary to meet this date requirement.

1.06 TRAINING

A. Provide one 4-hour training class on actuator operation, maintenance, & troubleshooting, for each type of actuator provided.

PART 2 - PRODUCT

2.01 MANUFACTURERS

A. Acceptable manufacturers for motorized actuators shall be Limitorque, EIM, Auma, or equal.

2.02 ACTUATOR CONSTRUCTION

A. Actuators shall consist of an electric motor, worm gear reduction, electronic torque sensor, mechanically and electrically interlocked reversing motor contactor, electronic control, protection, and monitoring package, manual override handwheel, valve interface bushing, LCD (Liquid Crystal Display), and local control switches. Actuator design life shall be at least one million drive sleeve turns.

B. Actuator Housing: Actuators installed above grade shall be NEMA 4X. Actuators installed below grade shall be NEMA 6 & IP-68 rated to 15 meters for 96 hours. Actuators proposed for hazardous areas (as indicated on the Drawings) shall be FM certified for the indicated hazardous area.

C. Actuators indicated as two-position actuators shall have limit switches to indicate position status. Modulating actuators shall have an absolute position encoder and shall accept 4-20mA input position control signal and shall generate a 4-20mA position feedback signal.

D. The power transmission shall be completely bearing-supported, and consist of a hardened alloy steel worm and bronze alloy worm gear; oil-bath lubricated using synthetic oil designed specifically for extreme pressure worm and worm gear transmission service.

E. The actuator voltage rating shall be as indicated on the Drawings. If the voltage is not indicated on the Drawings, the actuator shall be 120V single phase for valves 16" and less, and 208-230/460V three phase for valves over 16" in diameter. The motor shall have Class F insulation and a thermistor embedded within the motor windings to prevent damage due to overload. The motor shall be easily removed through the use of a plug-in connector and shaft coupling. Valve motors shall be listed for continuous duty operation.

F. An electronic torque sensor shall be included. The torque limit may be adjusted from 40-100% of rating in 1% increments. The motor shall be deenergized if the torque limit is exceeded. A boost function shall be included to prevent torque trip during initial valve unseating and during extreme arctic temperature operation (-50°C), and a "Jammed Valve" protection feature, with automatic retry sequence, shall be incorporated to de-energize the motor if no movement occurs.

G. A Phase Correction circuit shall be included to correct motor rotation faults caused by incorrect site wiring. The phase correction circuit shall also detect the loss of a phase and disable operation to prevent motor damage. The monitor relay shall trip and an error message shall be displayed on the LCD screen when loss of phase occurs and indicate the fault for Remote operation.

H. A monitor relay shall be included and shall trip when the actuator is not available for remote operation. Both N/O and N/C contacts shall be included, rated 125VAC, 0.5A and 30VDC, 2 amps. The monitor relay shall be configurable for three additional fault indications; lost phase, valve jammed, and motor overtemp. The yellow LED shall blink when the monitor relay is active.

I. A padlockable LOCAL-STOP-REMOTE switch and an OPEN-CLOSE switch shall be included for local valve actuator control. The control switches shall not penetrate the controls cover and shall be designed to electrically isolate the actuator's internal components from the external environment. The OPEN-CLOSE switch may be configured for maintained or push-to-run (inching) control.

J. Double sealed terminal compartment & Terminal block - All customer connections shall be located in a terminal chamber that is separately sealed from all other actuator components. Site wiring shall not expose actuator components to the environment.

K. Coatings - The actuator shall be coated with a polymer powder coat. The coating system shall be suitable for an ASTM B117 salt spray test of 1500 hours. External fasteners shall be stainless steel or high-strength carbon steel that has been chromate-hexavalent coated, and then top coated with a high-strength, high-endurance polymer. The fasteners shall be suitable for an ASTM B117 salt spray test of 500 hours.

L. A handwheel and declutch lever shall be provided for manual operation. The handwheel shall not rotate during electric operation nor can a seized motor prevent manual operation. Changing from motor to manual operation is accomplished by engaging the declutch lever. Energizing the motor shall return the actuator to motor operation. The lever to enable the declutch shall be padlockable to permit motor operation only.

M. The actuator shall include a removable torque or thrust bushing to mate with the valve shaft.

N. Factory testing - Every actuator shall be factory tested to verify: rated output torque, output speed, handwheel operation, local control, control power supply, valve jammed function, all customer inputs and outputs, motor current, motor thermistor, LCD and LED operation, direction of rotation, microprocessor checks, and position-sensor checks. A report confirming successful completion of testing shall be included with the actuator.

O. Communications: Fieldbus communications are not required on this project.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install the valve and actuator per manufacturer's instructions.

B. Test to ensure proper operation.

C. For modulating actuators – tune control loops to achieve stable operation with reasonable response time and accurate setpoint control.

END OF SECTION

SECTION 16280 – SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.01 REQUIREMENTS

A. The Contractor shall furnish, install, and place in satisfactory operation, the surge protective devices (SPD) as specified herein.

B. Surge protective devices shall be provided as a stand-alone unit, separate from the enclosure of the equipment to which they are connected or as integrally mounted devices as noted on the Contract Drawings.

1.02 CODES AND STANDARDS

A. The surge protective device shall be designed, manufactured, and listed to the following standards:

1. Underwriters Laboratories, Inc. (UL)

   a. UL1449 3rd Edition: Surge Protective Devices

   b. UL1283 5th Edition: Electromagnetic Interference Filters

2. American National Standards Institute (ANSI)/Institute of Electrical & Electronic Engineers (IEEE)

   a. C62.41.1: 2002 Guide for Surge Voltages in Low-Voltage AC Power Circuits

   b. C62.41.2: 2002 Recommend Practice on Characterization of Surges in Low Voltage (100V and Less) AC Power Circuits.

   c. C62.45: 2002 IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000V and Less) AC Power Circuits

   d. C62.62: 2000 IEEE Standard Test Specifications for Surge Protective Devices for Low Voltage (1000V and Less) AC Power Circuits

3. National Electric Code (NEC), Latest Edition

1.03 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Witnessed Shop Tests

   a. None required.

2. Certified Shop Tests and Reports

   a. Standard factory tests shall be performed on the equipment under this section. All tests shall be in accordance with the latest version of NEMA, ANSI, and UL standards.

   b. All surge protective devices, subassemblies, and components shall be 100% tested and certified by the manufacturer to meet their published performance parameters.

3. Field Tests

   a. None required.

1.04 SUBMITTALS

A. The Contractor shall obtain from the equipment manufacturer and submit the following per Section 01300:

1. Shop Drawings
2. Operation and Maintenance Manuals
3. Spare Parts List
4. Special Tools List
5. Reports of ShopTests

1.05 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for re-submittal.

C. Drawings submitted by the manufacturer shall be complete and documented to provide the Owner with operations and maintenance capabilities.

D. Shop drawings for each SPD shall include but not be limited to:

1. Product Data Sheets.
2. Detailed drawings showing weights and dimensions.
3. Wiring diagrams showing field connections.
4. Proof that all products provided under this Section are UL listed and labeled by Underwriters Laboratories to UL1449 3rd Edition. This proof shall be a copy of the data listed under the UL File Number for the manufacturer, which may be obtained from the UL Online Certification Directory. No other means of proving compliance (such as manufacturer data sheets, marketing material, etc) will be considered acceptable.
5. Proof of Short Circuit Current Ratings (SCCR), Voltage Protection Ratings (VPRs) for all modes, Maximum Continuous Operating Voltage rating (MCOV), Nominal Discharge Current (In), and device listing Type shall be submitted using the same means as described in the paragraph above.
6. Proof that all products provided under this Section are UL listed and labeled by Underwriters Laboratories to UL 1283 5th Edition. This proof shall be a copy of the data listed under the UL File Number for the manufacturer, which may be obtained from the UL Online Certification Directory. No other means of proving compliance (such as manufacturer data sheets, marketing material, etc) will be considered acceptable.
7. Warranty Information

E. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "Soft Cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are to provide are acceptable and shall be submitted.

1.06 OPERATION AND MAINTENANCE MANUALS

A. The Contractor shall submit operation and maintenance manuals.

1.07 TOOLS, SUPPLIES, AND SPARE PARTS

A. The SPDs and accessories shall be furnished with all special tools necessary to disassemble, service, repair, and adjust the equipment. All spare parts as recommended by the equipment manufacturer shall be furnished by the Contractor to the Owner.

B The Contractor shall furnish one (1) spare field replacement module of each rating provided under this Contract.

C. The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.

D. Spare parts shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such spare parts until completion of the Work, at which time they shall be delivered to the Owner.

E. Spare parts lists, included with the shop drawing submittal shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.

F. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same part number.

1.08 IDENTIFICATION

A. Each SPD shall be identified by equipment name. A nameplate shall be securely affixed in a conspicuous place on each SPD.

1.09 TRAINING

A. The Contractor shall provide training for Owner personnel. Training shall be conducted by the manufacturer's factory trained specialists who shall instruct Owner personnel in operation and maintenance of all equipment provided under this Section. The training shall also include an overview of current SPD standards, as well as basic SPD operation and maintenance.

B. Provide the services of an experienced, factory trained technician or service engineer of the SPD manufacturer at the jobsite for minimum of 1/2 day for training of Owner personnel, beginning at a date mutually agreeable to the Contractor and the Owner.

1.10 WARRANTY

A. All SPDs, associated hardware, and supporting components shall be warranted to be free from defects in materials and workmanship, under normal use and in accordance with the instructions provided, for a period of five (5) years after acceptance of the equipment by the Owner.

B. Any component or subassembly contained within the surge protection system that shows evidence of failure or incorrect operation during the five (5) year warranty period, shall be replaced and reinstalled by the manufacturer at no additional cost to the Owner.

PART 2 - PRODUCTS

2.01 GENERAL

A. The SPD shall be UL 1449 3rd Edition Listed and must bear the 3rd Edition mark. Units that are "manufactured in accordance with" UL 1449 3rd Edition or tested by other testing agencies "in accordance with" UL 1449 3rd Edition are not acceptable and will be rejected.

B. The SPD shall be UL 1283 5th Edition Listed and must bear the UL mark. Units that are "manufactured in accordance with" UL 1283 5th Edition or tested by other testing agencies "in accordance with" UL 1283 5th Edition are not acceptable and will be rejected. Further, SPD units using UL 1283 capacitors but not tested to UL 1283 will be rejected.

C. SPDs shall be provided as a stand-alone unit, separate from the equipment to which they are connected.

D. All SPDs furnished and installed under this Contract shall be from the same manufacturer.

2.02 PRODUCTS

A. Type I surge protective devices (SPD) shall be furnished and installed. Type II SPDs are not acceptable.

B. Each SPD shall be rated for the voltage and configuration of the equipment to which it is connected.

C. Each SPD shall have UL 1283 5th Edition EMI/RFI filtering with minimum attenuation of -50dB at 100kHz.

D. The short circuit current rating of each SPD shall match or exceed the rating of the equipment to which it is connected. The Contractor shall reference the Pump Station Schedule for short circuit current rating of each piece of equipment.

E. Each SPD system shall provide surge protection in all possible modes. Surge protection shall be as follows:

SYSTEM CONFIGURATION	MODES OF PROTECTION	NUMBER OF MODES
3-Phase Wye	L-N, L-G, N-G	7
3-Phase Delta	L-L, L-G	6
3-Phase Impedence Grounded	L-L, L-G	6
Single-Phase	L-N, L-G, N-G	3

F. Each SPD shall have a Maximum Continuous Operating Voltage (MCOV) of at least 115% of the nominal voltage of the equipment to which it is connected.

G. The Nominal Discharge Current (I_n) of each SPD shall be 20kA. Peak surge current ratings shall not be used as a basis for applying the SPD to the system.

H. The Voltage Protection Rating (VPR) of each SPD shall not exceed the following:

SYSTEM VOLTAGE	L-N	L-G	L-L	N-G
208Y/120	700V	700V	1200V	700V
480Y/277	1200V	1200V	1800V	1200V
480 DELTA	N/A	1200V	2000V	N/A
240 DELTA	N/A	1200V	1200V	N/A
120/240	700V	700V	1200V	700V

I. The surge current rating for each SPD shall be as indicated on the Contract Drawings. Surge current rating indicated is on a per phase basis.

J. Each SPD shall be provided in an enclosure to match or exceed the NEMA rating of the equipment enclosure that it is serving (i.e. NEMA1, NEMA 12, NEMA 4X, etc).

K. Each SPD shall be provided with the following accessories:

1. Each individual module shall feature an LED indicating the individual module has all surge protection devices active. If any single component is taken off-line, the LED shall turn off and another LED shall illuminate, providing individual module as well as total system status indication.

2. Surge counter and audible alarm with reset/silence switch.

3. One set of Form C (SPDT) dry contacts rated for at least 5A at 120VAC.

L. SPDs shall be as manufactured by Eaton Electrical, Thor Systems, Advanced Protection Technologies (APT), or LEA International.

2.03 CABINET/CONTROL PANEL SPD

A. The SPD shall be a Din-Rail-Mounted device and shall be installed to protect the equipment in the cabinet from harmful surges and voltage spikes. The SPD shall have a SPDT contact rated for 250 VAC, 1 amp used for remote indication/visual indicator of circuit integrity.

B. It shall have a surge handling capacity of 10kA (8/20microsecond) minimum. It shall have hybrid technology for "fine" voltage clamping and "coarse" surge current handling. The clamping voltage shall be less than or equal to 500V. The response time shall be less than or equal to 25 nanoseconds.

C. The device shall be a Phoenix Contact "Valvetrab" or equal.

2.04 INPUT/OUTPUT SPD

A. Analog I/O SPD

1. The Din-Rail-Mounted surge protection device shall be installed to protect the analog I/O.

2. The device shall have a surge handling capacity of 20kA (8/20microsecond) minimum. It shall have hybrid technology for "fine" voltage clamping and "coarse" surge current handling. The clamping voltage shall be less than or equal to 40V (Conductor to conductor) and 450V (conductor to ground). The response time shall be less than or equal to 1 nanosecond (conductor to conductor) or 100 nanoseconds (conductor to ground). The resistance of the device shall be no more than 2.2 ohms.

3. The device shall be suitable for din-rail mounting, and shall be no more than 17.5 mm thick.

4. The device shall be suitable for use on a 4-20mA analog circuit with 28VDC continuous operating voltage and up to 450mA continuous current.

5. The device shall be a Phoenix Contact "MCR-Plugtrab PT" surge protection device, or equal.

B. Digital 24VDC I/O SPD

1. The SPD shall be DIN-rail-mountable and shall be installed to protect the digital 24VDC I/O.

2. The device shall have a surge handling capacity of 10kA (8/20microsecond) minimum. It shall have hybrid technology for "fine" voltage clamping and "coarse" surge current handling. The clamping voltage shall be less than or equal to 42VDC. The response time shall be less than or equal to 25 nanoseconds. The resistance of the device shall be no more than 4.7 ohms.

4. The device shall be suitable for use on 24VDC circuit with up to 300mA continuous current.

5. The device shall be a Phoenix Contact "MCR-Plugtrab PT" surge protection device, or equal.

C. Digital 120VAC I/O SPD

1. The SPD shall be DIN-rail-mountable and shall be installed to protect the digital 120VAC I/O.

2. The device shall have a surge handling capacity of 10kA (8/20microsecond) minimum. It shall have hybrid technology for "fine" voltage clamping and "coarse" surge current handling. The clamping voltage shall be less than or equal to 600V. The response time shall be less than or equal to 25 nanoseconds.

4. The device shall be suitable for use on a 120VAC circuit with up to 26A continuous current.

5. The device shall be a Phoenix Contact "MCR-Plugtrab PT" surge protection device, or equal.

2.05 INSTRUMENTATION SPD

A. Local Surge Protection Device for Analog 4-20mA loops.

1. The local surge protection device shall be installed at the location of the instrument it is protecting.

2. The device shall have a surge handling capacity of 10kA (8/20microsecond) minimum. It shall have hybrid technology for "fine" voltage clamping and "coarse" surge current handling. The clamping voltage shall be less than or equal to 40V (Conductor to conductor) and 450V (conductor to ground). The response time shall be less than or equal to 1 nanosecond (conductor to conductor) or 100 nanoseconds (conductor to ground). The resistance of the device shall be no more than 10 ohms.

3. The device shall be Class 1, Div. 2 certified under UL1604 if it is located in a hazardous area as indicated on the Contract drawings.

4. The device shall be housed in a stainless steel pipe stub or similar for installation on a field-mounted conduit body. Temperature range shall be –40°C to 80°C.

5. The device shall be suitable for use on a 4-20mA analog circuit with 28VDC continuous operating voltage and up to 270mA continuous current.

6. The device shall be a Phoenix Contact "Pipetrab" surge protection device, or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The SPD units shall be furnished and installed in accordance with the manufacturer's installation instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

B. The SPD units shall be mounted such that the conductor lengths are as short as possible, but no greater than 36 inches. Any installation resulting in a conductor length of greater than 36 inches shall be reviewed with the Engineer as a special type of cable may need to be installed. For equipment such as panelboards, the Contractor shall relocate the circuit breaker that is to be connected to the SPD as needed to achieve the shortest conductor length possible.

C. The Contractor shall use a close nipple to enclose the conductors between the SPD and the equipment served. However, if due to field conditions a 90 degree conduit bend is required to connect the SPD to the equipment that it serves, the bend shall have a minimum radius of 36 inches to eliminate any potential for sharp bends in the conductors.

D. Conductors between the equipment served and the SPD shall be 600V power wire and cable as specified in Section 16120 – Conductors and Cables. The individual conductors shall be gently twisted.

E. Prior to energizing, the Contractor shall verify that the SPD unit voltage and configuration is suitable for the system to which it is connected.

F. Prior to energizing, the Contractor shall also verify that any Neutral to Ground bonding jumpers are installed as required.

G. Prior to energizing, the Contractor shall also verify that the impedence of the equipment grounding conductor between the SPD and the grounding electrode system is less than 1 ohm.

3.02 CABINET TVSS

A. Provide a Cabinet TVSS on all single phase control panels, SCADA and electronic cabinets, and all other equipment with solid-state circuitry.

3.03 INPUT/OUTPUT SPD

A. Provide SPDs on each analog and digital I/O termination in the cabinet.

3.04 INSTRUMENTATION SPD

A. Provide a local surge protection device at the instrument for all instruments mounted outside of the electrical building.

B. Provide a Din-rail-mounted surge protection device at the I/O cabinet termination on each 4-20mA loop and 24VDC instrumentation power supply circuit if the circuit extends beyond the perimeter of the electrical building.

END OF SECTION

SECTION 16440 - MOTOR CONTROL

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Contractor shall furnish and install motor control equipment as specified herein and as shown on the Drawings.

1.02 SUBMITTALS

A. Motor control equipment shall be new and the equipment of one manufacturer. Each component is specified by a particular trade name; however, this does not relieve the Contractor of the responsibility of submitting descriptive literature and Shop Drawings for review of all components. Motor control shall be the same brand as power distribution equipment on projects with both.

B. Shop drawings, including layout drawings, complete schematic and composite wiring diagrams, control circuit wiring diagrams and descriptive literature shall be submitted to the Engineer for review. Service manuals shall be submitted on all equipment and shall be bound in 3-ring looseleaf binders. The manuals shall also include information on accessories such as timers, etc., built in the control center.

1.03 SERVICE OF MANUFACTURER'S REPRESENTATIVE

A. The Contractor shall provide the services of a qualified manufacturer's technical representative who shall adequately supervise the installation and testing of all equipment furnished under this Contract and instruct the Contractor's personnel and the Owner's operating personnel in its maintenance and operation as outlined elsewhere in Division 1. The services of the manufacturer's representative shall be provided for a period of not less than as follows:

1. One trip of one (1) working day during installation of the equipment for each motor control center.

2. One trip of one (1) working day after acceptance of the equipment.

3. One trip of one (1) working day during the warranty period.

B. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor. The manufacturer's representative shall sign in and out at the office of the Engineer's Field Representative on each day he is at the project.

1.04 TRAINING

A. The Contractor shall provide training for Owner personnel. Training shall be conducted by the manufacturer's factory trained specialists who shall instruct Owner personnel in operation and maintenance of all equipment provided under this Section.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Control Equipment

1. "Square D", "Cutler Hammer", "Allen Bradley", or equal.

B. Timers

1. "Paragon", "Tork", "Intermatic", or equal.

2.02 MOTOR CONTROL CENTERS (MCC)

A. General

1. Quality of built-in transformers, starters, lighting panelboards, timers, etc. shall be as written elsewhere in this Division unless otherwise noted.

2. Motor Control Center(s) shall consist of one or more enclosed vertical sections joined together to form a rigid, free standing assembly. The construction of the Motor Control Center shall meet the requirements set forth by Underwriters' Laboratories publication UL-845, NEMA publication number ICS-2-322, the National Electrical Code, and color coded.

3. The structure shall be UL listed and labeled as service equipment if applicable. All sections shall bear UL labels.

4. Enclosures shall be NEMA 1 unless otherwise indicated, and each control center suitable for connection to an available fault current of 65,000 RMS symmetrical amperes unless otherwise indicated on the Drawings.

B. Construction

1. Vertical Sections

a. Vertical sections shall support the horizontal and vertical buses, combination starter units, covers and doors, and shall be designed to allow for easy rearrangement of units by the purchaser. Vertical sections shall have structural supporting members formed of a minimum of 13 gauge hot-rolled steel. All finished surfaces shall be blemish-free. Where needed, reinforcement structural parts shall be of 10-gauge steel to provide a strong rigid assembly. Each section shall be 90 inches high and shall have 7 gauge steel, 3 inch high removable lifting angle and two 1 1/2 inch high base channels. Complete control center line-ups shall be divided into shipping splits no wider than approximately 60 inches. The lifting angle shall be provided on the top of each shipping split and shall extend the entire width of the shipping split. Lifting angles shall be designed to support the entire weight of the MCC section. Base channels shall be provided with holes to permit bolting the Motor Control Center(s) to the floor. The entire assembly shall be constructed and packaged to withstand all stresses induced in transit and during installation.

b. Motor Control Centers shall be designed so that matching vertical sections of the same current rating and manufacture can be added later at either end of the line-up without use of transition sections and without difficulty or undue expense. Removable end closing plates shall be provided to close off openings on the end of the Motor Control Center line-up. A removable top plate shall be provided on each vertical section and shall be of one-piece construction for added convenience in cutting conduit holes. The design shall allow use of the standard conduit entrance area without significant sag or deformation of the top plate.

c. Vertical sections shall be designed to accommodate plug-on units in front-of-board or back-to-back construction as shown on Contract Drawings. Vertical sections housing plug-on units shall be 20 inches wide and shall be 20 inches deep. Wider sections will be permitted only for bolted connection type units not fitting the 20-inch wide sections. Unit mounting area shall be divided into 1/2 space factor divisions, each approximately 6 inches. NEMA Size 1 and 2 combination starter units shall use only 1 space factor, or 12 inches, of unit mounting space. Vertical sections shall allow for

7 space factors of unit mounting space. Removable blank plates shall cover all unused unit-mounting spaces. Blank plates shall be flanged on all 4 sides and shall be mounted with captive screws. Blank space shall be equipped for future use.

d. Vertical sections shall be provided with both horizontal and vertical wireways. Sufficient clearances shall be provided in the horizontal wireway so that no restriction is encountered in running wires from the vertical to horizontal wireway. Wireways shall be in accordance with the wireway sections contained in this document.

2. Horizontal Wireways

a. Horizontal wireways shall be provided in the top and bottom of each vertical section as indicated in the Contract Drawings and shall be arranged to provide full-length continuity throughout the entire assembly. The top horizontal wireway shall have a cross sectional area of not less than 20 square inches with openings between sections of not less than 11/2 square inches. The bottom horizontal wireway shall extend through the length and depth of the vertical sections and shall also be provided with openings of not less than 11/2 square inches to allow for full length continuity throughout the entire assembly. The bottom horizontal wireway height shall be not less than 9 1/4 inches. Covers for all wireways shall be equipped with captive type screws to prevent loss of hardware during installation. All wireways shall be isolated from the bus bars.

3. Vertical Wireways

a. A vertical wire trough shall be located on the right -hand side of each vertical section and shall extend from the top horizontal wireway to the bottom of the available unit mounting space. Each vertical wire trough shall have a cross sectional area of not less than 19 square inches and shall be isolated from the bus bars to guard against accidental contact. A separately hinged door having captive type screws shall cover the vertical wire trough to provide easy access to control wiring without disturbing control units.

b. Reusable wire ties shall be furnished in each vertical wire trough for the purpose of grouping and securely holding wires in place for a neat and orderly installation.

4. Busbars

a. A continuous main three-conductor horizontal bus shall be provided over the full length of the control center. A fully rated horizontal neutral bus (1200 ampere maximum) shall also be supplied over the full length of the Motor Control Center. When necessary, the bus shall be split to allow for ease in moving and handling. Splice bars will be supplied to join the bus wherever a split has been made. All splice connections shall be made with at least two bolts and shall employ the use of Belleville washers in the connection. Horizontal bus bars shall be mounted edgewise and supported by insulated bus supports.

b. For distribution of power from the main horizontal bus to each unit compartment, a three-phase vertical bus shall be provided. The vertical bus shall be firmly bolted to the horizontal bus for permanent contact.

c. The main horizontal and vertical buses shall be made of copper and the entire length shall be electrolytically tin plated to provide maximum protection to the bus bars from normal or adverse atmospheric conditions.

d. Bus supports shall be formed of high strength glass reinforced alkyd material. Bus supports shall have generous surface clearances in the vertical plane to shed dust and maintain dielectric integrity. Bus supports and insulators shall be red to indicate proximity of energized bus parts.

e. Horizontal and vertical buses shall have continuous current ratings adequate to handle all loads as shown on the one line diagram in the Contract Drawings. Continuous current ratings shall be in accordance with temperature rise specifications established by UL, ANSI, and NEMA standards.

f. A copper ground lug shall be provided in each incoming line vertical section capable of accepting a #8 to 250 MCM cable. A horizontal copper grounding bus shall be provided in each section of the Motor Control Center. Horizontal grounding bus shall run continuously throughout the control center except where splits are necessary for ease of shipment and handling in which case splice bars shall be provided. Grounding bus shall be tin plated copper and have a cross sectional area equal to 28% of the main horizontal bus cross sectional area. Horizontal ground bus shall be located at the bottom of the Motor Control Center.

5. Bus Barriers

a. Insulated horizontal and vertical bus barriers shall be furnished to reduce the hazard of accidental contact with the bus. Barriers shall have a red color to indicate proximity of energized buses. Vertical bus barriers shall have interlocking front and back pieces to give added protection on all sides and shall segregate the phases to reduce the possibility of accidental "flash over". Small, separate openings in the vertical bus barriers shall permit unit plug-on contacts to pass through and engage the vertical bus bars. Bottom bus covers shall be provided below the vertical bus to protect the ends of the bus from accidental contact with fish tapes or other items entering from the bottom of the enclosure.

b. Isolation of unused stab openings shall be accomplished by use of a manual shutter to close off the stab opening. These shutters shall be attached to the structure so that when they are removed (to allow a stab connection) they are retained in the structure and are readily accessible for use should a plug-in unit be removed from the motor control center.

6. Main Incoming Lug Compartment

a. A front accessible main lug compartment shall be provided with suitable main lugs to accommodate the number of cables per phase as indicated on the Contract Drawings. The compartment shall be located in the top most or bottom most unit space of the section to accommodate the user's cables entering the Motor Control Center as indicated on the Contract Drawings. The main incoming lug compartment shall be covered by a hinged door for maintenance access. This door shall be held closed with captive type screws to discourage unauthorized access. (A unit door padlock attachment shall also be provided to lock the door in the closed position with one 5/16 inch diameter shackle padlock. This attachment shall also accept a meter type seal.)

7. Units

a. Combination starter units shall consist of Size 1 minimum full voltage magnetic starters, autotransformer reduced voltage starters, molded case magnetic-only circuit breakers, and auxiliary control devices, as required and/or shown on the one-line and elementary diagrams. Pilot light assemblies (push-to-test) shall be 30 mm LED. All auxiliary equipment, except that which is specified for mounting on the door, shall be mounted within the compartment. All units shall be provided with unit doors, unit support pans, unit saddles and unit disconnect operators as outlined in this Specification. Each unit compartment shall be enclosed and isolated from adjacent units, buses and wireways except for openings for conductor entrance into units. Units shall be designed and constructed so that any fault will be localized within the

compartment. All units shall be UL listed for minimum of 65,000 amperes RMS symmetrical fault withstand ability unless otherwise indicated on the Drawings.

b. Plug-on combination starter units of the same NEMA size and branch feeder units of the same trip size shall be readily interchangeable with each other. It shall be possible to withdraw each plug-on unit to a de-energized position with the unit still being supported by the structure. It shall be possible to lock the unit in this position with one padlock.

c. Full voltage non-reversing combination starter units shall have the following minimum space factor requirements, shall be provided with plug-on connections and shall be provided with ample space for customer wiring room:

	Circuit Breaker Space Factor
Size 1	1
Size 2	1
Size 3	1 1/2
Size 4	2

8. Unit Plug-On

a. For convenient unit connection to bus bars, unit plug-on contacts shall be provided on the following units:

1) For circuit breaker type units; full voltage starters, size 4 and smaller; auto-transformer reduced voltage starters, size 4 and smaller; part winding reduced voltage starters, size 4PW and smaller; branch circuit units, 225 ampere and smaller.

b. The plug-on connection for each phase shall be of a high quality two- point connection and shall be designed to tighten around the vertical bus bar during a heavy current surge. For trouble-free connections, the plug-on fingers shall be silver plated and coated with a compound to assure a low resistance connection. Contact fingers shall be of a floating and self-aligning design to allow solid seating onto the vertical bus bars.

c. Starters NEMA size 4 and larger shall bolt directly to the vertical bus bars, circuit breakers rated higher than 225 amps shall also bolt directly to the bus bars.

9. Unit Doors

a. Each unit shall have a door securely mounted with rugged concealed-type hinges which allow the door to swing open a minimum of 112° for unit maintenance and withdrawal. Doors shall be fastened to the structure so that they remain in place when a unit is withdrawn and may be closed to cover the unit space when the unit has been temporarily removed. Doors shall be held closed with captive type screws which engage self-aligning cage nuts. These screws shall provide at least two threads of engagement to hold doors closed under fault conditions. Each unit door shall be interlocked with its disconnect mechanism to prevent the door from opening when the unit is energized. A defeater mechanism shall be provided for defeating this interlock by authorized personnel. Removable door panels held with captive type screws shall be provided on starter unit doors for mounting push buttons, selector switches or pilot lights. Blank door panels capable of accepting future pilot devices shall be furnished when pilot devices are not originally specified for starter units. Each starter unit door shall house an external low-profile overload reset button for resetting the overload relay in the event of tripping.

10. Unit Support Pan

a. Each plug-on unit shall be supported and guided by a tilt and lift-out removable pan so that unit rearrangement can be easily accomplished. For easy unit installation and rearrangement, transfer of this unit support pan from one location to another shall be accomplished with ease after the control unit and door have been removed.

11. Unit Saddles

a. Each plug-on unit shall have a saddle of 14 gauge hot rolled steel designed and constructed to physically isolate the unit from the bus compartment and adjacent units. Saddlers shall be equipped with captive, self-aligning mounting screws which shall hold the unit securely in place during shipment. Flanged edges shall be provided on each saddle to facilitate unit removal.

12. Disconnect Operators

a. An external operator handle shall be supplied for each switch or breaker. This mechanism shall be engaged with the switch or breaker at all times regardless of unit door position to prevent false circuit indication. The operator handle shall be color coded to display red in the "ON" position and black in the "OFF" position. The operator handle shall have a conventional up-down motion and shall be designed so that the down position will indicate the unit is "OFF". For added safety it shall be possible to lock this handle in the "OFF" position with up to three padlocks. The operator handle shall be interlocked with the unit door to prevent switching the unit to "ON" while the unit door is open. A defeater mechanism shall be provided for the purpose of defeating this interlock by a deliberate act of an electrician should he desire to observe the operation of the operator handle assembly or the unit components. Operators shall not be higher than 6'-6" above finished floor elevation, as installed.

13. Wiring

a. The motor control center wiring shall be NEMA Class II, Type B.

b. All wiring to the terminal strips from outside the MCC shall be made with spade type terminals of the proper size and rating for the wire used. Pull apart terminal blocks shall be provided in unit spaces of motor starters that contain field wiring energized from a remote source to comply with NEC Article 430-74.

c. All control wiring shall be No. 14 AWG (minimum) labeled at each end in accordance with the wiring numbers shown on the accepted shop drawings. Power wiring shall be sized to suit the maximum horsepower rating of unit; No. 12 AWG (minimum). Wiring shall be type MTW rated for 105 ☐C. Wire color and black for power. Wire numbers shall not be repeated in a motor control center.

14. Finish

a. The finish shall be manufacturer's standard gray enamel applied over a rust inhibiting phosphate primer.

15. Optional Modifications and Accessories

a. Additional modifications and accessories shall be as listed and specified on the Contract Drawings.

16. Identification

a. A control center identification nameplate describing section catalog numbers and characteristics shall be fastened on the vertical wire trough door of every section.

Each control center unit shall have its own identification nameplate fastened to the unit saddle. These nameplates shall have suitable references to factory records for efficient communication with supplier. Each control center unit shall also have an engraved Bakelite nameplate fastened to the outside of each unit door inscribed as written on the Contract Drawings for ease in identification and for making changes when regrouping units. An overall structure nameplate is also required.

17. Metering

    a. All voltmeters, ammeters, wattmeters, current transformers, potential transformers and phase selector switches shall be furnished as shown on the Contract Drawings. Meter accuracy shall be ± 1 percent. Solid state metering shall be as specified this section.

18. Surge Protective Devices

    a. Specification Section 16280 – Surge Protective Devices for motor control center SPD requirements.

C. Starters and Overcurrent Protective Devices

1. Magnetic Starters

    a. Magnetic starters shall be furnished in all combination starter units unless otherwise indicated on Contract Drawings. Starter Sizes 1 through 4 shall employ the use of a bell-crank lever design to transform vertical action of the armature into horizontal action of the contact carriers and thus minimize contact bounce and produce extra long contact life. Thermal overload relays on starters shall be ambient temperature compensated bimetallic type with selector for either auto or manual reset. Overload heater units shall be provided in each starter unit. Overload relay heater schedules shall be provided on each starter unit.

2. Circuit Breakers

    a. Type FA, KA, LA, MA and PA molded case circuit breakers shall be furnished in all starter and branch feeder units using circuit breakers as a disconnect means. All circuit breakers will have a push-to-trip test feature for testing and exercising the circuit breaker trip mechanism.

3. Starters shall conform to requirements listed under individually mounted Motor Control Devices, hereinafter.

D. Lighting Panelboards

1. Lighting panelboards shall be as specified in other section of this Division. Lighting panelboard unit doors shall be held closed with captive latches that may easily be operated without the use of tools, i.e., wing nuts, handle, etc.

E. Transformers

1. 480 volt primary, 120/240 volt or 120/208 volt secondary transformers shall be as specified in other sections of this Division.

F. Electronic Circuit Monitors

1. Circuit Monitor Installation

    a. Electronic circuit monitors shall be installed by the equipment manufacturer for all circuits as indicated on the Contract Drawings.

b. All control power, CT, PT, and communications wire shall be factory installed and harnessed within the lineup.

c. Where external circuit connections are required, terminal blocks shall be provided and the manufacturer's shop drawings must clearly identify the interconnection requirements, including wire type, to be used.

d. This equipment shall be Square D Power Logic, Eaton, General Electric, or equal.

2. Circuit Monitor Characteristics

a. The electronic circuit monitors shall accept inputs from industry standard instrument transformers (120 VAC secondary PTs and 5A secondary CTs).

b. The current and voltage signals shall be digitally sampled at a rate high enough to provide accurate rms sensing and valid data for waveform analysis beyond the 30th harmonic (fundamental of 60 Hz).

c. All setup parameters required by the circuit monitors shall be stored in nonvolatile memory (no battery backup) and retained in the event of a control power interruption.

d. The circuit monitor shall also maintain, in nonvolatile memory, a maximum and minimum value for each of the instantaneous values reported, as well as the time and date of the highest peak for all of the peak demand readings.

e. The circuit monitors shall be equipped with an integral LED display to provide local access to metered quantities.

f. The following instantaneous readings shall be reported by the circuit monitor:

1) Frequency
2) Temperature
3) Current, per phase rms
4) Current, 3-phase average rms
5) Current, apparent rms
6) Voltage, phase-to-phase & phase-to-neutral
7) Power factor, per phase
8) Power factor, 3-phase total
9) Real power, 3-phase total
10) Reactive power, 3-phase total
11) Apparent power, 3-phase total
12) Total Harmonic Distortion

g. The following demand readings shall be reported by the circuit monitor:

1) Average demand current, per phase
2) Peak demand current, per phase
3) Average demand, real power
4) Predicted demand, real power
5) Peak demand, real power

h. The following energy readings shall be reported by the circuit monitor:

1) Accumulated energy
2) Accumulated reactive energy

3. Waveform Capture Capability

a. All electronic circuit monitors shall include waveform capture capability.

b. Upon a user-initiated command, the circuit monitor shall capture and store, in nonvolatile memory, 3-phase voltage and current samples consisting of 256 data points each.

c. These data points shall represent at least four cycles of each current or voltage waveform.

d. These samples shall be evenly gathered from three voltage and three current phases such that the original power signals with proper magnitude and phase relationships may be reconstructed.

e. It shall be possible to recreate the original power signal from the stored data with sufficient accuracy such that steady-state power harmonic analysis will provide valid information on harmonic content for up to the 30th harmonic of the fundamental power frequency.

4. Connecting and Networking Circuit Monitors

a. An Ethernet port shall be included with Ethernet/IP or Modbus TCP protocol.

5. System Display

a. The circuit monitor shall include an LED readout which will allow local display of the following electrical parameters:

1) Current, per phase rms
2) Voltage, phase-to-phase & phase-to-neutral
3) Real power, 3-phase total
4) Reactive power, 3-phase total
5) Apparent power, 3-phase total
6) Power factor, 3-phase total & per phase
7) Frequency
8) Peak demand current, per phase
9) Peak demand, real power
10) Accumulated Energy, (MWH and MVARH)
11) Total harmonic distortion

b. Reset of the following electrical parameters shall also be allowed from the front of the circuit monitor:

1) Peak demand current
2) Peak demand power
3) Energy (MWH)
4) Reactive energy (MVARH)

c. Circuit monitor setup for system requirements shall be allowed from the front of the circuit monitor. Setup provisions shall include:

1) CT rating (xxxx:5)
2) PT rating (xxxx:120)
3) System type (3-wire and 4-wire)
4) Demand interval (5-60 min.)

d. All reset and setup functions shall be keyswitch-protected to prevent unauthorized/accidental changes.

e. System display units shall be installed by the manufacturer in the equipment as indicated on the drawings.

f. The system display units shall be flush mounted on door panels.

g. The system display unit shall utilize a 4-line by 20-character, high contrast LCD technology display with backlighting to provide high reliability and superior readability in all light conditions.

2.03 INDIVIDUALLY MOUNTED MOTOR CONTROL DEVICES (480, 240, OR 120 VOLT)

A. General

1. All motor control equipment shall be new and the product of 1 manufacturer. All individually mounted disconnects, push-button stations, latchout stations, starters, etc., indoors shall be mounted on a 1 inch galvanized unistrut, 1 inch Kindorf channel, or equal to provide an air space at rear. Outside mounted equipment shall utilize 1-inch aluminum strut as required in 16070.

B. Starters

1. General

a. All starters shall be of the voltage rating, type, and sized for the motor size shown in these Specifications and/or on the Contract Drawings. For enclosure type see the system operation description and/or the Contract Drawings. All starters shall be of the magnetic type. Should a piece of electrically driven equipment be furnished with a larger motor than shown on the Contract Drawings, the proper size combination starter shall be provided for the equipment supplied, at no extra cost to the Owner.

b. See the Contract Drawings for the auxiliary equipment to be furnished and/or Section 16900 - Controls of this division. Maximum control voltage shall be 120 volts, a-c. Minimum starter size shall be NEMA Size 1.

2. Overloads

a. Each starter shall have a thermal overload device in each ungrounded leg. The overload shall be of the "Ambient compensated Bi-metallic", thermal element type. All overloads shall be of the manual reset type and shall be reset without opening the starter enclosure. Heaters will be sized for the proper temperature rise of the motor that it is being used on. Heaters for general service shall be of the standard trip type. Adjustable Overload Relay Thermal Units are not allowed. All integral horsepower motors, 15 horsepower and over, require thermal elements embedded in the windings. See Motor Specifications, this division. Siemens-Allis overload relays shall be provided with a meter-sealed cover over relay adjustment controls.

3. Contactors

a. All contactors for motor starters shall be of the a-c magnetic type with "undervoltage" protection when used in conjunction with momentary contact push-button control and "undervoltage" release when used with maintained contact push-button control.

b. Contactor size shall be in accordance with NEMA Standards for the motor controlled and shall be horsepower rated. IEC rated equipment is not acceptable and shall be used as a basis for rejection of the equipment.

c. Contacts shall be of the heavy duty silver-to-silver type and shall be totally enclosed in individual arc quenching chambers. Contacts shall be easily accessible for replacement.

d. The contactor coil shall be of the vacuum impregnated or epoxy resin type, moisture resistant and corrosion proof.

C. Control Stations

1. General

a. Control stations shall be heavy duty, maintained or momentary contact type, as noted on the Contract Drawings. Contacts shall be silver alloy, double break type. The number and marking of controls shall be as shown on the Contract Drawings. Enclosures shall be NEMA 4X for indoor and outdoor mounting, unless otherwise noted on the Contract Drawings. All control stations shall operate on 120 volt, a-c maximum, unless otherwise designated on the Contract Drawings. "Latch-out" facilities shall be provided where called for in these Specifications and/or on the Contract Drawings.

2. Maintained Contact

a. Maintained contact control switches shall be marked "On" and "Off". The button pushed shall remain in and push the other button out until the other button is pushed. In general, they are to be used for hand control of motors which have to operate continuously and restart whenever power is off then resumed, without any manual operator. This is needed for motors which have to operate continuously in the absence of an operator.

3. Momentary Contact

a. Momentary contact control push-button switches shall be marked "start" and "stop". Pushbuttons shall spring out whenever pushed. If the circuit is dropped for any reason, operation cannot be resumed until a "start" push-button is pushed. In general, they are to be used for hand control of motors which are desired to operate intermittently in the presence of the operator and stop and start independently from more than one parallel control location.

D. Circuit Breakers

1. Circuit breakers shall be molded case type. Trip elements of multi-pole breakers shall be effectively insulated from one another. Multi-pole breakers shall be designed so that an overload on any one pole shall open all poles simultaneously.

2. The breaker operating mechanism shall be the quick-make, quick-break type and shall be entirely trip free to prevent the contacts being held in a closed position against a short circuit.

3. Breakers not used with motor starters shall be of the thermal magnetic type with a thermal bimetallic element for time delayed overload protection and a magnetic element for short circuit protection.

4. The breaker shall be trip indicating with the trip position midway between the "On" and "Off" positions.

5. Breakers for combination starters shall be 100 amp frame or larger. All breakers for combination starters shall have an adjustable magnetic trip element of the motor circuit protector type.

6. Breakers for combination starters shall be F frame or larger. All breakers shall have adjustable magnetic trip elements. Circuit breakers K frame and larger shall have interchangeable thermal-magnetic trip elements.

E. Safety Switches

1. Safety switches shall be of the heavy duty industrial, quick make, quick-break type. Ratings shall correspond to that of the equipment in which circuit it is used, fuses sized as shown on the Contract Drawings. All safety switches at motor locations are of the nonfused type unless otherwise noted.

2. Safety switches shall have a mechanical door interlock to prevent the door from being opened with the switch in the on position and facilities for locking it in the closed or open position. Enclosures for process areas and outside installations shall be NEMA 4X and enclosures for indoor, non-process areas, shall be NEMA 1, unless otherwise designated in Section 16900 of this division and/or on the Contract Drawings.

3. Safety switches shall be UL listed and shall conform to NEMA Standards. NEMA 4X enclosed safety switches where called for shall be stainless steel, or fiberglass.

4. NEMA 1 enclosed switches shall be phosphate coated or equivalent, code gauge steel with baked enamel finish.

F. Selector Switches

1. Hand-off-automatic type selector switches shall be of oil-tight construction and shall have 3 positions. The switch must not have a spring loaded return. It shall be of the "quick-make", "quick-break" type.

G. Manual Motor Starting Switches

1. Manual motor starting switches for the control of fractional horsepower motors shall be single pole, and shall be provided with a thermal heater of the correct size for the load controlled. Each starting switch shall be mounted where shown on the Contract Drawings. Where they are used for rotating equipment such as grinders, they shall be equipped with low voltage protection, and required manual reset after power failure. As an alternate to low voltage protection built-in, a "Safety Restart Plug" may be utilized, available from Mitchell Instrument Company.

H. Alarm Horns

1. Alarm horns, where called for on the Contract Drawings, shall be weatherproof, suitable for surface mounting and shall be provided with a silence button. Alarm horn shall be Edwards 876 series with 103dB at 10 feet, Federal Signal, or equal.

I. Timing Relays

1. Time delay relays shall have an adjustable timing range as shown on the Contract Drawings. The time delay shall be after energizing timer coil. Timing relays shall be Agastat, Square D, or equal.

J. Pilot lights shall be 30mm, push-to-test, LED type.

2.04 TIMERS

A. Timers for various services required in the motor control equipment shall be Paragon, Tork or equal as indicated in control circuits shown on the Drawings.

B. Timers requiring tripping pins shall be supplied with enough pins to completely fill all locations on the dial face.

PART 3 - EXECUTION

3.01 INSTALLATION/APPLICATION/ERECTION

A. Motor Control Centers

1. Ends of MCC(s) shall be closed with 1/4" mesh hardware cloth and galvanized or aluminized insect screen or sill covers to prevent the entrance of rodents and large insects into the MCC housing(s).

2. Each MCC shall be provided with a 4" high concrete pad.

3. One inch air space (min.) shall be allowed between back of MCC(s) and wall surface.

4. Lifting-eyes in tops of MCC(s) section shall be removed (and retained) and the threaded openings closed with stainless cap screws and plastic washers or plastic seals provided for that purpose by the MCC(s) manufacturer.

5. In installations where conduit runs to electrical equipment emanate from the top of MCC(s) there shall be provided additional wiring space in the form of metal trough(s) of the same metal housing(s) dimensions and details. Trough(s) shall be provided by the manufacturer of the MCC(s).

B. Individually Mounted Motor Control Devices (480, 240, or 120 Volt)

1. Each motor disconnect shall be located as near as possible to its respective motor.

2. Remote control station at or near motor shall be mounted near its respective motor, adjacent to the motor disconnect.

3. All devices and equipment furnished under this section (electronic circuit monitors, power correction equipment, etc.) shall be programmed, configured, and calibrated by the manufacturer. Any settings required shall be as determined by the manufacturer. If coordination studies or power system analysis is required, it shall be performed by the manufacturer.

3.02 EXTRA STOCK/SPARE PARTS

A. Provide the following spare parts:

10 fuses of each type/amperage used

1 pilot light lamp for each pilot light socket assembly provided

1 control transformer for each size utilized

END OF SECTION

SECTION 16442 - PANELBOARDS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section of the Technical Specifications includes furnishing all labor, materials, equipment, and incidentals required for the installation of all lighting and distribution panelboards as hereinafter specified and as shown on the Contract Drawings.

B. The panelboards for installation under this Contract shall be selected from the following types with the panel voltage and main sizes the determining factors. All panelboards shall be by the same manufacturer.

C. Circuit breakers of size and type shown on Contract Drawings and described herein shall be provided with the panelboards.

1.02 Submittals

A. Submit product data and shop drawings for approval.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. "Square D", "Cutler Hammer", "General Electric Company," or equal.

2.02 EQUIPMENT

A. Rating

1. Panelboard ratings shall be as shown on the Contract Drawings. All panelboards shall be rated for the intended voltage.

B. Standards

1. Panelboards shall be in accordance with the Underwriter Laboratories, Inc. "Standard for Panelboards" and "Standard for Cabinets and Boxes" and shall be so labeled where procedures exist. Panelboards shall also comply with NEMA Standard for Panelboards and the National Electrical Code.

C. Panelboard Construction (NEMA 1)

1. Interiors

a. All interiors shall be completely factory assembled with circuit breakers, wire connectors, etc. All wire connectors, except screw terminals, shall be of the anti-turn solderless type and all shall be suitable for copper or aluminum wire of the sizes indicated.

b. Interiors shall be so designed that circuit breakers can be replaced without disturbing adjacent units and without removing the main bus connectors and shall be so designed that circuits may be changed without machining, drilling or tapping.

c. Branch circuits shall be arranged using double row construction except when narrow column panels are indicated. Branch circuits shall be numbered by the manufacturer.

d. A nameplate shall be provided listing panel type, number of circuit-breakers and ratings.

2. Bussing

a. Bus-bars for the mains shall be of copper. Full size neutral bars shall be included. Bus-bar taps for panels with single pole branches shall be arranged for sequence phasing of the branch circuit devices. Bussing shall be braced throughout to conform to industry standard practice governing short circuit stresses in panelboards. Phase bussing shall be full height without reduction. Cross connectors shall be copper.

b. Neutral bussing shall have a suitable lug for each outgoing feeder requiring a neutral connection.

c. Spaces for future circuit-breakers shall be bussed for the maximum device that can be fitted into them.

d. Separate neutral and ground bus shall be provided, insulated and isolated from each other.

3. Boxes

a. Recessed boxes shall be made from galvanized code gauge steel having multiple knockouts, unless otherwise noted. Surface mounted boxes shall be painted to match the trim. Boxes shall be of sufficient size to provide a minimum gutter space of 4 inches on all sides.

b. Surface mounted boxes shall have an internal and external finish as hereinafter specified. Surface mounted boxes shall be field punched for conduit entrances.

c. At least 4 interior mounting studs shall be provided.

4. Trims

a. Hinged doors covering all circuit-breaker handles shall be included in all panel trims.

b. Doors shall have semi flush type cylinder lock and catch, except that doors over 43 inches in height shall have a vault handle and 3-point catch, complete with lock, arranged to fasten door at top, bottom and center. Door hinges shall be concealed. Two keys shall be supplied for each lock. All locks shall be keyed alike; directory frame and card having a transparent cover shall be furnished on each door.

c. The trims shall be fabricated from code gauge sheet steel.

d. All exterior and interior steel surfaces of the panelboard shall be properly cleaned and finished with manufacturer's standard gray paint over a rust-inhibiting phosphatized coating. The finish paint shall be of a type to which field applied paint will adhere without cracking or peeling.

e. Trims for flush panels shall overlap the box by at least 3/4 inch all around. Surface trims shall have the same width and height as the box. Trims shall be fastened with quarter turn clamps.

D. Overcurrent Protective Devices (Circuit Breakers)

1. Panelboards shall be equipped with circuit-breakers with frame size and trip settings as shown on the Contract Drawings.

2. Circuit-breakers shall be molded case, bolt-in, thermal-magnetic trip.

3. Circuit-breakers used in 120/208 volt panelboards shall have an interrupting capacity of not less than 10,000 amperes, RMS symmetrical.

4. Circuit-breakers used in 480 volt panelboards shall have an interrupting capacity of not less than 22,000 amperes, RMS symmetrical.

5. GFCI (ground fault circuit interrupter) shall be provided for circuits where indicated on the Contract Drawings. GFCI units shall be 1-pole, 120 volt, molded case, bolt-on circuit-breakers, incorporating a solid state ground fault interrupter circuit insulated and isolated from the circuit-breaker mechanism. The unit shall be UL listed Class A Group I device (5 milliamp sensitivity, 25 millisecond trip time), and an interrupting capacity of 10,000 amperes RMS.

6. Trip elements of multi-pole breakers shall be effectively insulated from one another. Multi-pole breakers shall be designed so that an overload on any pole shall open all poles simultaneously.

7. The breaker operating mechanism shall be the quick-make, quick-break type and shall be entirely trip free to prevent the contacts being held in a closed position against a short circuit.

8. Breakers shall have a thermal bimetallic element for time delayed overload protection and a magnetic element for short circuit protection.

9. The breaker shall be trip indicating with the trip position midway between the "On" and "Off" positions.

10. Breakers for power distribution panels shall be F frame or larger. All breakers rated above 225 amps shall have interchangeable magnetic trip elements.

11. All breakers shall be UL listed, and conform to requirements of NEMA Standards.

E. Surge Protective Devices

1. See Section 16280 – Surge Protection Devices for panelboard SPD requirements.

PART 3 - EXECUTION

3.01 INSTALLATION/APPLICATION/ERECTION

A. Boxes for surface mounted panelboards shall be mounted so there is at least 1/2 inch air space between the box and the mounting surface.

B. Circuit directories shall be typed giving location and nature of load served.

C. Each panelboard shall be nameplated with plastic engraved nameplates stating the panel's name, voltage, and the name of panel serving the panel. Nameplates shall be secured by use of stainless steel screws.

END OF SECTION

SECTION 16446 - VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.01 REFERENCES

A. The drive shall be designed to meet the following specifications:

1. NFPA 70 - US National Electrical Code
2. NEMA ICS 3.1 - Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems
3. NEMA 250 - Enclosures for Electrical Equipment
4. UL 508C – Underwriter's Laboratory
5. CAN/CSA-C22 No. 14-M91 - Canadian Standards Association
6. IEC 146 - International Electrical Code

1.02 REGULATORY REQUIREMENTS

A. The drive shall conform to the following requirements:

1. NFPA 70
2. IEC 146
3. EN Standard/CE marked for EMC directives

Emissions	Immunity
EN 50081-1	EN 50082-1
EN 50081-2	EN 50082-2
EN 55011 Class A	IEC 801-1,2,3,4,6,8
EN 55011 Class B	(per EN 50082-1,2)

4. EN Standard/CE marked for Low Voltage directives

   EN 60204-1
   PREN 50178

5. IEC 801
6. C-UL marking to provide an approved listing for both United States and Canadian users.

1.03 QUALIFICATIONS

A. Manufacturer: The drive manufacturer shall have been in the drive business continuously for a minimum of 15 years and specialize in the design and manufacturing of PWM Adjustable Frequency Drives.

B. Support: The drive manufacturer shall maintain factory trained and authorized service facilities for their drives within 100 miles of the project and have a demonstrated record of service for at least the previous three years. Full-time support personnel shall be employed by the drive manufacturer.

C. Certification: All drives must be assembled at locations that are certified to the ISO-9001

Series of Quality Standards. This insures all quality and corrective action procedures are documented and implemented with a goal of Total Customer Satisfaction.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. "Square D," "Eaton," "Robicon," "Allen Bradley", or approved equal.

2.02 RATINGS

A. Input Power: The drive shall be self-adjustable to accept an input voltage range between 200-240/380-480/500-600VAC, three phase +/-10%.

B. Displacement power factor shall range between 1.0 and 0.95, lagging, over the entire speed range (0.80 for 0.5-5hp/0.37-3.7kW, 200-480V drives). The efficiency of the drive shall be a minimum of 97% at full load and speed.

C. Environment: Storage ambient temperature range: -40 to 70 C (-40 to 158 F). Operating ambient temperature range: 0 to 40 C (0 to 109 F) without derating. The relative humidity range shall be 5% to 95% non-condensing.

D. Operating elevation: up to 1000 Meters (3,300ft) without derating.

E. Output Power: The output voltage is adjustable from 0 to rated input voltage. The output frequency range shall be adjustable from 0 to 80 Hz. The inverter section will produce a pulse width modulated (PWM) waveform using latest generation IGBTs.

2.03 DESIGN

A. Hardware: The drive hardware shall employ the following power components:

1. Diode or fully gated bridge on the input.
2. DC bus inductor on all ratings 5.5kW (7.5HP) or greater.
3. Switching logic power supply operating from the DC bus.
4. Phase to phase and phase to ground MOV protection.
5. Gold plated plug-in connections on printed circuit boards.
6. Microprocessor based inverter logic isolated from power circuits.
7. Latest generation IGBT inverter section.
8. Inverter section shall not require commutation capacitors.
9. Customer Interface common for all horsepower ratings. Interface shall include an LCD digital display, programming keypad and operator keys option.
10. Main Control Board common for 5.5kW (7.5HP) and up.
11. Common control connection for all ratings.
12. Optimized for 4kHz carrier frequency at 44kW (60HP) or less, and 2kHz at 55kW (75 HP) and larger.

13. Peripheral Interface to enable attaching common options.

B. Control Logic: The drive shall be programmable or self adjusting for operation under the following conditions:

1. Operate drive with motor disconnected.

2. Controlled shut down, when properly fused, with no component failure in the event of an output phase to phase or phase to ground short circuit and annunciation of the fault condition.

3. Adjustable PWM carrier frequency within a range of 2-8kHz.

4. Selectable Sensorless Vector or V/Hz mode.

5. Selectable for variable or constant torque loads. Selection of variable torque provides 115% of rated VT current for up to one minute. Selection of constant torque provides 150% of rated CT current for up to one minute.

6. Multiple programmable stop modes including - Ramp, Coast, DC-Brake, Ramp-to-Hold and S-curve.

7. Multiple acceleration and deceleration rates.

8. Multiple acceleration and deceleration rates.

9. All adjustments to be made with the door closed.

10. Adjustable output frequency up to 400Hz.

C. POWER CONDITIONING: The drive shall be designed to operate on an AC line which may contain line notching and up to 10% harmonic distortion. An input isolation transformer shall not be required for protection from normal line transients. If line conditions dictate the use of a transformer, the K factor shall be 4.0 or less.

2.04 FEATURES

A. Interface: The drive shall provide a removable Human Interface Module with integral display to show drive operating conditions, adjustments and fault indications. The display shall be removable under power without causing a fault and is visible and operable without opening the enclosure door. The display shall consist of 2 lines of 16 character alphanumeric, backlit LCD with the display being configurable for simultaneously displaying two values using customized multi-lingual text and user scaled units. The module shall provide LED indication of drive direction and commanded direction. The display shall be capable of remote mounting by means of cable connection up to 10 meters (33ft) from the drive and is capable of being used as a hand-held terminal.

B. Control Mode: Programming shall provide the ability to select sensorless vector or v/hz mode. The sensorless vector mode shall use motor nameplate data plus motor operating data, such as IR drop, nominal flux current and flux up time. The volts per hertz mode shall be able to be programmed for squared, cubed, straight line, pre programmed or full custom patterns.

C. Current Limit: Programmable current limit shall be available from 20% to 160% of constant torque rating. Current limit shall be active for all drive states; accelerating, constant speed and decelerating. The drive shall employ PI regulation with an adjustable gain for smooth transition in and out of current limit.

D. Acceleration/Deceleration: Accel/Decel settings shall provide separate adjustments to allow

either setting to be adjusted from 0 seconds to 3600 seconds. A second set of remotely selectable Accel/Decel settings shall be accessible with Control Interface option. An adaptive current limit circuit shall be able to be disabled in programming for fast acceleration of low inertia loads.

E. Speed Regulation: The programmable speed regulation modes shall include the following:

1. Open Loop
2. Slip Compensation with 0.5% speed regulation
3. Droop - Negative Slip Compensation with 0.5% speed regulation
4. Traverse Function
5. Closed loop encoder feedback with 0.1% speed regulation
6. Process PI control

F. Speed Profiles: Programming capability shall allow the user to produce speed profiles with linear acceleration/deceleration or "S-Curve" profiles that provide changing accel/decel rates. S-Curve profiles shall be selectable for fixed or adjustable values.

G. Adjustments: The digital interface shall be provided for all set-up, operation and adjustment settings. All adjustments are shall be stored in nonvolatile memory (EEPROM). Potentiometer adjustments are not acceptable. The drive shall provide EEPROM memory for factory default values.

H. Process PI Control: An internal process PI regulator shall have both proportional and integral gain adjustments as well as error inversion and output clamping functions. The feedback may be configured for normal or square root functions. If the feedback indicates that the process is moving away from the setpoint, the regulator will adjust the drive output until the feedback equals the reference. Process control shall be enabled or disabled with a hardwire input. Transitioning in and out of process control shall be able to be tuned for faster response by preloading the integrator. Protection shall be provided for a loss of feedback or reference signal.

I. Fault Reset/Run: The drive shall have the ability to conduct up to nine automatic fault reset and restarts following a fault condition before locking out and requiring manual restart. The automatic mode is not applicable to a ground fault, shorted output faults and other internal microprocessor faults. The time between restarts shall be adjustable from 0.5 seconds to 30 seconds.

J. Skip Frequencies: The drive shall contain three adjustable set points that lock out continuous operation at frequencies which may produce mechanical resonance. The set points shall have a bandwidth adjustable from 0Hz to 15Hz.

K. Run On Power Up: A user programmable restart function shall be provided to automatically restart the equipment after restoration of power after an outage. A maintained 2-wire start input is required for this function.

L. Line Loss Restart: This programmable function shall be provided to select the reconnect mode of the drive after recovery from a line loss condition. The reconnect modes shall be B Last Speed, Speed Search, Track Volts, or Use Encoder. Disabling this feature shall force the drive to start from zero hertz.

M. Fault Memory: The last four faults as well as operating frequency, drive status and power mode shall be stored at the time of fault. Information shall be maintained in the event of a power loss.

N. Overload Protection: The drive shall provide Class 20 motor overload protection investigated by UL to comply with N.E.C. Article 430. Overload protection shall be speed sensitive and adjustable for motors with speed ranges of 2:1, 4:1 and 10:1. A viewable parameter shall store the overload usage in percent. An alarm bit can be used to adjust a process to eliminate an overload trip.

O. Auto Economizer: This feature shall automatically reduce the output voltage when the drive is operating in an idle mode (drive output current less than programmed motor FLA). The voltage shall be reduced to minimize flux current in a lightly loaded motor thus reducing kW usage. If the load increases, the drive shall automatically return to normal operation.

P. Terminal Blocks: Separate terminal blocks shall be provided for control and power wiring.

Q. Flying Start: The drive is shall be capable of determining the speed and direction of a spinning motor and adjust its output to "pick-up" the motor at the rotating speed. The flying start feature shall be operable with or without encoder feedback.

R. Ride Through: The control logic shall be capable of "riding through" a power outage of up to 2 seconds in duration.

S. Analog Output: An output signal shall be provided and be jumper selectable for 0 - 10V DC or 0 - 20 mA which is user programmable such that it is proportional to one of 13 process parameters including output frequency, output current, encoder feedback, output power and others. A programmable offset shall be provided to allow modification of the analog output to obtain 2 - 10V DC or 4 - 20 mA. Programmable gain adjustments for both upper and lower settings shall allow for system calibration.

T. Reference Signals: The drive shall be capable of the following input reference signals:

Digital pulse input	Digital MOP
Remote potentiometer	Serial
10V DC	HIM (Program/Control panel)
4-20 mA	

U. Loss of Reference: In the event of loss of the 4 - 20 mA reference signal, the drive shall be user programmable to the following:

Fault and stop
Alarm and maintain last reference within 10%
Alarm and go to preset speed
Alarm and go to minimum speed
Alarm and go to maximum speed
Active for Process PI reference or feedback

V. Digital I/O: Contact output ratings shall be 115V AC/30V DC, 5.0 Amp resistive, 2.0 Amp inductive. All four contacts provided shall be programmable to 17 different conditions. Factory settings shall be as follows:

Form A Run contact
Form C Fault contact
Form C Alarm contact
Form A at Speed contact

W. Operator Devices, and Control Interface: Provide start and stop controls integrally with the drive. Also provide control interface cards as required to accommodate the external control deices shown in Control Circuits.

X. Each drive shall be equipped with an Ethernet port.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Comply with manufacturer's recommendations, except as modified herein.

B. Drives shall be adjusted such that maximum speed is motor nameplate RPM, and minimum speed is just high enough to provided motor driven equipment cooling.

3.02 START-UP, TRAINING, AND TESTING

A. The drive manufacturer shall provided factory authorized, trained service personnel for start-up and testing. Upon successful completion of installation and testing, training shall be provided in accordance with 16050.

3.03 TOOLS AND SPARE PARTS

A. Any special tools required for normal operation and maintenance shall be provided by the equipment manufacturer.

B. Furnish the following spare parts:

1. Ten fuses for each type used.

2. Ten lamps for each type used.

END OF SECTION

SECTION 16460 - SMALL POWER AND MISCELLANEOUS TRANSFORMERS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Transformer locations and size shall be as shown on the Contract Drawings, as specified herein.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. "Square D", "Cutler Hammer", or approved equal.

2.02 FABRICATION

A. General Purpose Dry-Type Transformers

1. Single phase transformers shall be 480 volt primary and 120/240 volt secondary. Three phase transformers shall be 480 volts delta primary and 208 Y/120 or 240 volt delta secondary. Transformers 25 KVA and larger shall have a minimum of 4 (2 above, 2 below) 2 1/2 percent full capacity primary taps.

2. Transformers shall be 150 degrees Celsius temperature rise above a 40 degrees Celsius ambient. All insulating materials are to be in accordance with the latest NEMA Standards for a 220 degrees Celsius UL recognized insulation system.

3. Transformer coils shall be of the continuous wire wound construction and shall be impregnated with non-hygroscopic, thermo-setting varnish. The coils shall also have a final wrap of electrical insulating material to prevent mechanical injury to the wire as well as increasing the electrical breakdown strength.

4. All cores shall be constructed of high grade, non-aging silicon steel with high magnetic permeability, and low hysteresis and eddy current losses. Magnetic flux densities are to be kept well below the saturation point. The core laminations shall be clamped together with steel angles. The completed core and coil shall then be bolted to the base of the enclosure but isolated from the base by means of rubber, vibration absorbing mounts. There shall be no metal-to-metal contact between the core and coil to the enclosure. On transformers 500 KVA and smaller, the vibration isolation system shall be designed to provide a permanent fastening of the core and coil to the enclosure. To further facilitate vibration and noise isolation, the final section of conduit to the transformer shall be flexible.

5. Transformers 25 KVA and larger shall be in heavy gauge, sheet steel, ventilated enclosures. The ventilating openings shall be designed to prevent accidental access to live parts in accordance with UL, NEMA, and National Electrical Code Standards for ventilated enclosures. Transformers 25 KVA through 75 KVA shall be designed so they can either be floor or wall mounted. Above 75 KVA they shall be of the floor mounted design.

6. The entire transformer enclosure shall be degreased, cleaned, phosphatized, primed, and finished in the same color as the motor control equipment. For more details see Division 9 of these Specifications.

7. The maximum temperature of the top of the enclosure shall not exceed 50 degrees Celsius rise above a 40 degrees Celsius ambient.

8. The core of the transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor sized in accordance with NEMA and NEC Standards.

9. The transformer shall be marked "DANGER HIGH VOLTAGE" with labels specified in the section on marking, this Division.

10. The transformers shall be manufactured to requirements of applicable standards, especially as they apply to noise level and surface temperatures.

PART 3 - EXECUTION

3.01 INSTALLATION / APPLICATION / ERECTION

A. Transformers shall be rigidly mounted to the structure or the foundation in the case of freestanding units.

B. Transformers shall be megger tested prior to energization.

C. Transformers with taps shall be adjusted to supply the nominal service voltage required on the secondary.

D. Transformers shall be installed in accordance with NEC requirements and manufacturer recommendations.

END OF SECTION

SECTION 16495 - SWITCHBOARD MATTING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Switchboard matting shall be furnished by the Contractor and placed in front of all power distribution and control equipment.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Switchboard matting shall be W.H. Salisbury & Company, Wearwell, Erico, or equal.

2.02 MATERIALS

A. Switchboard matting shall be nonconductive with a minimum of 40,000 volts dielectric strength. The mat shall have a corrugated, non-slip surface and shall be a minimum of 1/4 inch thick. Width shall be 36 inches and length shall be as required at each location. The mat shall be black in color, ozone and oil resistant, and manufactured to meet all applicable ANSI/ASTM standards.

PART 3 – EXECUTION

A. Install per manufacturer instructions.

END OF SECTION

SECTION 16500 - LIGHTING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The specific characteristics of the light fixtures to be furnished and installed shall be as detailed in the light fixture schedule on the Contract Drawings. Should a fixture of a different type or manufacturer than that specified be submitted for the Engineer's review, it will be compared to that specified on: construction, dimensions, and photometrics. Failure to compare equally to what was specified will be grounds for rejection.

PART 2 - PRODUCTS

2.01 BALLASTS

A. All ballasts shall have built in thermal protection and be of the high power factor type built to conform to UL and ANSI standards (as attested by CBM certification).

B. Where shown on the Contract Drawings premium efficiency ballasts shall be provided with luminaires.

2.02 LUMINAIRES

A. All fixtures shall be delivered complete with suspension and mounting accessories, ballasts, diffusers, reflectors, etc., all wired and assembled. All accessory wiring shall be furnished and installed as shown on the Contract Drawings.

B. All steel supports required for luminaires in addition to that furnished under the general building construction shall be furnished and installed by the Contractor.

C. When fixtures are noted to be installed flush, they shall be complete with the proper accessories for installing in the particular ceiling involved. All flush mounted fixtures shall be supported from the structure and shall not be dependent on the hung ceilings for their support.

D. All outside luminaires shall be a type that will prevent insect accumulation inside the luminaire.

E. Exterior luminaires shall be weatherproof and rustproof.

F. Luminaires for vaults and pipe galleries shall be watertight and rustproof.

G. Luminaire wire shall be fixture type of non-asbestos construction.

2.03 LAMPS

A. Fluorescent lamps shall have standard cool white (CW) color characteristics unless otherwise indicated, and shall be of the type that will not require starter switches.

PART 3 - EXECUTION

3.01 INSTALLATION/APPLICATION/ERECTION

A. General

1. The Contractor shall furnish all light fixtures, lighting equipment, components, hangers, etc., as shown on the Contract Drawings and shall install them at the locations shown on the Contract Drawings.

2. All fixture wiring shall be in conformance with the latest revision of the NEC and UL standards.

3. Lamps of the proper type, wattage and voltage rating shall be delivered to the project in the original cartons and installed in the fixtures just prior to the completion of the project, with spare lamps as listed on the Contract Drawings.

4. All fluorescent lamps used during the building construction in contract lighting fixtures prior to 2 weeks from the completion of the work shall be removed and replaced with new lamps.

B. Luminaires

1. Fixtures shall be rigidly mounted against the surface of the ceiling unless otherwise noted on the Contract Drawings. Conduit runs to and between fixtures shall be rigid metallic type. Use of flexible conduit for connection to fixtures is prohibited, except where concealed above a suspended ceiling.

2. All ferrous metal surfaces of fixtures and plaster frames shall be treated and given rust-inhibiting and finish coat adherence properties before final enamel coats are applied. Finish enamel coat shall be baked on at approximately 320 degrees Fahrenheit.

3. Similar fixtures in each room or area shall be installed with bottom of fixtures at same elevation, unless otherwise noted.

4. Minimum wire size shall be AWG No. 10 for runs over 75 feet.

5. Outlets shall be as specified herein and shall be suitable for the installation conditions encountered.

6. Flexible fixture hangers shall be used for all pendant mounted fixtures.

7. Conduit run in areas with hung ceilings shall be installed in the space above the hung ceiling as close to the structure as possible. Conduits and junction boxes shall be supported from the structure.

8. No light fixtures shall be hung or installed until after painting is completed, however, temporary lighting shall be provided by the Contractor.

9. All fixtures shall be left in a clean condition, free of dirt and defects, before acceptance by the Engineer.

C. Light Poles:

1. A concrete foundation shall be provided for each pole as detailed on the Contract Drawing. The poles shall be mounted utilizing anchor bolts set in the concrete. The anchor bolts shall have galvanized or plated threads and shall be furnished with the pole by the manufacturer.

2. When anchor bolts are positioned prior to pouring concrete, spacing and projection must be verified with pole manufacturer's recommendations. A plastic or plywood template should be fabricated from the manufacturer's instructions to use when setting the anchor bolts. Anchor bolts that are not installed plumb and

in the correct locations shall be removed and replaced. The Contractor shall not be allowed to bend the anchor bolts back to plumb after concrete is set.

3. Leveling nuts shall be utilized for the mounting of poles to foundations. A nut should be screwed down on each bolt until it meets the concrete, then the nuts must be adjusted until they are level.

4. The pole shall be carefully lowered onto the anchor bolts and allowed to rest on the leveling nuts. Flat washers followed by lockwashers should be placed on the anchor bolts and the top nut installed. Minor adjustments on the leveling nuts may be necessary to plumb the pole before the top nuts are tightened down. Special care shall be taken to tighten the top nuts to the torque level recommended by the pole manufacturer. All nuts and washers shall be galvanized or plated.

5. Concrete grout of the nonshrink type must be installed between the base of the pole and the concrete foundation. The grout should be puddled around the edge of the pole base and firmly packed in the space between the pole and foundation. A short piece of small diameter pipe must be installed to make a drain hole through the grout to the pole interior.

6. Aluminum poles must have the bottom of the base painted with Koppers bitumastic No. 50 or equal substitute product before grouting so that the aluminum does not come in contact with the concrete.

7. Poles shall not be modified or drilled on the job site.

8. Under no circumstances should a ground wire be wrapped around an anchor bolt underneath an anchor bolt nut.

9. Do not set poles without light fixtures installed, as poles are more likely to vibrate and become damaged.

10. Manufacturer's installation instructions should be followed as well as those instructions contained herein. Should a discrepancy exist, promptly contact the Engineer for clarification.

11. Bases shall have 1" chamfer all around and rubbed and buffed smooth to below grade.

12. Anchor bolt covers shall also be provided and installed.

END OF SECTION

SECTION 16620 - STANDBY POWER GENERATOR SYSTEMS – NATURAL GAS

PART 1- GENERAL

1.01 SCOPE OF WORK

A. This Specification covers the installation of fixed emergency standby generator systems and their major items of auxiliary equipment.

1.02 RELATED WORK

A. Section 16010 – General Electrical Requirements

B. Section 16496 – Automatic Transfer Switches

1.03 SUBMITTALS

A. The submittal shall include complete shop drawings and specification data on the generator systems. Submit in accordance with Section 16010 requirements.

B. The submittal shall include complete wiring schematics and interconnection diagrams identifying by terminal number each required interconnection between the transfer switch, emergency shutoff pushbuttons, engine control panel, etc. The submittal shall also contain complete descriptive literature on every piece of equipment, battery-sizing calculations, and spare parts list.

C. The submittal shall include complete installation, startup, operation, and maintenance instructions.

D. Exceptions to this specification shall be clearly indicated in the submittal.

E. The submittal shall include all factory test results for testing required under this specification.

F. Shop Drawings shall be clearly marked and or highlighted as to which product, type, option, etc. is being submitted. Product literature with one or more styles / configurations for a single product shall have a written description of use for each of the styles / configurations represented on the literature.

1.04 QUALITY ASSURANCE

A. The engine, generator, and all equipment that make up the standby generator systems shall be bid direct to each Contractor by the manufacturer or his authorized distributor maintaining a parts and service facility within 150 miles of the project location.

B. All materials equipment and parts comprising the units specified herein shall be new and unused, of current manufacture and of the highest grade. All equipment shall be free from all defects or imperfections.

1.05 GUARANTEE

A. Equipment furnished under this section shall be guaranteed against defective parts or workmanship for a period of 2 years from the date of field-testing and acceptance by the Owner. This warranty shall include all expenses that will normally be incurred if a service technician must visit the site to troubleshoot and/or repair a defective generator system.

1.06 REFERENCE STANDARDS

The generator covered by these specifications shall be designed, tested, rated, assembled and installed in strict accordance with current Editions of the following standards:

A. NFPA 1 – Fire Code

B. NFPA70 – National Electrical Code. Equipment shall be suitable for use in systems in compliance with Article 700, 701, and 702.

C. UL508A. The entire control system of the generator set shall be UL508A Listed and labeled.

D. UL2200. The generator set shall be UL2200 Listed

E. UL1008. The automatic transfer switch shall be UL1008 Listed.

F. EPA – Generator engines shall be certified to the latest applicable regulations issued by the EPA regarding emissions compliance.

G. NFPA 54 - Fuel/Gas Code – The generator and all field-installed gas piping shall comply with the Fuel-Gas Code.

1.07 TESTING

A. Generator Set

The generator sets shall receive the manufacturers standard factory testing prior to shipment. Prior to acceptance of the installation, the equipment shall be tested to show it will perform satisfactorily, including automatic starting, subject to full load test or as much of full load as is available at the plant, shutdown, and reset as required in these Specifications. Prior to acceptance, the Contractor shall correct any defects that become evident during this test.

B. Automatic Transfer Switch

After fabrication of the transfer switches in the manufacturer's plant, perform an insulation check to ensure the integrity of insulation and continuity of the entire system. Perform a temperature rise test in accordance with UL1008. In addition, an operating test shall be simulated to verify that all of the equipment performs as described below. When conducting temperature rise tests to paragraph 99 of UL-1008, the manufacturer shall include post-endurance temperature rise tests to verify the ability of the transfer switch to carry fully rated current after completing the overload and endurance tests. A certified test report shall be furnished by the manufacturer to show that each transfer switch meets all requirements of these Specifications and that the operational requirements have been met.

1.08 START-UP

A. Generator Set

On completion of the installation, the initial startup shall be performed by a factory-trained representative of the engine supplier. At the time of startup, operating instruction and maintenance procedures shall be thoroughly explained to operating personnel. Installation, operating, and maintenance instruction books shall be submitted for each electric set and all auxiliary equipment in a 3-ring binder, at the time of submittal of descriptive literature, for review. The manufacturer's service representative shall be prepared to check phase rotation "by instrument", prior to start-up. It will not be allowed to isolate one motor on the generator and check its rotation to determine phasing.

B. Automatic Transfer Switch

After the installation is completed, the transfer switch shall be tested by simulating a power failure and having each unit automatically start, come up to speed, and assume the available load at the site. The alarm and shutdown features of each set shall be tested to make sure they are in proper working order. Any defects that become evident at this time shall be corrected before acceptance of the complete standby generating system by the Owner. The supplier shall specify the nearest location where parts and service will be available.

PART 2- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Generators shall be manufactured by "Caterpillar", "Cummins", "Kohler", "Generac" or equal.

B. Transfer switches shall be manufactured by "Russelectric," or equal.

2.02 GENERATOR SET

A. Rating

1. Each standby emergency generator shall be rated as indicated on the Drawings at 0.8 power factor, 1800 RPM, and with fan for continuous service with normally varying loads during interruption of utility power. The maximum ambient temperature shall be at least 104°F, and the minimum ambient temperature shall be –10°F or lower.

2. Ratings must be substantiated with manufacturer's standard published curves. Special ratings for a particular application are not permitted. These ratings must reflect the net power available after deducting all engine driven accessories.

B. Engine

1. The engine shall be natural gas fueled, radiator and fan cooled. Engine accessories and features shall include: Complete engine fuel system, including all pressure regulators, strainers, and control valves. The fuel system shall be plumbed to the generator set skid for ease of site connections to the generator set.

2. An electronic governor system shall provide automatic isochronous frequency regulation to +/-0.25% at stead state. The governing system dynamic capabilities shall be controlled as a function of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions. The control system shall actively control the fuel rate and excitation as appropriate to the state of the generator set. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed, and operating in various isochronous or parallel states.

3. Skid-mounted radiator and cooling system rated for full load operation in 104 degrees F (40 degrees C) ambient as measured at the generator air inlet, based on 0.5 in H2O external static head. Radiator shall be sized based on a core temperature that is 20F higher than the rated operation temperature, or prototype tested to verify cooling performance of the engine/radiator/fan operation in a controlled environment. Radiator shall be provided with a duct adapter flange. The equipment manufacturer shall fill the cooling system with a 50/50-ethylene glycol/water mixture. Rotating parts shall be guarded against accidental contact.

4. A critical type silencer shall be furnished for each unit with an inlet properly sized according to the silencer manufacturer's recommendation for the engines used. A stainless steel flexible exhaust fitting shall be provided for mounting between the engine exhaust and exhaust pipe. The silencer system shall be of a type and size to ensure against loss of engine power due to excessive backpressure. The silencer shall be equipped with a condensate drain. A bird screen shall be welded into the exterior end of the exhaust pipe. Rain-caps shall be provided where there is possibility of rain entering the pipe.

5. Safety shutoff alarms shall be provided for high water temperature, low oil pressure, engine overspeed, engine overcrank, and high lubricating oil temperature.

6. The engine assembly shall be mounted on a structural steel subbase and shall be provided with vibration isolators between the engine and the steel subbase or between the base and floor.

7. The engine shall be equipped with an engine mounted thermal circulation type water heater to maintain engine jacket water at 90 degrees Fahrenheit in an ambient temperature of 30 degrees Fahrenheit. The heaters shall be single phase, 60 Hz., 208VAC.

C. Generator

1. Each generator shall be of a standard generator size to provide the specified output under jobsite conditions and shall be built to NEMA MG 1 standards.

2. Generators shall be 3 phase, 60 Hz., 0.8 power factor, single bearing, synchronous type, NEMA Class H insulation vacuum impregnated with epoxy varnish for fungus resistance, and directly connected to the engine flywheel housing with a flex coupling. Temperature rise of the rotor and stator shall not exceed NEMA Class F 130°C (maximum) at the standby power rating in a 40 degrees Celsius ambient.

3. Generators shall have permanent magnet exciters, which shall derive excitation current from a pilot exciter, mounted on the rotor shaft. It shall enable the alternator to sustain 300% of rated current for ten seconds during a fault condition.

4. Generators shall have an automatic voltage regulator to provide voltage regulation over the engine load range to within ±0.5 percent of rating for constant loads. The regulator shall include electronic voltage buildup, volts per Hertz regulation, three phase sensing, over-excitation protection, loss of sensing protection, temperature compensation, voltage limit on startup, and shall be environmentally sealed.

5. The generator shall include anti-condensation winding heaters of the same voltage as the water jacket heater.

D. Engine Generator Controls

1. Provide for each generator a control panel incorporating complete controls for all functions of the electric set and associated mechanisms. The panel shall be generator mounted or freestanding, as shown on the Drawings, one enclosure of 14 gauge steel, dead front. The enclosure shall be rated NEMA 4 unless integrally mounted with the generator enclosure such that it is protected from the weather. Each panel shall contain as a minimum the following:
   a. Voltmeter, digital, .5% true RMS accuracy
   b. Ammeter, digital, .5% true RMS accuracy
   c. Combination phase selector switch
   d. Engine oil pressure
   e. Coolant temperature
   f. Engine RPM

g. System DC volts
h. Engine Running Hours
i. Generator AC volts
j. Generator AC amps
k. Generator frequency, digital
l. KW meter
m. KVA meter
n. KVAR meter
o. Power Factor meter
p. Automatic starting controls as specified herein
q. Automatic voltage regulator
r. Field circuit breaker

2. Fully automatic engine start-stop controls shall be furnished in each generator control panel. Provide a 4-position selector switch marked, "Auto", "Manual", "Off', and "Reset"; battery charger disconnect contacts; 2 auxiliary contacts, normally open; and 2 contacts normally closed. The control panel shall be furnished with a disconnect switch for control of the engine mounted thermal circulation type water heater.

3. For generator sets without a walk-in enclosure, the controls shall be set up to accept a momentary contact remote emergency shutoff switch to be installed by the Contractor. For generator sets with a walk-in enclosure, the generator set shall be furnished with an emergency shutoff switch prewired and installed just inside the entrance of the enclosure.

4. Provide the following additional indicators for protection and diagnostics according to NFPA Level 1:

a. Low Oil Pressure
b. High Water Temperature
c. Low Coolant Level
d. Overspeed
e. Overcrank (with lockout)
f. Emergency Stop Depressed
g. Approaching High Coolant temperature
h. Approaching Low Oil Pressure
i. Low Coolant temperature
j. Low voltage in battery
k. Control switch not in auto. Position
l. Low fuel pressure
m. Battery charger AC failure
n. High Battery voltage
o. EPS supplying load
p. Spare

E. Circuit Breaker

1. Provide a generator mounted circuit breaker, molded case or insulated case construction, 3 pole, with rating as indicated on the Contract drawings. Breaker shall have adjustable LSIG trip settings.

2. The breaker shall be enclosed in a Nema 1 enclosure and shall be protected by the generator system's weather protective enclosure. It shall be mounted on the side of the generator.

3. Breaker shall utilize a solid-state trip unit and a shunt trip mechanism.

4. The breaker shall be UL listed with shunt trip device connected to engine/generator safety shutdowns.

5. Provide lugs on the load side of the breaker for feeder connections.

F. Automatic Starting System

1. The electric starting system for each unit shall be d-c with positive engagement.

2. Provide a lead-acid storage battery set with battery service safety kit and cell covers, for each unit, of the heavy-duty cold-cranking type. Battery voltage shall be compatible with the starting systems. Batteries shall be of sufficient capacity to provide full cranking power for 1-1/2 minutes cranking time without recharging at a battery and engine temperature of 32 degrees Fahrenheit (assume SAE 30 oil for calculation purposes). Supply battery racks, warming pads and all necessary cables. The battery warming pads shall be wired to a common cord with the jacket water heater for connection by the Contractor.

3. The battery charger to be furnished for each unit shall employ transistor controlled magnetic amplifier circuit to provide continuous taper charging. Each charger shall maintain rated output voltage with a-c line fluctuations of +/- 10 percent. Each charger shall be equipped with full wave rectifiers, automatic surge suppressors, automatic a-c line compensation, automatic overload protection, d-c ammeter and voltmeter, fused a-c input and d-c output. Each charger shall be equipped with a timer to automatically equalize charge every 30 days for 24 hours. Input voltage shall be 120 volts, 60 Hz., a-c. The charger shall have LED annunciation for low DC volts, rectifier failure, loss of AC power, and high DC volts. Amperage output shall be no less than ten (10) amperes.

G. Weatherproof Housing

1. The generator assembly shall be installed in a full size sound-attenuated weather protective housing for generator outside operation. The housing shall be manufactured of 14-gauge hot-roll sheet steel, powder-coated. It shall have five hinged, removable doors with lockable, tamperproof, stainless steel latches to allow easy routine maintenance. The roof shall be pitched to prevent moisture accumulation. The housing shall be large enough to enclose the engine, generator, batteries, control panel, and all generator accessories except for the automatic transfer switch and remote annunciator.

2. The assembly shall be tested to ensure that there is no loss of generator set performance while operating in the enclosure.

4. The housing shall be painted utilizing electrostatically applied powder baked paint. The color shall be a custom color selected by the Owner during submittal review. Provide a color selection sheet with a minimum of 10 colors to choose from.

H. Remote Annunciator: A remote annunciator is not required; the generator will be monitored by the plant SCADA system. Provide dry contacts for remote monitoring of the following signals: generator running status, generator fault/alarm.

I. Sound Attentuation: Provide sound attenuation such that the noise generated by the generator set operating at 100 percent load shall not exceed the following A-weighted sound pressure levels in any of the indicated frequencies when measured in a free field at a radial distance of 22.9 feet at 45 degrees apart in all directions:

Frequency Band (Hz)	Maximum Acceptable Pressure Level (dBA)
20-75	81
75-150	71

150-300	64
300-600	58
600-1200	55
1200-2400	54
2400-4800	54
4800-10kHz	56

Note: The broadband total sound pressure level (logarithmic sum of the above spectral data) allowable is 81.5dBA or lower. This sound pressure level will be tested in the field with a sound pressure meter and the genset will be rejected if it does not pass this test.

2.03 AUTOMATIC TRANSFER SWITCH

A. Rating

1. Automatic transfer switches shall be furnished with ratings as indicated in the Drawings. The transfer switches shall be capable of switching all classes of load and shall be rated for continuous duty when installed in a non-ventilated enclosure that is constructed in accordance with Standard UL-50. The switch shall be 3 pole with solid neutral connection.

B. Construction and Performance

1. The transfer switches shall be double throw, actuated by a dual motor electrical operator momentarily energized; and connected to the transfer mechanism by a simple over center type linkage with a total transfer time of 400 ms. The switch operators shall be capable of transferring successfully in either direction with 70 percent of rated voltage applied to the switch terminals. The dual operated switch shall have an adjustable timed off position for switching motor load.

2. The normal and emergency contacts shall be positively interlocked mechanically and electrically to prevent simultaneous closing. Main contacts shall be mechanically locked in position in both the normal and emergency positions without the use of hooks, latches, magnets, or springs; and shall be silver-tungsten alloy. Provide separate arcing contacts with magnetic blowouts on each pole. Parallel main contacts are not acceptable. Interlocked, molded case circuit breakers or contactors are not acceptable.

3. The transfer switch shall be equipped with a safe external manual operator that is designed to prevent injury to the operating personnel if the electrical operator should suddenly become energized during manual transfer. The manual operator shall provide the same contact-to-contact transfer speed as the electrical operator to prevent a flashover from switching the main contacts slowly.

4. The transfer switch shall align in height and depth with the switchgear.

5. The transfer switch shall be mounted in a NEMA 1 enclosure unless indicated otherwise on the Contract drawings. Exterior-mounted transfer switches shall not have any displays/controls exposed on the exterior of the enclosure. Controls and displays shall be installed on an inner door, accessible after opening the outer enclosure door.

6. The transfer switch shall have both top and bottom cable access.

7. Control components and wiring shall be front accessible and shall be identified with markers and identification tags.

8. Non-stainless or non-aluminum transfer switches shall be finished with gray ANSI 61 polyester powder paint. Aluminum or Stainless transfer switches shall have a smooth brushed finish.

9. The transfer switch shall include a plant exerciser that can be scheduled for weekly operation. The exerciser shall include an option for either "no load" (switch doesn't transfer) or load (switch transfers) operation.

C. Sequence of Operation

1. Engine starting contacts shall be provided to start the generating plant if any phase of the normal source drops below 80 percent of rated voltage (adjustable), after an adjustable (0-9999 second) time delay period of 3 seconds, to allow for momentary dips. The transfer switch shall transfer to emergency as soon as the generator voltage and frequency have reached 90 percent of rated voltage (adjustable) and after an adjustable time delay period of 0-30 minutes shall delay retransfer to normal power until it has had time to stabilize. If the emergency power source should fail during the time delay period, the time delay shall be bypassed, and the switch shall return immediately to the normal source. After the switch is retransferred to normal, the engine-generator shall be allowed to operate at no load for an adjustable period of time (0-5 minutes) to allow it to cool before shutdown. The transfer switch shall include a key operated test switch (provide the Owner 5 keys) to simulate normal power failure (maintained contact), pilot lights on the cabinet door to indicate the switch closed on normal or emergency, and 2 auxiliary contacts on the main shaft: One closed on normal, the other closed on emergency. A selector switch shall be provided so that the switch may be either manually transferred or automatically transferred. A pushbutton manual operator shall be provided so that the plant operator will not have to manually throw the switch by lever. In addition, 1 set of relay contacts shall be provided in the automatic transfer switch that is normally open and closes upon transfer of the switch to emergency position, to signal an alarm at the meter panel. All relays, timers, control wiring and accessories to be front accessible.

2. Three phase amperage and voltage metering with phase selector switches shall be provided on the door of the transfer switch for monitoring utility conditions. Accuracy shall be +/-1% through the full range of the rated current and voltage of the switch. All necessary potential and current transformers shall be provided as well.

3. In addition to the above, the transfer switch must have a short circuit withstand capability in excess of the UL requirement in the amount of 35,000 amps. To establish conformance with the above, the manufacturer must be able to produce certified test reports (if necessary) from an independent testing laboratory to verify that identical samples have been subjected to 3 phase short circuit currents at 480 VAC, for a minimum of 3 cycles duration, without contact damage or contact welding and without the use of current limiting fuse protection.

2.04 ACCESSORIES

A. Provide hearing protectors, earmuff type, Willson No. 365, fibermetal No. 2011 or equal - 2 sets required.

B. Provide a weatherproof Class B fire extinguisher, 10lb min, installed near the genset.

PART 3 - EXECUTION

3.01 GENERATOR SET INSTALLATION / APPLICATION / ERECTION

A. The design and construction of the electric generator sets shall be such that they are neat and clean in appearance, and that normal adjustments and maintenance can be effected without use of special tools. See Drawings for generator installation details.

B. An adequate supply of the proper lubricant shall be provided to perform one oil change. In addition, spare elements shall be provided for fuel, oil, and air filters, for one complete change. The engine shall be filled with all necessary liquids required for operation.

C. The Contractor shall strictly adhere to this specification and the approved shop drawings and manufacturer's installation instructions for the installation of the generator system and its accessories.

D. Install gas piping in accordance with manufacturer's instructions and the applicable fuel/gas code.

3.02 STARTUP & TRAINING

A. Provide startup assistance from the manufacturer's authorized representative. The rep is required to submit a startup report documenting that the system was installed per manufacturer requirements and that there are no deficiencies.

A. Provide one day of training by manufacturer's authorized representative. Approved O&M manuals are required to be in hand prior to this training.

END OF SECTION

SECTION 16670 - LIGHTNING PROTECTION SYSTEMS (AIR TERMINALS)

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The lightning protection system shall be furnished, installed, and connected as detailed on the Contract Drawings to provide a complete and functional system. Installation and equipment construction shall comply with Lightning Protection Institute Installation Code LPI-175, UL Master Label Code 96A, and NFPA 780.

B. The Contractor shall provide shop drawings indicating location and installation of equipment for review of the Engineer before beginning installation.

C. All equipment shall be of the same manufacturer, insofar as possible.

D. Equipment specified herein supplements actual suppression devices specified in Section 16280.

1.02 Submittals

A. Shop drawings including product data and drawings of proposed installation are required for approval.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. "Thompson Lightning Protection, Inc.," "Independent Protection Co., Inc.," or equal.

2.02 EQUIPMENT

A. All equipment used in this installation shall be UL approved and labeled in accordance with UL procedures, with each air terminal bearing an "A" label and all main conductors bearing a "B" label at 10'-0" intervals.

B. All equipment shall be new, and of design and construction to suit the application where it is used in accordance with accepted industry standards and LPI and UL code requirements and as per manufacturers recommendations.

C. Downlead conductors from roof to ground shall be copper, of 28 strands, 17 gauge minimum. All main roof conductors shall be aluminum, of 24 strands, 14 gauge minimum.

D. Air terminals shall be solid, round aluminum bar of 1/2" minimum diameter, and shall project 10" minimum above the object to be protected.

E. Air terminal bases shall be of cast aluminum with bolted pressure cable connections and shall be securely mounted with stainless steel screws or bolts. Bases on built-up tar and gravel roofs shall be secured with a proper adhesive and shall have a minimum surface contact area of 18.5 square inches.

F. Ground rods shall be a minimum of 3/4" in diameter and 10'-0" long. They shall be connected to the system using exothermic welds, Cadweld, or equal.

G. Cable fasteners shall be substantial in construction, electrolytically compatible with the conductor and mounting surface and shall be spaced according to LPI and UL code requirements.

H. Bonding devices, cable splicers and miscellaneous connectors shall be of cast aluminum with bolted pressure connections to cable. Cast or stamped crip fittings are not acceptable.

I. Equipment on stacks and chimneys shall be protected from corrosion and sized in accordance with LPI and UL requirements.

J. All miscellaneous bolts, nuts, and screws shall be stainless steel.

K. An approved bimetal transition fitting shall be used at the roof level to change from aluminum roof conductor to copper downlead cable.

PART 3 - EXECUTION

3.01 INSTALLATION/APPLICATION/ERECTION

A. The installation shall be accomplished by an experienced installer listed with Underwriters' Laboratories as qualified and who is also a Certified Master Installer of the LPI or working under the direct supervision of an LPI manufacturer as listed above or his authorized LPI Certified Master Installer representative.

B. All equipment shall be installed in a neat workmanlike manner in the most inconspicuous manner possible. The system shall consist of a complete cable network on the roof including all air terminals, splices, and bonds with cable downleads routed concealed directly in the building construction for a new structure

C. The copper downlead cables shall not be brought directly through the roof. Through roof connectors with solid rods or conduits though pitch pockets shall be utilized for this purpose.

D. The limitations on areas of usage for aluminum cables and for copper and aluminum materials together as outlined in UL 96A and LPI 175 shall be observed. The lightning protection installer will work with other trades to ensure a correct, neat, and unobtrusive installation.

E. It shall be the responsibility of the lightning protection installer to assure a sound bond to the metallic main water service and to assure interconnection with other building ground systems, including both telephone and electrical and also to ensure that proper arresters have been installed on the power service.

F. Downlead conductors from roof to ground shall be protected from mechanical damage from a point 8 feet above to 1 foot below grade by conduit or other means.

G. The lightning protection installer shall secure and deliver a UL Master Label and LPI System Certification to the Engineer for the Owner upon completion of the installation.

H. The Contractor shall also submit 2 copies of as built shop drawings, 1 with the UL Master Label Application Form and another with LPI forms 175A and B.

I. A permanent plate shall be affixed to the protected structure in a prominent location, indicating its UL approval.

END OF SECTION

DIVISION 17

INSTRUMENTATION

SECTION 17311 - PLC HARDWARE AND SOFTWARE

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This Section includes Programmable logic controllers for control of process equipment, process oriented machinery, and process systems.

1.02 RELATED WORK

A. Refer to Section 17410.

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

1.03 SUBMITTALS

A. Refer to Sections 01300 and 17410.

B. 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, and terminal connections.

C. Operation and Maintenance Data: Provide literature detailing routine maintenance requirements (if any) for each PLC component including:

1. System specifications
2. Electrical power requirements
3. Application considerations
4. Assembly and installation procedures
5. Power-up procedures
6. Programming procedures
7. Explanation of internal fault diagnostics
8. Shut down procedures
9. Recommended spare parts list

1.04 REFERENCE STANDARDS

A. ASTM D999-91: Vibration

B. (CFR) Title 47, Part 18 (European EN 55011 (formerly C1SPR 11))

C. CSA Certification Class I, Division 2, Group A, B, C, D Hazardous or non-hazardous locations

D. IEC 60068-2.1 Environmental testing — Part 2-1: Tests - Test A: Cold, 2.2 Environmental testing - Part 2: Tests. Tests B: Dry heat, 2.3, 2.6 Environmental testing - Part 2: Tests - Test Fe: Vibration (sinusoidal) and 2.27 Environmental testing. Part 2: Tests. Test Ea and guidance: Shock

E. IEC 61000 Electromagnetic compatibility (EMC) - Testing and measurement techniques

1. Part 4-2: Electrostatic discharge immunity test
2. Part 4-3: Radiated, radio-frequency, electromagnetic field immunity test
3. Part 4-4: Electrical fast transient/burst immunity test
4. Part 4-5: Surge immunity test
5. Part 4-6: Immunity to conducted disturbances, induced by radio-frequency fields

F. IEC 61131-3: Programmable controllers - Part 3: Programming languages

G. IEC 801-3: RFI Immunity

H. IEC 801-5: Ground Continuity

I. IEC 801-2: Electrostatic Discharge

J. IEEE 472-1974/ANSI C37.90/90A-1974 (Surge Withstand) IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus

K. MIL STD 461B CS02: RFI/EMI Susceptibility

L. NEMA Pub No ICS2-230.42: Showering Arc Test

M. NSTA Project 1 A

N. UL 508 and CSA Standard C22.2 No. 142 (Isolation Voltages)

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer shall be capable of providing training, parts, and coordination of emergency maintenance and repairs.

B. The programmable controller and all of the corresponding components within the family of controller products shall be manufactured by a company that regularly manufactures and services this type of equipment.

C. The manufacturer shall comply with IS09001 standards for "Quality Systems- Model for Quality Assurance in Design/Development, Production, Installation, and Servicing".

D. The manufacturer shall provide complete technical support for all of the products. This shall include factory or on-site training, regional application centers, local or factory technical assistance, and a 24/7/365 technical support phone service.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver PLC components in packaging designed to prevent damage from static electricity and physical damage.

B. Store PLC equipment according to manufacturer requirements. At 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.

1.07 NOMENCLATURE AND IDENTIFICATION DEFINITIONS

A. AI: Analog Input

B. AO: Analog Output

C. Fixed I/O: A PLC style consisting of a fixed number of I/0, a processor, and a power supply all in one enclosure. Some fixed PLCs have limited expansion ability.

D. CPU: Central Processing Unit

E. DI: Discrete Input

F. Distributed I/O: Hardware specially designed to function as Remote I/O.

G. DO: Discrete 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: I/O that is located remotely from the processor. Remote I/O can communicate 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

1.08 SPARE I/O

A. Each I/O drop and I/O location shall include at least 20 percent (minimum of four) points of each type (AI, AO, DI, and DO) for future use, regardless of whether any of those point types are used in that drop or location or not. The spares shall be the same type of I/O modules supplied.

B. Spare output points that require the use of an external relay shall be supplied with the external relay.

C. Regardless of the spare requirement, all installed unused points on all I/O modules shall be wired to terminal blocks in the order that they occur on the I/O modules. Unwired spares shall not be acceptable.

1.09 SPARE PARTS

A. General requirements for spare parts are specified in section 17490.

B. The following PLC spare parts shall be furnished:

1. Processors: Provide (1) spare processor unit(s) for each unique processor installed. The as-built program shall be stored on the memory card for quick transfer to the spare processor in the event of processor failure.

2. Memory Cards: Provide spares for each type of card installed.

3. I/O Cards: Provide spares for each unique I/O module type installed. Provide two or 10 percent of installed quantity, whichever is greater.

4. Network interface, remote I/O, and communication modules: Provide one spare communication module for each unique communication module 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. PLC Power supplies: Provide (1) spare power supply for each unique power supply installed.

7. Chassis: Provide (1) spare chassis for each unique chassis installed.

8. Miscellaneous components (including cables): Provide spares for each unique component installed.

1.10 MANUFACTURER SUPPORT

A. Provide a written proposal for a manufacturer support agreement for PLC hardware and software for a minimum of 12 months starting at final completion of the project. The cost of this manufacturer support agreement shall not be included in the Contract Price. The support agreement shall be executed in the name of, and for the benefit of, the OWNER. At a minimum, this agreement shall provide the OWNER with:

1. Twenty-four hour, 7 day per week manufacturer telephone support

2. Access to the manufacturer's technical support web site

3. Software and firmware updates.

PART 2 - PRODUCTS

2.01 GENERAL

A. Provide Programmable Logic Controller equipment with the required memory and functional capacity to perform the specified sequence of operation with the scheduled input and output points.

B. Processor Systems shall include processor, power supply, input/output modules, communication modules, redundancy modules, and remote interface modules as required to meet system requirements.

C. Furnish products listed and classified by Underwriters Laboratories (UL), CSA, or FM approval as suitable for purpose specified and indicated.

D. All equipment and devices furnished hereunder shall be designed for continuous industrial service. The system shall contain products of a single manufacturer, insofar as possible, and shall consist of equipment models that are currently in production.

E. All equipment furnished shall be designed and constructed so that in the event of power interruption the systems shall go through an orderly shutdown with no loss of memory, and resume normal operation without manually resetting when power is restored.

F. The PLCs shall communicate between the operator workstation and field-mounted transducers, switches, controllers, and process actuators. Communications protocol shall be completely transparent to process operators at the Human Machine Interface (HMI).

G. The PLC shall be capable of stand-alone operation in the event of failure of the communication link to the HMI subsystem.

H. Backup Processor Systems, if indicated on the drawings, shall consist of two chassis with power supplies, each containing a processor, redundancy module and communications module(s). Remote chassis shall be provided with communication modules to meet I/O and communication requirements.

I. Remote Input/Output Units shall include input/output modules, interface modules, communication modules, and power supply to meet system input and output requirements.

J. Agency and environmental specifications:

1. Electrical supply voltage to the PLC shall be 120 Vac, plus or minus 15 percent, 48-63Hz. PLC system power supplies shall be fused for overload protection.

2. Vibration: 3.5 mm Peak-to-Peak, 5-9 Hz: 1.0G, 9-1501Hz. The method of testing is to be based upon IEC 68-2-6 and JIS C 0911 standards for vibration. The system is to be operational during and after testing. Vibration Rating of 2.0G maximum peak acceleration for 10 to 500Hz. in accordance with at least one of the following:

   a. Installed rating: 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.

   c. In compliance with IEC 60068 and IEC 61131.

3. Shock: 15G, 11 msec. The method of testing is to be based upon IEC 68-2-27 and JIS C 0912 standards for shock. The system is to be operational during and after testing.

4. Temperature: All PLC hardware shall operate at an ambient temperature of 0 to +55 degrees C (+32 to +140 degrees F), with an storage ambient temperature rating of -25 to +70 degrees C (-40 to +185 degrees F).

5. Relative Humidity: The Programmable Controller hardware shall function continuously in the relative humidity range of 30 percent to 95 percent non-condensing.

6. Noise Immunity: The Programmable Controller system shall be designed and tested to operate in the high electrical noise environment of an industrial plant as governed by the following regulations: IEEE 472, IEC 801, MILSTD 461B, IEC 255-4, NEMA ICS 2-230.40, and ANSI/IEEE C-37.90A-1978.

7. Altitude:

   a. Operation: 0-6,500 feet

   b. Storage: 0-9,800 feet

8. Degree of protection: NEMA 1 (IP20)

9. All products shall have corrosion protection.

K. All major assemblies and sub-assemblies, circuit boards, and devices shall be identified using permanent labels or markings indicating:

1. Modules product type such as analog or digital

2. Modules catalog number

3. Modules major revision number

4. Modules minor revision number

5. Module manufacturer vendor

6. Module serial number

L. All necessary cables shall be included. All cables and connectors shall be as specified by the manufacturer. Cables shall be assembled and installed per the manufacturer recommendations.

M. Manufacturers

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. Provide the PLC system by one of the following:

a. Rockwell Automation Allen-Bradley CompactLogix

b. Or Engineer approved equal

N. Central Processing Unit (CPU)

1. Processor Memory: 1.5 megabytes, battery backed RAM, minimum
2. Capability of controlling up to (30) I/O modules
3. Shall have typical throughput Time of 0.08 ms/K based upon a 1K ladder logic program consisting of simple ladder logic and communications servicing.
4. Shall have Bit Execution Time of less than 0.51 microseconds
5. Shall support Proportional Integral Derivative Control with up to 451 microsecond execution time
6. Shall support online programming including runtime editing
7. Memory Back-up provided through minimum two year lithium battery
8. LED indicators for: POWER, RUN, CPU Fault, Forced I/O, Battery Low, DH485, RS-232
9. One USB port
10. Shall support a Real Time Clock
11. The processor shall support Ethernet communications via RJ-45 connection
12. Provide a SD card for non-volatile program storage.

O. Programming Environment

1. Programming port: The PLC shall utilize a serial USB or Ethernet port for programming.

2. On-Line programming: Application programs may be modified or stored while the CPU is running, with minimal impact on the scan time.

3. Online programming including runtime editing

4. IEC 61131-3 programming languages supported: Ladder logic, function block, sequential function chart, and structure text.

5. Supply all hardware and software necessary to program the CPU in these languages.

2.02 POWER SUPPLIES

A. The PLC shall have chassis mounted power supplies to power the chassis backplane, and provide power for the processor and applicable modules.

B. Power supplies shall have a clearly visible LED to indicate that the incoming power is acceptable and the output voltage is present.

C. Power supplies shall feature over-current and over-voltage protection and should be designed to operate in most industrial environments without the need for isolation transformers.

D. Power supplies shall be sized to accommodate the anticipated load plus 30%.

E. DC power supplies shall be capable of handling ripple up to 2.4V peak to peak.

F. AC Line Voltage rating of 85 to 265Vac, 47-63Hz

G. The power supplies shall allow for brown outs of at least 1/2 of a cycle, a harmonic rate of 10%, and will sustain continuous operation through momentary interruptions of AC line voltage of 10ms or less.

H. Automatically shut down the Programmable Controller system whenever its output power is detected as exceeding 125% of its rated power

I. Provide surge protection, isolation, and outage carry-over up to 2 cycles of the AC line.

2.03 DISCRETE INPUT AND OUTPUT MODULES

A. General

1. Digital input and output modules shall provide ON/OFF detection and actuation.

2. The I/O count and type shall be as required to implement the functions specified plus an allowance for active spares, as noted below.

3. Modules shall be designed to be installed or removed while chassis power is applied.

4. Modules shall have indicators to display the status of communication, module health and input / output devices.

5. Each module shall have the following status indicators.

   a. The On/Off state of the field device.

   b. The module's communication status.

6. I/O modules shall contain a maximum of 16 points per module.

B. Module Specifications (120Vac Isolated Input Module)

1. Nominal Input Voltage of 120V ac

2. On-State Current of 15inA @132V ac, 47-63Hz maximum

3. Maximum Off-State Voltage of 20V

4. Maximum Off-State Current of 2.5mA

C. Module Specification (120Vac Isolated Output Module)

1. Each triac type discrete output shall have an associated interposing relay located in the same control panel. 120 VAC power for relay outputs shall be provided from the associated motor starter control circuit (when used with motor starters) or other 120 VAC source (when I/O is not associated with a particular motor starter).

2. Output Voltage Range of 74-265V ac, 47-63Hz.

3. Output Current Rating:

a. Per Point - 2A maximum @ 30 degrees C; 1.0A maximum @ 60 degrees C; Linear Derating

b. Per Module - 5A maximum @ 30 degrees C; 4A maximum @ 60 degrees C; Linear Derating

4. Surge Current Per Point of 20A for 43ms each, repeatable every 2s @ 60 degrees C

5. Minimum Load Current of 10mA per point

6. Maximum On-State Voltage Drop of 1.5V peak @2.0A and 6V peak @load less than 50mA

7. Maximum Off-State Leakage of 3mA per point

D. Module Specifications (Contact Output Module)

1. Output Voltage Range of 10-265V ac, 47-63Hz

2. Output Current Rating:

a. Resistive - 2A @ 125V ac

b. Inductive - 2A Steady State, 15A make @125V ac

3. Power Rating (Steady State) of 250VA maximum for 125V ac inductive output

4. Maximum Off-State Leakage of 0 mA per point

5. Configurable States

a. Fault Per Point - Hold Last State, ON or OFF

b. Program Mode Per Point - Hold Last State, ON or OFF

2.04 ANALOG INPUT AND OUTPUT MODULES

A. General

1. Analog input modules shall convert an analog signal that is connected to the module's screw terminals into a digital value. The digital value representing the magnitude of the analog signal shall be transmitted on the backplane. Analog output modules shall convert

a digital value that is delivered to the module via the backplane into an analog signal on the module's screw terminals.

2. Modules shall be designed to be installed or removed while chassis power is applied.

3. Modules shall have indicators to display the status of communication, module health and input / output devices.

4. Each analog module shall provide both hardware and software indication when a module fault has occurred. Each module shall have an LED fault indicator and the programming software shall display the fault information.

5. Analog modules shall be software configurable through the I/O configuration portion of the programming software.

6. The following status shall be capable of being examined in ladder logic

   a. Module Fault Word — Provides fault summary reporting.

   b. Channel Fault Word — Provides under-range, over-range and communications fault reporting.

   c. Channel Status Words — Provides individual channel under-range and over-range fault reporting for process alarm, rate alarms and calibration faults.

7. The 24 VDC power for analog instrument loops shall be provided as a part of the system. The 24 VDC power supply shall be derived from the 120 VAC input power circuit to the PLC. The field side of the 24 VDC power sources(s) shall have individual or grouped (of logically associated circuits) fusing and be provided with a readily visible, labeled blown fuse indicator.

B. Isolated Analog Input Module

1. Input Range of 4-20 mA

2. Resolution of approximately 16 bits across range

3. Input Impedance of Greater than 249 Ohms

4. Overvoltage Protection: 8V ac/dc with on-board current resistor

5. Normal Mode Rejection of 60dB at 60Hz

6. Common Mode Noise Rejection of 120dB at 60Hz, 100dB at 50Hz

7. Isolation Voltage

   a. Channel to Channel - 100% tested at 1700V dc for Is based on 250V ac

   b. User to System - 100% tested at 1700V de for is based on 250V ac

C. Isolated Analog Output Current Module

1. Output Current Range of 4 to 20 mA

2. Current Resolution of 12 bits across 20 mA

3. Open Circuit Detection — None

4. Output Overvoltage Protection - 24V ac/dc maximum

5. Output Short Circuit Protection — 20 mA or less (electronically limited)

6. Calibration Accuracy - Better than 0.1% of range from 4mA to 20 mA

7. Calibration Interval - 12 months typical

2.05 COMMUNICATION INTERFACES

A. The PLC shall be capable of the following communication protocols as shown on the drawings:

1. 10BASE-T/100BASE-TX Ethernet communication with Ethernet/IP protocol.

B. Where required provide a Communications Interface Module mounted in the chassis or the equivalent port directly on the CPU.

2.06 PLC SOFTWARE

A. Development software licensing is not required on this project.

2.07 OPERATOR INTERFACE TERMINALS (OIT)

A. OITs shall be mounted on control panels and shall run interface software separate from the existing SCADA HMI software.

B. Manufacturers

1. Provide operator interface terminals (OIT) from one of the following:

a. Allen-Bradley Panel View Plus 6 series

b. Or equal

C. Software

1. The Operator Interface Terminal shall be pre-packaged with all configuration and programming software necessary to perform functions as shown on drawings and within the specifications.

2. The integrated OIT software shall have the following features

a. Trending

b. Data Logging

c. Alarms

d. Graphic Symbols

e. Animations

D. I/O Ports and Devices

1. The OIT shall have a minimum of one Ethernet 10/100 Mbps for connectivity or programming

2. The OIT shall have a minimum of one Serial RS232 port.

3. Compact flash ports shall be Type 2.

4. The OIT shall have a minimum of one USB port.

E. Display

1. The OIT display size shall be 15"

2. The type of display for the OIT shall be Color Active Matrix TFT.

3. The display resolution shall be a minimum of 1024x768.

4. Display shall support touch screen input.

F. Environmental

1. Rating: OIT shall be rated to maintain the rating of the control panel it will be mounted in.

2. Operating Temperature: 0-50 degrees C.

G. Manufacturers:

1. Rockwell Automation Allen-Bradley Panel View Plus 6

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

A. Maintain area free of dirt and dust during and after installation of programmable controller products.

B. Anchor PLCs within enclosures as recommended by the PLC manufacturer.

C. Ventilation slots shall not be blocked, or obstructed by any means.

D. Examine areas, surfaces, and substrates to receive PLCs for compliance with requirements, installation tolerances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

E. Install in accordance with manufacturer's instructions.

F. Unload, unpack and transport equipment to prevent damage or loss.

G. Replace damaged components as directed by Engineer.

3.02 PANEL LAYOUT

A. Coordinate size and configuration of enclosure to meet project requirements. Drawings indicate maximum dimensions for PLCs, minimum clearances between PLCs, and adjacent surfaces and other items.

B. Comply with indicated maximum dimensions and clearances, or with PLC vendors required distances if they are greater than the distances indicated.

1. Provide spacing around PLC as required by the PLC manufacturer to insure adequate cooling. Insure that the air surrounding the PLC has been conditioned to maintain the required temperature and humidity range.

2. 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.

3. For chassis mounted PLCs, no wiring, wire ducts, or other devices shall obstruct the removal of cards from the rack.

4. 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.

C. Control panel designer shall provide independent line fuses or circuit breakers, per the PLC manufacturer recommendation, for each power supply, input module, output module, and other modules with separately derived power requirements.

D. Control panel designer shall insure that communication signals, 4-20mA signals (including those with embedded HART), are properly conditioned for the PLC and protected from all sources of radiated energy or harmonics.

E. Each PLC (including all I/O) shall be powered from the UPS power conditioning system in Section 17430.

F. Where multiple mechanical components are provided for process redundancy, their field connections to I/O modules shall be arranged such that the failure of a single module will not disable all mechanical components associated with the process redundancy (e.g., inputs and outputs for redundancy device 1 shall reside on different modules than the inputs and outputs for redundancy device 2, etc.), irrespective of the number of used points resulting from this configuration.

G. Provide all required cables, cords, and connective devices for interface with other control system components.

END OF SECTION

SECTION 17312 – RADIO TELEMETRY SYSTEM

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section describes the requirements for furnishing, installing, and starting up a radio system for polling SCADA communications using Ethernet protocol.

1.02 SYSTEM DESCRIPTION

A. The successful communication of the new RTU panel back to the LFUCG WWTP (Town Branch) is the sole responsibility of the Contractor. The new radio shall be fully compatible with the existing system.

B. The radio system shall be comprised of, but not limited to, the following (refer to the Drawings):

1. For radio all communications:

a. Provide a new 812.06250 MHz radio. The radio shall be connected to a new PLC at the site. Antenna, transmission cable, connectors, enclosure and mounting hardware shall be provided as required and as shown on the Drawings.

b. A central repeater will be utilized for all communications from the site back to the designated LFUCG WWTP (Town Branch or West Hickman) where the data will be utilized for monitoring and control from SCADA.

c. Provide directional (Yagi) antenna, coaxial cable, connectors, in-line coaxial cable surge protectors, and antenna mounting supports as required. The antenna shall be mounted on a support structure which meets the requirements as shown on the drawings. The Contractor shall be responsible for obtaining any and all required Construction Permits for the installation of equipment at the site and shall meet all applicable codes and regulations.

d. Provide Coordination with Owner to meet all applicable federal communications commission (FCC), state and local regulations.

C. The Contractor shall furnish and install any additional equipment (e.g. repeaters, towers, etc.) necessary to provide a functional system. A functional system shall be defined as a system where the received signal at any location not be less than 25 dB fade margin based on radio manufacturer's published receive sensitivity for 10-6 bit error rate for unfaded signal.

D. The existing SCADA system shall clearly identify the station being polled, the number of consecutive fails at each station, and the current poll timer, maximum poll time, and minimum poll time.

1.03 SUBMITTALS

A. Include the following information for each product specified in this section in the submittal for this section.

1. Data sheets and catalog literature for hardware (radios and accessories), and for the poll/response SCADA communications software that will be used.

2. Physical dimension drawings.

3. A complete set of installation and service manuals for the equipment specified in this section.

4. Installation and interconnection/wiring diagrams depicting the proposed installation of the equipment, in conformance to the requirements specified on the Plans. These drawings shall be detailed to the extent that they may be modified after installation to serve as the "AS-BUILT" drawings.

5. After installation is complete at each site, provide printout of radio/communication performance data (i.e. forward and reverse power, etc.).

B. A path study/verification submittal is required prior to approval and procurement of the radio system equipment and antenna tower. The path study is required to be perfomed physically with rental or loaner radio and equipment using a bucket truck. Software-generated path studies will not be accepted. The received signal shall not be less than 25 dB fade margin based on radio manufacturer's published receive sensitivity for 10-6 bit error rate and unfaded signal. A 40-ft antenna tower shall be included in the bid. If the path study indicates that a higher or lower antenna tower height is needed, then the Contract will be adjusted accordingly via change order.

1.04 SPARE PARTS

A. One spare radio shall be provided and pre-programmed to match the installed unit.

PART 2 - PRODUCTS

2.01 RADIOS

A. The following general requirements shall be met by the radio:

1. Frequency Band: 800 MHz.

2. Data Rate: 1 Mbps/512 kbps, user configured.

3. Environmental: Full performance -30 □ to +60□C

4. Power Requirements: 10-30 VDC.

5. RTU/PLC Interface: 10/100-base T, RJ45 connector.

6. System Gain: 139dB @ 512kbps; 134dB@1Mbps

7. Receiver Sensitivity: -97dBm @ 512kbps with 10-6 BER; -92dBm @ 1Mbps with 10-6 BER

8. Protocols: Wireless Ethernet TCP/IP.

9. Encryption: AES-128 with automatic key rotation.

10. Management: HTTPS.

B. Radios shall be a Trio ER45e.

2.03 ANTENNAS

A. Antennas (Yagi type) shall be furnished.

B. Antenna characteristics:

1. Frequency Range: 806 to 890 MHz

2.	Gain:	as required
3.	Input Power:	50 watts minimum
4.	VSWR:	Less than 1.5
5.	Lightning Protection:	Direct ground
6.	Connector:	18 inch flexible extension (RG-393/U), type N male with neoprene housing or equivalent
7.	Mounting Hardware:	Clamps, standoff hardware as recommended by the antenna manufacturer
8.	Manufacturer:	Radio Frequency Systems (Celwave), or approved equal

C. ANTENNA TOWER: Shall be ROHN G-series or equal. The antenna tower shall be capable of withstanding the (non-simultaneous) environmental conditions of 70 mph wind and 1/2-inch radial ice without failure. The antenna tower shall be self supporting with hot-dip galvanization inside and out. Lightning protection shall comply with NFPA 780. Grounding Conductors Antenna grounding conductors shall be minimum 32-strand, No. 17 AWG copper. A safety cable is required to be furnished by the manufacturer and installed on the tower. A 40' tower shall be provided (to be verified during path study/verification prior to procurement).

2.04 TRANSMISSION CABLE AND ACCESSORIES

A. The transmission cable connecting the radio antenna port with the antenna shall be the low-loss foam-dielectric coaxial type. A single continuous piece of coaxial cable shall be furnished for each radio. This cable shall be ½ inch diameter (Andrew LDF4-50A, or equal). For coax runs exceeding 100 feet in length, furnish 7/8" diameter cable (Andrew LDF5-50A, or equal).

B. Provide one 3-foot section of "superflexible" transmission cable for coax interconnection at the radio antenna port. Provide standard Type N connectors at each end which will mate with the SS radio and the transmission cable.

C. Furnish two N-type connectors for terminating both ends of each transmission cable.

D. Furnish two coaxial cable grounding kits per radio. Furnish Andrew, or equal.

E. Provide Andrew coaxial cable hanger kits and clamping hardware, in 316 stainless steel. Adequate kits shall be installed to anchor the cables at three-foot intervals on the vertical antenna mast/tower.

F. All outdoor coaxial connectors shall be wrapped with two layers of Scotch Super 88 UV resistant tape, and then coated with two layers of Scotch-Kote.

2.05 LIGHTNING/SURGE PROTECTION

A. Furnish one in-line coaxial cable surge protector for each cable. Furnish Polyphaser, or equal with N-connector mating.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

A. Instrumentation and accessory equipment shall be installed in accordance with the Manufacturer's instructions. Obtain in the field all information relevant to the placing of process control work and in case of any interference with other work, coordinate with the Engineer/Owner and furnish all labor and materials necessary to complete the work in an acceptable manner.

B. All work shall be executed in full accordance with codes and local rulings. Should any work be performed contrary to said rulings, ordinances and regulations, the Contractor shall bear full responsibility for such violations and assume all costs arising therefrom.

END OF SECTION

SECTION 17410 - BASIC MEASUREMENT AND CONTROL INSTRUMENTATION MATERIALS AND METHODS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. The Contractor shall furnish all materials, labor, tools, equipment, supplies and services necessary to install all process control and instrumentation equipment complete as specified herein and shown on the Drawings. The Contractor shall be responsible for the expense of changing Drawings or structures, or any other expense necessitated by reason of installing alternative equipment. The Contractor will assume the responsibility for the satisfactory operation of any and all equipment offered.

B. The following equipment specification is included to establish the quality of equipment to be obtained. It is the intent of these Specifications to obtain industrial quality instrumentation and control equipment. Equipment furnished shall be accepted by the Engineer, prior to purchase by the Contractor.

C. Auxiliary and accessory devices necessary for system operation or performance, such as transducers or relays to interface with equipment provided under other Sections of this Specification, shall be included whether specified or not, at no extra cost.

D. In order to ensure proper integration and compatibility of the Wet Weather Storage instrumentation and control systems, the systems must be supplied by a single provider of instrumentation and control equipment. This is not to say that all equipment being supplied shall be manufactured by a single manufacturer, but rather that a single provider of instrumentation and control equipment shall be responsible for supplying the complete system. To facilitate the Owner's future operation and maintenance, products performing the same function shall all be of the same manufacturer, type, and model number.

E. Substitutions on functions or equipment specified will not be acceptable. In order to ensure the interchangeability of parts, the maintenance of quality, the ease of interfacing between the various subsystems, and the establishment of minimums with regard to ranges and accuracy, strict compliance with the above requirements shall be maintained. In order to ensure compatibility between all equipment, it shall be the responsibility of the system supplier hereunder to coordinate all interface requirements with mechanical and electrical system suppliers and furnish any signal isolation devices that might be required.

F. Equipment shall be fabricated, assembled, installed, and placed in proper operating condition in full conformity with detail drawings, specifications, engineering data, instructions and recommendations of the equipment manufacturer as accepted by the Engineer.

G. The instrument supplier for this Contract shall be responsible for making the modifications shown on the Drawings and for recalibrating all instruments and placing them in proper working order.

1.02 RELATED WORK

A. The following Sections of this Specification Division contain requirements on instrumentation and control equipment and software which are considered to be covered by applicable requirements of this section (and shall be included in the bid by a single Instrumentation Supplier for this Project):

Section 17311 – Plc Hardware and Software
Section 17420 - Instruments
Section 17430 - Boxes, Panels and Control Centers
Section 17480 - Instrument Lists and Reports

B. The following Divisions of these Specifications contain requirements on equipment furnished by other suppliers that must interface with the instrument system, or on methods and materials to be performed/used in the installation and/or wiring of the instrumentation system.

Division 1 - General Requirements
Division 11 - Equipment
Division 16 - Electrical

1.03 QUALITY ASSURANCE

A. The system supplier shall be required to demonstrate a minimum of 4 years recent, past experience in the design, manufacture, and commissioning of instrumentation and control systems of comparable size, type, and complexity to the proposed project. Further, the manufacturer must have at least 10 similar systems in operation currently. The system supplier shall be required to have his own in-house capability to handle complete system engineering, fabrication, and testing.

B. The system supplier shall have in his employ the capable personnel for detail engineering, coordination, drafting, procurement and expediting, scheduling construction, testing inspection, installation, start-up service for calibration and commissioning, and warranty compliance for the period specified. A minimum of (3) technical/programming engineers are required to be on the supplier's direct-employed staff in the local office/shop. The local office/shop shall not be located more than 130 miles from the project site.

C. The project manager for the I&C supplier shall be a controls engineer with a minimum of a bachelor's degree in engineering at an ABET-accredited institution and a minimum of 5 years' experience. Provide resume and references for the proposed project manager.

D. Proposed suppliers who do not meet the above qualifications will be rejected during the submittal phase. Contractors are encouraged to submit a pre-bid qualifications submittal for approval (minimum 10 days prior to bid date) if there is any question of whether or not a supplier is qualified.

1.04 REFERENCES

A. The Contractor is referred to Standards and Practices for Instrumentation published by the International Society of Automation (latest edition), for terminology, symbols, methods and practices used or described herein or on the Drawings.

1.05 SUBMITTALS

A. General

1. Submit detailed supplier and project manager qualifications. Although a pre-bid submittal is not required, suppliers lacking the requisite qualifications will be rejected during the submittal review phase. Contractors are encouraged to submit pre-bid qualifications if there is any question on whether or not a proposed supplier meets the qualifications.

2. Complete detail Drawings of the instrumentation and control systems and all components shall be submitted in 3 copies in a 3-ring loose-leaf cardboard reinforced vinyl binder to the Engineer for preliminary review. They shall include installation instructions, operation and maintenance instructions, descriptive literature, connection drawings, and parts list for each item as well as individual control schematic drawings for each item.

3. The Contractor shall make any corrections or changes required by the Engineer, within the scope of the Drawings and Specifications, and return copies in 3-ring loose-leaf cardboard reinforced vinyl binders for final review and distribution. Number of copies

shall be as specified in Special conditions and as agreed at the pre-construction conference.

4. Should any system submitted in the shop drawings not meet with the Engineer's acceptance as to conformity with requirements of the Drawings and Specifications, it shall be the responsibility of the successful Contractor to make whatever changes are necessary for acceptance at no extra cost to the Owner.

B. Detailed Requirements - Instruments/Hardware

1. Detailed information for each instrument or control device shall be submitted, including manufacturer's descriptive literature and a specific data sheet for each device which shall include as a minimum:

   a. Tag number assigned by the Contract Documents.

   b. Product (item) name used herein and on the Contract Drawings.

   c. Manufacturer's complete model number.

   d. Location of the device.

   e. Input - output characteristics.

   f. Electrical characteristics.

   g. Range, size, and graduations.

   h. Physical size with dimensions, enclosure NEMA classification, and mounting details.

   i. Materials of construction of all components.

   j. Instrument or control device sizing calculations where applicable.

   k. Certified calibration data on all flow metering devices.

2. Submit a detailed loop diagram, for each monitoring or control loop, each on a single 8 ½ in. x 11 in. sheet. The format shall be the Instrument Society of America, Standard for Instrument Loop Diagrams, ISA-S5.4.

3. The data sheets shall be provided with an index and proper identification and cross-referencing. Partial submittals will be rejected.

4. Submit detailed drawings concerning control panels and/or enclosures including:

   a. Cabinet assembly and layout drawings to scale.

   b. Fabrication and painting specifications.

   c. I/O layout.

   d. Elementary panel wiring diagrams

   e. Point to point wiring diagrams depicting wiring within the panel as well as connections to external devices.

   f. Color samples for paint selection by the Engineer and/or Owner.

   g. Panel submittal drawings shall be on 11 in x 17 in. sheets.

5. Exceptions to the Specifications or Drawings shall be clearly indicated in the submittal by the system supplier. Data shall contain sufficient details so a proper evaluation may be made by the Engineer.

6. Prior to final acceptance, the final shop drawing submittal, which is to include Installation, Operation, and Maintenance instructions, shall be updated to reflect "As Constructed" status, and shall provide at least the following as a minimum:

   a. A comprehensive index.

   b. A complete "As Constructed" set of accepted shop drawings.

   c. A complete list of the equipment supplied, including serial numbers, ranges, and pertinent data.

   d. Full specifications on each item.

   e. System schematic drawings "As Constructed", illustrating all components, piping and electrical connections of the systems supplied under this Section.

   f. Detailed service, maintenance, and operation instructions for each item supplied.

   g. Special maintenance requirements particular to this system shall be clearly defined, along with special calibration and test procedures.

   h. The operating instructions shall also incorporate a functional description of the entire system, with reference to the systems schematic drawings and instructions.

   i. Complete parts lists with stock numbers and name, address, and telephone number of the local supplier.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Shipping Precautions:

1. After completion of shop assembly, factory test, and acceptance, all equipment, cabinets, panels, and consoles shall be packed in protective crates and enclosed in heavy duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust, and moisture. Dehumidifiers shall be placed inside the polyethylene coverings. The equipment shall then be skid-mounted for final transport. Lifting rings shall be provided for moving without removing protective covering. Boxed weights shall be shown on shipping tags together with instructions for unloading, transporting, storing, and handling at the job site.

2. Special instructions for proper field handling, storage and installation required by manufacturer for proper protection, shall be securely attached to each piece of equipment proper to packaging and shipment.

B. Identification:

1. Each component shall be tagged to identify its location, tag number and function in the system. Identification shall be prominently displayed on the outside of the package.

2. A permanent stainless steel or other non-corrosive material tag firmly attached and permanently and indelibly marked with the instrument tag number, as given in the tabulation, shall be provided on each piece of equipment supplied under this Section.

C. Storage:

1. Equipment shall not be stored out-of-doors. Equipment shall be stored in dry permanent shelters including in-line equipment, and shall be adequately protected against mechanical injury. If any apparatus has been damaged, such damage shall be repaired by the Contractor at his own cost and expense. If any apparatus has been subject to possible injury by water, it shall be thoroughly dried out and put through such tests as directed by the Engineer. This shall be at the cost and expense of the Contractor, or the apparatus shall be replaced by the Contractor at his own expense.

1.07 WARRANTY (MAINTENANCE CONTRACT)

A. A written total instrument maintenance contract shall be provided to the Owner, executed by the system supplier as a part of the work under this Section. The maintenance contract shall include all labor, parts, and emergency calls providing on-site response within 48 hours, to provide complete instrument system maintenance for a period of one year after the date of final acceptance of the system. The maintenance contract shall also include a minimum of 2 semi-annual preventive maintenance visits by a qualified serviceman of the supplier who is familiar with the type of equipment provided for this project. Each preventive maintenance visit shall include routine adjustment, calibration, cleaning, and lubrication of all system equipment and verification of correct operations. Emergency maintenance procedures or plant visits may coincide with a scheduled preventive maintenance visit, however, they shall not replace the work intended to be performed during a preventive maintenance visit. The system supplier shall have full responsibility for the preventive and corrective maintenance including replacing of defective components, maintaining sufficient spare parts on-site, and complete calibration of all components under this section, all at no cost to the Owner. The maintenance contract shall not begin until both the instrumentation training course and the system acceptance test have been successfully completed, at which time the Owner shall be capable of performing necessary preventive maintenance, and all instruments shall be functional.

B. During the one-year maintenance period, observation of maintenance operations by designated Owner personnel, and the instruction of said personnel in the details of the maintenance work being performed shall be provided.

C. A complete written report shall be furnished the Engineer and Owner after each scheduled and unscheduled visit, giving problems corrected, systems needing recalibration, and recommendations to prevent recurrence, if applicable.

D. The costs for the one-year maintenance service contract shall be included in the Contract price.

1.08 TRAINING

A. A training program shall be set up and conducted by the major equipment manufacturer furnishing the instrumentation package. The training session shall be for a minimum period of 1 day uninterrupted and shall be conducted at the pump station.

B. A course outline showing the material to be covered shall be submitted to the Engineer for review. The training program shall include both classroom and "hands-on" instruction for each instrument supplied under this group of the Specifications and shall furthermore include operational training, maintenance training, and training on use of calibration equipment.

C. As the equipment installed at the plant shall be used for the "hands-on" training, the training program shall not be conducted until all of the systems are operational, and operational related "punch list" items are corrected.

D. Training on equipment supplied by a manufacturer other than the major equipment manufacturer shall be by the original equipment manufacturer, and shall be scheduled in the training programs by the major equipment manufacturer. Exceptions may be granted if the

instructor demonstrates adequate knowledge on the care and operation of the other manufacturers' equipment.

E. The training programs shall be conducted at a time mutually agreeable to the Engineer, Owner, Contractor, and Supplier. The Owner shall decide how many of his personnel shall attend the training. A representative of the Engineer may observe the training in progress. The Owner shall have the right to videotape all training as it is conducted.

F. The supplier shall make use of audio-visual aids in the training courses and shall provide the OWNERS staff his undivided attention (i.e., shall not conduct his company business during training hours) for the full 1 day. The supplier shall furnish training participants with written handouts, preferably copies of the shop drawing submittal books, up to a maximum of 6 copies, for purposes of familiarization with the shop drawings, and to assist in explanations.

PART 2 - PRODUCTS

2.01 GENERAL

A. All instrumentation supplied shall be of the manufacturer's latest design and shall produce or be activated by signals which are established standards for the water industry.

B. All electronic instrumentation shall be of the solid-state type and shall utilize linear transmission signals of 4 to 20 mAdc (milliampere direct current).

C. No zero based signals will be allowed for remote transmission.

D. All instruments shall be provided with mounting hardware and floor stands, wall brackets, or instrument racks as shown on the Drawings or as required.

E. All indicators and LED readouts shall be linear, direct reading in process units, unless otherwise noted. Percentage scales and indicators are prohibited.

F. All transmitters shall be provided with either integral indicators or conduit mounted indicators in process units, accurate to two percent, unless otherwise noted.

G. Electronic equipment shall be of the manufacturer's latest design, utilizing printed circuitry and suitably coated to prevent contamination by dust, moisture and fungus. Solid state components shall be conservatively rated for their purpose, to assure optimum long term performance and dependability over ambient atmosphere fluctuations and 0 to 95 percent relative humidity. The field mounted equipment and system components shall be designed for installation in dusty, humid, and slightly corrosive service conditions.

H. All equipment, cabinets and devices furnished hereunder shall be heavy-duty type, designed for continuous industrial service. The system shall contain products of a single manufacturer, in-so-far as possible, and shall consist of equipment models which are currently in production. All equipment provided shall be of modular construction and shall be capable of field expansion.

I. All equipment shall be designed to operate on a 60 Hertz alternating current power source at a nominal 115 volts, plus or minus 10 percent, except where specifically noted. All regulators and power supplies required for compliance with the above shall be provided between power supply and interconnected instrument loop. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.

J. All analog transmitter and controller outputs shall be 4-20 milliamperes into a load of 0-750 ohms, unless higher load capacity is required.

K. All switches shall have double-pole double-throw contacts rated at a minimum of 600 VA, unless specifically noted otherwise.

L. Materials and equipment used shall be UL listed (or other independent lab listed) wherever such listed equipment and materials are available.

M. All equipment shall be designed and constructed so that in the event of a power interruption, the equipment specified hereunder shall resume normal operation without manual resetting when power is restored.

N. All circuit boards in instruments mounted in damp locations or mounted outdoors shall be fungus proofed. All field transmitters mounted outside shall be equipped with sunshields and shall be capable of operation to -20° Fahrenheit.

O. Equipment installed in a hazardous area shall meet Class, Group and Division as shown on the contract drawings, to comply with the National Electrical Code. All power supply and signals coming from and going to hazardous areas shall have intrinsic safety barriers provided.

2.02 INSTRUMENTS AND ACCESSORY EQUIPMENT

A. Refer to other Division 17 Instrumentation Specification Sections for equipment requirements for field mounted primary devices, transmitters and secondary instruments, receivers and central control equipment.

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 17420 - INSTRUMENTS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. The CONTRACTOR shall furnish and install all primary devices, transmitters, primary and secondary receivers, and accessory items as shown on the Contract Drawings and as specified herein.

B. Provide spare parts as specified herein.

1.02 RELATED WORK

A. The following Sections of this Specification Division contain requirements on instrumentation and control equipment and software which are considered to be covered by applicable requirements of this section (and shall be included in the bid by a single Instrumentation Supplier for this Project):

Section 17311 - Plc Hardware and Software
Section 17312 - Radio Telemetry System
Section 17410 - Basic Measurement and Control Instrumentation Materials and Methods
Section 17430 - Boxes, Panels and Control Centers
Section 17480 - Instrument Lists and Reports
Section 17490 - Measurement and Control Commissioning

B. The following Divisions of these Specifications contain requirements on equipment furnished by other suppliers that must interface with the instrument system, or on methods and materials to be performed/used in the installation and/or wiring of the instrumentation system.

Division 1 - General Requirements
Division 11 - Equipment
Division 16 - Electrical

1.03 SPARE PARTS

A. Provide (1) spare ultrasonic level sensor and transmitter matching type LE/LIT-4.

B. Provide (1) spare surge protector of each type installed.

PART 2 - PRODUCTS

2.01 INSTRUMENTS AND ACCESSORY EQUIPMENT

A. Product Descriptions

1. Loop Isolator/Signal Converter:

   a. Loop isolators or signal converters shall be furnished and installed where indicated, to isolate signals or to increase the load capacity of a system required to have many devices in the loop. Isolators shall provide 3-way isolation, and shall have a power supply voltage of 115 VAC unless otherwise indicated. 2 wire style isolators are not acceptable. Isolators shall be Moore SCT, AGM, RIS, or equal, enclosed as appropriate for the application, or as indicated.

2. Computing Relays/Integrators:

a. Not applicable; the PLC shall be used for this purpose.

3. Transient/Lightning Suppressors:

a. Device Locations: As a minimum, provide surge protection devices at the following locations:

1) At any connections between ac power and electrical and electronic equipment, including panels, assemblies, and field mounted analog transmitters.

2) At both ends of all analog signal circuits that have any portion of the circuit extending outside of a protecting building.

3) At both ends of all copper-based communications cables which extend outside of a building, including at field instruments and the field side of analog valve position signals.

4) On all external telephone communications lines.

b. Surge protection device assemblies for connections to AC power supply circuits shall:

1) Be provided with two 3-terminal barrier terminal strips capable of accepting No. 12 AWG solids or stranded copper wire. One terminal strip shall be located on each end of the unit.
2) Have a nonflammable enclosure that meets or exceeds UL 94 V0 flammability requirements. The surge protection device shall be provided with provisions for mounting to interior of equipment racks, cabinets, or to the exterior of freestanding equipment.
3) Be constructed as multistage devices consisting of gas tube arrestors, high energy metal oxide varistors, or silicon avalanche suppression diodes. Assemblies shall automatically recover from surge events, and shall have status indication lights.
4) Comply with all requirements of UL 1449, second edition.
5) Be able to withstand a peak surge current of 10,000 amps based on a test surge waveform with an 8-microsecond rise time and a 20-microsecond exponential decay time, as defined in UL 1449.
6) Have the following characteristics:

a) Maximum Continuous Operating Voltage: 150VAC
b) Maximum Operating Current: 20 amps
c) Ambient Temperature Range: -20 degrees C to +65 degrees C
d) Response Time: 5 nanoseconds

c. Surge protection device assemblies for analog signal circuits shall:

1) Have four lead devices with a threaded mounting/grounding stud or DIN Rail mounting.
2) Have a nonflammable enclosure that meets or exceeds UL 94 V0 flammability requirements.
3) Be constructed as multistage devices consisting of gas tube arrestors and silicon avalanche suppression diodes. Gas tube arrestors and diodes shall be separated by a series impedance of no more than 20 ohms. Assemblies shall automatically recover from surge events.
4) Comply with all requirements of UL 497B.
5) Be able to withstand a peak surge current of 10,000 amps based on a test surge waveform with an 8-microsecond rise time and a 20-microsecond exponential decay time, as defined in UL 1449.
6) Limit line-to-line voltage to 40 volts on 24VDC circuits.
7) Have the following characteristics:

a) Maximum Continuous Operating Voltage: 28VDC
b) Ambient Temperature Range: -20 degrees C to +65 degrees C
c) Response Time (Line-to-Line): 5 ns

d. Acceptable manufacturers shall be Phoenix Contact, Weidmuller, Transtector, or equal.

4. Altitude and Pressure Gauges:

a. All indicating gauges are pipe mounted with male and brass threaded pipe connections. Gauges shall be 4 1/2 inch liquid filled for maximum vibration and corrosion protection. Gauges shall have phosphor bronze Bourdon tubes, white laminated phenol dials. Gauges shall have micrometer adjustment of pointers and black phenol, black cast iron, brass, or aluminum case and ring, original rotary gear design, corrosion resistant, stainless steel movement, blowout protection, and bronze socket with wrench flats. Accuracy shall be within 1/2 of 1 percent of the scale range. They shall be as manufactured by Helicoid Gage Division, "410"; Ashcroft; U.S. Gauge; Wika; or equal.

b. All gauges shall be piped with provisions for venting pressure to allow calibration (zero) checks. Valves for gauge shutoff and zeroing shall be 1/4 turn ball valves with lever handle, corrosion-resistant.

c. Liquid filled diaphragm seals shall be installed on all gauges as indicated in the Gauge Schedule in Section 17480 of the Specifications. Diaphragm seals shall be of the continuous duty type, 3 piece construction with 1/4 inch flushing connection, 1/4 inch fill connection, 316 stainless steel lower housing and diaphragm material 1/4 inch gauge connection and 1/2 inch lower connection. Housing bolts shall also be stainless steel. Acceptable models are Marsh 42-01, Helicoid 100H, Ashcroft, or equal. Viton diaphragms are required on low range pressure applications (less than 15 psig). To prevent accidental loss of fluid, diaphragm seals shall be permanently attached to gauges by installation of a lead sealed wire connecting the two. Fill fluid shall be factory installed silicone. All gauges shall be precalibrated, as an assembly, with the seal.

5. Eccentric Weight Float Type Level Sensors

a. The level monitor shall be the integral eccentric weight non-mercury float switch type, Flygt Model ENM-10, or approved equal.

6. Ultrasonic Level

a. The system shall be of the ultrasonic type for continuous level measurement. System shall consist of transmitter, transducer and interconnecting cable. The system accuracy shall be +/- 2mm + 0.17% of measured distance.

b. The transmitter shall be microprocessor based with an integral operator interface housed within a NEMA 4X corrosion resistant enclosure with a separate wiring connection compartment. There shall be no jumpers, trimpots, dip switches or external devices required to fully commission the transmitter. The operator interface shall have an illuminated 6 line graphic display with country specific menu guidance, on-site diagnosis with envelope curve on display. All error codes, process variables and internal values shall be accessible and displayable on the display. The transmitter shall contain a fuzzy logic implementation manager to allow untrained operators to commission the system without assistance. Transmitter shall support Floating Average Curve (FAC), fixed target suppression, zone evaluation, and agitator filtering algorithms. Power supply shall be 120VAC. Unit shall include a heater for operation in temperature down to -4°F.

c. The transmitter shall support transducers covering a span of one inch to 50 feet without modification or hardware adjustment. One or two fully isolated 0/4-20 outputs @ 600 ohms maximum shall be supplied, as required by the contract documents. Output shall be proportional to level, flow, or volume as indicated. A minimum of two fully programmable 4 amp SPDT relay outputs shall be provided as well as companion LED status indicators on the operator interface. An integral six digit non-resetable counter and remote totalizer counter driver shall be provided. Pump sequencing, differential level, open channel flow, solids level, liquid level applications shall be supported.

d. The transducer shall be powered by the transmitter with less than 50 V up to 1000 feet away via standard twisted shielded two conductor cabling. EMI/RFI effects on the combined system shall be less than 1% at 10volts/meter (NAMUR, IEC 801-3 standards) allowing installation in standard aluminum conduit. The transducer shall have polypropylene or Tefzel housings and be rated Class I Division 1 or Class II Division 1 by Factory Mutual (FM), and NEMA 6P (submersible). A 1 inch NPT connection shall be provided to mount the transducer.

e. The transducer shall be provided with interconnecting cable, length as required, and shall be capable of being extended from the transmitter up to 1000 feet away. Transducers shall have integral temperature sensors to support speed of sound compensation and be weather proof and fully submersible.

f. The transmitter shall be the Endress+Hauser Prosonic FMU 90 or equal. The transducer shall be the Endress+Hauser Prosonic FDU 90F, or equal.

7. Single Station Smoke Detectors

a. The detector shall be photo-electric type with 2.5% normal sensitivity.

b. The alarm shall utilize an infrared LED sensing circuit which pulses in 4 to 5 second intervals; when subjected to smoke the pulse rate shall increase 8 times. After 2 consecutive pulses in smoke, the detector will alarm.

c. The alarm shall provide minimum 5-to-1 signal-to-noise ratio in the optics frame to assure stability of operation in environments of high RF and transient conditions.

d. The sensing chamber shall be fully protected to prevent entrance of small insects, thus reducing the probability of false alarms.

e. A solid state piezo alarm rated at 90dBA at 10ft.

f. A visual LED monitor (condition indicator) will pulse in normal operation and will remain solid in alarm.

g. An easily accessible test knob shall be provided. The test knob in the TEST position will simulate an actual smoke condition of approximately 3.4% causing the detector to alarm within 20-36 seconds. It will also have the capability of testing to 0.85% as a required minimum. A magnetic switch closure or other switch closure, or smoke generating equipment which does not scatter the light beam or test sensitivity is not sufficient.

h. The alarm shall have a tandem interconnect capability of up to 12 units or 6 units with relay.

i. Form C relay output shall be provided.

j. Unit must be UL 217 listed for both wall and ceiling mount.

k. All equipment shall be completely factory assembled, wired and tested, and the contractor shall be prepared to submit a certified letter testifying to this condition.

l. The Photoelectric Smoke Alarm shall be a Gentex Model 7100F, or equal.

8. Temperature Transmitter

a. Provide a temperature transmitter for monitoring temperature in the Electrical Building.

b. Transmitter shall be Bapi BA/T1K[0 TO 100F]-B4SD-X-Z-CG-WMW or equal with display and 4-20mA output.

9. Rain Gauge

a. Provide a rain gauge, ISCO 674 or equal.

b. Gauge shall be a tipping bucket style with 0.01" sensitivity. Accuracy shall be +/- 1% at 2 inches of rain per hour.

c. Gauge shall include an encapsulated reed switch rated at 10W, 0.5A, 200V minimum, arranged for connection to external PLC.

d. Gauge shall be rated for temperatures up to 120°F in direct sunlight, and shall withstand temperatures down to -25°F.

PART 3 – EXECUTION (NOT USED)

END OF SECTION

SECTION 17430 - BOXES, PANELS, AND CONTROL CENTERS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. The Contractor shall furnish and install all boxes, panels and control centers and accessory items as shown on the Contract Drawings and as specified herein.

1.02 RELATED WORK

A. The following Sections of this Specification Division contain requirements on instrumentation and control equipment and software which are considered to be covered by applicable requirements of this section (and shall be included in the bid by a single Instrumentation Supplier for this Project):

Section 17311 – Plc Hardware and Software
Section 17312 – Radio Telemetry System
Section 17410 – Basic Measurement and Control Instrumentation Materials and Methods
Section 17420 – Instruments
Section 17480 – Instrument Lists and Reports
Section 17490 – Measurement and Control Commissioning

B. The following Divisions of these Specifications contain requirements on equipment furnished by other suppliers that must interface with the instrument system, or on methods and materials to be performed/used in the installation and/or wiring of the instrumentation system.

Division 1 - General Requirements
Division 11 - Equipment
Division 16 - Electrical

PART 2 - PRODUCTS

2.01 FABRICATION

A. Control Panels

1. Furnish and install the following Control panels:

   a. Wet Weather Storage (WWS) Control Panel – UL698a listed with circuit extensions to hazardous areas.

   The control panels shall be similar in design to that shown on the Drawings or as specified herein. The panels shall be NEMA 12, floor-mount type with lockable disconnect.

2. Doors shall have a 3-point roller latch with continuous hinge and handle and lock. The top of the panel shall be covered. The panel shall mount on the floor and be anchored down, similar to the way Motor Control Centers are anchored.

3. Panels shall contain an interior light with switch by the door inside, and an interior GFCI duplex receptacle. The duplex receptacle shall be powered upstream of the UPS.

4. The panels shall be sized to provide heat dissipation such that the maximum operating temperature for the lowest rated component is not exceeded with an ambient temperature of 100 deg F.

6. All conductors running from the field to the panels shall be a single, continuous length, without splices, except at accepted junction boxes. Junction boxes shall have terminal blocks with 20 percent spares in addition to terminals for all wires including spare wires. Special care shall be exercised to carry grounding lines through such junction boxes with the least possible resistance.

7. All panel equipment shall be mounted and wired on or within the cabinet. Wiring shall comply with the latest National Electrical Code. All wiring within the panel shall be grouped together with harnesses or ducts and secured to the structure. All wiring shall be numbered in accordance with the numbering system used on the wiring/connection diagrams. Power wiring shall be routed in separate wireways from low voltage DC signal wiring. Where crossing power and low voltage DC wiring is necessary, crossing shall be at right angles. Parallel troughs for different voltages shall be separated by a minimum of 12 inches. Power wire shall be 12 AWG type THWN stranded, insulated for not less than 600 volts, unless specified otherwise. Signal wire shall be 16 AWG, THW stranded, insulated for not less than 600 volts.

8. Wire color shall be as follows:

    a. Line Power – Black

    b. Neutral or common – White

    c. AC Control – Red

    d. DC Control – Blue

    e. Equipment or Chassis Ground – Green

    f. Externally powered circuits - Yellow

9. Wiring and connection diagrams shall conform to ISA S5.4 Instrument Loop Diagrams and shall be submitted by the manufacturer as part of the shop drawings for review by the ENGINEER.

10. All wiring in the panels shall terminate in a terminal blocks. Terminal blocks shall have a minimum of 25 percent spares of each type. Terminal blocks shall be arranged in vertical rows and separated into groups (Power, AC control, DC signal, alarm). Terminal blocks shall be barrier type with the appropriate voltage rating (600 volts minimum). They shall be the raised channel mounted type. Wiring trough for supporting internal wiring shall be plastic type with snap-on covers. The sidewalls shall be open top type to permit wire changing without disconnecting. Wire connectors shall be the hook fork type with non-insulated barrel for crimp type compression connection to the wire. Wire and tube markers shall be the sleeve type with heat impressed letters and numbers. Terminal strips shall be provided for the purpose of connecting all control and signal wiring. Direct interlock wiring between equipment will not be allowed. Only one side of a terminal block row shall be used for internal wiring. The field wiring side of the terminal shall not be within 6 inches of the side panel or adjacent terminal. Wiring troughs shall not be filled to more than 60 percent visible fill. Wiring trough covers shall be match marked to identify placement. If component identification is shown on covers for visibility, the ID shall also appear on the mounting sub-panel.

11. All wiring to hand switches and devices which are live circuits independent of the panel's normal circuit breaker protection shall be clearly identified as such.

12. Nameplates shall be provided for all flush mounted equipment. The nameplates shall be approximately 1 inch by 3 inch constructed of black and white laminated, phenolic material having engraved letters approximately 1/4 inch high, extending through the white

face into the black layer. Nameplates may be omitted if a nameplate of approximately the same dimension is more conveniently and suitably located on the instrument door or face. Nameplates shall be attached to panels by self-tapping screws.

13. Print storage pockets shall be provided on the inside of each panel. Its size shall be sufficient to hold all of the prints required to service the equipment.

14. The control panel shall be factory-tested prior to shipment. Field installation by the Subcontractor shall consist only of setting the panel in place and making necessary electrical connections.

15. All components shall be mounted in a manner that shall permit servicing adjustment, testing and removal without disconnecting, moving or removing any other component. All gages, meters, receivers, switches, pushbuttons and accessories shall be flush mounted.

16. Components mounted on the inside of panels shall be mounted on removable plates and not directly to the enclosure. Mounting shall be rigid and stable unless shock mounting is required otherwise by the manufacturer to protect equipment from vibration. Component mounting shall be oriented in accordance with the component manufacturer's and industries' standard practices. All internal components shall be identified with suitable plastic or metal engraved tags attached with drive pins adjacent to (not on) each component identifying the component in accordance with Drawings, Specifications, and Supplier's data.

17. Pushbuttons shall be heavy-duty, oil tight, 30.5 mm, with momentary contacts. Switches shall be supplied with the number of poles required for the application, an escutcheon plate, and contacts rated for 10 amperes at 120 volts AC.

18. Relays shall be double pole, double throw, octal plug-in type with a transparent dust cover. The relay shall be equipped with a manual operator and an indicating light to indicate when its coil is energized. The relays shall have contacts rated for 10 amperes at 120-volts AC. The mechanical life of the relay shall be 10,000,000 operations minimum (ampere rating shall be increased as necessary for load handling capacity where needed.) PLC interposing relays shall be Allen-Bradley 700-HL series or equal with 6A single-pole double-throw contact, LED indicator, and built-in transient protection.

19. Timing relays shall be solid-state plug-in type with a dust and moisture resistant case. The timers shall be of the multi-range/analog or digital type with selectable ranges, between 1 second and 10 hours full scale. The output contacts shall be rated at 2.5 amperes minimum at 120 volts AC. The timing relay shall have a "timing in progress" indication. The mechanical life shall be 10,000,000 operations minimum.

20. Selector switches shall be heavy-duty 30.5 mm, oil tight. Switches shall be supplied with the number of poles required for the application, an escutcheon plate, and contacts rated for 10 amperes at 120 volts AC. Selector switches shall be provided for each redundant instrument specified to allow selection of which instrument is utilized in the controls.

21. General layout of instruments and controls are shown on the Drawings. Minor deviations from the layout may be allowed after review by the ENGINEER.

22. The instrument panels shall be furnished by the instrumentation and control system supplier. Complete shop drawings, including wiring diagrams and panel structural drawings, shall be required for review prior to shipment.

23. Furnish Cutler-Hammer Oxidation Inhibitors and install one in each panel at time of start-up.

24. UPS output shall power the instrument panel. An uninterruptible power supply, Allen-Bradley, or equal shall be provided for power to all PLC equipment for a minimum of 1

minute until generator power is online, as well as field instruments. Provide alarm relay card. The UPS shall be the industrial type, 500VA minimum.

25. Intrinsic Safety Barriers – Provide UL listed intrinsic safety barriers for circuit extensions into hazardous areas. The barriers shall be Phoenix Contact, or equal.

26. The main Ethernet switch in PLC-WWS shall be an Allen Bradley Stratix 8300 or equal, Layer 3 managed switch. Provide the base switch with ten copper ports.

27. Surge protection on power and I/O is required and shall be provided in accordance with Section 16280.

PART 3 – EXECUTION

3.01 LABELING

A. Provide labels for all conductors and components.

B. Legends for starter nameplates shall be taken from the one line diagram in the Contract Drawings. Wire and miscellaneous component labels shall match the O&M manual wiring diagrams.

3.02 GROUNDING

A. Enclosures shall be grounded in accordance with the NEC.

B. Each analog signal loop shall be grounded at a single point for the loop at the location of the DC power supply for the loop.

3.03 PROTECTION

A. All electrical and electronic components of the Control Panel shall be protected against damage due to electrical transients induced in interconnecting lines from lightning discharges and surges in nearby electrical systems. Provide a surge protection device (SPD).

3.04 INSTALLATION/ERECTION

A. Equipment furnished under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, manufacturer Shop Drawings, and manufacturer installation instructions.

END OF SECTION

SECTION 17480 – WET WEATHER STORAGE SEQUENCE OF OPERATIONS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. The CONTRACTOR shall provide programming, integration, and commissioning services as needed to implement the Sequence of Operations as shown on the Contract Drawings and as specified herein.

1.02 RELATED WORK

A. The following Sections of this Specification Division contain requirements on instrumentation and control equipment and software which are considered to be covered by applicable requirements of this section (and shall be included in the bid by a single Instrumentation Supplier for this Project):

Section 17311 – Plc Hardware and Software
Section 17312 – Radio Telemetry System
Section 17410 – Basic Measurement and Control Instrumentation Materials and Methods
Section 17420 – Instruments
Section 17430 – Boxes, Panels and Control Centers
Section 17490 – Measurement and Control Commissioning

B. The following Divisions of these Specifications contain requirements on equipment furnished by other suppliers that must interface with the instrument system, or on methods and materials to be performed/used in the installation and/or wiring of the instrumentation system.

Division 1 – General Requirements
Division 11 – Equipment
Division 16 – Electrical
Division 18 – SCADA

1.03 SEQUENCE OF OPERATIONS

The following sequence of operation shall be provided:

A. Each piece of controlled equipment shall have 3 modes of operation: hand, manual, or automatic. In hand mode, the equipment shall be operated from physical hand controls either at the MCC or on the valve actuator. Manual or auto mode shall be selected from the HMI. In manual mode, operator shall be able to start/stop/open/close as the case may be and, in the case of drives or modulating valves, set the % speed or % open setpoint. In auto mode, the equipment shall be controlled according to the sequence below.
B. The existing Wolf Run Pump Station (WRPS) Allen-Bradley PLC shall be polled once per hour by Wolf Run Wet Weather Storage (WRWWS) PLC. Wetwell level and pump running status shall be transmitted. If communication is not functional, an alarm shall be generated. If at least 0.25" of rain has fallen within the past four hours, the polling rate shall be increased to once per minute.
C. Code logic shall be added to the existing WRPS PLC such that, if the level in the WRPS wetwell starts getting higher than normal, than an "increase poll rate" bit shall be transmitted asynchronously to WRWWS and the WRPS PLC shall then be polled once per minute by WRWWS until the level falls back to normal and for four hours thereafter.
D. Diversion Structure:
   1. The diversion structure status shall be either "Normal Operation – No Diversion" or "Diverting Sewage to WWS". A high level of sewage at either Trunk Line A MH WR1_6A (as measured by LE/LIT-4) or the existing Wolf Run Pump Station (WRPS) (as measured by the existing level sensor) shall initiate diversion of sewage to Wolf Run Wet Weather Storage (WRWWS.) If a high level alarm is received from the screen system level sensor

LE/LIT-1, then the system shall be forced to "Normal Operation – No Diversion" until the alarm clears.

2. The default mode of operation ("Normal Operation – No Diversion") shall be with the Diversion Structure throttling gate (EOV-1) fully open, allowing flow to proceed to the existing WRPS.
3. Four adjustable level set points shall be programmed into the system controller via the system HMI:
   a. "WRPS Initiate Diversion" set point – to be above the normal operational range of the existing WRPS pumps to indicate that the pump station's capacity has been exceeded. Note: the polling rate If the PLC shall be increased to once per minute before the wet well reaches this set point.
   b. "WRPS Max Diversion" set point
   c. "MH WR1_6A Initiate Diversion" set point - Initial set point of 869.3'.
   d. "MH WR1_6A Max Diversion" set point – Initial set point of 869.8'.
4. When the level in the WRPS wet well rises to the "Initiate Diversion" set point, the Diversion Structure throttling gate (EOV-1) shall start to close. As the level rises, the gate shall continue to throttle linearly until the level reaches the "Max Diversion" set point, at which point the gate shall be closed to the "Minimum Diversion Throttling Gate Position" setpoint which shall initially be 61.7% open (at "max diversion" the gate lowers 1.15 ft). When the level falls, the throttling gate shall open linearly until the level reaches the "Initiate Diversion" set point, at which point it shall be fully open again. The controls shall be similar for the MH WR1-6A level.
5. In the event that both MH WR1_6A and the WRPS are calling for diversion, the level sensor calling for the most diversion shall be the controlling level sensor. The HMI screen shall indicate which level sensor is controlling at any given time.
6. The screening system shall be controlled by the ultrasonic level sensor in the Diversion Structure (LE/LIT-1) via the manufacturer's control panel. When the level rises to the adjustable set point (initially 869.34, or 3-in. below the bottom of the screen), the screen shall activate and will run until the level falls to a lower set point. The screening system shall be interlocked with the tank isolation gate such that it will shut off if the tank isolation gate is closed, regardless of the Diversion Structure level.
7. The tank isolation gate (EOV-2) shall be controlled by the level in the WRWWS tank. Normally the tank isolation gate shall be closed. When the system shifts to "Diverting Sewage to WWS" mode, then the isolation gate shall be opened. When the tank level reaches the "Close" set point, the isolation gate will close and will not be re-opened until the tank level falls to a lower adjustable "Open" set point. If a high level alarm is received from the screen system level sensor LE/LIT-1, then the tank isolation gate shall be closed.

E. WRWWS Pump System:
1. A pump-down variable speed pumping algorithm is required. Normally all three WRWWS pumps shall be off.
2. When the liquid level in the wet well rises to the "Lead" set point, the lead pump will start and ramp to 100 percent speed. If the liquid level in the wet well then starts falling, the lead pump speed shall slow down until influent and effluent flows stabilize (i.e. the level stops falling). When the lead pump has reached its minimum speed set point and the level continues to fall to the "Lead Off" level set point, the pump shall initiate shutdown (see shutdown flush cycle requirements described below.)
3. If the lead pump is running at 100 percent speed and the level continues to rise to the "Lag" set point, the lag pump shall start and shall run at the same speed as the lead pump.
4. Both pumps shall decrease speed together as the level falls to the "Lag Off" set point. At this point, the lag pump shall initiate its shutdown sequence (described below) and shut off. If the level keeps falling to the "Lead Off" level setpoint, then the lead pump shall initiate its shutdown sequence.
5. A high level alarm shall be generated if the level continues to rise to the "High Level" set point.
6. The lead pump shall be alternated with each "Off" cycle. The operator shall have the ability to manually "lock-in" a pump as lead pump or alternate.

7. Shutdown Flush Sequence: Each of the WWS pumps, when shut down is initiated, shall be flushed by running at 100% speed for an adjustable period of time (initially 15 seconds).
8. The pumping system shall be integrated with the WWS tank level sensor (LE/LIT-3). When the liquid level in the WWS tank reaches the "Close" level set point the tank isolation gate in the Diversion Structure shall close. The pumps shall continue to operate until the level in the wetwell reaches the "Off" setpoints. The pump shall not re-enable until the liquid level in the WWS tank falls to a lower, adjustable set point (WWS Tank Inhibit Pumping Level).
9. A low level float switch trigger shall cause all WWS pumps to be turned off when the liquid level in the wet well is insufficient for pumping.
10. Both piping drain valves are to be opened when all pumps are turned off and closed when any single pump is turned on.
11. A wet well dewatering sump pump shall be turned on when all WWS pumps are turned off. The dewatering sump pump shall be turned off when the dewatering is complete as determined by the dewatering pump off float switch, or when a WWS pump turns back on. The operator shall have a screen control to allow dewatering sump pump alternation or to lock in a specific dewatering pump. When in alternation mode, the dewatering sump pumps shall be alternated with each cycle off.

F. WWS Tank

1. The discharge valve (EOV-3) shall normally be closed on the tank.
2. The WWS tank shall be allowed to discharge when the following conditions are met:
   a. The diversion system has returned to "Normal Operation – No Diversion" mode, the Diversion Structure throttling gate is fully open, and no WWS pumps are running.
   b. It is confirmed that a maximum of two pumps are running at the WRPS (to ensure that spare capacity is available) and the water level elevation is not exceeding "MH WR1_6A Max Diversion" set point.
3. There shall be two level set points to control the rate of tank discharge by modulating the discharge valve - both referenced from the MH WR1-6A:
   a. "Tank Discharge Valve 0% Open Level"
   b. "Tank Discharge Valve 100% Open Level"
4. When the level in the manhole falls to the "Tank Discharge Valve 0% Open Level" and keeps falling, the discharge valve shall start opening if a maximum of two pumps are running at the WRPS and the Diversion Structure throttling gate is fully open. The discharge valve shall continue to open linearly as the level falls to the "Tank Discharge Valve 100% Open Level", at which point it shall be 100% open. Regardless of manhole level, however, the discharge valve position % open shall not exceed the value calculated by the following equation (in order to limit the discharge velocity):
   MaxPosition = 707.714 / sqrt(64.4 – h) where h = Tank Level from 0 to 42 feet.
5. The valve shall return to the closed position when the WWS tank is empty after an adjustable time delay.
6. A flow totalizer shall be implemented to totalize tank discharge flow by measuring the volume of level change in the tank during the discharge sequence. This flow total shall be displayed and logged both daily and monthly.

G. Equipment Failure to Start Alarms: Any piece of equipment that is indicated to have both a control signal and a feedback status signal shall have a failure to start alarm configured that has a reasonable delay time.

H. Instrument failure Alarms – All 4-20mA instruments shall have instrument failure alarms configured which shall go true if the instrument signal is lost or out of range.

I. Backup Instruments: Several locations on the Drawings indicate primary and backup instruments. For these instruments, a selector switch shall be provided on the WWS HMI to control which instrument is used. Upon receipt of an instrument failure alarm, the system shall automatically switch to the redundant instrument.

1.04 MINIMUM REQUIRED SETPOINTS

A. As per the sequence of operations listed above, the minimum required setpoints are as follows:
   1. Building Temperature Lo-Lo/Lo/Hi/Hi-Hi (°F)
   2. Diversion Structure Level Hi/Hi-Hi (FT)
   3. WWS Tank Level Hi/Hi-Hi (FT)
   4. WWS Tank Inhibit Pumping Level (FT)
   5. Tank Isolation Gate Open (FT)
   6. Tank Isolation Gate Close (FT)
   7. WWS Pump #1 Manual Speed (%)
   8. WWS Pump #2 Manual Speed (%)
   9. WWS Pump #3 Manual Speed (%)
   10. WWS Pump Minimum Speed (%) (shall apply to all 3 pumps)
   11. Diversion Throttling Gate Manual Position (% Open)
   12. Diversion Throttling Gate Position Lo/Lo-Lo (% Open)
   13. Minimum Diversion Throttling Gate Position (% Open)
   14. WWS Discharge Valve Manual Position (% Open)
   15. Manhole WR1_6A Level Hi/Hi-Hi (FT)
   16. WRPS Initiate Diversion Level (FT)
   17. WRPS Max Diversion Level (FT)
   18. MH WR1_6A Initiate Diversion Level (FT)
   19. MH WR1_6A Max Diversion Level (FT)
   20. MH WR1_6A Tank Discharge Valve 0% Open Level (FT)
   21. MH WR1_6A Tank Discharge Valve 100% Open Level (FT)
   22. SCREEN SYSTEM ON (FT)
   23. SCREEN SYSTEM OFF (FT)
   24. Pump Wetwell Lead On (FT)
   25. Pump Wetwell Lead Off (FT)
   26. Pump Wetwell Lag On (FT)
   27. Pump Wetwell Lag Off (FT)
   28. Pump Wetwell Hi /Hi-Hi (FT)
   29. Pump Shutdown Flush Time (s)
   30. Discharge Valve Time Delay to Close after Tank Empty (min)

1.05 GENERAL REQUIRED SOFTWARE SERVICES

A. General: Software services shall include program development, testing, documentation, and work necessary to implement a complete and fully operating system as shown on Drawings and as specified. Work requires coordination with concurrent program development for programmable controllers (PLCs), Operator Interface, and Data Collection. Include PLC error detection logic for communications failures, data highway faults, internal faults, and time outs. Communicate PLC error conditions to Operator Interface. Employ a "watchdog" timer for each remote PLC and poll that PLC if no message has been received in a reasonable amount of time. Accept Operator Interface directives for set point changes and hand switches.

B. Programmable Controller Logic: Develop programs for execution on PLC. Logic shall perform functions required to control processes and equipment as shown on Drawings and/or as specified. Develop complete cross-references for ladder logic and complete input/output listings.

C. HMI Interface Screens: Provide graphic representation of system processes and control over machinery. Provide the following screens as a bare minimum:
   1. Main Menu
   2. System Overview
   3. Diversion Structure Detail
   4. Pump Station Detail
   5. WWS Tank Detail
   6. Alarms (Active & Historical)
   11. Network Status
   12. Trending

13. Elapsed Run Time Reports
14. Flow Total Reports (Calculate from tank volume changes)
15. Sequence of Operations – Provide screens with written sequence of operations explaining the setpoints and controls so that operators do not have to search for the physical O&M manual in order to understand system operation.

D. HMI software required application features:

1. Video displays shall be color and shall be fully windowed with touchscreen control and popup keyboards for data entry. Use colors, function keys, and navigational controls consistently.

2. Alarm Management: For each process or system event classed as an alarm provide facilities for displaying and logging in database, acknowledgment, and purging of stale messages. Alarm events are derived from discrete inputs, analog trip values, logic combinations and computations as needed. Log and display both alarm events and returns to normal. Provide date/time stamps for events, descriptive message, and event type code. Use color combinations to distinguish following alarm states: Alarm-Unacknowledged, Alarm-Acknowledged, Normal-Unacknowledged, and Normal-Acknowledged.

3. Graphic Displays:

   a. Provide process-oriented displays showing current process status and accepting operator input for setpoint and status changes.
   b. For each display, show process elements such as pumps, valves, tanks, pipe lines, etc., with their current operational status. Emphasis shall be placed on depicting the plant in a "P&ID" format that allows easy conceptualization of process flow rather than depicting equipment in actual physical location or scale.
   c. Not running state: graphic shall be natural color with no motion.
   d. Running state: Graphic shall be green color and shall rotate or show other type of motion as appropriate. Both color and motion shall be depicted.
   e. Red color shall be reserved for alarm graphics.
   f. Tanks shall include both analog and digital indication of current fill/level status. Also, static text must be added to indicate level at bottom of tank and top (or overflow) of tank.
   g. Indicators shall use an appropriate number of significant digits and dead band to produce steady values.

4. Trending: Each analog input point shall be trended on a pre-configured trend screen that includes both historical and real-time trending. Provide facilities for user selection of colors, time (horizontal), and measurement (vertical) scales. Accommodate real-time sampling intervals as short as 1 second. Historical trend displays shall have time-scale panning controls. All trends must have an adjustable cursor that indicates both Y and X axis values at the user-selected location.

5. Security: Using operator interface and operating system software, implement a security system to restrict access to parts of system. Provide the following as a minimum:

   a. Programmer - Access to all facilities including app modifications.

   b. Supervisor - Access to all displays, change set points and purge stale

alarm messages.

c. Operator - Access to all displays, start/stop equipment, and acknowledge alarms.

d. Guest - Access to displays only.

6. Data Storage:

a. Analog trend data shall be logged for a minimum of 3 months for historical trending. Report data shall be retained indefinitely.

7. Reports:

a. Reporting requirements shall consist of both live HMI screens that dynamically update the values for "today" & "yesterday" and also published historical CSV (or similar) files for logging old totals.

b. Daily totals shall be published at 11:59:55 PM and reset to zero at midnight. Monthly totals shall be published at 11:59:55 PM on the last day of the month and reset at midnight.

c. Totalization time slices shall not exceed 5 seconds.

d. The following parameters shall be reported:

i. Motor & Equipment Run times: For each motor or piece of equipment that is monitored, report "Run Time Today" and "Run Time Yesterday".

ii. Flow Totals: For the tank, report "Flow Total Today", "Flow Total Yesterday", "Flow Total This Month", and "Flow Total Last Month." These totals shall be calculated using the change in volume from the tank level sensor.

iii. Rain totals: Report "Rain Today", "Rain Yesterday", "Rain This Month", and "Rain Last Month". These totals shall be summed by monitoring the rain gauge.

e. Data Export: Establish a simple method of data export to Excel.

E. SCADA Integration Coordination

1. The I&C contractor is required to provide coordination time including meetings onsite and at LFUCG Town Branch WWTP to coordinate SCADA monitoring of the system. Program tags, databases, addresses, etc. must be shared so that each contractor is successful in implementing their respective project requirements.
2. The PLC program must be configured to minimize radio traffic due to LFUCG's restricted radio network. This will require copying all program data (as listed in the I/O table) to a contiguous block of memory that can be transmitted in a single message. Coordination with the SCADA contractor in mapping this memory block is required.

END OF SECTION

SECTION 17490 - MEASUREMENT AND CONTROL COMMISSIONING

PART 1 - GENERAL

1.01 WORK INCLUDED

A. The Contractor shall furnish and install all instrumentation equipment and accessory items as shown on the Contract Drawings and as specified herein.

1.02 RELATED WORK

A. The following Sections of this Specification Division contain requirements on instrumentation and control equipment and software which are considered to be covered by applicable requirements of this section (and shall be included in the bid by a single Instrumentation Supplier for this Project):

Section 17311 - Plc Hardware and Software
Section 17312 - Radio Telemetry System
Section 17410 - Basic Measurement and Control Instrumentation Materials and Methods
Section 17420 - Instruments
Section 17430 - Boxes, Panels and Control Centers
Section 17480 - Instrument Lists and Reports

B. The following Divisions of these Specifications contain requirements on equipment furnished by other suppliers that must interface with the instrument system, or on methods and materials to be performed/used in the installation and/or wiring of the instrumentation system.

Division 1 - General Requirements
Division 11 - Equipment
Division 16 - Electrical

PART 2 – PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 SEQUENCE OF CONSTRUCTION

A. Installation and startup of the new Weat Weather Storage (WWS) Control Panel shall be coordinated with the Owner, as the equipment will communicate over an existing trunked radio system.

B. Delivery, startup, and programming of new equipment furnished under this Division shall be coordinated with process equipment installation. A qualified technician shall be present on site during system startup.

3.02 INSTALLATION/APPLICATION/ERECTION

A. Instrumentation and accessory equipment shall be installed in accordance with the manufacturer's instructions. The locations of equipment, transmitters, alarms and similar devices shown on the Drawings are approximate only. Exact locations shall be as accepted by the Engineer during construction. Obtain in the field all information relevant to the placing of process control work, proceed as directed by the manufacturer and furnish all labor and materials necessary to complete the work in an acceptable manner.

B. The instrumentation installation details on the Drawings indicate the designed installation for the instruments specified. Where specific installation details are not specified or shown on

the Drawings, the manufacturer's recommended practice shall be followed.

C. All work shall be executed in full accordance with codes. Should any work be performed contrary to said codes and/or regulations, the Contractor shall bear full responsibility for such violations and assume all costs arising therefrom. All equipment used in areas designated as hazardous shall be designed for the Class, Division, and Group as required on the Drawings for the locations.

D. Unless specifically shown in the Contract Documents, direct reading or electrical transmitting instrumentation shall not be mounted on process piping. Instrumentation shall be mounted on instrument racks or stands. All instrumentation connections shall be provided with shutoff and drain valves.

E. All piping to and from field instrumentation shall be provided with necessary unions, test tees, couplings, adaptors, and shut-off valves.

F. Field instruments requiring power supplies shall be provided with local electrical shut-offs and fuses as required.

G. Brackets and hangers required for mounting of equipment shall be provided. They shall be installed in a workmanlike manner and not interfere with any other equipment.

H. The system supplier shall investigate each space in the building through which equipment must pass to reach its final location. If necessary, the system supplier shall be required to ship his material in sections sized to permit passing through restricted areas in the building. The system supplier shall also investigate, and make any field modifications to the allocated space for each cabinet, enclosure and panel to assure proper space and access (front, rear, side).

I. The shield on each process instrumentation cable shall be continuous from source to destination and be grounded as directed by the manufacturer of the instrumentation equipment but in no case shall more than one ground point be employed for each shield.

J. Lifting rings shall be removed from cabinets/assemblies. Hole plugs shall be provided for the holes of the same color as the cabinet.

K. The system supplier, acting through the Contractor, shall coordinate the installation, the placing and location of system components, their connections to the process equipment panels, cabinets and devices, subject to the Engineer's acceptance. He shall be responsible to ensure that all field wiring for power and signal circuits are correctly done in accordance with best industry practice and provide for all necessary system grounding to ensure a satisfactory functioning installation. The Contractor hereunder shall schedule and coordinate his work under this Section with that of the electrical work specified under applicable Sections of Division 16.

3.03 FIELD QUALITY CONTROL

A. After equipment and materials have been shipped to the job site, the Supplier shall furnish the services of a factory-trained service technician or engineer to assist and advise the Contractor during installation and to provide programming/calibration/ adjustment at initial startup. A minimum period of 2 calendar days on the job site is required, and expenses associated with additional days necessary shall be at no cost to the Owner.

B. Following installation, checkout, and final adjustment of all panels, instruments, meters, monitoring, and control devices, the Contractor shall schedule a performance test in the presence of the Engineer on all equipment. The Contractor shall furnish the services of the system supplier's servicemen, all special tools, calibration equipment, and labor to perform the tests.

C. Meters shall be tested at 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent of scale, if possible. All status and alarm switches as well as all monitoring and control functions shall also be checked, including logging at printers and change of state on graphics. Testing shall be done from the signal source to the final element or device including all field wiring. Results of all testing shall be submitted to the Engineer in writing.

D. As much as possible, points shall be checked "end-to-end". For example, valve status inputs shall be checked by stroking the valve, and a pump start output shall be checked by using it to start to start the pump. Simulated testing shall be allowed only when no practical alternative exists. Workstation displays shall be verified for correctness at the same time. An I/O checklist shall be used to record test results and a copy provided to the Engineer upon completion. During system testing, the Contractor shall have a representative onsite continuously who is capable of troubleshooting and modifying system configuration programming.

E. If, during running of the tests, one or more points appear to be out by more than the system accuracy statement, or fails to perform in accordance with agreed strategies, the system supplier's servicemen shall make such adjustment or alterations as are necessary to bring equipment/programming up to specification performance. Following such adjustment, the tests shall be repeated for all specified points to ensure compliance.

3.04 PERFORMANCE TEST

A. Subsequent to the full system implementation, the Contractor shall conduct a successful 30 day final acceptance test for the system furnished and installed under this Contract. In this test, the entire system must operate continuously for 24 hours per day, 7 days per week during the test period, with zero downtime resulting from system failures. If a system failure occurs, the 30-day test period will be repeated, starting over at time zero, from the time that the system failure is repaired. The Contractor shall repeat the test until it is satisfactorily completed. The system will only be acceptable to the Owner after all equipment and software has satisfied the performance test requirements.

B. The Contractor shall submit a final acceptance test completion report which shall state that all Contract requirements have been met and which shall include a summary of maintenance/repair efforts that were required during the test period. Final acceptance of the system by the Owner until this has occurred.

3.05 ADJUSTING AND CLEANING

A. All equipment furnished under this Section of the Specifications shall be adjusted/calibrated as defined elsewhere this Section/Division.

B. All instruments and equipment shall be left free from shipping stickers, paint splatter, dirt, grease, etc., and shall be clean and in like new condition at final acceptance. Touch-up paint shall be furnished as needed to repair blemishes and scratches in finish paint on panels and enclosures, which shall be corrected by the Contractor.

3.06 EXTRA STOCK/SPARE PARTS

A. See equipment specifications for spare parts required. All spare parts shall be packaged in an acceptable manner for long-term storage and adequately protected against corrosion, humidity and temperature extremes. All items shall be tagged externally with what they are; both a written description and a manufacturer brand/part number.

END OF SECTION

DIVISION 18

SUPERVISORY CONTROL AND DATA ACQUISISTION (SCADA)

SECTION 18000 - SCADA INTEGRATION

PART 1 – GENERAL

1.01 SCOPE OF WORK

A. Provide SCADA software development, testing, commissioning, debugging, and maintenance services as specified herein. The services specified in this section shall be provided by ControlTouch Systems of Louisville, KY under a bid allowance. See the Form of Proposal for bid allowance.

B. Integrate each I/O point indicated on the Contract drawings into the SCADA software.

C. Provide software operation training services.

D. Coordinate with the Instrumentation/Control contractor who is awarded the Wolf Run Wet Weather Storage (WRWWS) control system contract, as specified herein.

1.02 RELATED WORK

A. General requirements are located in Division 1.

B. Division 17 – Instrumentation & Control

1.03 SUBMITTALS

A. Software Submittals: Provide software submittal in hardcopy form. Provide initial graphic display and report format layouts as described later in this specification. List and briefly describe all operator interface functions provided at the SCADA PC, including: alarm annunciation and acknowledgment, status displays, report generation, event logging, trending, etc.

B. Operation & Maintenance: O&M manual shall consist of system description and as-built-screen shots with description of features and operator interface. Reports and report access shall be described. An alarm list and alarm description shall be included. Also it shall describe backup procedures and how to check backup functionality and how to restore if an outage occurs.

1.04 QUALITY ASSURANCE

A. The project manager assigned by the integrator shall have at least five years' experience within the last five years in the design, manufacture, installation, calibration, and commissioning of instrumentation/Scada systems of similar size and complexity to this project.

B. The project manager assigned by the integrator shall have a minimum of a Bachelor's degree in Engineering or similar from an ABET accredited university.

C. Software Progress Meetings: Allow in Bid for (3) meetings at Engineer's office in Lexington, KY, for review of graphic operator screens. Meetings to commence at time of initial software development kickoff and continue up to final completion. These meetings shall be for specific purpose of assuring that software development work is in accord with

Contract requirements and are in addition to project progress meetings that may otherwise be required. If the software can be hosted on a website such that the Engineer can access the logic and graphics, then the software progress meetings can be implemented via telephone or web conference.

1.05 WARRANTY & SERVICE

A. The Contractor shall guarantee all work including equipment, materials, and workmanship. This guarantee shall be against all defects of the electrical system or improper equipment operation. It shall last for the period of time specified in the General Conditions of the Contract, but not less than one year from the date of system acceptance (i.e. – when the Engineer accepts that the punchlist is complete.)

B. Return visits – the Contractor shall provide a minimum of one 8-hr return visit after final completion to implement additional software items as requested by the Owner. The costs for this return visit shall be included in the bid price.

1.06 TRAINING

A. The required training shall include instruction on how the software works, its relationship to site equipment and operation, detailed review of O & M instructions, troubleshooting and record-keeping recommendations.

B. Onsite software training shall be provided, 4-hour minimum class.

1.07 GENERAL SCADA SOFTWARE REQUIREMENTS

A. The existing Citect SCADA software shall be utilized. If additional software tag or other licensing is needed to implement the requirements of this Contract, then that licensing shall be provided. If a SCADA software version upgrade is necessary to implement the requirements of this Contract, then that version upgrade shall be provided.

1.08 COORDINATION WITH CONTROL CONTRACTOR

A. SCADA contractor shall be required to coordinate with the control contractor awarded the development and installation of the WRWWS control system. This will involve two-way communication for proper configuration of radio system, assignment of IP addresses and other network parameters, and sharing of tag/address databases to ensure each contractor is able to successfully implement their portion of the scope for overall project success. It will also involve matching (as closely as possible) the process visualization graphics on the local HMI screen at WRWWS to prevent operator confusion. The control contractor shall be required to develop and submit for approval on their graphics first, and then the SCADA contractor shall prepare his remote SCADA HMI screens closely following the layout of the local HMI.

PART 2 – PRODUCTS

Not Applicable

PART 3 - EXECUTION

3.01 SOFTWARE SERVICES

A. General: Software services shall include program development, testing, documentation, and work necessary to implement a complete and fully operating system as shown on Drawings and as specified. Work requires coordination with programmable controllers (PLCs), implementation of Operator Interface and reports, alarm handling, and data collection. Include PLC error detection logic for communications failures, data highway faults, internal faults, and time outs. Communicate PLC error conditions to Operator Interface for logging and reporting. Employ a "watchdog" timer for each remote PLC and generate an alarm if the communications fail. Accept Operator Interface directives for set point changes and hand switches.

B. SCADA Interface Screens: Provide graphic representation of Wet Weather Storage System processes and control over machinery. Also provide data collection activities to provide historical trend analysis and process data readings for use in management reporting. The entire Wolf Run Wet Weather Storage system visualization shall be provided on a single process flow diagram screen for quick visualization of process state. Provide the following screens as a bare minimum. Some of these screens (such as Network Status) may already exist and the Wolf Run site will just need to be integrated into the existing screen:

1. Wolf Run Wet Weather Storage Overview, including Active Alarms
2. Wolf Run Wet Weather Storage Process Flow Diagram
3. Alarm & Event History
4. Network Status
5 Trending
6. Elapsed Run Time Reports
7. Flow Total Reports

C. SCADA software required application features:

1. Screens shall be fully windowed and shall use a mouse for control. Use colors, function keys, and navigational controls consistently.

2. Alarm Management: For each process or system event classed as an alarm provide facilities for displaying and logging in database, acknowledgment, and purging of stale messages. Alarm events are derived from discrete inputs, analog trip values, logic combinations and computations as needed. Log and display both alarm events and returns to normal. Provide date/time stamps for events, descriptive message, and event type code. Use color combinations to distinguish following alarm states: Alarm-Unacknowledged, Alarm-Acknowledged, Normal-Unacknowledged, and Normal-Acknowledged. Each alarm point indicated in the I/O Table is required to be integrated into SCADA. In addition to this, the following alarms must also be collected from the local WRWWS controller and integrated into SCADA:

   a. Alarms for each level sensor
   b. Equipment fail-to-start alarms
   c. Instrument failure alarms
   d. Radio communications failure alarm

3. Graphic Displays:

   a. Provide process-oriented displays showing current process status.
   b. Setpoint manipulation or control of equipment from SCADA is NOT required.
   c. For each display, show process elements such as pumps, valves, tanks, pipe lines, etc., with their current operational status. Emphasis shall be placed on depicting the system in a "P&ID" format that allows easy conceptualization of process flow and tank levels rather than depicting equipment in actual physical location or scale. Three-dimensional graphics are not required.
   d. Not running state: graphic shall be natural color with no motion.
   e. Running state: Graphic shall be green color and shall rotate or show other type of motion as appropriate. Both color and motion shall be depicted.
   f. Red color shall be reserved for alarm graphics.
   g. Tanks shall include both analog and digital indication of current fill/level status. Also, static text must be added to indicate level at bottom of tank and top (or overflow) of tank.
   h. Indicators shall use an appropriate number of significant digits and dead band to produce steady values.

4. Print Screen function shall direct an image of the currently displayed screen to any system printer as the user directs. When directed to a color printer, a color screen image shall be produced.

5. Trending: Provide on-screen trending displays that are user definable that operate from either previously collected historical trend groups (named file) or from a group of real-time variables. Provide facilities for user selection of colors, time (horizontal), and measurement (vertical) scales. Accommodate real-time sampling intervals as short as 1 second. Real-time trends shall show alarm setpoints. Historical trend displays shall have time-scale panning controls. All trends must have an adjustable cursor that indicates both Y and X axis values at the user-selected location.

6. Security: Not required since SCADA will not have control over equipment or setpoints.

7. Data Storage:

   a. Data shall be stored to the Historian's database. Text, binary, or otherwise "flat" file storage is not acceptable.

   b. All tags, both analog and digital, shall be stored via "Delta" storage method. That is, a new value shall be stored only when the tag has changed an appropriate amount. Normally the delta storage should be triggered at 0.1% change against the tag's maximum value, although this level may need to be adjusted if the tag has an abnormally wide range of operation.

   c. Establish automatic backup of historical data on a daily basis. The data shall be stored on an external harddrive unless other procedures have been approved by LFUCG.

8. Trending

   a. For each tag selected to be trended in the I/O table, provide a pre-configured trend that shows both real-time and historical values. Certain

tags may be added to the same trend where appropriate as long as they are uniquely identified via color and label.

b. Provide a custom trend screen whereby the operator has the ability to trend any tag in the database for WRWWS.

9. Reports:

a. Reporting requirements shall consist of both live HMI screens and published historical reports. The live HMI screens shall dynamically update the values for "today" or "this month" and shall display the values for "yesterday" or "last month". The published reports shall be accessible such that LFUCG can select which date or month they would like to view. In lieu of published reports, it is acceptable to store the data in a database with a report template as long as query date selection tools are provided to allow LFUCG to query a specific date range to obtain the desired report.

b. Daily totals and monthly totals (both run-times and flow totals) shall be captured from the WRWWS controller and logged to the database.

c. The following parameters shall be reported:

i. Motor & Equipment Run times: For each motor or piece of equipment that is monitored, report "Run Time Today" and "Run Time Yesterday" on the HMI screen and log each runtime to the database daily.

ii. Flow Totals: For both Tank Influent and Effluent flows, report "Flow Total Today", "Flow Total Yesterday", "Flow Total This Month", and "Flow Total Last Month." The flow totals shall be calculated locally at the WRWWS controller and transmitted to SCADA for display on the HMI screen and each flow total shall be logged to the database daily or monthly as applicable.

e. Data Export: Establish a simple method of data export to Excel for each run time and flow total value.

3.02 PERFORMANCE TEST

A. Following installation, checkout, and final adjustment of software, the Contractor shall schedule a performance test in the presence of the Engineer and the Owner.

B. Demonstrate to the Engineer and Owner that each I/O point scheduled on the Contract Drawings has been integrated and is functioning properly.

C. Demonstrate trending, reporting, and alarm messaging has been configured properly and is operational.

D. Software development shall not be accepted until the SCADA system functions for at least one week with zero nuisance alarms. Nuisance alarms shall be as defined by the Engineer.

END OF SECTION

APPENDIX A

LFUCG Standard Drawings 2008

Lexington Fayette Urban County
Government
Department of Public Works and Development

Standard Drawings 2008

Marwan A. Rayan, P.E.
Urban County Engineer
May 2008

Mayor Jim Newberry

LEXINGTON - FAYETTE URBAN COUNTY GOVERNMENT

Division of Engineering

May 1, 2008

Users of Lexington-Fayette Urban County Engineering Standard Drawings

Re: Standard Drawings 2008

Attached is the latest edition of the LFUCG Standard Drawings for construction of storm sewers, sanitary sewers, streets and roads in Lexington-Fayette County. These drawings are to replace any and all other standard drawings previously issued by the Division of Engineering.

These drawings become effective as of May 1, 2008 and any project dedicated to public use after the above date must comply with or contain references to these Standard Drawings or revisions thereof where applicable.

Questions or comments should be directed to:

Urban County Engineer
Division of Engineering
Fourth Floor
101 E. Vine Street
Lexington, KY 40507
859-258-3410

Sincerely,

Marwan A. Rayan, P.E.
Urban County Engineer

MAR:RAB:AFG

C: File

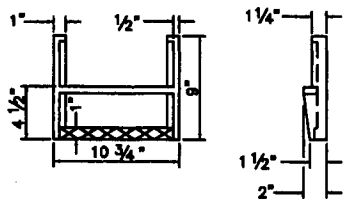
08.1000.106.StandDrw

LEXINGTON-FAYETTE URBAN COUNTY GOVERNMENT
STANDARD DRAWINGS 2008
TABLE OF CONTENTS

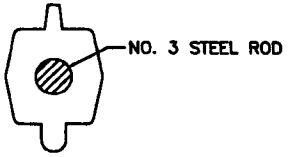
LEXINGTON-FAYETTE URBAN COUNTY GOVERNMENT
STANDARD DRAWINGS 2008
TABLE OF CONTENTS

LEXINGTON-FAYETTE URBAN COUNTY GOVERNMENT
STANDARD DRAWINGS 2008
TABLE OF CONTENTS

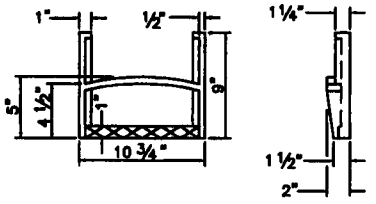
LEXINGTON-FAYETTE URBAN COUNTY GOVERNMENT
STANDARD DRAWINGS 2008
TABLE OF CONTENTS



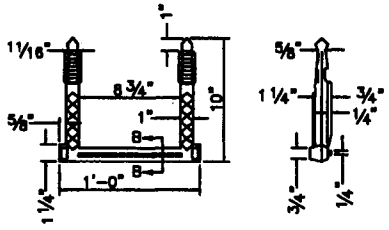
STEP TYPE NO. 1



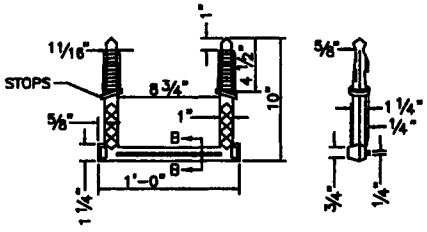
SECTION B–B



STEP TYPE NO. 2



STEP TYPE NO. 3

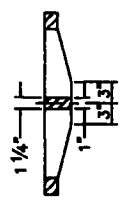


STEP TYPE NO. 4

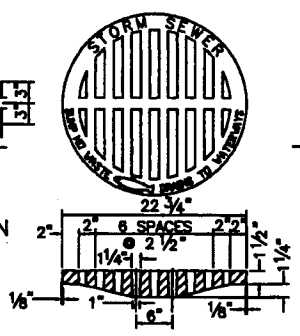
MANHOLE STEPS

NOTES:

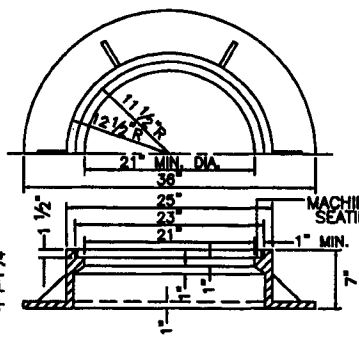
1. STEPS SHALL BE ASPHALT COATED CAST IRON OR POLYPROPYLENE PLASTIC COATED STEEL ROD OR OF A TYPE AND SIZE APPROVED BY THE ENGINEER.
2. STEPS SHALL BE SPACED APPROXIMATELY 12" TO 16" O.C. VERTICALLY SO AS TO FORM A CONTINUOUS LADDER.
3. STEPS SHALL BE REQUIRED IN MANHOLES WHEN THE STRUCTURE IS 4 FEET AND GREATER IN DEPTH. (MEASURE FROM FLOWLINE OF LOWEST PIPE TO TOP OF STRUCTURE.)
4. THE TREADS OF ALL STEPS SHALL HAVE ANTI–SKID PROPERTIES FOR HAND AND FOOT GRIPS.
5. MANHOLE STEPS SHALL BE INSTALLED IN A VERTICAL LINE AND SHALL COMPLY WITH OSHA STANDARDS IN ALL RESPECTS.
6. FOR CAST–IN–PLACE OR PRECAST CIRCULAR AND NON–CIRCULAR MANHOLES.
7. FIRST STEP SHALL BE NO MORE THAN 18" FROM TOP OF RIM.



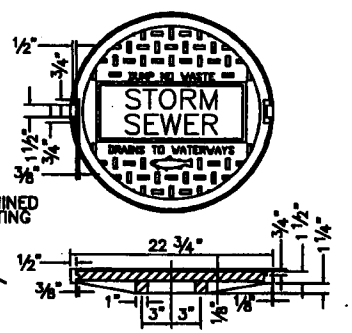
SECTION



GRATING COVER



FRAME



SOLID COVER

NOTES:

1. MINIMUM WEIGHT FOR THE 7" FRAME SHALL BE 185 LBS.
2. MINIMUM WEIGHT FOR THE SOLID COVER SHALL BE 120 LBS.
3. CASTINGS TO MEET ASTM A–48 CLASS 35.

MANHOLE FRAME AND COVERS

NO.	DATE	REVISION DESCRIPTION	BY

DIVISION OF ENGINEERING

MANHOLE FRAMES, COVERS, & STEPS

STANDARD DRAWING NO. 103

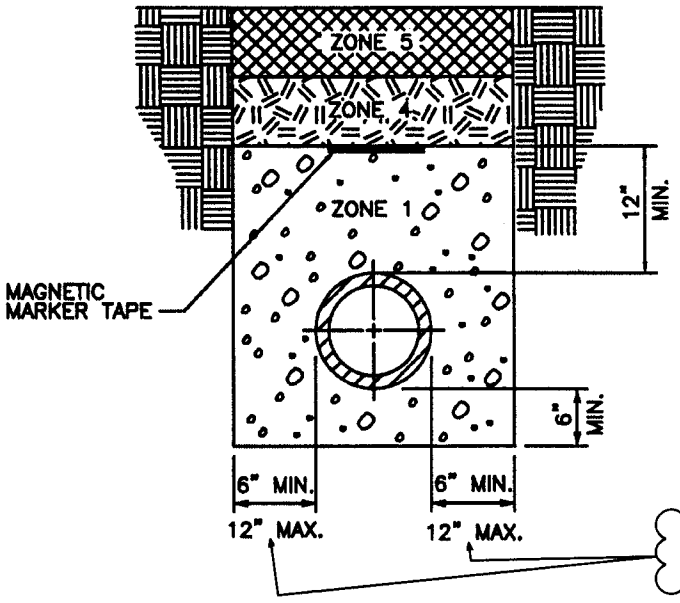
APPROVED _____ 5/1/02 DATE

URBAN COUNTY ENGINEER

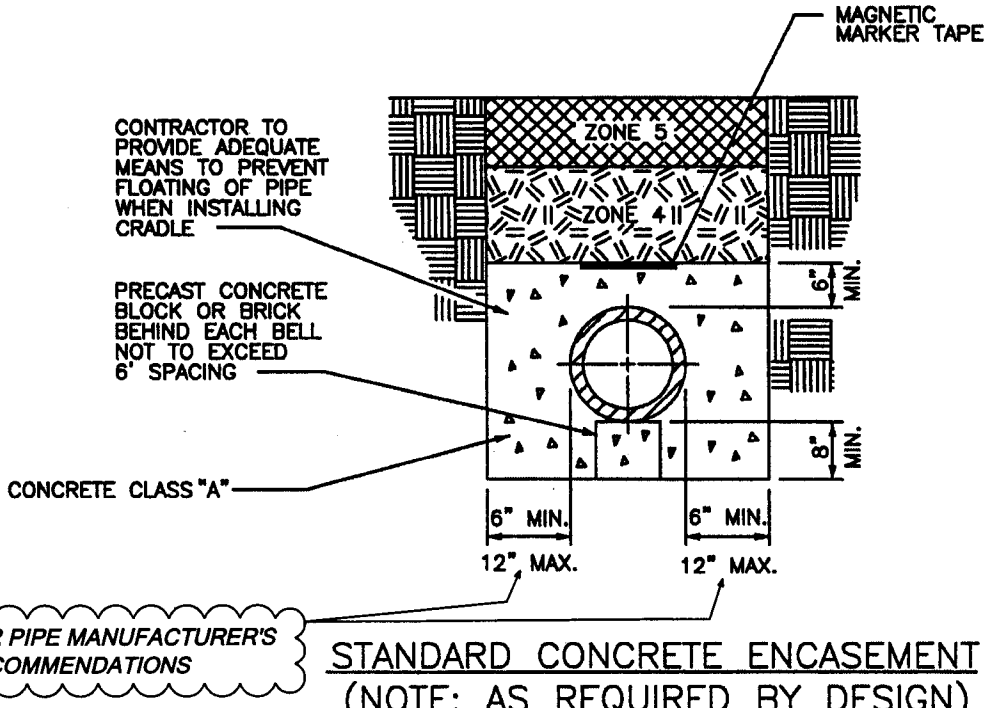
_____ 5/1/02 DATE

COMMISSIONER

LEXINGTON–FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT



PIPE LAID IN ROCK OR SOIL TRENCH



STANDARD CONCRETE ENCASEMENT (NOTE: AS REQUIRED BY DESIGN)

PIPE BACKFILL DESCRIPTIONS	
ZONE 1	NO. 9 STONE
ZONE 2	NO. 9 OR NO. 57 STONE
ZONE 3	COMPACTED DGA
ZONE 4	CONSOLIDATED SOIL (NO ROCK GREATER THAN 6" DIAMETER), NO. 9, OR NO. 57 STONE
ZONE 5	12" MAX. TOPSOIL, NO ROCK ALLOWED

NOTES:

1. COVER, UP TO AND INCLUDING ZONE 4 SHALL BE ESTABLISHED BEFORE TRENCH EXCAVATION.
2. ALL SANITARY SEWER LINES CONSTRUCTED FROM NON-METALLIC MATERIALS SHALL HAVE MAGNETIC MARKER TAPE INSTALLED IN THE TRENCH ABOVE THE SANITARY SEWER LINE.
3. MAGNETIC MARKER TAPE FOR SANITARY SEWER ONLY.

(FORCE MAINS)

(FORCE MAINS)

NO.	DATE	REVISION DESCRIPTION	BY

DIVISION OF ENGINEERING

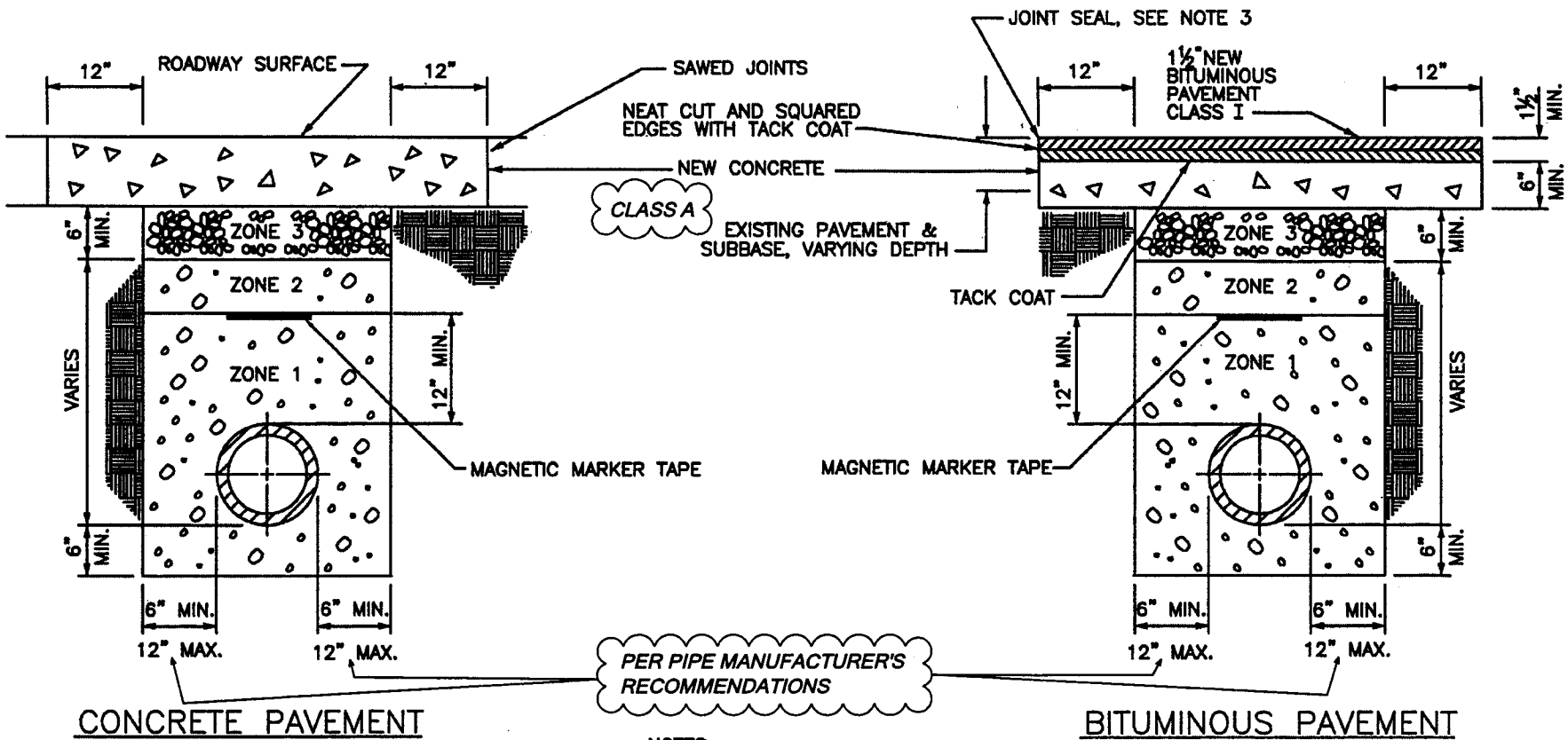
TRENCHING, LAYING, BACKFILLING AND BEDDING OUTSIDE R/W LIMITS

STANDARD DRAWING NO. 200

APPROVED 5/1/02

DATE

LEXINGTON-FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT



CONCRETE PAVEMENT

BITUMINOUS PAVEMENT

PIPE BACKFILL DESCRIPTIONS	
ZONE 1	NO. 9 STONE
ZONE 2	NO. 9 OR NO. 57 STONE
ZONE 3	COMPACTED DGA
ZONE 4	CONSOLIDATED SOIL, (NO ROCK GREATER THAN 6" DIAMETER), NO. 9, OR NO. 57 STONE
ZONE 5	12" MAX. TOPSOIL, NO ROCK ALLOWED

NOTES:

1. REPLACE CONCRETE PAVEMENT WITH NEW CONCRETE PAVEMENT, 6"MINIMUM OR EXISTING THICKNESS, WHICHEVER IS GREATER.
2. JOINT SEAL PERIMETER OF CUT PAVEMENT WITH FLEXMASTER POURABLE CRACK SEALANT 1109 OR APPROVED EQUAL.
3. MAGNETIC MARKER TAPE FOR SANITARY SEWER ONLY. *(FORCE MAINS)*

4. #9 CRUSHED LIMESTONE IN ZONE 3 IS ACCEPTABLE ALTERNATIVE TO DGA

NO.	DATE	REVISION DESCRIPTION	BY

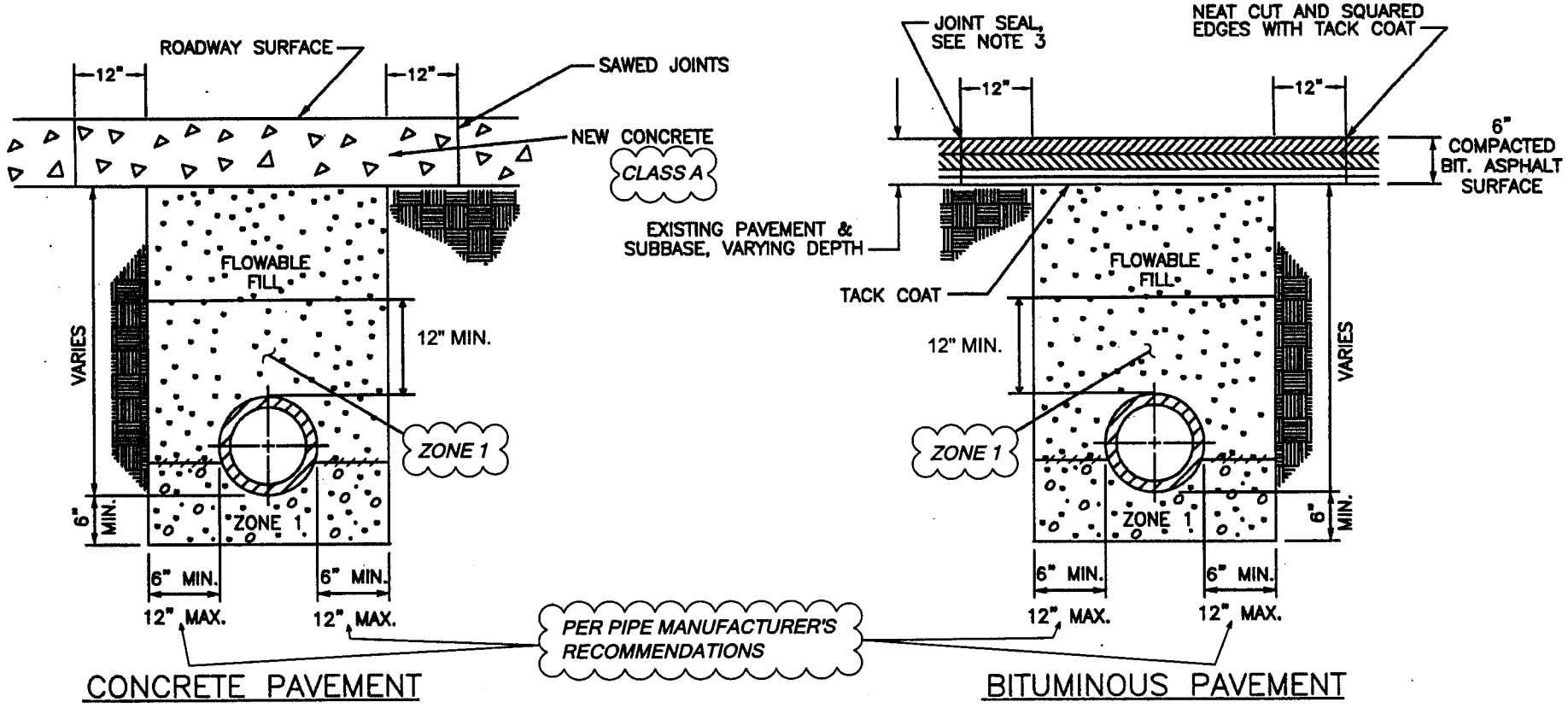
DIVISION OF ENGINEERING

TRENCHING, LAYING, BACKFILLING AND BEDDING UNDER STREET PAVEMENT

STANDARD DRAWING NO. 201-1

APPROVED 5/1/08

LEXINGTON–FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT



CONCRETE PAVEMENT

BITUMINOUS PAVEMENT

PIPE BACKFILL DESCRIPTIONS	
ZONE 1	NO. 9 STONE
ZONE 2	NO. 9 OR NO. 57 STONE
ZONE 3	COMPACTED DGA
ZONE 4	CONSOLIDATED SOIL, (NO ROCK GREATER THAN 6" DIAMETER), NO. 9, OR NO. 57 STONE
ZONE 5	12" MAX. TOPSOIL, NO ROCK ALLOWED

NOTES:

1. PER KYTC SPECIFICATION 601.03.03 FROM STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION EDITION 2004, OR MOST RECENT.
2. REPLACE CONCRETE PAVEMENT WITH NEW CONCRETE PAVEMENT, 6" MINIMUM OR EXISTING THICKNESS, WHICHEVER IS GREATER.
3. JOINT SEAL PERIMETER OF CUT PAVEMENT WITH FLEXMASTER POURABLE CRACK SEALANT 1109 OR APPROVED EQUAL.

NO.	DATE	REVISION DESCRIPTION	BY

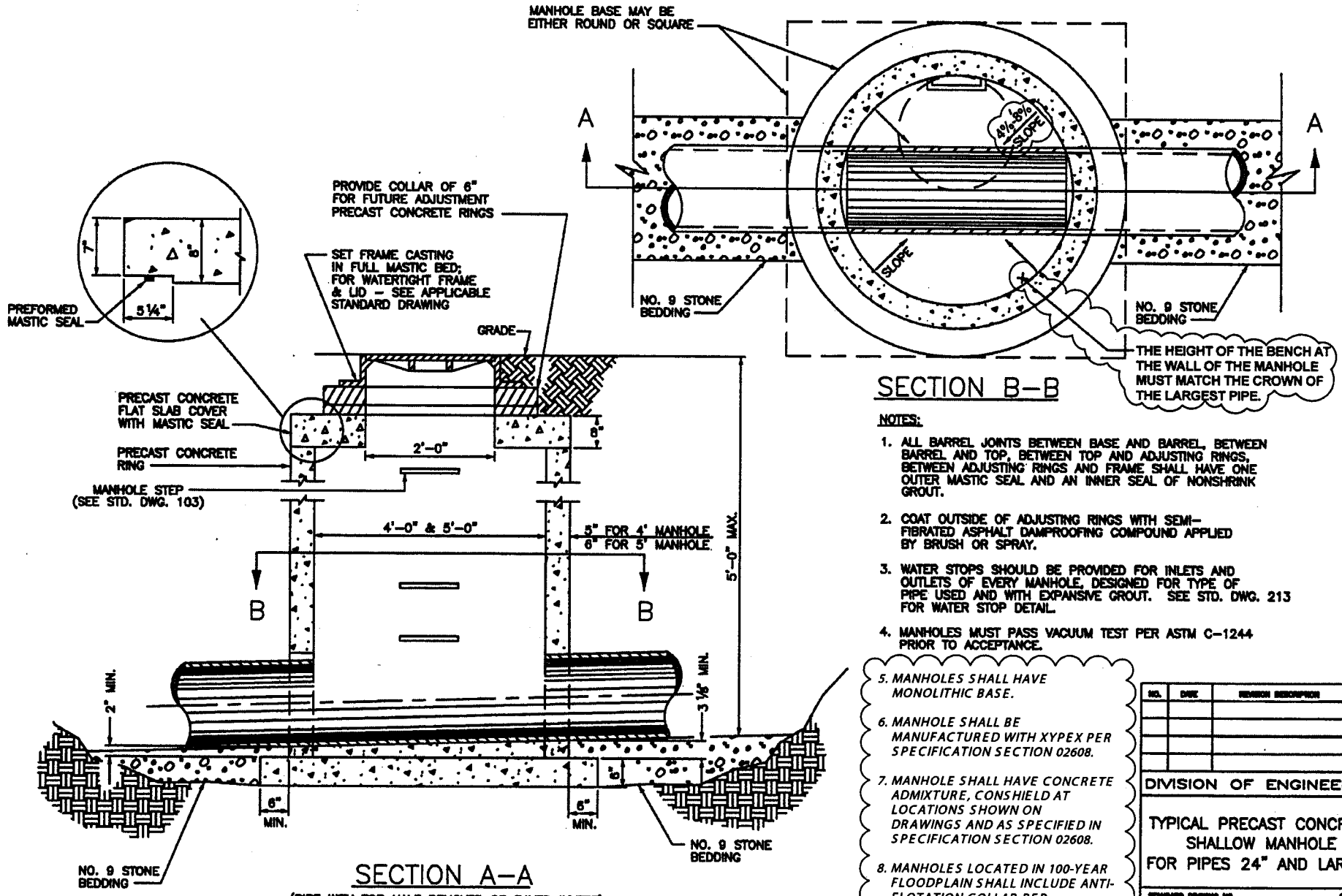
DIVISION OF ENGINEERING

TRENCHING, LAYING, BACKFILLING, AND BEDDING UNDER STREET PAVEMENT USING FLOWABLE FILL

STANDARD DRAWING NO. 201-2

APPROVED 5/1/08

LEXINGTON-FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT



SECTION B–B

SECTION A–A

(PIPE WITH TOP HALF REMOVED OR PAVED INVERT)

NOTES:

1. ALL BARREL JOINTS BETWEEN BASE AND BARREL, BETWEEN BARREL AND TOP, BETWEEN TOP AND ADJUSTING RINGS, BETWEEN ADJUSTING RINGS AND FRAME SHALL HAVE ONE OUTER MASTIC SEAL AND AN INNER SEAL OF NONSHRINK GROUT.
2. COAT OUTSIDE OF ADJUSTING RINGS WITH SEMI–FIBRATED ASPHALT DAMPROOFING COMPOUND APPLIED BY BRUSH OR SPRAY.
3. WATER STOPS SHOULD BE PROVIDED FOR INLETS AND OUTLETS OF EVERY MANHOLE, DESIGNED FOR TYPE OF PIPE USED AND WITH EXPANSIVE GROUT. SEE STD. DWG. 213 FOR WATER STOP DETAIL.
4. MANHOLES MUST PASS VACUUM TEST PER ASTM C–1244 PRIOR TO ACCEPTANCE.
5. *MANHOLES SHALL HAVE MONOLITHIC BASE.*
6. *MANHOLE SHALL BE MANUFACTURED WITH XYPEX PER SPECIFICATION SECTION 02608.*
7. *MANHOLE SHALL HAVE CONCRETE ADMIXTURE, CONSHIELD AT LOCATIONS SHOWN ON DRAWINGS AND AS SPECIFIED IN SPECIFICATION SECTION 02608.*
8. *MANHOLES LOCATED IN 100-YEAR FLOODPLAIN SHALL INCLUDE ANTI-FLOTATION COLLAR PER SPECIFICATION SECTION 02608.*

NO.	DATE	REVISION DESCRIPTION	BY

DIVISION OF ENGINEERING

TYPICAL PRECAST CONCRETE SHALLOW MANHOLE FOR PIPES 24" AND LARGER

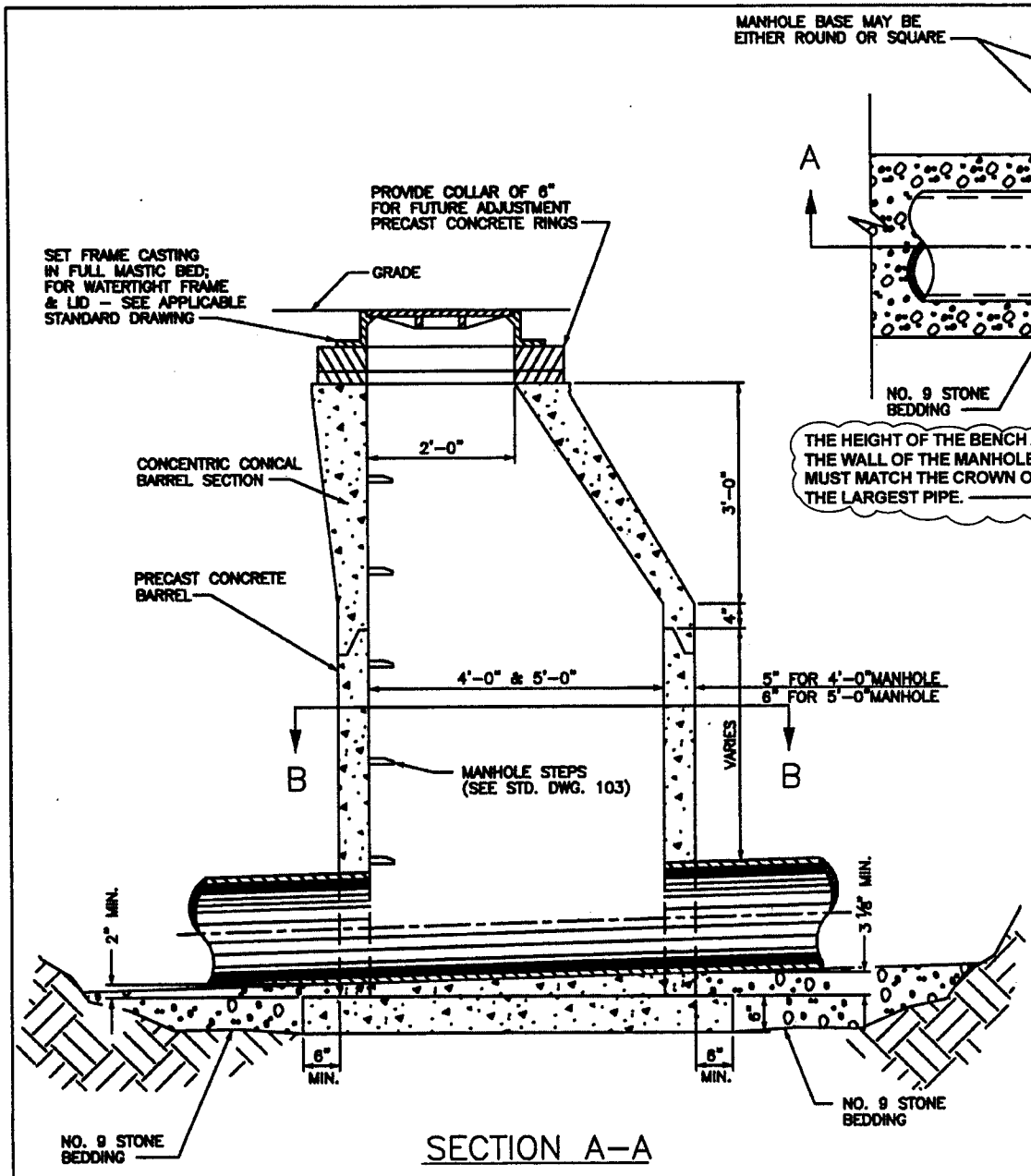
STANDARD DRAWING NO. 210

APPROVED 5/1/08

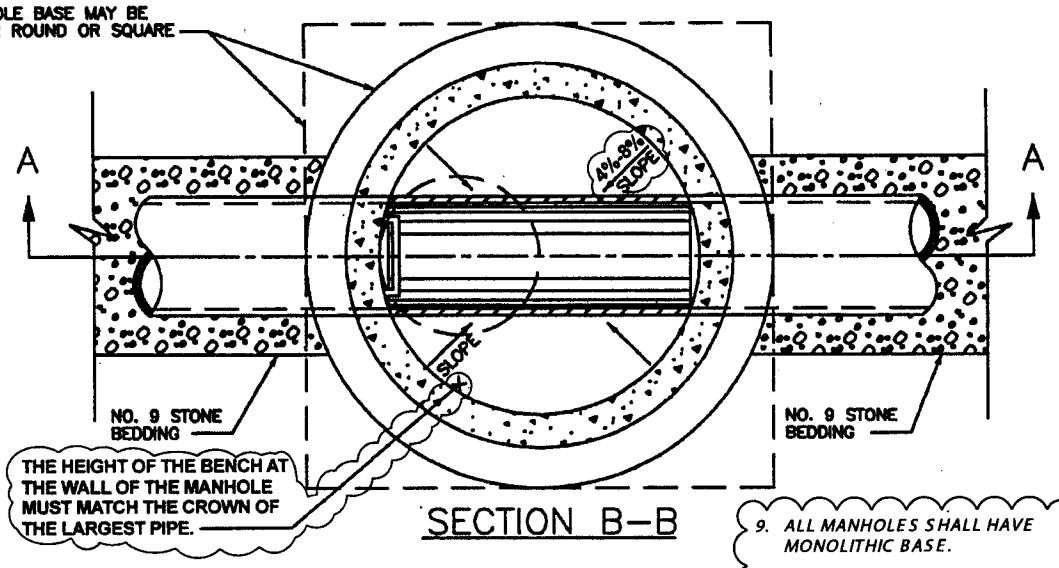
DIRECTOR

COMMISSIONER DATE

LEXINGTON–FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT



SECTION A–A



SECTION B–B

NOTES:

1. ALL BARREL JOINTS BETWEEN BASE AND BARREL, BETWEEN BARREL AND TOP, BETWEEN TOP AND ADJUSTING RINGS, BETWEEN ADJUSTING RINGS AND FRAME SHALL HAVE ONE OUTER MASTIC SEAL AND AN INNER SEAL OF NONSHRINK GROUT.
2. COAT OUTSIDE OF ADJUSTING RINGS WITH SEMI–FIBRATED ASPHALT DAMPROOFING COMPOUND APPLIED BY BRUSH OR SPRAY.
3. WATER STOPS SHOULD BE PROVIDED FOR INLETS AND OUTLETS OF EVERY MANHOLE, DESIGNED FOR TYPE OF PIPE USED AND WITH EXPANSIVE GROUT. SEE STD. DWG. 213 FOR WATER STOP DETAIL.
4. NO REINFORCEMENT NEEDED IN BOTTOM SLAB AT DEPTHS UP TO 12'. AT DEPTHS GREATER THAN 12' REINFORCE WITH NO. 4 BARS – 12" C–C.
5. A DIFFERENCE OF FLOW ELEVATION MORE THAN 24" REQUIRES AN OUTSIDE DROP. (SEE STD. DWG. 212)
6. MANHOLE STEPS SHALL BE ALIGNED WITH STRAIGHT SIDE OF CONCENTRIC CONE SECTION, AND ALIGNED OVER THE OUTLET PIPE.
7. PIPES SHALL NOT ENTER THE CONE SECTION.
8. MANHOLES MUST PASS VACUUM TEST PER ASTM C–1244 PRIOR TO ACCEPTANCE.
9. *ALL MANHOLES SHALL HAVE MONOLITHIC BASE.*
10. *MANHOLE SHALL BE MANUFACTURED WITH XYPEX PER SPECIFICATION SECTION 02608.*
11. *MANHOLE SHALL HAVE CONCRETE ADMIXTURE, CONSHIELD AT LOCATIONS SHOWN ON DRAWINGS AND AS SPECIFIED IN SPECIFICATION SECTION 02608.*
12. *MANHOLES LOCATED IN 100-YEAR FLOODPLAIN SHALL INCLUDE ANTI-FLOTATION COLLAR PER SPECIFICATION SECTION 02608.*

NO.	DATE	REVISION DESCRIPTION	BY

DIVISION OF ENGINEERING

TYPICAL STANDARD PRECAST CONCRETE MANHOLE FOR PIPES UP TO 24"

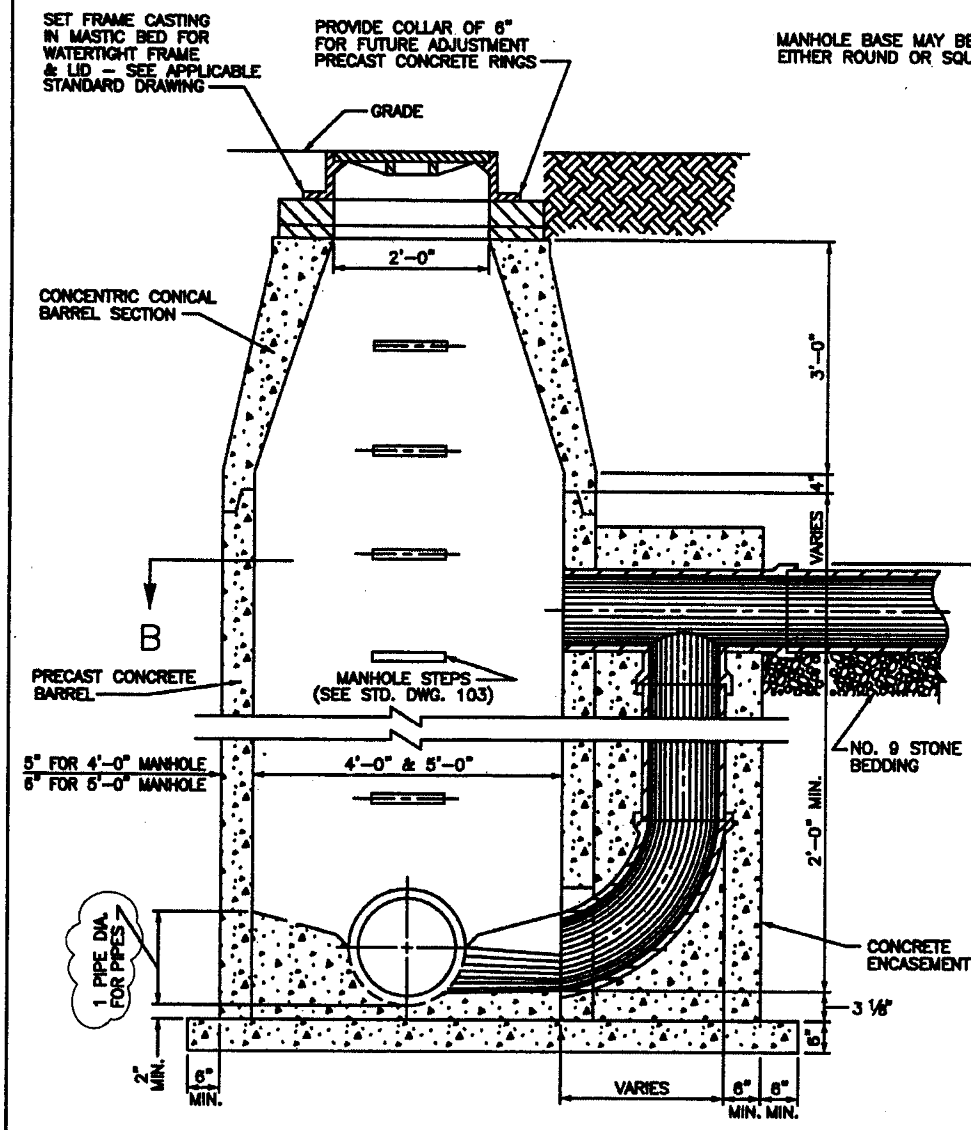
STANDARD DRAWING NO. 211

APPROVED _____ DATE 5/1/08

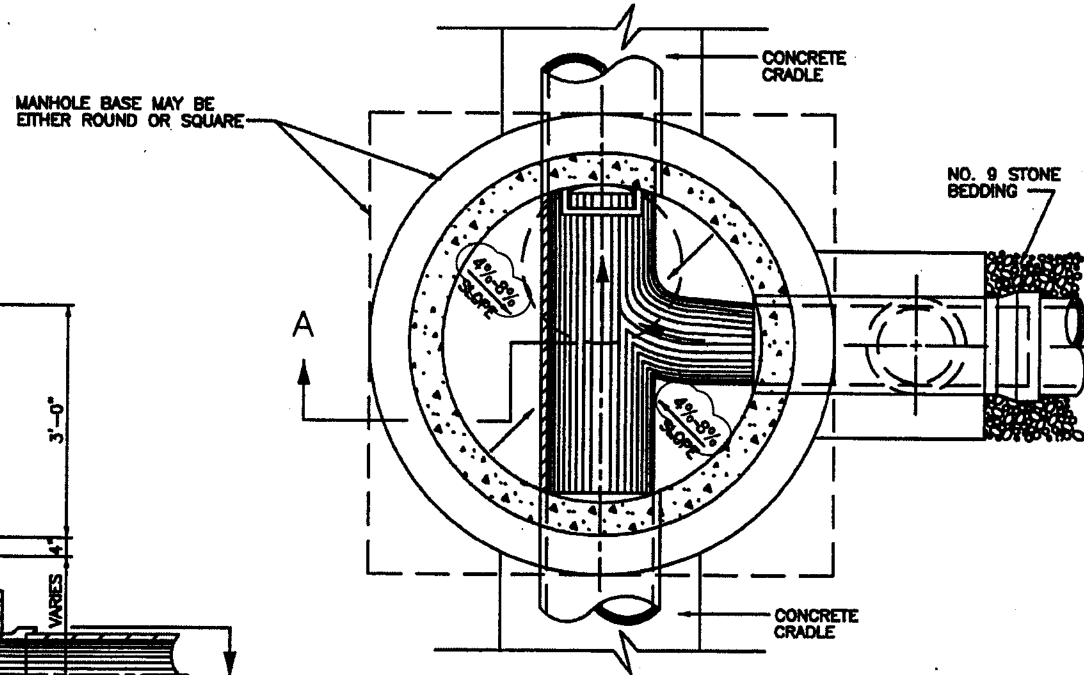
URBAN COUNTY ENGINEER

COMMISSIONER _____ DATE _____

LEXINGTON–FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT



SECTION A–A



SECTION B–B

NOTES:

1. ALL BARREL JOINTS BETWEEN BASE AND BARREL, BETWEEN BARREL AND TOP, BETWEEN TOP AND ADJUSTING RINGS, BETWEEN ADJUSTING RINGS AND FRAME SHALL HAVE ONE OUTER MASTIC SEAL AND AN INNER SEAL OF NONSHRINK GROUT.
2. COAT OUTSIDE OF ADJUSTING RINGS WITH SEMI-FIBRATED ASPHALT DAMPROOFING COMPOUND APPLIED BY BRUSH OR SPRAY.
3. WATER STOPS SHOULD BE PROVIDED FOR INLETS AND OUTLETS OF EVERY MANHOLE, DESIGNED FOR TYPE OF PIPE USED AND WITH EXPANSIVE GROUT. SEE STD. DWG. 213 APPLICABLE FOR WATER STOP DETAIL.
4. NO REINFORCEMENT NEEDED IN BOTTOM SLAB AT DEPTHS UP TO 12'. AT DEPTHS GREATER THAN 12' REINFORCE WITH NO. 4 BARS – 12" C–C.
5. PROVIDE A MINIMUM FALL OF 0.1 FOOT FROM DROP TO MANHOLE OUTLET.
6. MANHOLES SHALL PASS VACUUM TEST PER ASTM C–1244 PRIOR TO ACCEPTANCE.
7. PIPE SHALL NOT ENTER CONE SECTION.
8. MANHOLE STEPS SHALL BE ALIGNED WITH STRAIGHT SIDE OF CONCENTRIC CONE SECTION, AND ALIGNED OVER OUTLET PIPE.
9. DO NOT USE IN CASES WHERE THE DROP IS 2'-0" OR LESS.

NO.	DATE	REVISION DESCRIPTION	BY

DIVISION OF ENGINEERING

TYPICAL PRECAST CONCRETE DROP MANHOLE FOR PIPES UP TO 36"

STANDARD DRAWING NO. 212

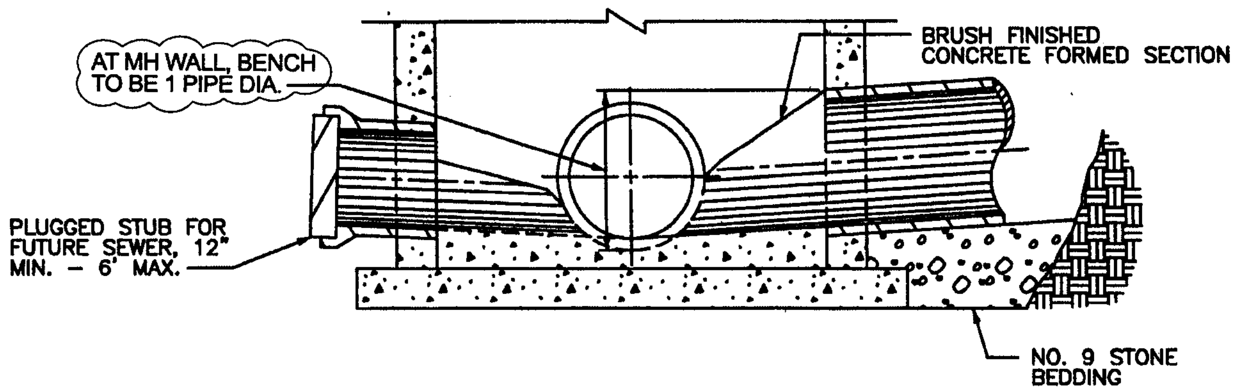
APPROVAL: URBAN COUNTY ENGINEER 5/1/08 DATE

COMMISSIONER DATE

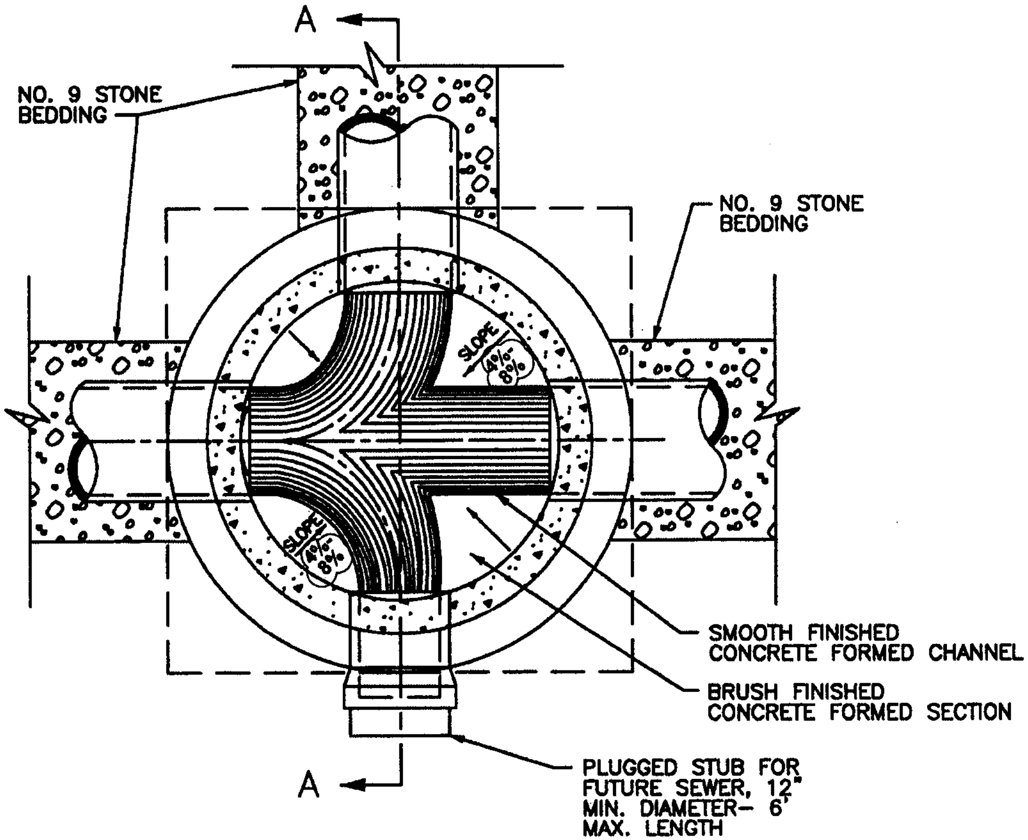
LEXINGTON–FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT

NOTES:

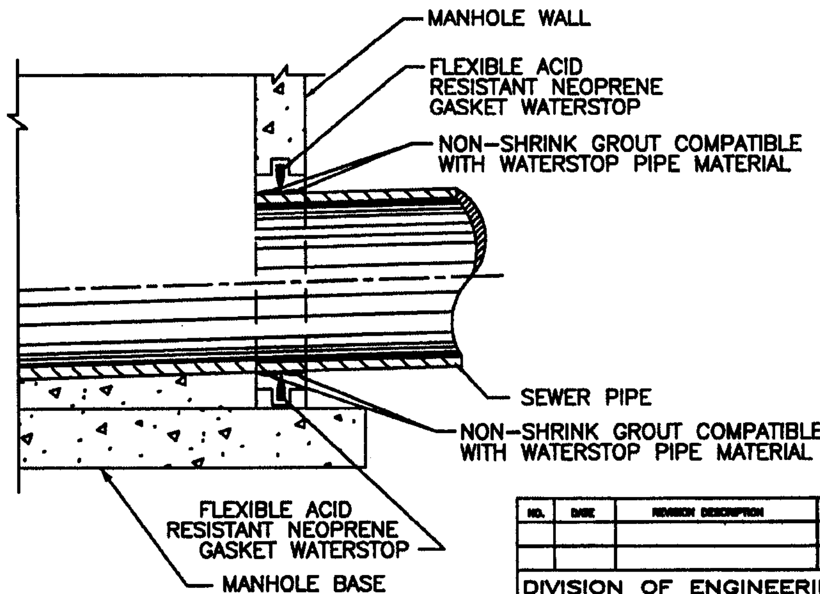
1. ALL MANHOLES SHALL HAVE MONOLITHIC BASE.
2. MANHOLE SHALL BE MANUFACTURED WITH XYPEX PER SPECIFICATION SECTION 02608.
3. MANHOLE SHALL HAVE ADMIXTURE, CONSHIELD AT LOCATIONS SHOWN ON DRAWINGS AND AS SPECIFIED IN SPECIFICATION SECTION 02608.
4 MANHOLES LOCATED IN 100-YEAR FLOODPLAIN SHALL INCLUDE ANTI-FLOTATION COLLAR PER SPECIFICATION SECTION 02608.



SECTION A–A



SECTION PLAN



WATER STOP DETAIL

NOTE:

MANHOLES SHALL PASS VACUUM TEST PER ASTM C–1244 PRIOR TO ACCEPTANCE.

NO.	DATE	REVISION DESCRIPTION	BY

DIVISION OF ENGINEERING

STANDARD MANHOLE JUNCTION AND WATER STOP DETAILS

STANDARD DRAWING NO. 213

APPROVAL 5/1/08

URBAN COUNTY ENGINEER

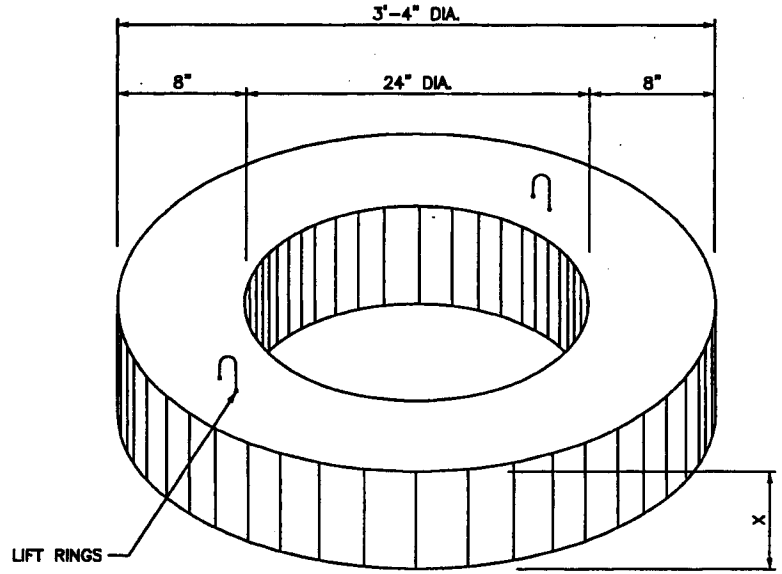
COMMISSIONER

DATE

LEXINGTON–FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT

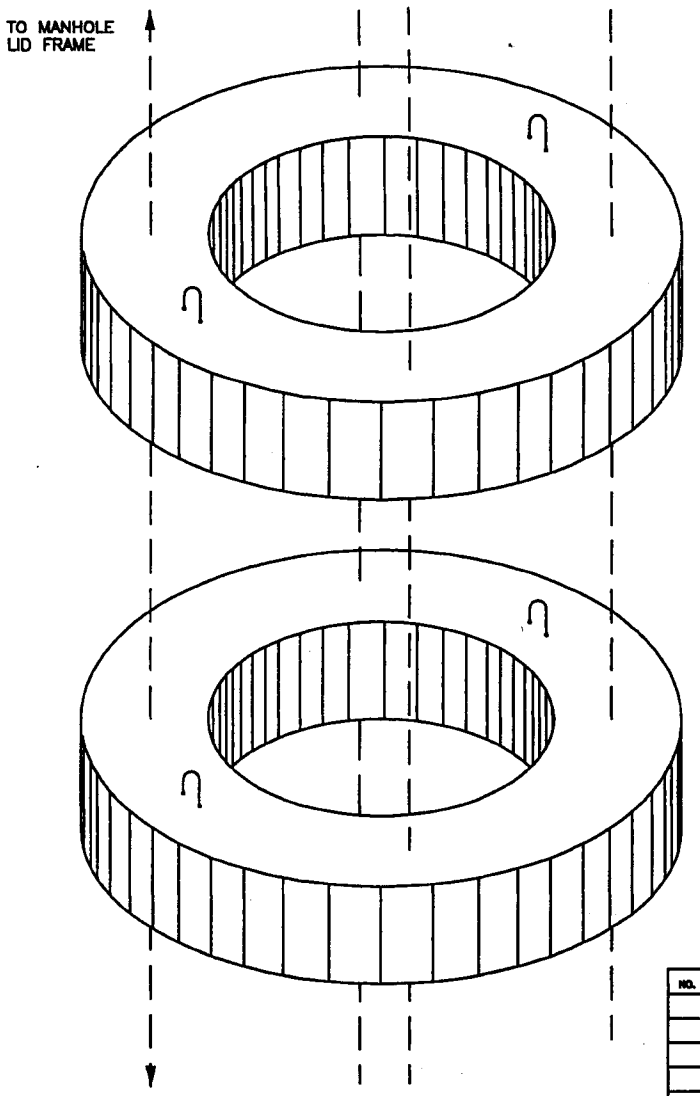
NOTES:

1. LIFT RINGS TO BE CUT BEFORE ADDING THE NEXT RING OR TOP.
2. COAT OUTSIDE AND IN BETWEEN ADJUSTING RINGS WITH SEMI-FIBRATED ASPHALT DAMPROOFING COMPOUND APPLIED BY BRUSH OR SPRAY.
3. GRADE RINGS WITH NON-PARALLEL SURFACES MAY BE USED TO ADJUST CASTING TO SLOPED SURFACE.
4. CONCRETE: CLASS "A" 3500 PSI AT 28 DAYS, AND IN ACCORDANCE WITH ASTM C-478, OR LATEST EDITION.
5. NO MORE THAN 2 GRADE RINGS MAY BE USED AT ONE LOCATION AND THE MAXIMUM HEIGHT OF ALL RINGS USED SHALL NOT EXCEED 12 INCHES.
6. APPLY MASTIC BETWEEN ALL JOINTS.



GRADE RING WIDTH CHART

X	WEIGHT LBS.
2"	140
3"	210
4"	279
6"	419
8"	560
12"	730



NO.	DATE	REVISION DESCRIPTION	BY

DIVISION OF ENGINEERING

SEWER MANHOLE ADJUSTMENT GRADE RINGS

STANDARD DRAWING NO. 214

APPROVAL _____ 5/1/08
URBAN COUNTY ENGINEER DATE

_____ 5/1/08
COMMISSIONER DATE

LEXINGTON-FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT

GENERAL NOTES

1. SHALLOW MANHOLE TYPE CONSTRUCTION SHOWN ON STD. DWG. 210 MAY BE USED FOR ALL MANHOLES UP TO 5' IN DEPTH.
2. ALL DIMENSIONS ARE BASED ON SIZE OF LARGEST PIPE IN MANHOLE.
3. MANHOLES FOR PIPE LARGER THAN 36" SHALL BE SPECIALLY DESIGNED.
4. BOTTOM SLAB OF MANHOLES SHALL BE SPECIALLY DESIGNED WITH REGARD TO AREA, THICKNESS, AND REINFORCING IN SITUATIONS WHERE HIGH WATER TABLE OR UNSTABLE SOIL CONDITIONS EXIST.
5. MANHOLE STEPS SHALL BE INSTALLED IN A VERTICAL LINE AND SHALL COMPLY WITH OSHA STANDARDS IN ALL RESPECTS.
6. ALL FLOORS OF MANHOLES SHALL SLOPE AT LEAST 1" PER FT. FROM WALL TO CHANNELS AND SHALL HAVE SMOOTH FLOAT AND BRUSH FINISH.
7. CHANNEL SURFACE OF MANHOLES FROM INLET TO OUTLET SHALL HAVE SMOOTH FLOAT FINISH.
8. ELEVATIONS OF PIPES IN MANHOLES SHALL BE SUCH THAT THE TOP OF ALL INFLUENT PIPES WILL BE AT AN EL-EVATION EQUAL TO OR GREATER THAN THE TOP OF THE EFFLUENT PIPE.
9. A MINIMUM FALL OF 0.10 FOOT SHALL BE PROVIDED.
10. BASE OF MANHOLES GREATER THAN 12' DEEP TO BE REINFORCED WITH NO. 4 BARS AT 12" BOTH WAYS.
11. ASPHALT DAMPROOFING COMPOUND IS REQUIRED ON PRECAST MANHOLES IN WET AREAS OR OTHERWISE AS DIRECTED BY THE ENGINEER.
12. LEAKS IN MANHOLES OBSERVED DURING CONSTRUCTION OR INSPECTION SHALL BE CORRECTED IMMEDIATELY.
13. MANHOLES SHALL PASS VACUUM TEST PER ASTM C-1244 PRIOR TO ACCEPTANCE.
14. ALL INLETS, INCLUDING LATERALS, MUST HAVE FLOW CHANNELS.
15. NEW CONNECTIONS TO EXISTING SANITARY SEWER MANHOLES MUST REPLACE EXISTING BRICK MANHOLES OR DAMAGED MANHOLES AT NO EXPENSE TO THE LFUCG.
16. FIELD POURED BASES (DOGHOUSE MANHOLES) SHALL ONLY BE ALLOWED WITH PRIOR APPROVAL OF THE LFUCG.

SPECIFICATIONS

1. CASTINGS SHALL BE ASTM A-48, CLASS 35.
2. CONCRETE FOR MANHOLES, CRADLE ENCASEMENT, ETC. SHOWN IN THESE DETAILS SHALL BE CLASS "A".
3. CONCRETE MANHOLE BARREL CONSTRUCTION SHALL CONFORM TO ASTM C-478 OR ITS LATEST REVISION.

DOES NOT APPLY

NO.	DATE	REVISION DESCRIPTION	BY

DIVISION OF ENGINEERING

MANHOLE SIZE STANDARDS AND GENERAL NOTES FOR DEEP MANHOLES

STANDARD DRAWING NO. 216

APPROVED [signature] 5/1/08
DIRECTOR, DIVISION OF ENGINEERING — DATE

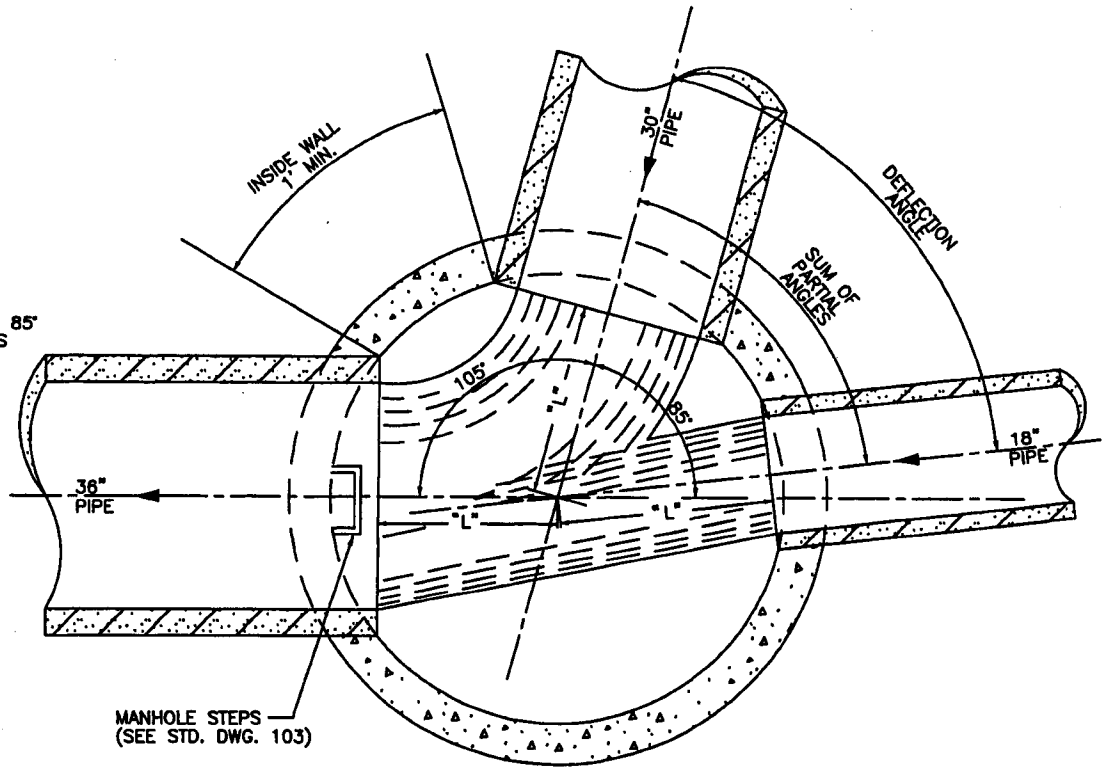
[signature]
COMMISSIONER — DATE

CIRCULAR MANHOLE NOTES:

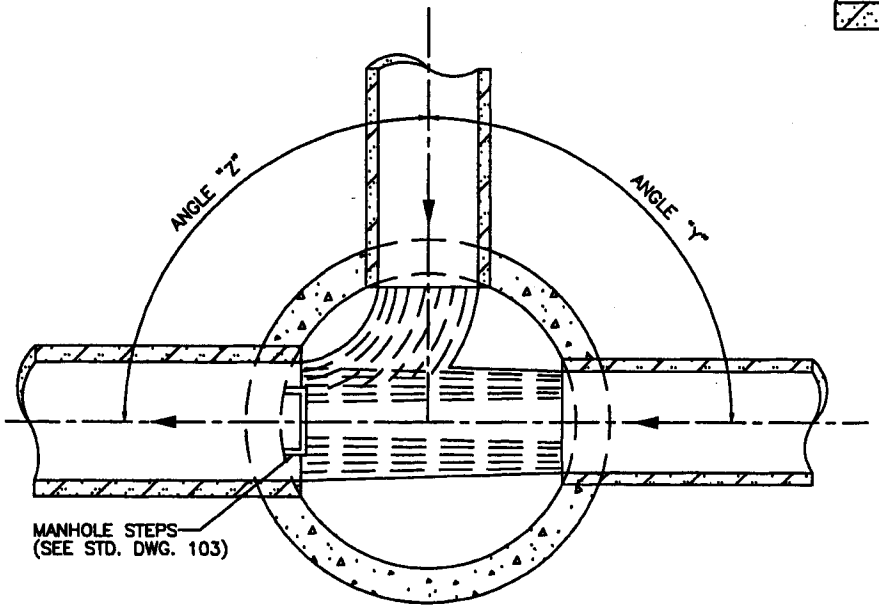
1. THE ANGLE BETWEEN ANY TWO PIPES (e.g. ANGLE "Y" OR "Z") MUST BE GREATER THAN THE SUM OF THE PARTIAL ANGLES. REFER TO SEPARATE STANDARD DRAWINGS FOR TABLE OF MINIMUM PARTIAL ANGLES. ANGLES SMALLER THAN LISTED ON TABLE SHALL REQUIRE LARGER MANHOLE SELECTION.
2. THE MAXIMUM DEFLECTION ANGLE BETWEEN ANY INCOMING PIPE AND THE CENTERLINE EXTENSION OF THE DISCHARGE PIPE SHALL BE NO MORE THAN 90° FOR PIPES UP TO 24" IN DIAMETER. THE MAXIMUM DEFLECTION ANGLE FOR 27" TO 36" PIPES SHALL BE 75°.

EXAMPLE FOR SANITARY MANHOLE SIZE SELECTION:

FOR MANHOLE SHOWN AT RIGHT, THE ANGLE BETWEEN THE 18" AND 30" PIPES IS 85° AND THE ANGLE BETWEEN THE 30" AND 36" PIPES IS 105°. THE TABLE INDICATES THAT FOR A 5'-0" DIAMETER MANHOLE THE MINIMUM PARTIAL ANGLE FOR AN 18" PIPE IS 34° AND FOR A 30" PIPE IS 50°. THE SUM OF THE PARTIAL ANGLES IS 84°. THIS SUM IS LESS THAN THE 85° THEREFORE, A 5'-0" MANHOLE DIAMETER IS ACCEPTABLE.



PLAN SECTION



PLAN SECTION

TABLE OF MINIMUM PARTIAL ANGLES FOR SANITARY MANHOLES

PIPE SIZE	MANHOLE SIZE 4'-0" P. ANGLE	4'-0" L. DIST.	5'-0" P. ANGLE	5'-0" L. DIST.
15"	38°	1'-10"	30°	2'-3"
18"	43°	1'-8"	34°	2'-3"
24"	53°	1'-6"	39°	2'-2"
27"	–	–	45°	2'-0"
30"	–	–	50°	1'-11"

NO.	DATE	REVISION DESCRIPTION	BY

DIVISION OF ENGINEERING

DEFLECTION ANGLE CRITERIA FOR SANITARY MANHOLES

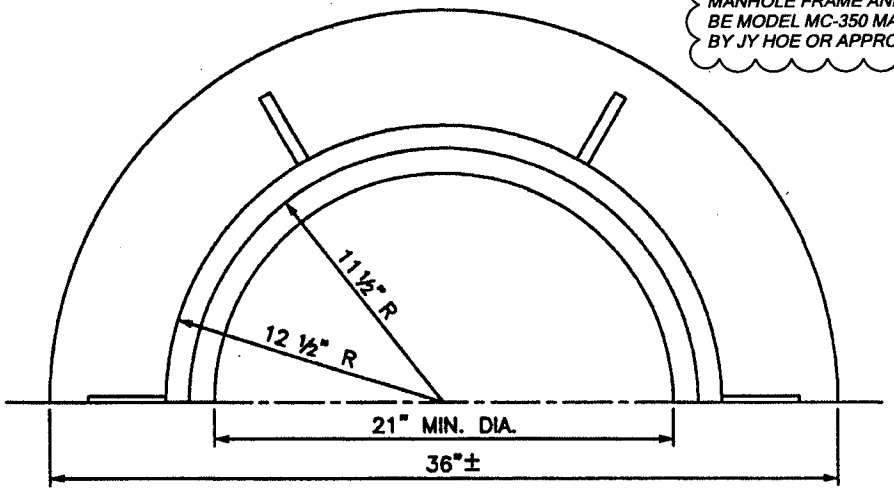
STANDARD DRAWING NO. 217

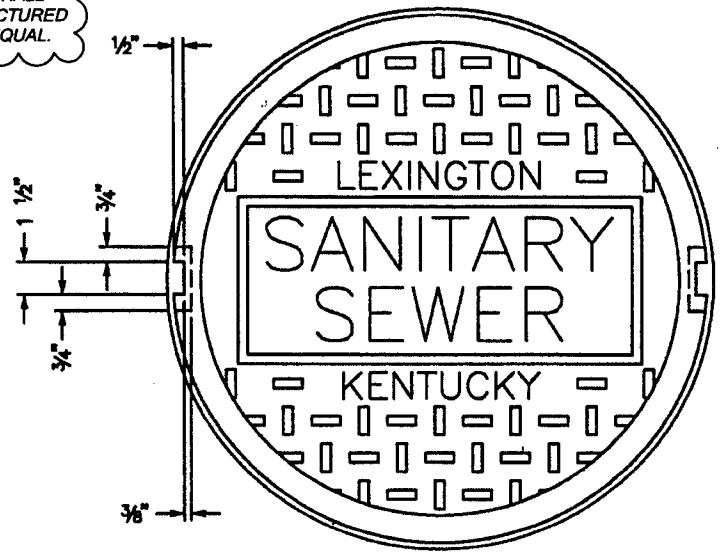
APPROVED: URBAN COUNTY ENGINEER — DATE 5/1/08

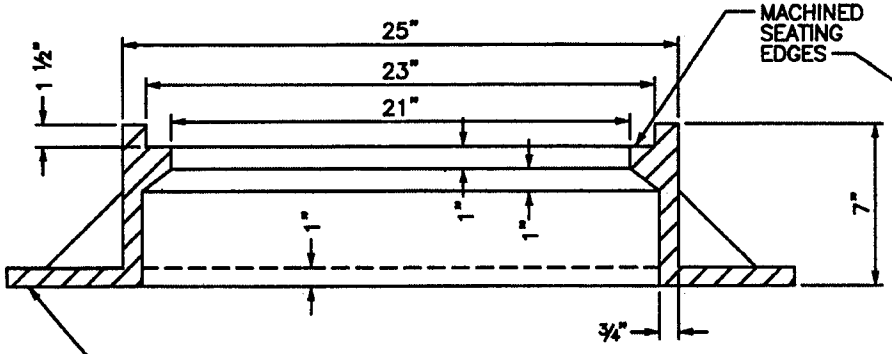
COMMISSIONER — DATE 5/1/08

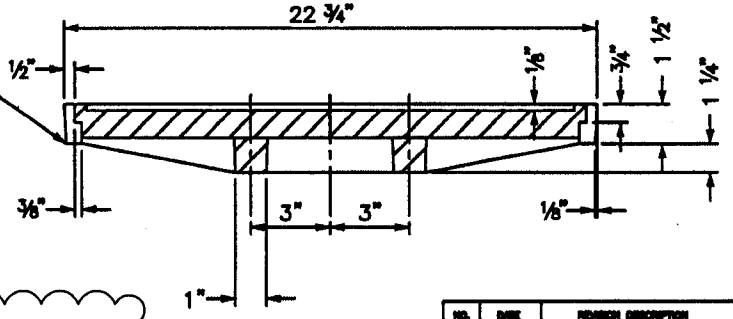
LEXINGTON-FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT

MANHOLE FRAME AND LID SHALL BE MODEL MC-350 MANUFACTURED BY JY HOE OR APPROVED EQUAL.









SET FRAME CASTING IN FULL MORTAR BED, FOR WATERTIGHT MANHOLE FRAME AND LID – SEE APPLICABLE STANDARD DRAWING

FRAME DETAIL

COVER DETAIL

NOTES:

1. MANHOLE FRAME & LID ASSEMBLY SHALL BE TRAFFIC H-20 RATED, HAVE A MINIMUM WEIGHT OF 125 LBS. AND A TOTAL MINIMUM FRAME AND LID WEIGHT OF 305 LBS. WITH ALL STEEL IN ACCORDANCE WITH ASTM A-48 CLASS 35 SPEC.
2. FRAME SHALL BE SET IN BEAD OF BUTYL MASTIC SEALANT THEN MORTARED AROUND FRAME LIP.
3. NON-TRAFFIC AREA MANHOLES SHALL BE BOLTED DOWN WITH FOUR (4) HILTI-TYPE S.S. ANCHOR BOLTS IN ACCORDANCE WITH SPECIFICATION SECTION 02608.

NO.	DATE	REVISION DESCRIPTION	BY

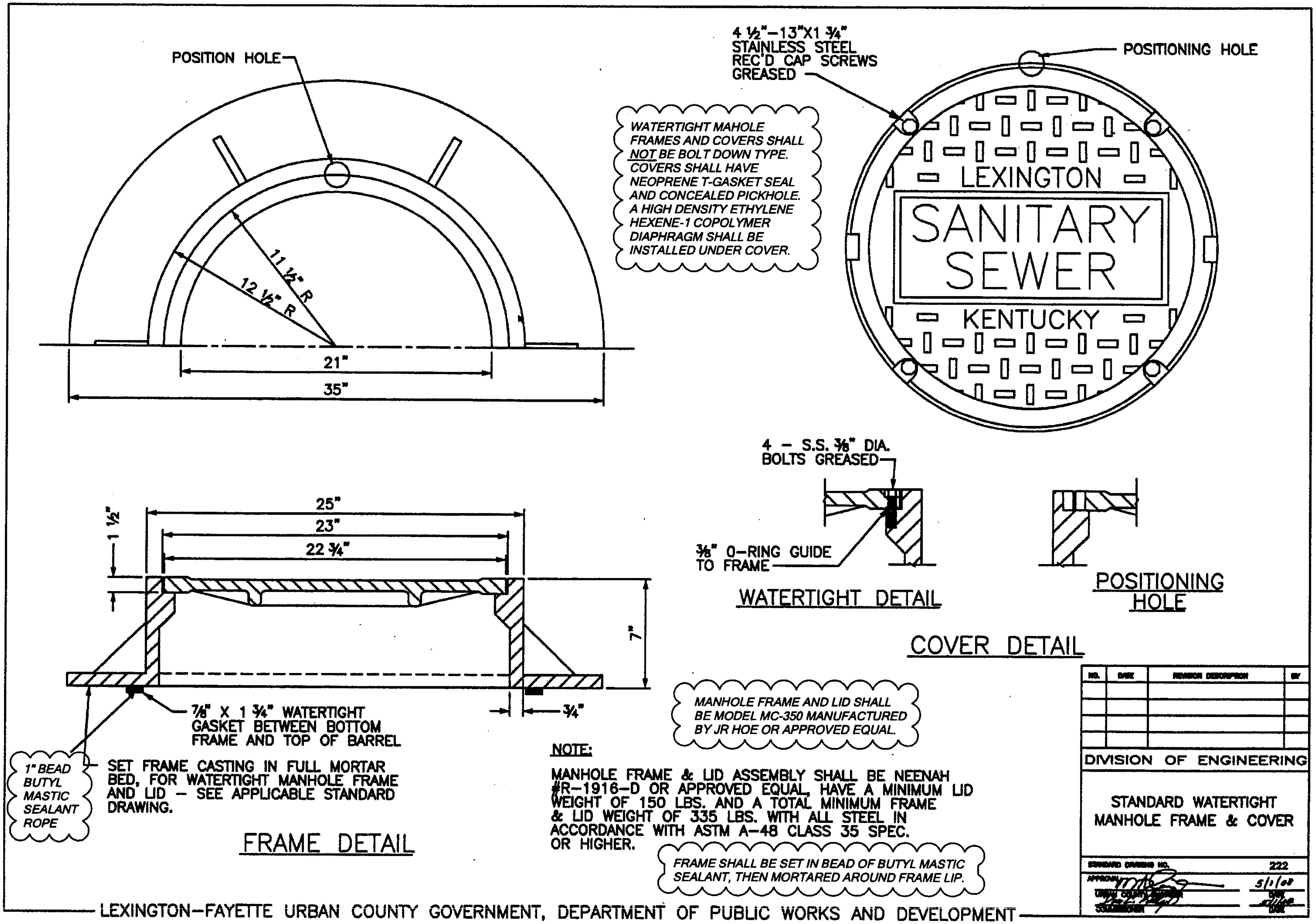
DIVISION OF ENGINEERING

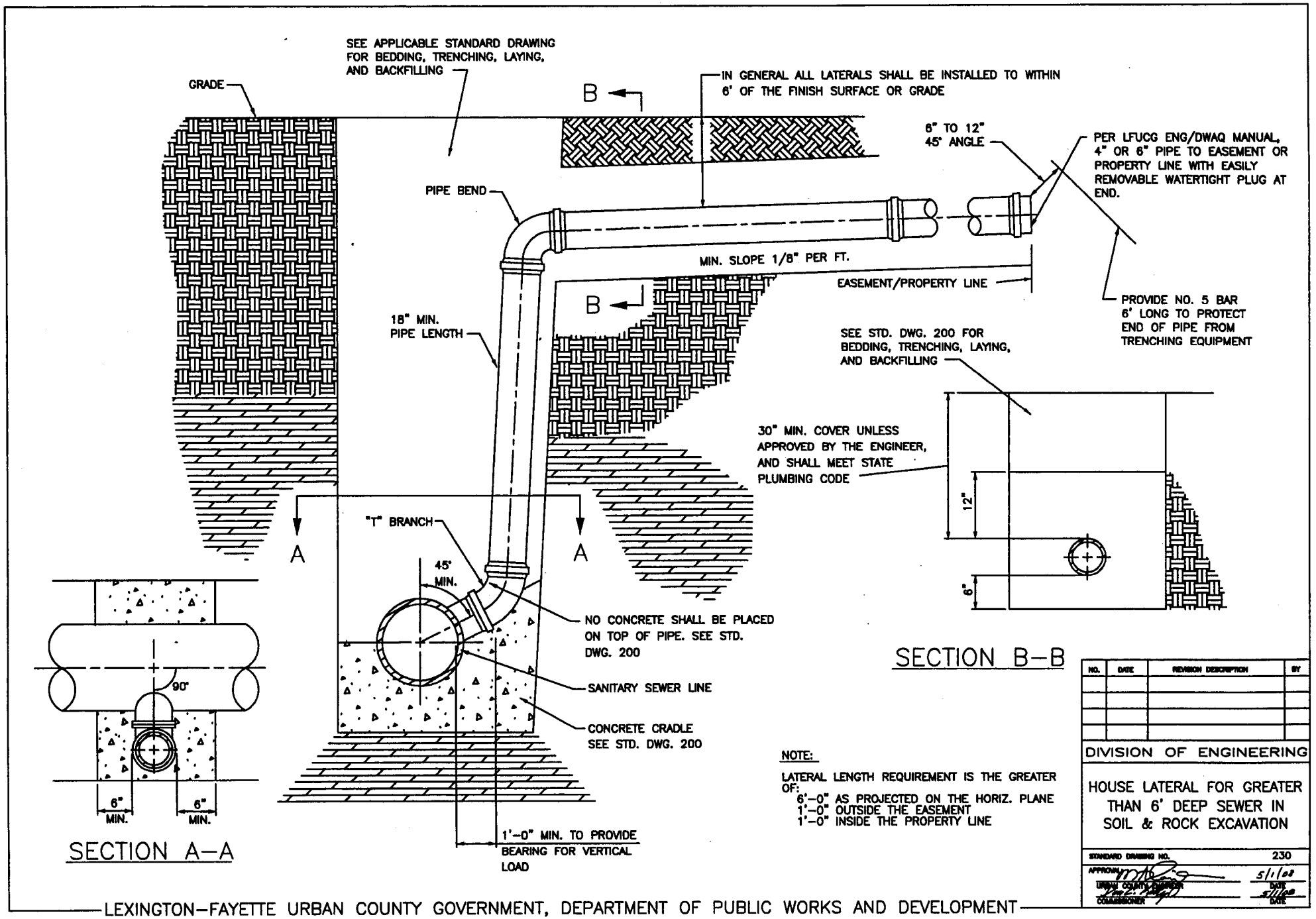
STANDARD CIRCULAR MANHOLE FRAME & COVER

STANDARD DRAWING NO. 220

APPROVED 5/1/08

LEXINGTON–FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT


POSITION HOLE
11 ½" R
12 ½" R
21"
35"
25"
23"
22 ¾"
1 ½"
7"
¾"
⅞" X 1 ¾" WATERTIGHT GASKET BETWEEN BOTTOM FRAME AND TOP OF BARREL
1" BEAD BUTYL MASTIC SEALANT ROPE
SET FRAME CASTING IN FULL MORTAR BED, FOR WATERTIGHT MANHOLE FRAME AND LID - SEE APPLICABLE STANDARD DRAWING.
FRAME DETAIL
4 ½"-13"X1 ¾" STAINLESS STEEL REC'D CAP SCREWS GREASED
POSITIONING HOLE
WATERTIGHT MAHOLE FRAMES AND COVERS SHALL NOT BE BOLT DOWN TYPE. COVERS SHALL HAVE NEOPRENE T-GASKET SEAL AND CONCEALED PICKHOLE. A HIGH DENSITY ETHYLENE HEXENE-1 COPOLYMER DIAPHRAGM SHALL BE INSTALLED UNDER COVER.
LEXINGTON
SANITARY SEWER
KENTUCKY
4 - S.S. ⅜" DIA. BOLTS GREASED
⅜" O-RING GUIDE TO FRAME
WATERTIGHT DETAIL
POSITIONING HOLE
COVER DETAIL
MANHOLE FRAME AND LID SHALL BE MODEL MC-350 MANUFACTURED BY JR HOE OR APPROVED EQUAL.
NOTE:
MANHOLE FRAME & LID ASSEMBLY SHALL BE NEENAH #R-1916-D OR APPROVED EQUAL, HAVE A MINIMUM LID WEIGHT OF 150 LBS. AND A TOTAL MINIMUM FRAME & LID WEIGHT OF 335 LBS. WITH ALL STEEL IN ACCORDANCE WITH ASTM A-48 CLASS 35 SPEC. OR HIGHER.
FRAME SHALL BE SET IN BEAD OF BUTYL MASTIC SEALANT, THEN MORTARED AROUND FRAME LIP.
DIVISION OF ENGINEERING
STANDARD WATERTIGHT MANHOLE FRAME & COVER
222
5/1/08
LEXINGTON-FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT



NOTE:

LATERAL LENGTH REQUIREMENT IS THE GREATER OF:
- 6'-0" AS PROJECTED ON THE HORIZ. PLANE
- 1'-0" OUTSIDE THE EASEMENT
- 1'-0" INSIDE THE PROPERTY LINE

NO.	DATE	REVISION DESCRIPTION	BY

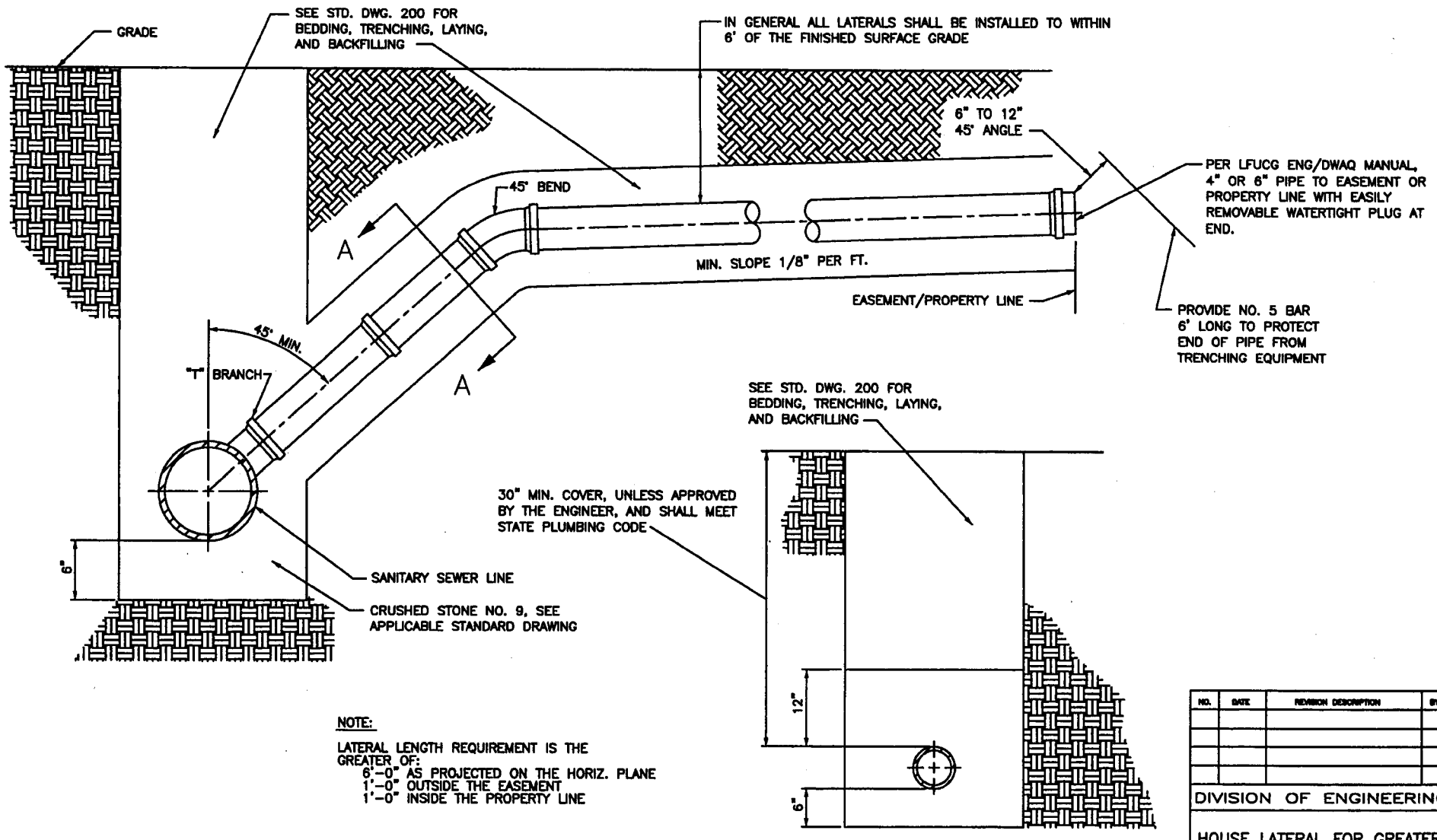
DIVISION OF ENGINEERING

HOUSE LATERAL FOR GREATER THAN 6' DEEP SEWER IN SOIL & ROCK EXCAVATION

STANDARD DRAWING NO. 230

APPROVAL
URBAN COUNTY ENGINEER — DATE 5/1/08
COMMISSIONER — DATE 5/1/08

LEXINGTON-FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT



NOTE:

LATERAL LENGTH REQUIREMENT IS THE GREATER OF:
- 6'-0" AS PROJECTED ON THE HORIZ. PLANE
- 1'-0" OUTSIDE THE EASEMENT
- 1'-0" INSIDE THE PROPERTY LINE

SECTION A–A

NO.	DATE	REVISION DESCRIPTION	BY

DIVISION OF ENGINEERING

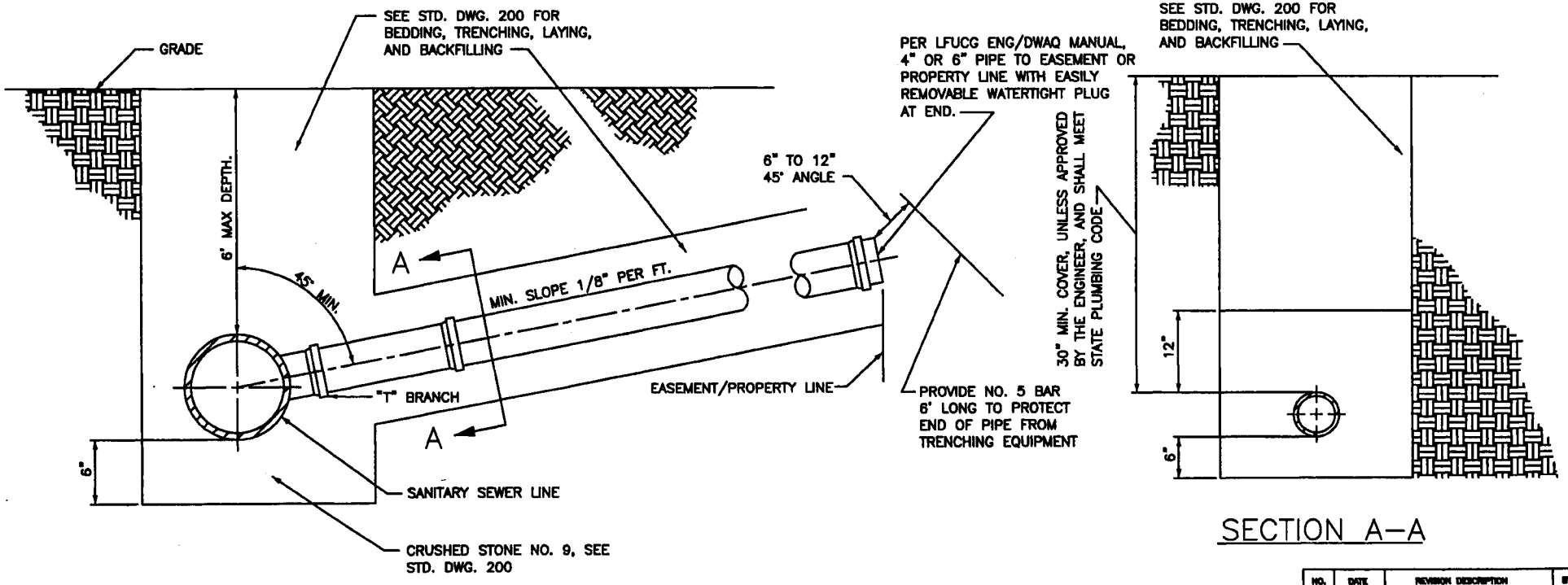
HOUSE LATERAL FOR GREATER THAN 6' DEEP SEWER IN SOIL

STANDARD DRAWING NO. 231

APPROVED: URBAN COUNTY ENGINEER — DATE 5/1/08

COMMISSIONER — DATE 5/1/08

LEXINGTON–FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT



SECTION A–A

NOTE:

LATERAL LENGTH REQUIREMENT IS THE GREATER OF:
- 6'–0" AS PROJECTED ON THE HORIZ. PLANE
- 1'–0" OUTSIDE THE EASEMENT
- 1'–0" INSIDE THE PROPERTY LINE

NO.	DATE	REVISION DESCRIPTION	BY

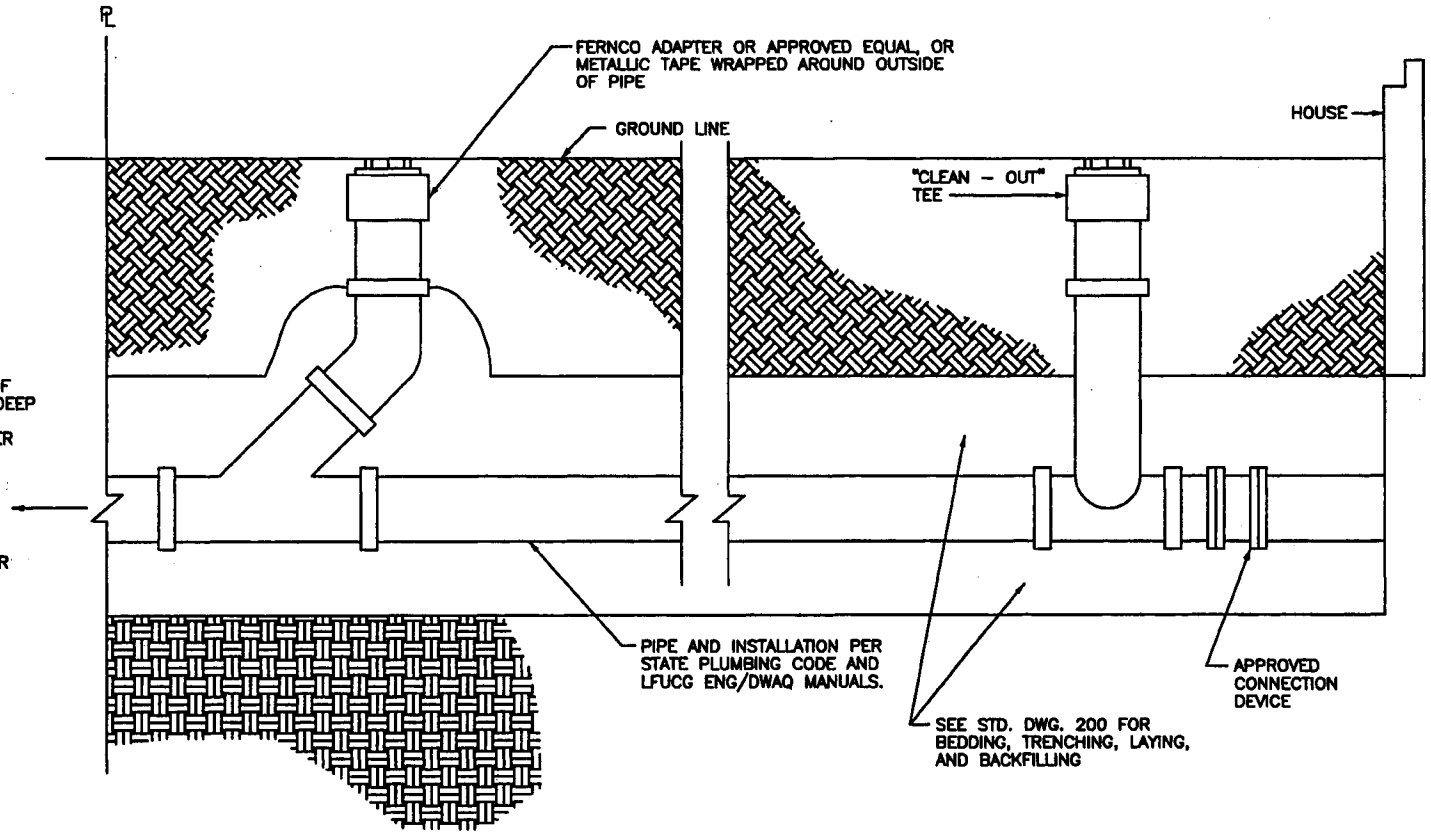
DIVISION OF ENGINEERING

HOUSE LATERAL FOR SHALLOW SEWER IN SOIL OR ROCK

STANDARD DRAWING NO. 232

APPROVED
URBAN COUNTY ENGINEER — DATE 5/1/08
COMMISSIONER — DATE

LEXINGTON–FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT



NOTE:

SEWER PIPE FROM HOUSE TO THE LONG SWEEP "L" MUST BE IN ACCORDANCE WITH STATE PLUMBING CODE AND LFUCG ENG/DWAG MANUALS.

NO.	DATE	REVISION DESCRIPTION	BY

DIVISION OF ENGINEERING

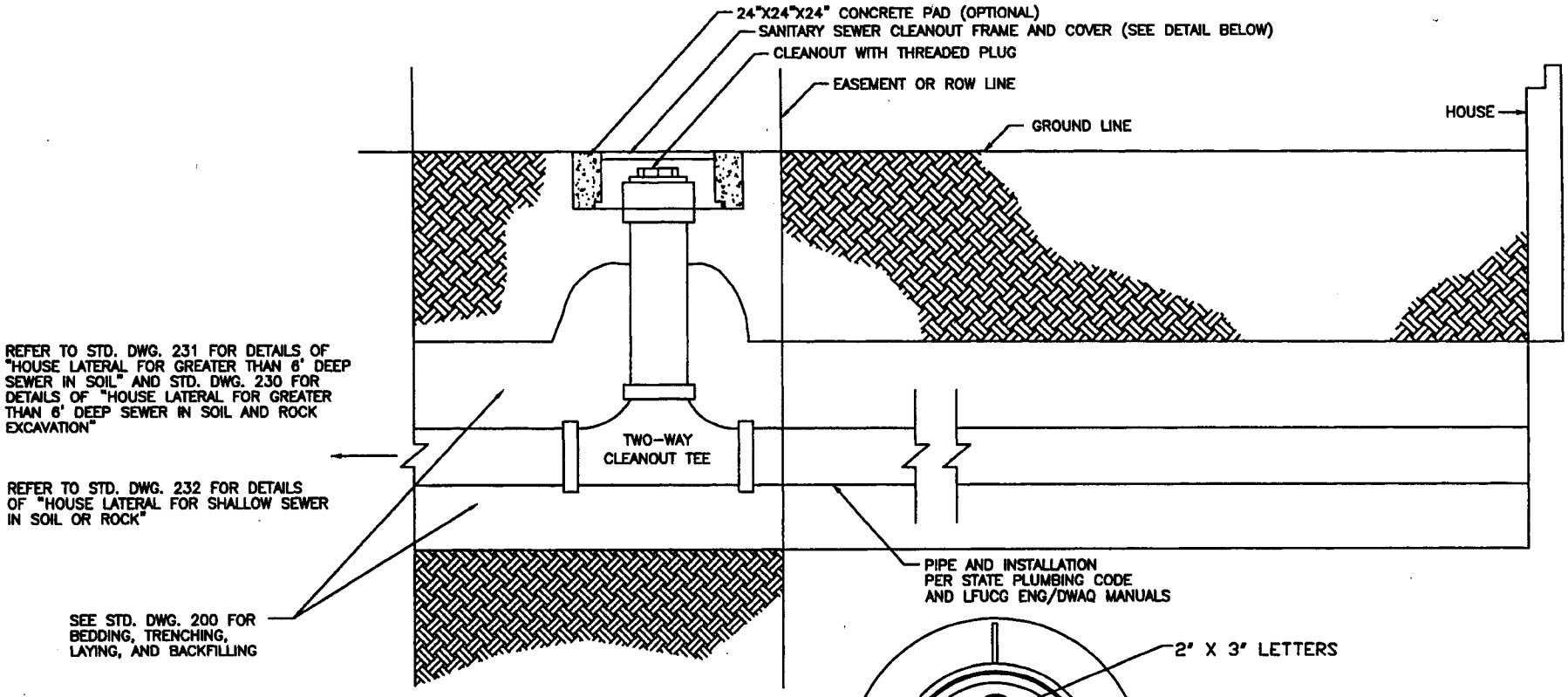
LATERAL CLEANOUT IN NON–PAVED AREAS AND YARDS

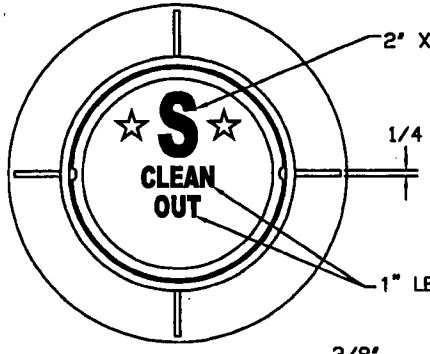
STANDARD DRAWING NO. 233

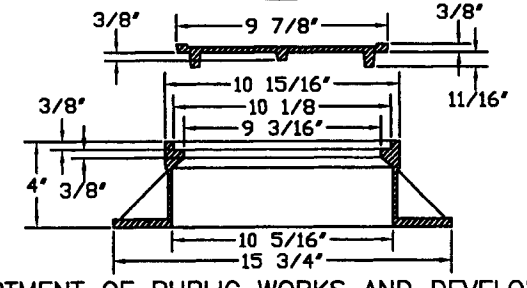
APPROVED: [signature] 5/1/08
URBAN COUNTY ENGINEER — DATE

[signature] 5/1/08
COMMISSIONER — DATE

LEXINGTON–FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT







NOTES:

SEWER PIPE FROM HOUSE TO CLEANOUT MUST BE IN ACCORDANCE WITH STATE PLUMBING CODE AND LFUCG ENG/DWAQ MANUALS.

TWO-WAY CLEANOUT TEE IS TO BE INSTALLED BY THE PLUMBER AND OR CONTRACTOR PRIOR TO CONNECTION OF THE LATERAL TO PUBLIC SANITARY SEWER LINE.

CLEANOUT TO BE INSTALLED AT THE END OF PUBLICLY MAINTAINED SEWER. POINT TO BE DETERMINED BY THE DIVISION OF ENGINEERING.

NO.	DATE	REVISION DESCRIPTION	BY

DIVISION OF ENGINEERING

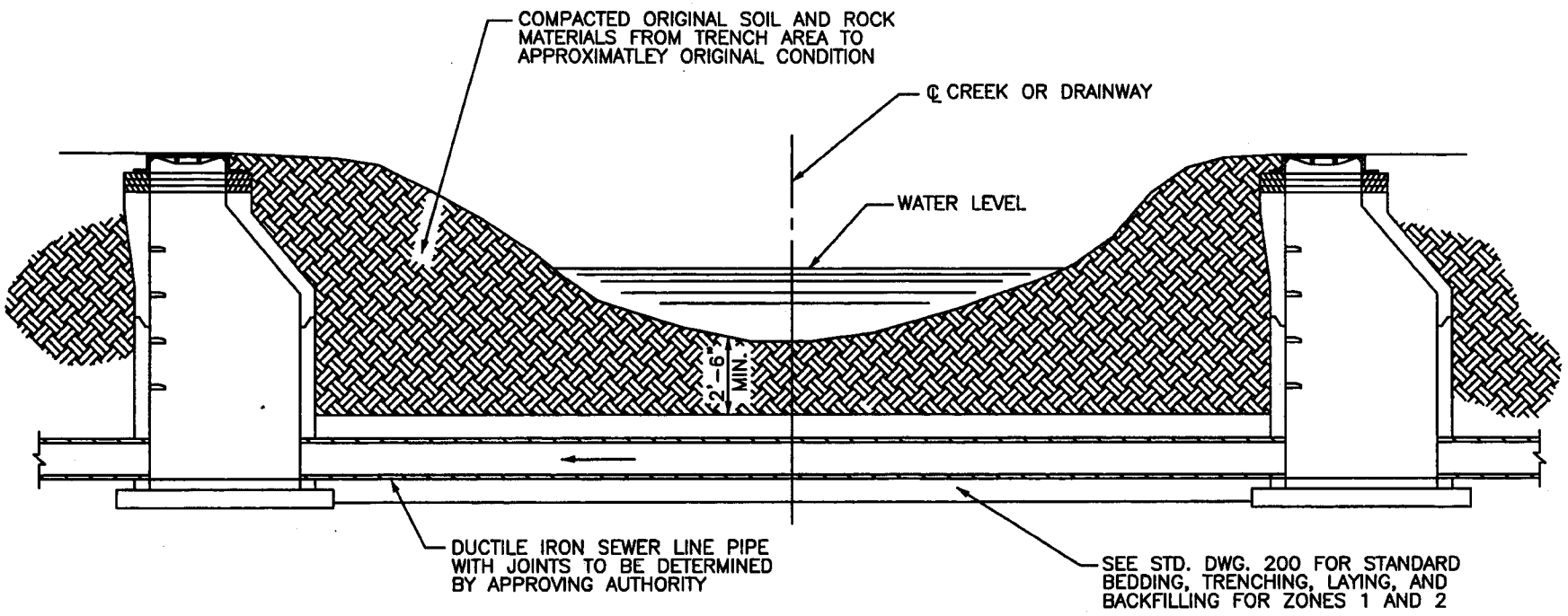
RIGHT OF WAY OR EASEMENT LATERAL CLEANOUT IN NON-PAVED AREAS AND YARDS

STANDARD DRAWING NO. 234

APPROVED _____ DATE 5/1/08

URBAN COUNTY ENGINEER
COMMISSIONER _____ DATE 5/1/08

LEXINGTON-FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT



NOTES:

1. A WATERSTOP SHALL BE PROVIDED ON THE UPSTREAM SIDE OF THE DOWNSTREAM MANHOLE.
2. SPECIAL DESIGN REQUIRED WHEN COVER IS 30" OR LESS.

NO.	DATE	REVISION DESCRIPTION	BY

DIVISION OF ENGINEERING

TYPICAL CREEK CROSSING FOR SANITARY SEWER LINE

STANDARD DRAWING NO. 240

APPROVAL: URBAN COUNTY ENGINEER — DATE 5/1/08

COMMISSIONER — DATE 5/1/08

LEXINGTON–FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT

Mayor Jim Gray

LEXINGTON-FAYETTE URBAN COUNTY GOVERNMENT

Division of Engineering

Date: February 2, 2012

Re: LFUCG **Standard Drawings 250 Revision**

The Lexington Fayette Urban County Government, Department of Environmental Quality and Public Works, has revised the Division of Engineering **Standard Drawings 250 – Schematic Example For Grease Interceptor**. This Standard Drawing became effective on January 16, 2012 and replaces any/all previous versions.

Attached is the revised Standard Drawing.

A paper copy of the **Standard Drawings 2008** edition is available for purchase from the Lexington Fayette Urban County Government, Division of Engineering, 101 East Vine Street 4th floor.

If you have questions please contact Mr. Andrew Grunwald, P.E. with the Division of Engineering at 258-3410.

Questions or Comments should be directed to:

Urban County Engineer
Division of Engineering
Fourth Floor
101 E. Vine Street
Lexington, KY 40507
859-258-3410

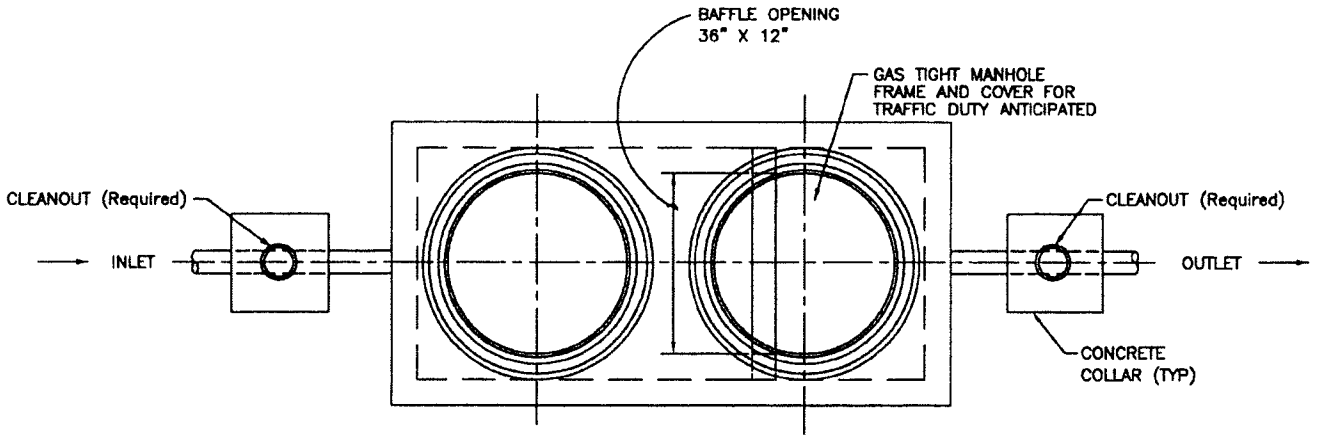
Sincerely,

Marwan A. Rayan, P.E.
Urban County Engineer

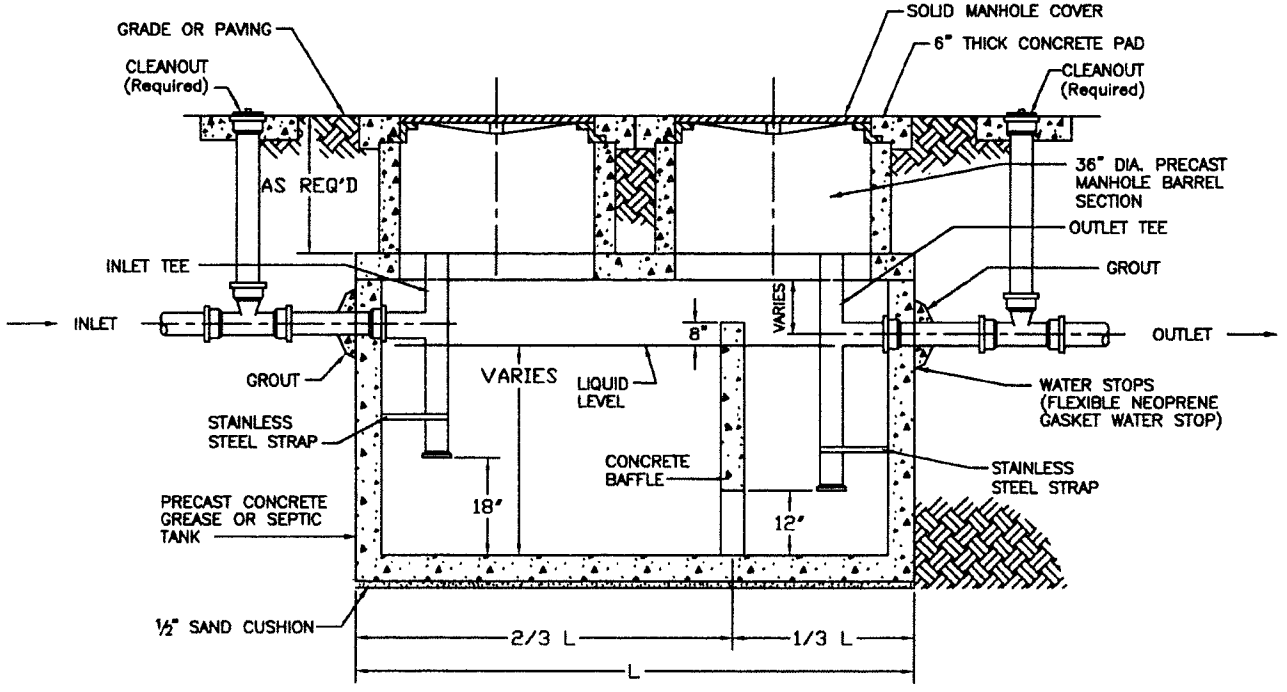
MAR:RAB:AFG

C: File

12.1000.106.Letter for Amended STD#250.doc



TOP VIEW



SECTION

GENERAL NOTES:

1. THIS STRUCTURE IS TO BE ACCESSIBLE FOR MAINTENANCE OR INSPECTION WITH COVERS AND CLEANOUTS BROUGHT TO GRADE.
2. DESIGN CRITERIA SHALL BE HS-20 LOADING.
3. FLOW TO THE INTERCEPTOR SHALL EXCLUDE SANITARY SEWAGE AND SURFACE DRAINAGE.
4. DESIGN AND CAPACITY OF GREASE INTERCEPTOR TO BE CERTIFIED BY ENGINEER IN ACCORD WITH KENTUCKY STATE PLUMBING CODE AND REVIEWED FOR CAPACITY BY THE DIVISION OF ENGINEERING PRIOR TO CONSTRUCTION.
5. MULTIPLE COMPARTMENT INTERCEPTORS ARE REQUIRED.
6. PIPE CLEANOUT TEE SHALL BE THE SAME SIZE AS THE PIPE AND BE WITHIN 6' OF THE GREASE INTERCEPTOR ON THE OUTLET LINE.
7. MANUFACTURER WILL PROVIDE GREASE TRAP WITH TWO(2) ACCESS POINTS AS SHOWN. PLUMBING CONTRACTOR TO INSTALL FIXTURES AS SHOWN.
8. THE MINIMUM CAPACITY OF INTERCEPTORS IS 1000 GALLONS.

NO.	DATE	REVISION DESCRIPTION	BY

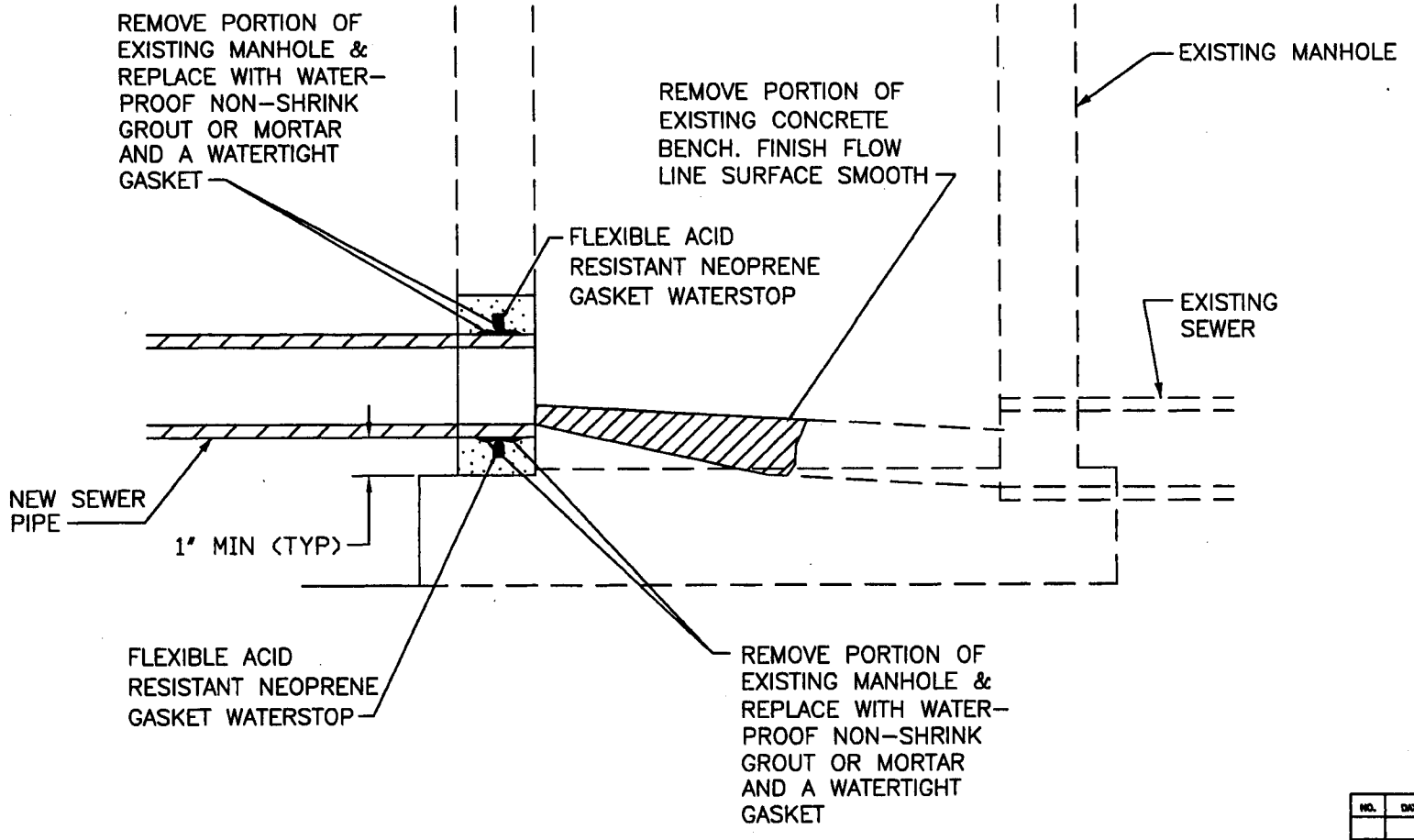
DIVISION OF ENGINEERING

GREASE INTERCEPTOR
TYPICAL
CONFIGURATION

STANDARD DRAWING NO. 250

APPROVAL:
URBAN COUNTY ENGINEER — DATE 1/13/12
COMMISSIONER — DATE 1/14/12

LEXINGTON-FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT



ALL HOLES CUT INTO SEWER MANHOLES SHALL BE CORE DRILLED.

SEWER CONNECTION TO EXISTING MANHOLE

NO.	DATE	REVISION DESCRIPTION	BY

DIVISION OF ENGINEERING

SEWER CONNECTION TO EXISTING CONCRETE MANHOLE

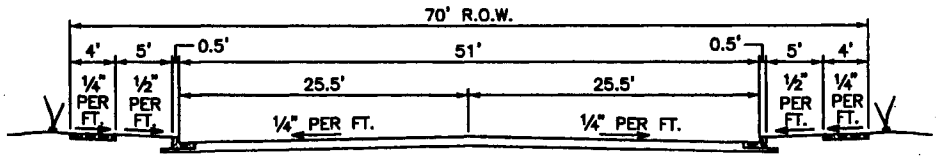
STANDARD DRAWING NO. 260

APPROVED _____ 5/1/08 DATE

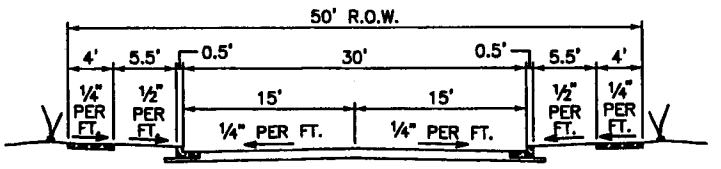
URBAN COUNTY ENGINEER

COMMISSIONER _____ DATE

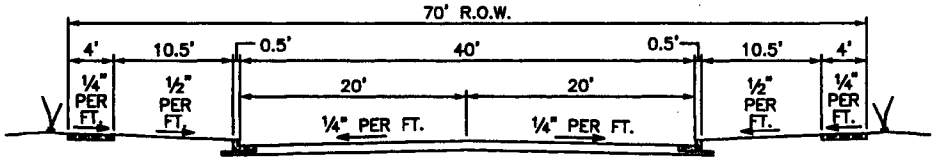
LEXINGTON-FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT



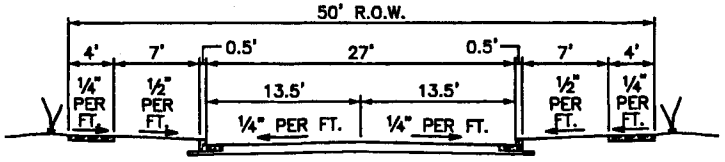
NON–RESIDENTIAL COLLECTOR



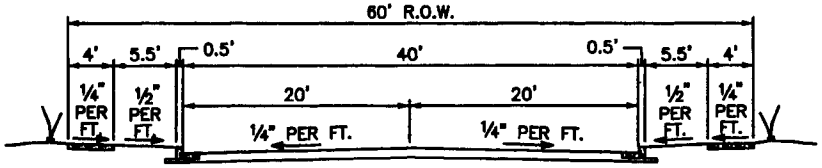
RESIDENTIAL LOCAL



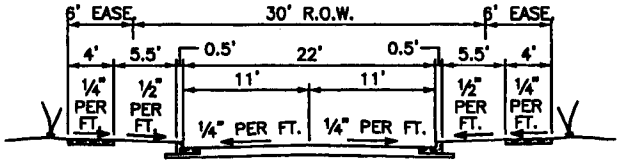
NON–RESIDENTIAL AND INDUSTRIAL COLLECTORS



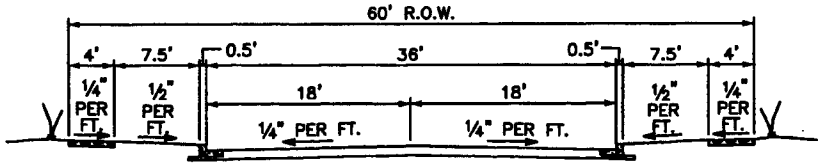
RESIDENTIAL CUL–DE–SAC



RESIDENTIAL COLLECTOR AND INDUSTRIAL LOCALS

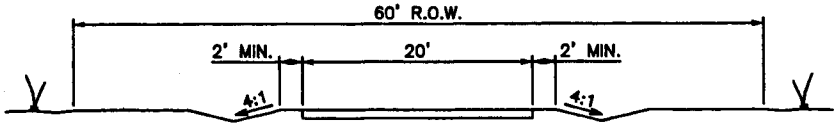


URBAN RESIDENTIAL LOCAL



RESIDENTIAL COLLECTOR

(OBSOLETE) – USED TO COMPLETE EXISTING STREETS



RURAL RESIDENTIAL LOCAL

NOTES:

1. SLOPES AND DRAINAGE DITCHES OUTSIDE THE R.O.W. SHALL BE APPROVED BY THE ENGINEER.
2. THE APPLICATIONS AND USES OF THE ABOVE TYPICAL SECTIONS SHALL BE IN ACCORDANCE WITH THE L.F.U.C.G. LAND SUBDIVISION REGULATIONS, ARTICLE 6.

NO.	DATE	REVISION DESCRIPTION	BY

DIVISION OF ENGINEERING

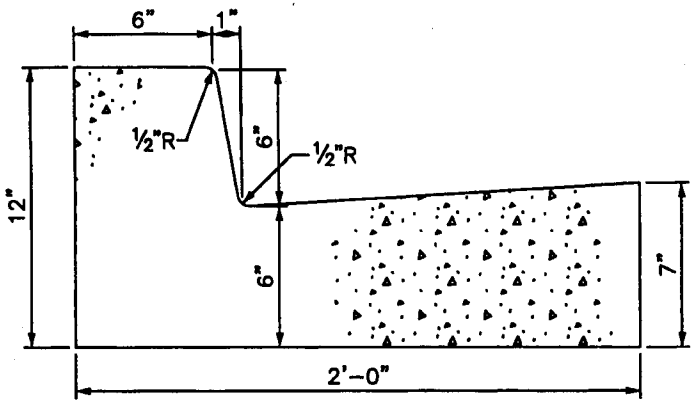
TYPICAL STREET SECTIONS

STANDARD DRAWING NO. 300

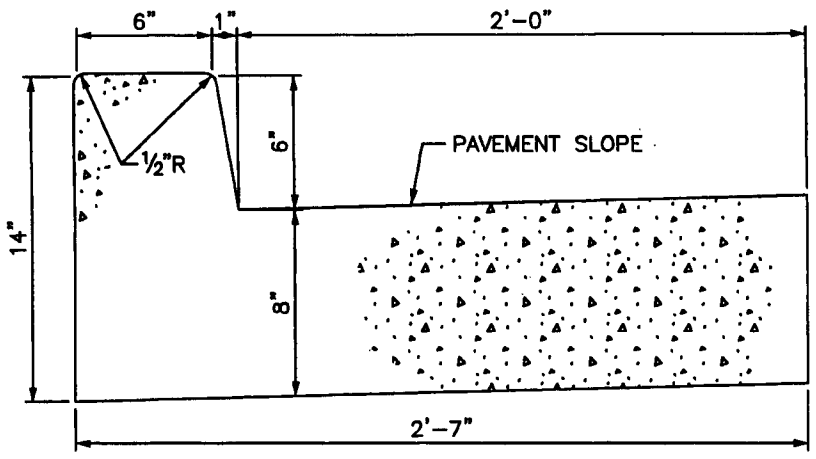
APPROVED _____ DATE 5/1/08
URBAN COUNTY ENGINEER

_____ DATE 5/1/08
COMMISSIONER

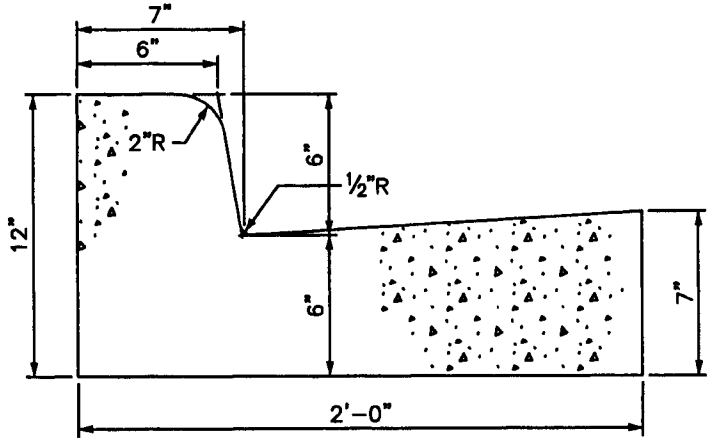
LEXINGTON–FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT



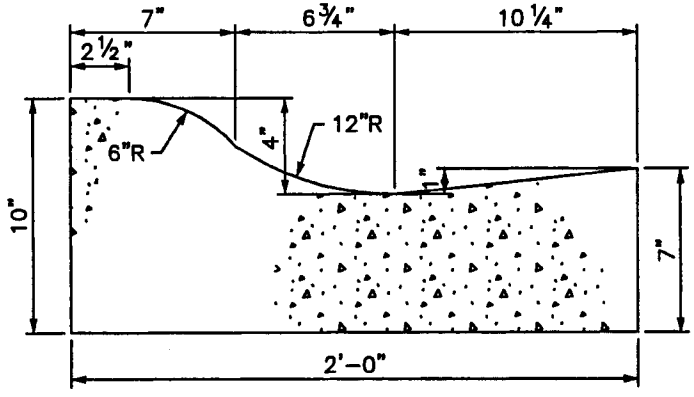
TYPE 1



TYPE 2



TYPE 3



TYPE 4
(RESIDENTIAL LOCAL STREETS ONLY)

NOTES:

1. CONCRETE SHALL BE KDOT CLASS "A".
2. SAWED CONTRACTION JOINTS SHALL BE CONSTRUCTED EVERY 20 FEET, WITH A MIN. DEPTH OF 3", IN ACCORDANCE WITH KDOT STANDARD SPECIFICATION.
3. EXPANSION JOINTS SHALL BE CONSTRUCTED AT ALL BREAKS IN ALIGNMENT, AT CONTACT WITH NEW OR EXISTING CONCRETE, AT ALL DRAINAGE INLETS, AT THE BEGINING AND ENDING POINTS OF CURVES, AND NOT TO EXCEED 200' MAXIMUM SPACING FOR SLIP FORM APPLICATION AND 30' MAXIMUM SPACING FOR HAND PLACED.
4. ALL CONCRETE SHALL BE CURED WITH WHITE PIGMENTED MEMBRANE FORMING COMPOUND (AASHTO M 148, TYPE 2).

NO.	DATE	REVISION DESCRIPTION	BY

DIVISION OF ENGINEERING

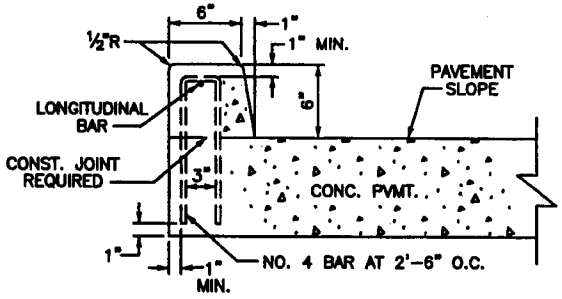
CURB & GUTTER

STANDARD DRAWING NO. 301

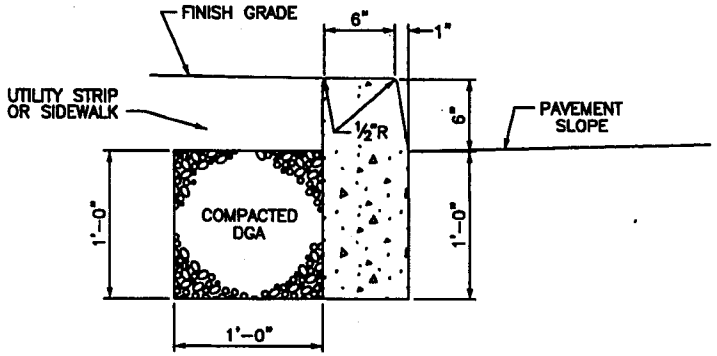
APPROVAL — URBAN COUNTY ENGINEER — DATE 5/1/08

COMMISSIONER — DATE 5/1/08

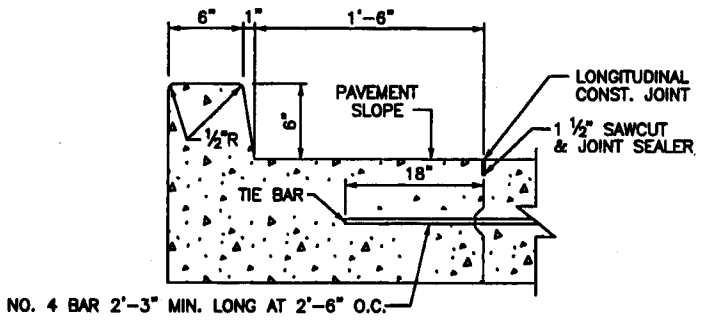
LEXINGTON–FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT



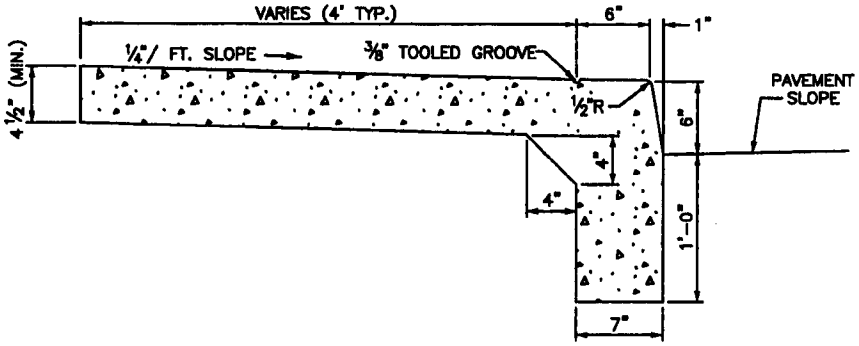
INTEGRAL CURB, TYPE 1



HEADER CURB



INTEGRAL CURB, TYPE 2



MONOLITHIC CURB AND SIDEWALK

NOTES:

1. CONCRETE SHALL BE KDOT CLASS "A".
2. SAWED CONTRACTION JOINTS SHALL BE CONSTRUCTED EVERY 20 FEET, 3" MINIMUM DEPTH.
3. THE CONTRACTOR HAS THE OPTION OF CONSTRUCTING THE STANDARD INTEGRAL CURB AS DETAILED IN EITHER TYPE 1 OR 2. IF TYPE 2 IS CHOSEN A LONGITUDINAL CONSTRUCTION JOINT SHALL BE REQUIRED AND THE REMAINING PAVEMENT AND CURB SHALL BE CONSTRUCTED MONOLITHIC WITHOUT A HORIZONTAL CONSTRUCTION JOINT AND ACCOMPANYING REINFORCING STEEL (TYPE 1).
4. EXPANSION JOINTS SHALL BE CONSTRUCTED AT ALL BREAKS IN ALIGNMENT, AT ALL DRAINAGE INLETS AND AT THE BEGINNING AND ENDING POINTS OF CURVES.
5. ALL CONCRETE, EXCEPT BONDING SURFACES, SHALL BE CURED WITH WHITE PIGMENTED MEMBRANE FORMING COMPOUND (AASHTO M 148, TYPE 2).

NO.	DATE	REVISION DESCRIPTION	BY

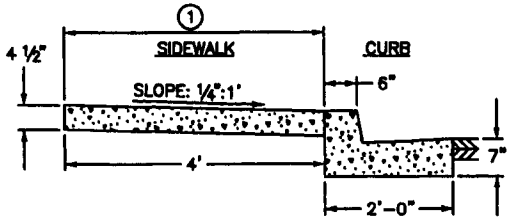
DIVISION OF ENGINEERING

INTEGRAL CURB, HEADER CURB, MONOLITHIC CURB & SIDEWALK

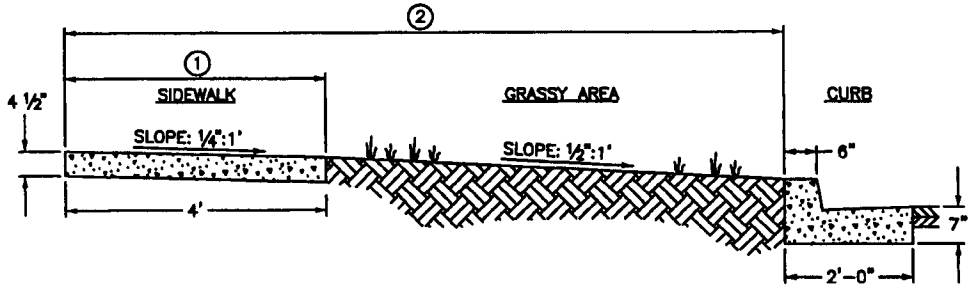
STANDARD DRAWING NO. 302

APPROVED: URBAN COUNTY ENGINEER / COMMISSIONER — DATE 5/1/08

LEXINGTON–FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT



SIDEWALK/CURB AND GUTTER



SIDEWALK/CURB AND GUTTER
WITH GRASS UTILITY STRIP

NOTES:

1. CONCRETE SIDEWALKS AND WALKWAYS SHALL BE CONSTRUCTED ON A THOROUGHLY COMPACTED SUB-GRADE AND SHALL BE FOUR AND ONE HALF (4 ½) INCHES IN THICKNESS AND A MINIMUM WIDTH OF FOUR (4) FEET. CONCRETE SHALL HAVE SPECIFICATIONS FOR CLASS "A", KENTUCKY DEPARTMENT OF HIGHWAYS, STANDARD SPECIFICATIONS, CURRENT EDITION. WHITE PIGMENTED (TYPE 2, CLASS "A" OR "B") CURING COMPOUND IS REQUIRED (ALSO KENTUCKY DEPARTMENT OF HIGHWAYS, STANDARD SPECIFICATIONS, CURRENT EDITION).
2. EXPANSION JOINTS SHALL BE PLACED AT THIRTY-TWO (32) FOOT INTERVALS. IN EXISTING NEIGHBORHOODS, EXPANSION MATERIAL SHALL BE PLACED AT THE BEGINNING AND END OF NEWLY CONSTRUCTED AREAS.
3. THE SIDEWALKS SHALL BE PLACED ADJACENT TO THE STREET RIGHT-OF-WAY LINE. SLOPE TOWARD CURB SHALL BE ONE QUARTER (¼) OF AN INCH TO THE FOOT. CONSTRUCTION IN EXISTING NEIGHBORHOODS SHALL REQUIRE THE CONTRACTOR TO MATCH EXISTING GRADE AND SIDEWALK WIDTH UNLESS SPECIFIED OTHERWISE BY THE DIVISION OF ENGINEERING.

SHEET NOTES:

① NORMAL SIDEWALK WIDTH SHALL BE 4' UNLESS CHANGE IS AUTHORIZED BY URBAN COUNTY ENGINEER'S OFFICE.

② DISTANCE WILL VARY WITH ROAD CROSS-SECTION.

NO.	DATE	REVISION DESCRIPTION	BY

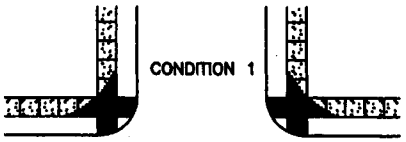
DIVISION OF ENGINEERING

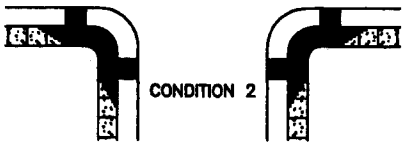
SIDEWALK CONSTRUCTION SPECIFICATIONS

STANDARD DRAWING NO. 303

APPROVED: URBAN COUNTY ENGINEER — DATE 5/1/02

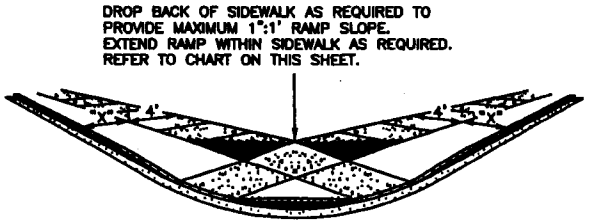
COMMISSIONER — DATE 5/1/02



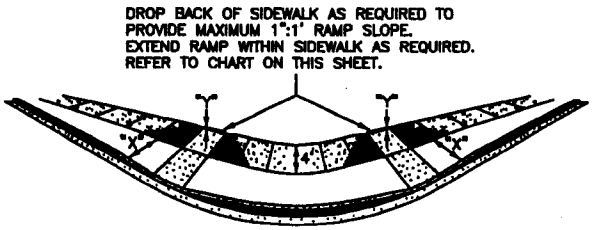


RAMP TYPE 1

NORMAL TREATMENT FOR ARTERIALS AND SIGNALIZED INTERSECTIONS



RAMP TYPE 1 CONDITION 1

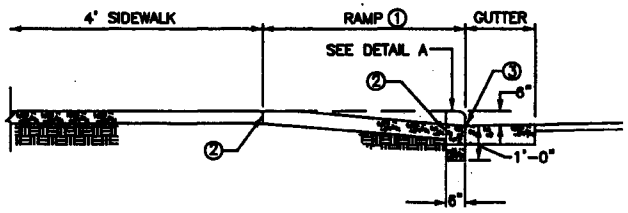


RAMP TYPE 1 CONDITION 2

NOTE:
FOR USE WITH 6" HEADER CURB OR 6" CURB AND GUTTER

① UTILITY STRIP WIDTH "X"	② BACK OF 4' SIDEWALK DROP FROM NORMAL "Y"*
0	3"
1	2½"
2	2"
3	1½"
4	1"
5	½"
≥6	0

① ½":1' CROSS SLOPE ② ¼":1' CROSS SLOPE
*WHERE ROLL CURB IS USED, "Y" DOES NOT APPLY.



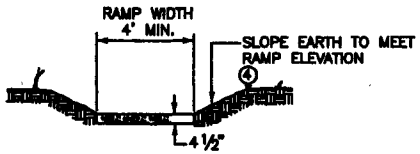
PROFILE RAMP TYPE 1

NOTES:

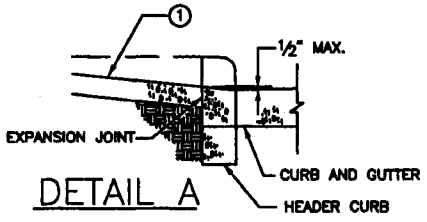
1. INLET LOCATIONS WILL VARY, DEPENDENT ON CROSSWALK AND RAMP LOCATION.
2. THE RAMP SHALL BE CONSTRUCTED OF CLASS "A" CONCRETE. STEP-SAFE® TRANSPO INDUSTRIES TILE OR ENGINEER APPROVED EQUIVALENT SHALL BE INSTALLED IN ACCORDANCE WITH MANUFACTURER'S SPECIFICATIONS.
3. THE NORMAL GUTTER LINE SHOULD BE MAINTAINED THROUGH THE RAMP.
4. RAMPS SHOULD BE LOCATED WITHIN MARKED LIMITS OF CROSSWALKS.
5. WHERE NO CURB EXISTS, STREET EDGE SHALL BE SAW CUT, OR AS DIRECTED BY L.F.U.C.G. ENGINEER.

SHEET NOTES:

① MAXIMUM RAMP SLOPE 1":1'.
② ½" EXPANSION JOINT AT BACK OF CURBLINE AND SIDEWALK LINE.
③ NO BUMP PERMITTED.
④ SLOPE VARIES UNIFORMLY TO A MAXIMUM OF 1":1' AT GUTTER LINE.



CROSS SECTION RAMP TYPE 1



DETAIL A

NO.	DATE	REVISION DESCRIPTION	BY

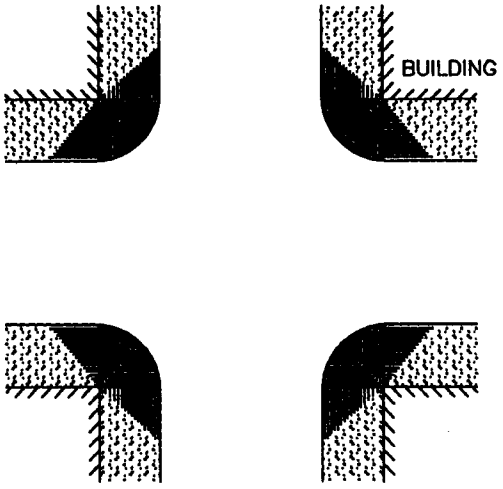
DIVISION OF ENGINEERING

SIDEWALK
RAMP TYPE 1

STANDARD DRAWING NO. 304

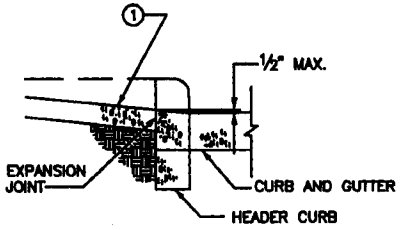
APPROVED: URBAN COUNTY ENGINEER — DATE 5/1/08
COMMISSIONER — DATE 5/1/08

LEXINGTON–FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT

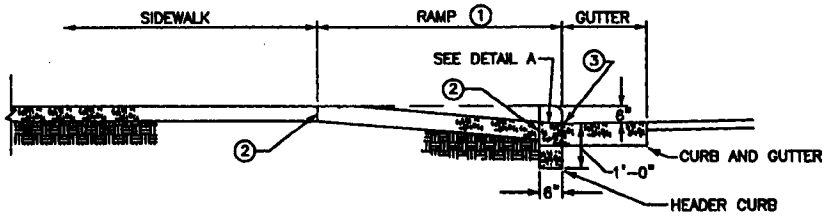


RAMP TYPE 3

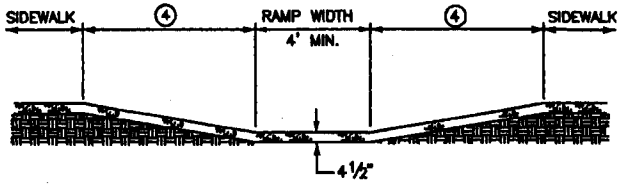
NORMAL TREATMENT FOR SIDEWALK ADJACENT TO CURB



DETAIL A



PROFILE RAMP TYPE 3



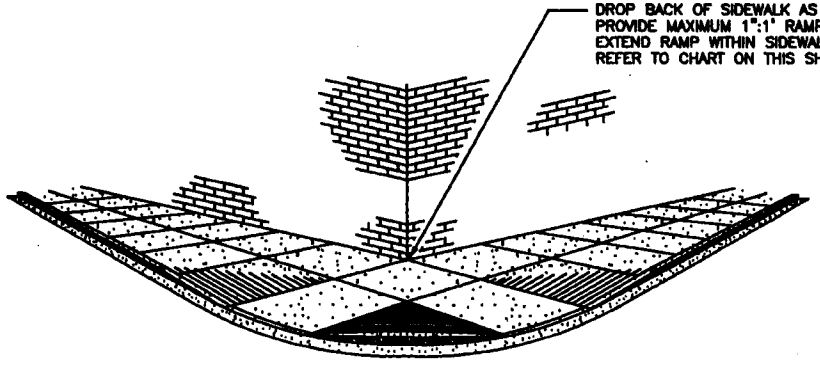
CROSS SECTION RAMP TYPE 3

NOTES:

1. INLET LOCATIONS WILL VARY, DEPENDENT ON CROSSWALK AND RAMP LOCATION.
2. THE RAMP SHALL BE CONSTRUCTED OF CLASS "A" CONCRETE. STEP-SAFE® TRANSPO INDUSTRIES TILE OR ENGINEER APPROVED EQUIVALENT SHALL BE INSTALLED PER MANUFACTURER'S SPECIFICATIONS.
3. THE NORMAL GUTTER LINE SHOULD BE MAINTAINED THROUGH THE RAMP.
4. RAMPS SHOULD BE LOCATED WITHIN MARKED LIMITS OF CROSSWALKS.

SHEET NOTES:

① MAXIMUM RAMP SLOPE 1":1'.
② ½" EXPANSION JOINT AT BACK OF CURBLINE AND SIDEWALK LINE.
③ NO BUMP PERMITTED.
④ SLOPE VARIES UNIFORMLY TO A MAXIMUM OF 1":1'. AT GUTTER LINE.



RAMP TYPE 3

NOTE:
FOR USE WITH 6" HEADER CURB OR 6" CURB AND GUTTER

SIDEWALK WIDTH ① "X"	BACK OF SIDEWALK DROP FROM NORMAL "Y"*
4'	3"
5'	2¼"
6'	1½"
7'	¾"
≥ 8'	0

① ¼":1' CROSS SLOPE
* WHERE ROLL CURB IS USED, "Y" DOES NOT APPLY.

NO.	DATE	REVISION DESCRIPTION	BY

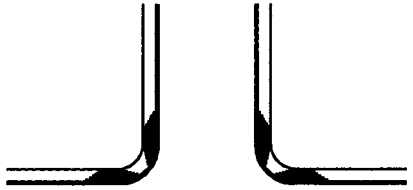
DIVISION OF ENGINEERING

SIDEWALK
RAMP TYPE 2

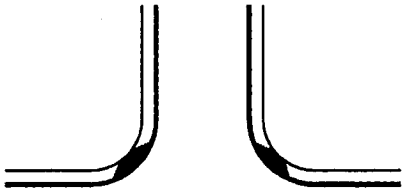
STANDARD DRAWING NO. 305

APPROVED: URBAN COUNTY ENGINEER — DATE 5/1/08
COMMISSIONER — DATE 5/1/08

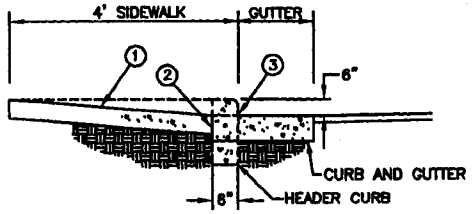
LEXINGTON-FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT



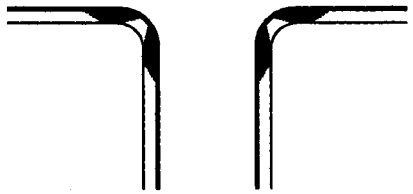
CONDITION 1



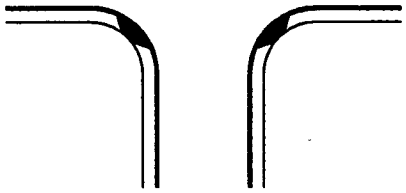
CONDITION 2



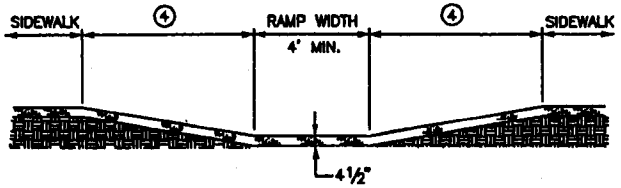
RAMP PROFILE



4' SIDEWALK ADJACENT TO CURB



4' SIDEWALK ADJACENT TO CURB



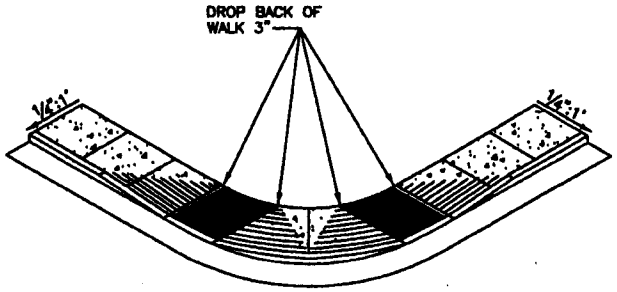
RAMP CROSS-SECTION

NOTES:

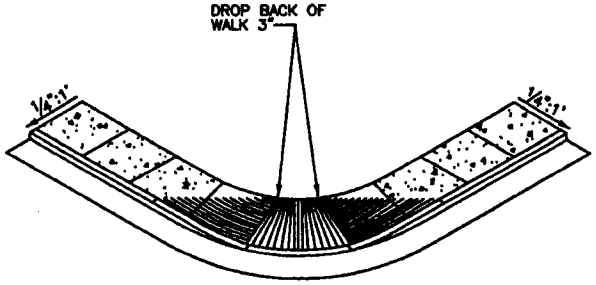
1. INLET LOCATIONS WILL VARY, DEPENDENT ON CROSSWALK AND RAMP LOCATION
2. THE RAMP SHALL BE CONSTRUCTED OF CLASS "A" CONCRETE. STEP-SAFE® TRANSPO INDUSTRIES TILE OR ENGINNEERS APPROVED EQUIVALENT SHALL BE INSTALLED PER MANUFACTURER'S SPECIFICATIONS.
3. THE NORMAL GUTTER LINE SHOULD BE MAINTAINED THROUGH THE RAMP.
4. RAMPS SHOULD BE LOCATED WITHIN MARKED LIMITS OF CROSSWALKS.

SHEET NOTES:

1. MAXIMUM RAMP SLOPE 1":1'.
2. ½" EXPANSION JOINT AT BACK OF CURBLINE AND SIDEWALK LINE.
3. NO BUMP PERMITTED.
4. SLOPE VARIES UNIFORMLY TO A MAXIMUM OF 1":1' AT GUTTER LINE.



CONDITION 1



CONDITION 2

NO.	DATE	REVISION DESCRIPTION	BY

DIVISION OF ENGINEERING

SIDEWALK RAMP
TYPE 3

STANDARD DRAWING NO. 306

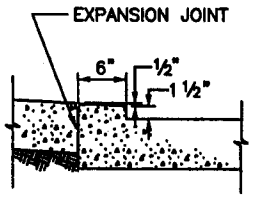
APPROVED: URBAN COUNTY ENGINEER — DATE 5/1/08

APPROVED: COMMISSIONER — DATE 5/1/08

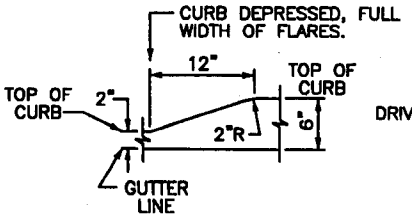
LEXINGTON-FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT

MAXIMUM ALLOWABLE APRON AND DRIVEWAY WIDTHS

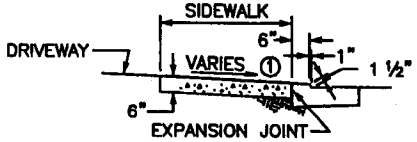
CLASSIFICATION	DRIVEWAY	APRON
SINGLE RESIDENTIAL	12'	18'
DOUBLE OR JOINT RESIDENTIAL	20'	26'



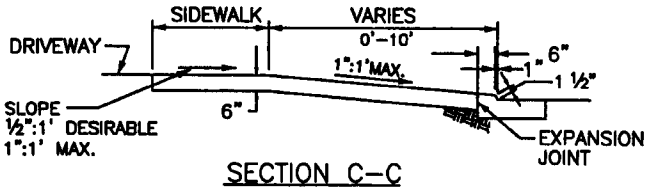
SECTION A–A



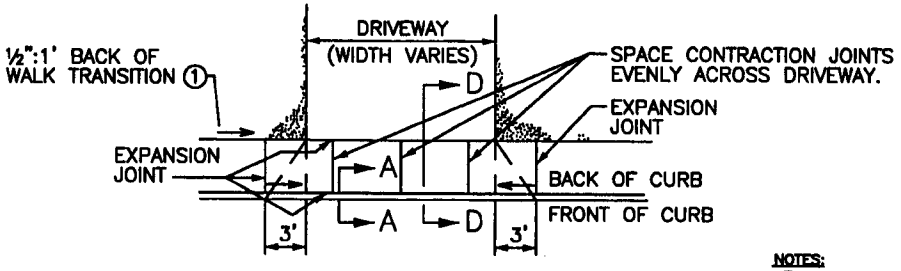
SECTION B–B



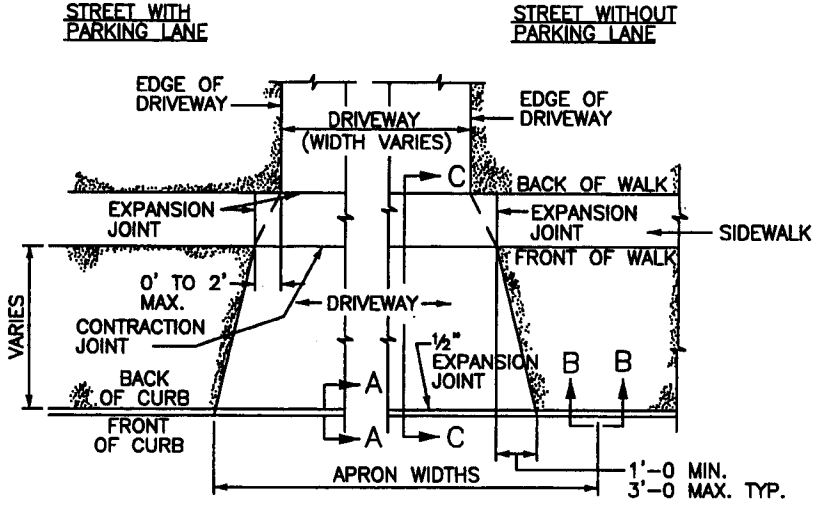
SECTION D–D



SECTION C–C



ENTRANCE WITHOUT UTILITY STRIP



ENTRANCE WITH UTILITY STRIP

NOTE:
FOR USE WITH 6" HEADER CURB OR 6" CURB AND GUTTER

BASED ON UTILITY STRIP WITH ½":1' CROSS SLOPE

UTILITY STRIP WIDTH	DROP BACK OF 4' SIDEWALK	SIDEWALK SLOPE	SLOPE ON APRON
0'	1½"	7.29%	N/A
2'	1½"	5.21%	8.33%
4'	1½"	3.12%	8.33%
5'	1½"	2.08%	8.33%
6'	1"	2.08%	8.33%
8'	0"	2.08%	8.33%
10'	0"	2.08%	7.50%

BASED ON UTILITY STRIP WITH ¼":1' CROSS SLOPE

UTILITY STRIP WIDTH	DROP BACK OF 4' SIDEWALK	SIDEWALK SLOPE	SLOPE ON APRON
0'	1½"	7.29%	N/A
2'	1½"	4.17%	8.33%
3'	1½"	2.60%	8.33%
4'	1"	2.08%	8.33%
6'	0"	2.08%	7.64%
8'	0"	2.08%	6.25%
10'	0"	2.08%	5.42%

NOTES:

① DROP BACK OF SIDEWALK GRADE 1 ½" OVER 3' TO PROVIDE A MAXIMUM SLOPE OF 1":1'.

2. PROVIDE A SAWED JOINT ALONG CENTER LINE OF APRON.
3. MAXIMUM DROP AT BACK OF SIDEWALK SHALL NOT EXCEED 1 ½".
4. MAXIMUM CROSS SLOPE ON SIDEWALK SHALL NOT EXCEED 1":1' (8.3%).
5. MAXIMUM SLOPE ON APRON SHALL NOT EXCEED 1":1' (8.3%).
6. ENTIRE APRON FROM BACK OF CURB TO BACK OF SIDEWALK SHALL BE CONSTRUCTED WITH A SINGLE POUR.

NO.	DATE	REVISION DESCRIPTION	BY

DIVISION OF ENGINEERING

RESIDENTIAL ENTRANCE DETAILS

STANDARD DRAWING NO. 307

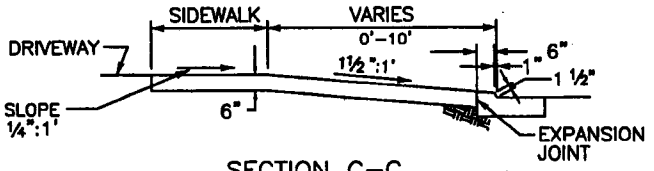
APPROVED: 5/1/08 DATE

URBAN COUNTY ENGINEER

COMMISSIONER 5/1/08 DATE

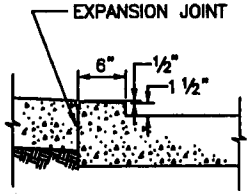
MAXIMUM ALLOWABLE APRON AND DRIVEWAY WIDTHS

CLASSIFICATION	DRIVEWAY	STANDARD APRON	ALTERNATE APRON
NON-RESIDENTIAL	30'	5' STRAIGHT FLARE=40' CURB CUT	10' RADIAL FLARE=50' CURB CUT
COMMERCIAL LOADING	30'	15' STRAIGHT FLARE=60' CURB CUT	20' RADIAL FLARE=70' CURB CUT
INDUSTRIAL	40'	20' STRAIGHT FLARE=80' CURB CUT	25' RADIAL FLARE=90' CURB CUT

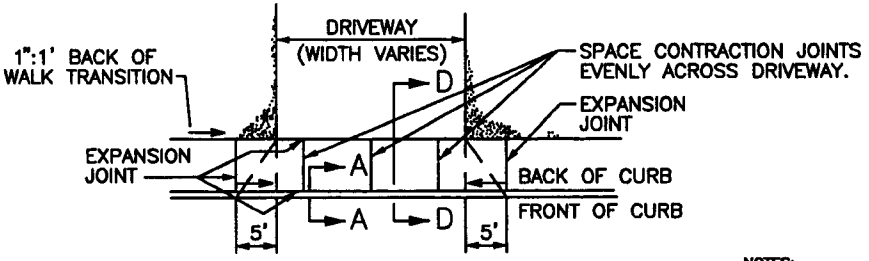


SECTION C-C

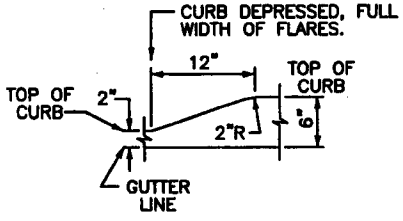
FRONT OF SIDEWALK ELEVATION DETERMINED BY ADDING ½ ": 1' ACROSS UTILITY STRIP FROM TOP OF CURB. IF COMING OFF 1½ " LIP ADD ANOTHER 4½ " TO DETERMINE ELEVATION AT FRONT OF SIDEWALK.



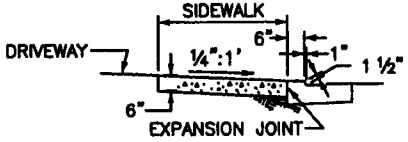
SECTION A-A



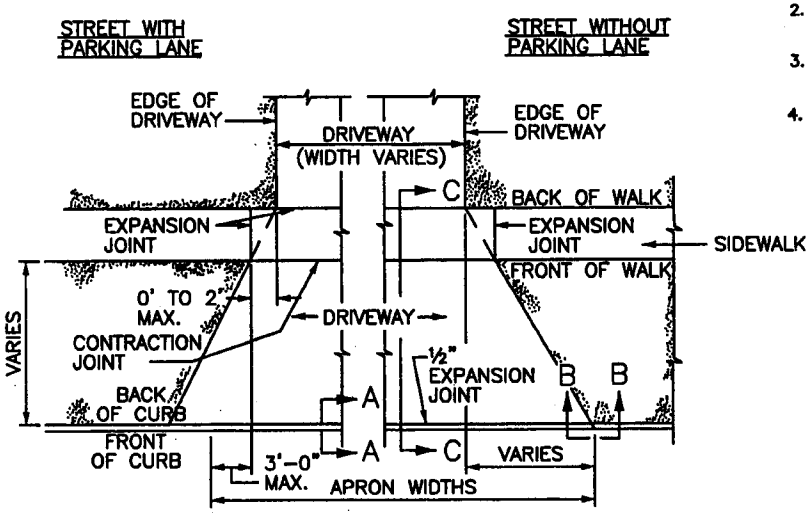
ENTRANCE WITHOUT UTILITY STRIP



SECTION B-B



SECTION D-D



ENTRANCE WITH UTILITY STRIP

NOTES:

1. PROVIDE A SAWED JOINT ALONG CENTER LINE OF APRON.
2. MAXIMUM CROSS SLOPE ON SIDEWALK SHALL NOT EXCEED ¼":1'.
3. MAXIMUM SLOPE ON APRON SHALL NOT EXCEED 1½":1'.
4. NO CATCH BASINS WILL BE PUT IN APRONS.

NO.	DATE	REVISION DESCRIPTION	BY

DIVISION OF ENGINEERING

COMMERCIAL ENTRANCE DETAILS

STANDARD DRAWING NO. 307-1

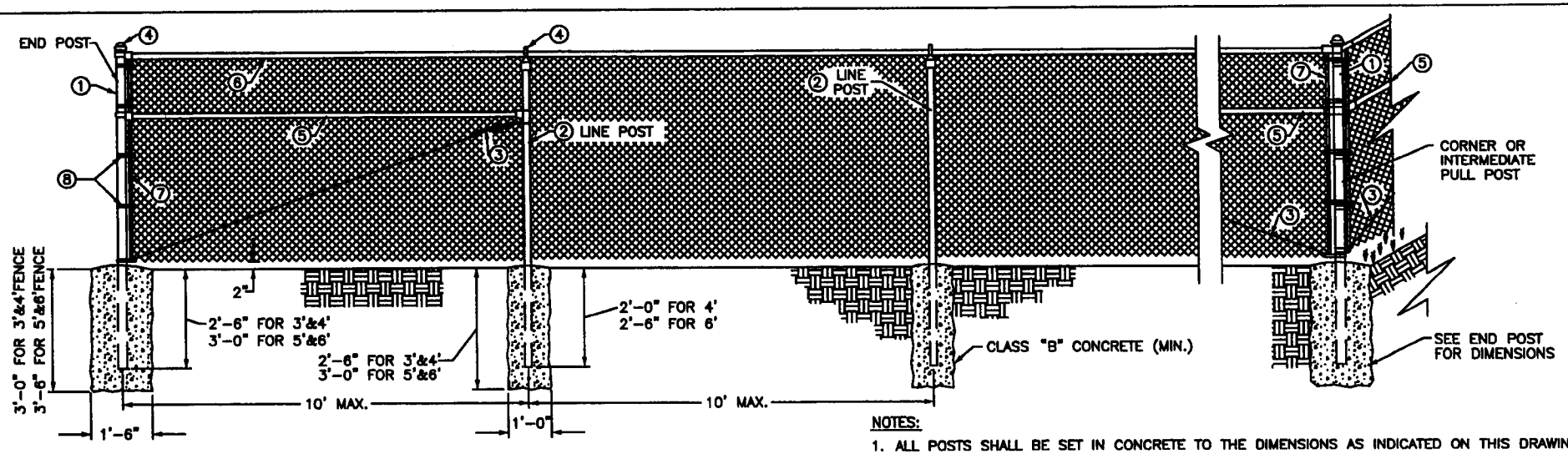
APPROVED _____ DATE 5/1/08

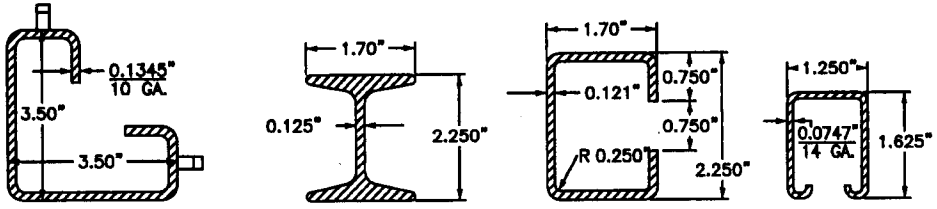
URBAN COUNTY ENGINEER

_____ DATE 5/1/08

COMMISSIONER

LEXINGTON-FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT





TERMINAL POST & CORNER POST

LINE POST H-COLUMN

LINE POST HEAVY "C" ROLL FORM

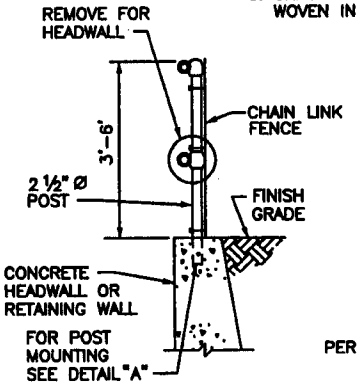
TOP & BRACE RAIL

NOTES:

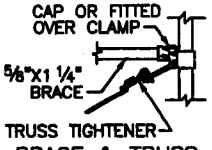
1. ALL POSTS SHALL BE SET IN CONCRETE TO THE DIMENSIONS AS INDICATED ON THIS DRAWING.
2. 3' HIGH FENCE SHALL HAVE 3' FABRIC HEIGHT. 4' HIGH FENCE SHALL HAVE 4' FABRIC HEIGHT. 5' HIGH FENCE SHALL HAVE 5' FABRIC HEIGHT. 6' HIGH FENCE SHALL HAVE 6' FABRIC HEIGHT.
3. BRACE BANDS SHALL BE 7/8"X 1/8" GALVANIZED STEEL 5/16"X1 1/4" CARRIAGE BOLT.
4. POST CAPS AND SOCKET TYPE BRACE END CONNECTIONS SHALL BE GALVANIZED MALLEABLE IRON OR OTHER TYPE AS APPROVED BY THE ENGINEER. THEY SHALL BE DESIGNED IN A MANNER TO EXCLUDE MOISTURE FROM INSIDE POSTS AND RAILS.
5. O.D. DEPICTED FOR TUBULAR POSTS IS NOMINAL-ASTM A-120 SHALL GOVERN.
6. STRUCTURAL SHAPES SHALL CONFORM TO STD. SPEC. 816.07.01 EXCEPT YIELD SHALL BE A MIN. 45,000 P.S.I.
7. INDISCRIMINATE MIXING OF POSTS WILL NOT BE PERMITTED.
8. CHAIN LINK FENCE FABRIC SHALL BE 0.148 INCH NOMINAL DIAMETER (NO. 9 GAGE) WIRE WOVEN IN 2 INCH MESH.

LEGEND-(ALTERNATES)

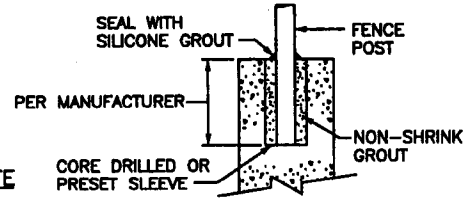
	TUBULAR	ROLL FORMED
①	2 1/2" O.D. @ 3.65#/L.F.	3.5"X3.5" @ 5.14#/L.F.
②	2" O.D. @ 2.72#/L.F.	2.250" H-COL.@ 3.26#/L.F. OR 2.250" C-COL.@ 2.64#/L.F.
③	3/8" Ø TRUSS ROD & TIGHTENER	0.375"Ø TRUSS ROD & TIGHTENER
④	APPROVED CAPS	NOT REQUIRED
⑤	1 5/8" BRACE @ 2.27#/L.F.	1.250"X1.625" @ 1.35#/L.F.
⑥	1 5/8" O.D. @ 2.27#/L.F.	1.250"X1.625" @ 1.35#/L.F.
⑦	3/16"X3/4" FLAT STRETCHER BAR	NOT REQUIRED
⑧	BRACE BAND & TENSION BAND	NOT REQUIRED



CHAIN LINK FENCE MOUNTED TO CONCRETE HEADWALL OR RETAINING WALL



BRACE & TRUSS CONNECTION



DETAIL "A"

NO.	DATE	REVISION DESCRIPTION	BY

DIVISION OF ENGINEERING

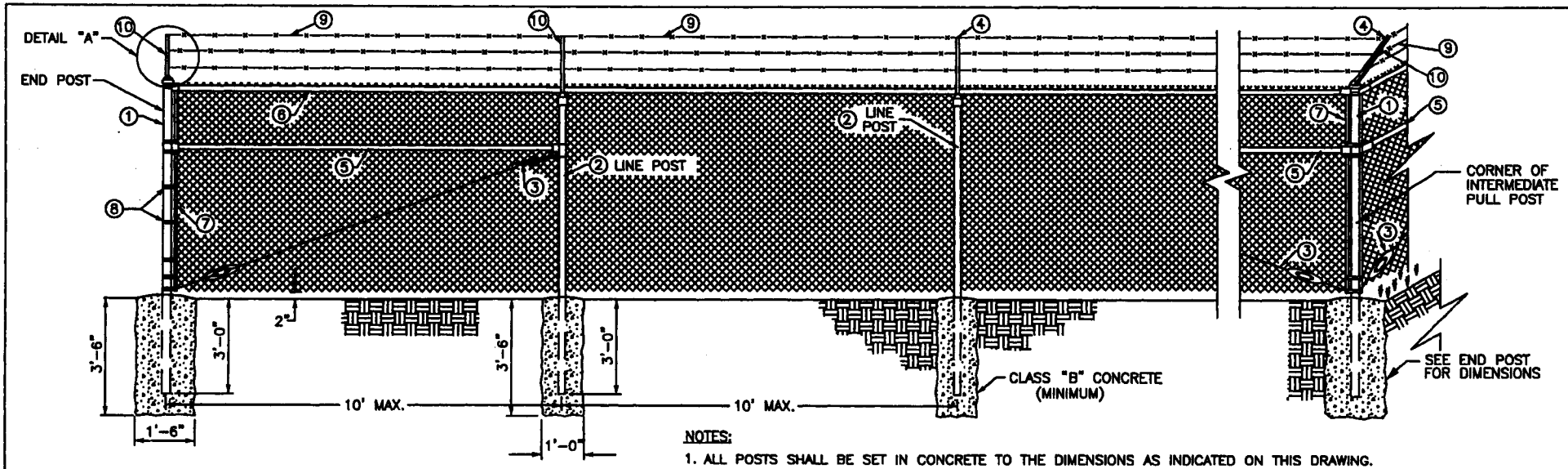
CHAIN LINK FENCE
3'-6"

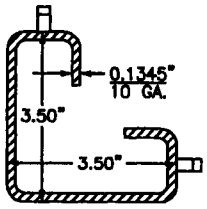
STANDARD DRAWING NO. 308

APPROVED _____ 5/1/08
URBAN COUNTY ENGINEER DATE

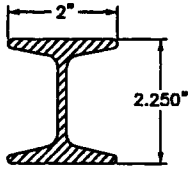
_____ 5/1/08
COMMISSIONER DATE

LEXINGTON-FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT

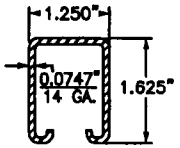




TERMINAL POST & CORNER POST



LINE POST



TOP & BRACE RAIL

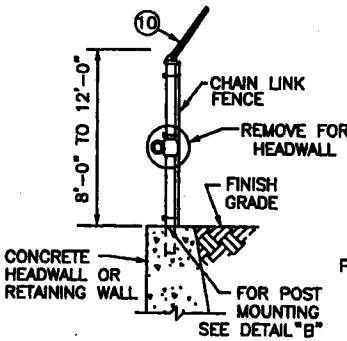
LEGEND–(ALTERNATES)

	TUBULAR	ROLL FORMED
①	2 ½" O.D. ● 3.65#/L.F.	3.5"X3.5" ● 5.14#/L.F.
②	2" O.D. ● 2.72#/L.F.	2.250" H–COL. ● 3.26#/L.F. OR 2.250" C–COL. ● 2.64#/L.F.
③	⅜" Ø TRUSS ROD & TIGHTENER	0.375" Ø TRUSS ROD & TIGHTENER
④	APPROVED CAPS	NOT REQUIRED
⑤	1 ⅝" BRACE ● 2.27#/L.F.	1.250"X1.625" ● 1.35#/L.F.
⑥	1 ⅝" O.D. ● 2.27#/L.F.	1.250"X1.625" ● 1.35#/L.F.
⑦	3/16"X ¾" FLAT STRETCHER BAR	NOT REQUIRED
⑧	BRACE BAND & TENSION BAND	NOT REQUIRED
⑨	BARBED WIRE	BARBED WIRE
⑩	BARBED WIRE ARMS	BARBED WIRE ARMS

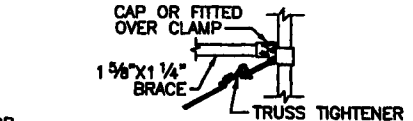
NOTES:

1. ALL POSTS SHALL BE SET IN CONCRETE TO THE DIMENSIONS AS INDICATED ON THIS DRAWING.
2. A 1 ⅝" O.D. AT 2.27 LB. PER L.F. OR 1 ¼"X1 ⅝" ROLL FORMED SECTION AT 1.35 LB. PER L.F. BOTTOM RAIL SHALL BE REQUIRED AROUND ALL UTILITY INSTALLATIONS AND AT OTHER LOCATIONS DESIGNATED BY THE ENGINEER.
3. 8' HIGH FENCE SHALL HAVE 7' FABRIC HEIGHT. 9' HIGH FENCE SHALL HAVE 8' FABRIC HEIGHT. 10' HIGH FENCE SHALL 9' FABRIC HEIGHT. 11' HIGH FENCE SHALL HAVE 10' FABRIC HEIGHT. 12' HIGH FENCE SHALL HAVE 11' FABRIC HEIGHT.
4. BRACE BAND SHALL BE ⅞"X ⅛" GALVANIZED STEEL WITH 5/16"X1 ¼" CARRIAGE BOLTS. POST CAPS AND SOCKET TYPE BRACE END CONNECTION SHALL BE GALVANIZED MALLEABLE IRON OR OTHER TYPE AS APPROVED BY THE ENGINEER. THEY SHALL BE DESIGNED IN A MANNER TO EXCLUDE MOISTURE FROM INSIDE POSTS AND RAILS.
5. O.D. DEPICTED FOR TUBULAR POSTS IS NOMINAL – ASTM A–120 SHALL GOVERN.
6. CHAIN LINK FENCE FABRIC SHALL BE 0.148 INCH NOMINAL DIAMETER (NO.9 GAGE) WIRE WOVEN IN 2 INCH MESH.

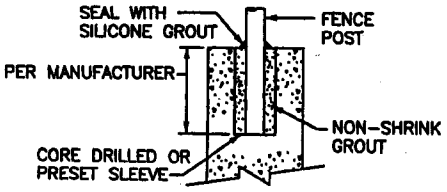
DETAIL "A" ROLL FORMED



CHAIN LINK FENCE MOUNTED TO CONCRETE HEADWALL OR RETAINING WALL



BRACE & TRUSS CONNECTION



DETAIL "B"

NO.	DATE	REVISION DESCRIPTION	BY

DIVISION OF ENGINEERING

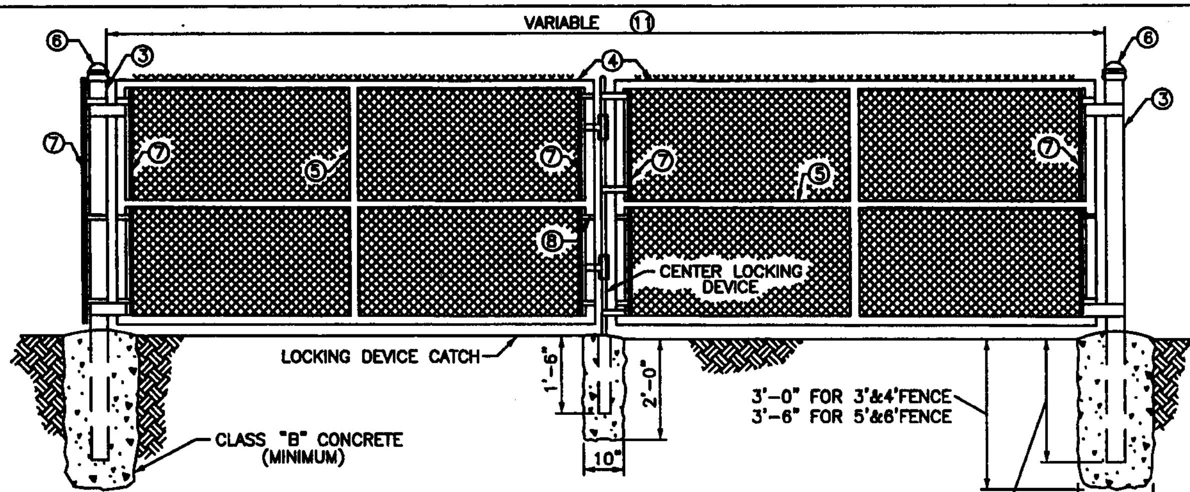
CHAIN LINK FENCE
8'–12'

STANDARD DRAWING NO. 309

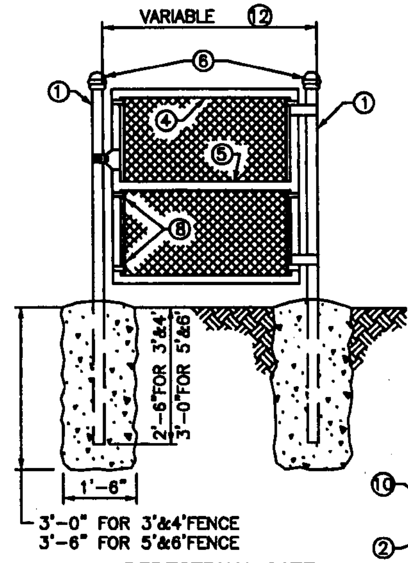
APPROVAL: URBAN COUNTY ENGINEER — DATE 5/1/08

COMMISSIONER — DATE

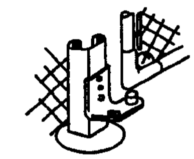
LEXINGTON–FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT



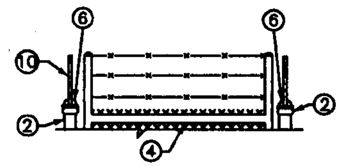
VEHICULAR GATE (3'-6' HIGH FENCE)



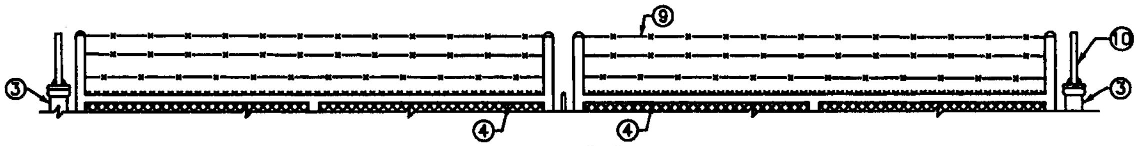
PEDESTRIAN GATE (3'-6' HIGH FENCE)



HINGE DETAIL



DETAIL "A"



DETAIL "B"

NOTES:

1. ALL POSTS SHALL BE SET IN CONCRETE TO THE DIMENSIONS AS INDICATED ON THIS DRAWING.
2. VEHICULAR AND PEDESTRIAN GATES SHALL HAVE HEAVY PRESSED STEEL CORNERS SECURELY RIVETED OR SHALL BE MACHINE NOTCHED, AND ELECTRICALLY WELDED SO AS TO BE RIGID AND WATER TIGHT; AND EQUIPPED WITH PADLOCKING DEVICE AND GROUND STOP.
3. ALL WELDED JOINTS SHALL BE CLEANED AND PAINTED WITH TWO (2) COATS OF ALUMINUM PAINT.
4. 3' HIGH GATES SHALL HAVE 3' FABRIC HEIGHT. 4' HIGH GATES SHALL HAVE 4' FABRIC HEIGHT. 5' HIGH GATES SHALL HAVE 5' FABRIC HEIGHT. 6' HIGH GATES SHALL HAVE 6' FABRIC HEIGHT. 8' HIGH GATES SHALL HAVE 7' FABRIC HEIGHT. 9' HIGH GATES SHALL HAVE 8' FABRIC HEIGHT. 10' HIGH GATES SHALL HAVE 9' FABRIC HEIGHT. 11' HIGH GATES SHALL HAVE 10' FABRIC HEIGHT. 12' HIGH GATES SHALL HAVE 11' FABRIC HEIGHT.
5. SEE DETAIL "A" FOR BARBED WIRE INSTALLATION ON 8' TO 12' HIGH PEDESTRIAN GATES.
6. SEE DETAIL "B" FOR BARBED WIRE INSTALLATION ON 8' TO 12' HIGH VEHICULAR GATES.
7. THE CONTRACTOR IS NOT TO ORDER GATES UNTIL THEIR NECESSITY AND LOCATION HAVE BEEN CERTIFIED BY THE ENGINEER.
8. O.D. DEPICTED FOR TUBULAR POSTS IS NOMINAL – ASTM A-120 SHALL GOVERN.
9. CHAIN LINK FENCE FABRIC SHALL BE 0.148 INCH NOMINAL DIAMETER (NO.9 GAGE) WIRE WOVEN 2 INCH MESH.

(11) 6' TO 13' WIDTH FOR SINGLE GATE OR 12' TO 26' WIDTH FOR DOUBLE GATE.

(12) 4' TO 6' WIDTH

LEGEND – (ALTERNATES)

	TUBULAR	ROLL FORMED
1	END POST 2½" O.D. @ 3.65#/L.F.	3½"X3½" @ 5.14#/L.F.
2	END POST 3" O.D. @ 3.65#/L.F.	3½"X3½" @ 5.14#/L.F.
3	4" O.D. @ 9.1#/L.F. GATE POST	NO ALTERNATE
4	2" O.D. @ 2.72#/L.F. GATE FRAME	NO ALTERNATE
5	1⅝" O.D. @ 2.27#/L.F.	NO ALTERNATE
6	APPROVED CAPS	NOT REQUIRED
7	3/16"X5/8" FLAT STRETCHER BAR	NOT REQUIRED
8	BRACE BAND & TENSION BAND	NOT REQUIRED
9	BARBED WIRE	BARBED WIRE
10	BARBED WIRE ARMS	BARBED WIRE ARMS

NO.	DATE	REVISION DESCRIPTION	BY

DIVISION OF ENGINEERING

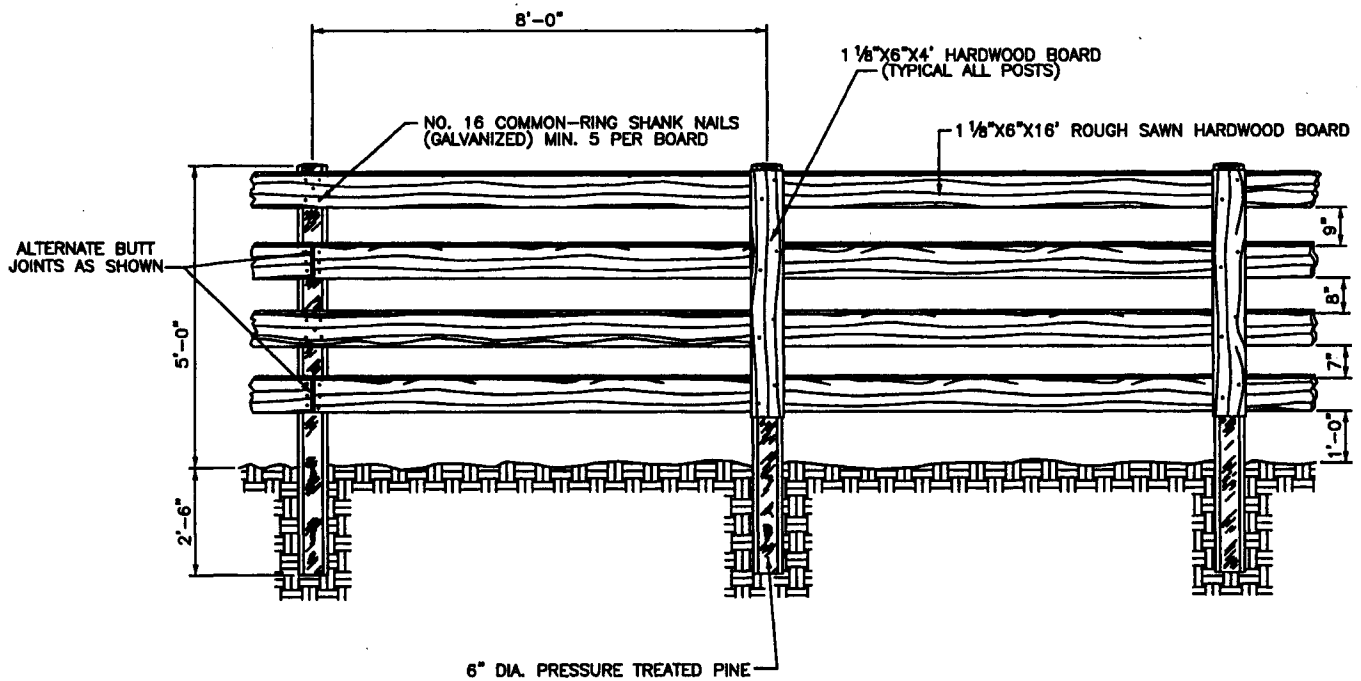
CHAIN LINK GATE

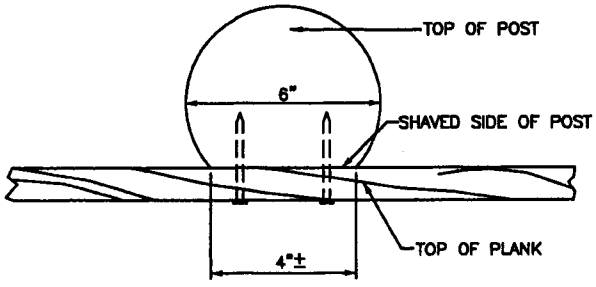
STANDARD DRAWING NO. 310

APPROVAL: URBAN COUNTY ENGINEER 5/1/08 DATE

COMMISSIONER 5/1/08 DATE

LEXINGTON–FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT





NOTES:

1. POSTS ARE TO BE DRIVEN 2'-6" INTO GROUND AND TOPS CUT AT AN ANGLE TO DRAIN WATER.
2. FENCE SHALL BE PAINTED BLACK OR WHITE WITH PAINT AND APPLICATION RATE AS APPROVED BY THE ENGINEER.
3. HARDWOODS APPROVED ARE RED OAK, WHITE OAK, AND POPLAR.

NO.	DATE	REVISION DESCRIPTION	BY

DIVISION OF ENGINEERING

PLANK FENCE

STANDARD DRAWING NO. 311

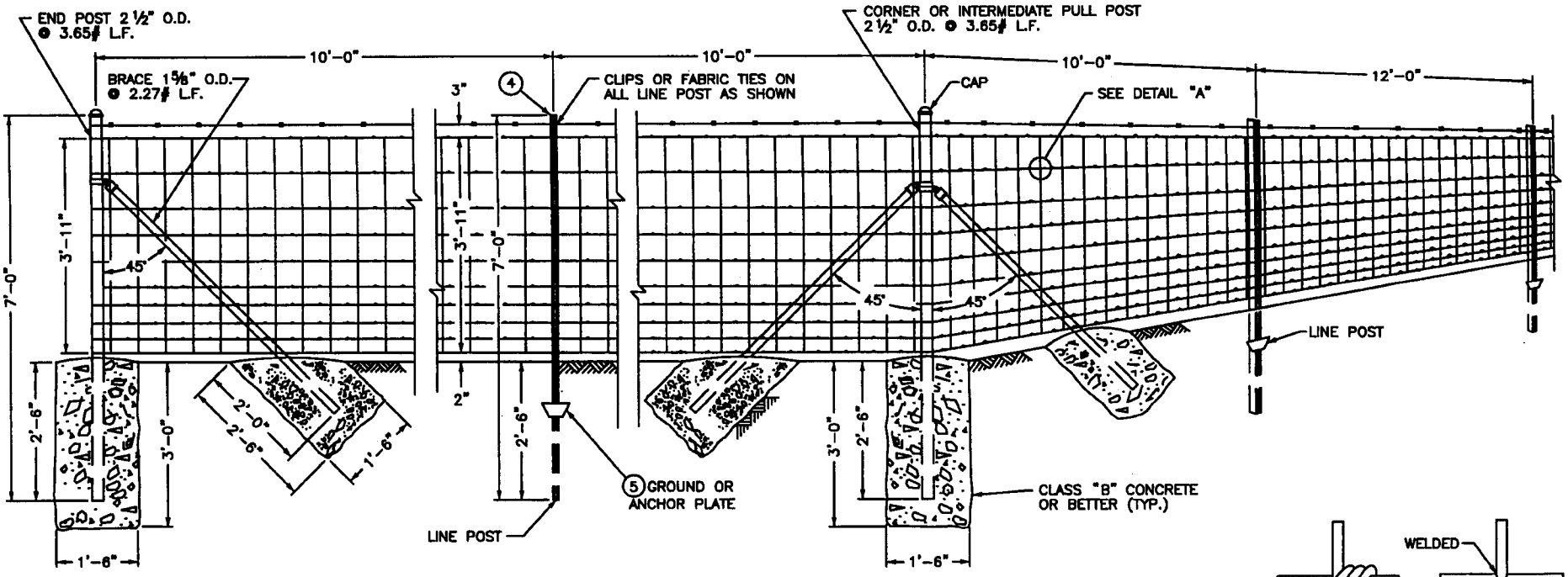
APPROVED: 5/1/08 DATE

URBAN COUNTY ENGINEER

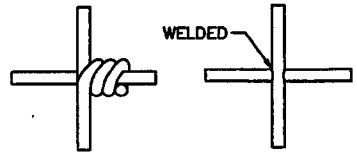
5/1/08 DATE

COMMISSIONER

LEXINGTON-FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT



RIGHT-OF-WAY FENCE



ALTERNATE METHODS OF SECURING VERTICAL STAY WIRE TO THE HORIZONTAL WIRE OF THE FABRIC.

DETAIL "A"

NOTES:

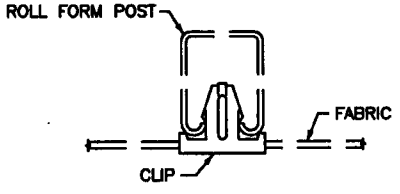
1. WOVEN-WIRE USED FABRIC IN RIGHT-OF-WAY FENCE SHALL BE EITHER ALUMINUM-COATED STEEL NO. 1047-6-9 OR ZINC-COATED STEEL NO. 1047-6-9.
2. ALL FENCE FITTINGS SHALL COMPLY WITH ASTM F 626.
3. O.D. DEPICTED FOR TUBULAR POSTS IS NOMINAL - ASTM F 1083 SHALL GOVERN.

(4) STUDDED "T" POST AT 1.33 LBS. PER FOOT.

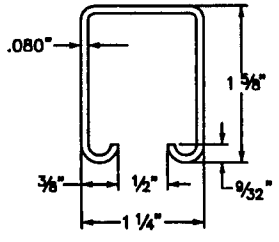
- OR -

ROLL FORM POST AT 1.35 LBS. PER FOOT. (SEE DETAIL)

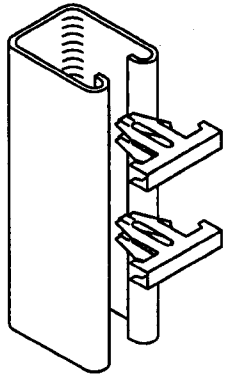
(5) NOT REQUIRED FOR ROLL FORM POST.



PLAN VIEW OF CLIP
INSTALLED IN ROLL FORM POST



PLAN VIEW OF
ROLL FORM POST



ISOMETRIC EXPLODED VIEW
OF ROLL FORM POST AND CLIPS

CLIPS SHALL BE SPRING STEEL ALUMINUM - FINISHED

NO.	DATE	REVISION DESCRIPTION	BY

DIVISION OF ENGINEERING

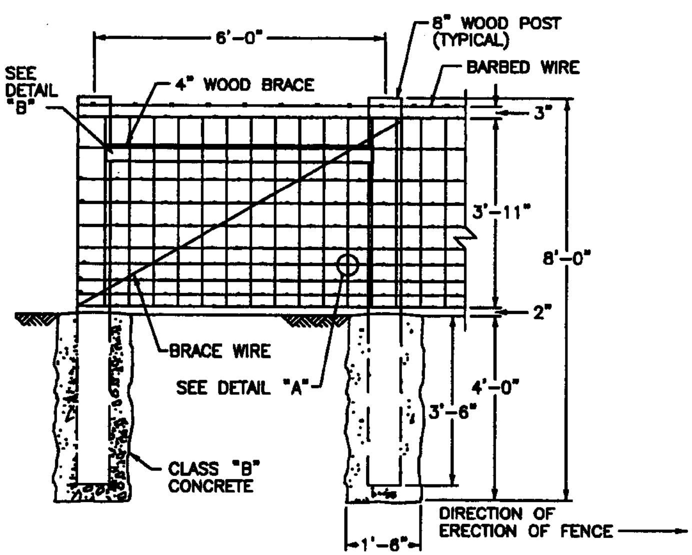
WOVEN WIRE
RIGHT-OF-WAY FENCE
TYPE 1

STANDARD DRAWING NO. 312

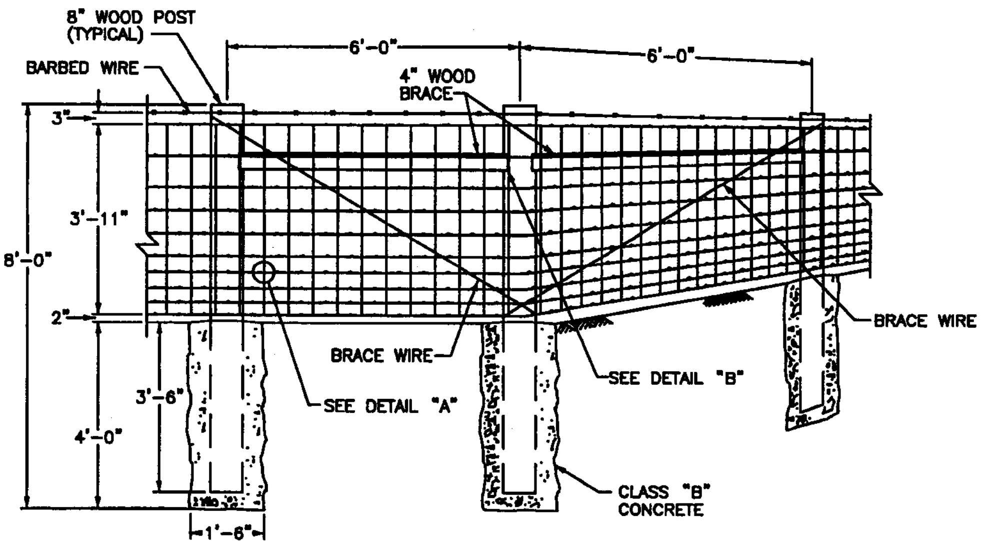
APPROVED _____ 5/1/08
URBAN COUNTY ENGINEER DATE

_____ 5/1/08
COMMISSIONER DATE

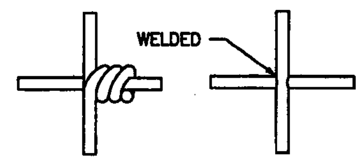
LEXINGTON-FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT



PULL OR END POST ASSEMBLY

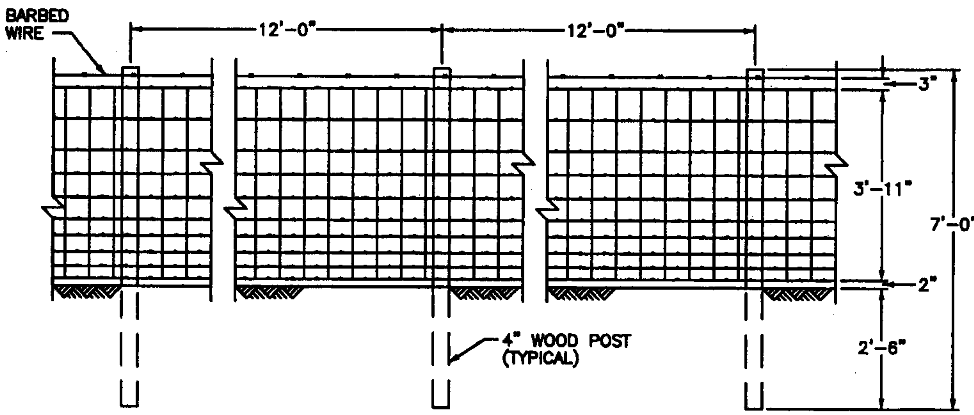


CORNER POST ASSEMBLY

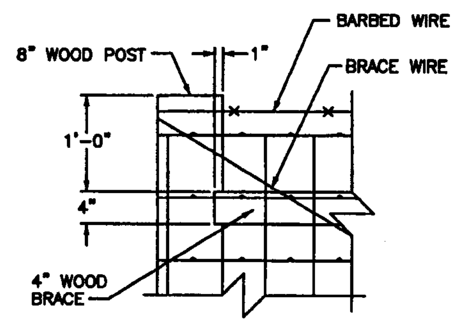


ALTERNATE METHODS OF SECURING VERTICAL STAY WIRE TO THE HORIZONTAL WIRE OF THE FABRIC.

DETAIL "A"



LINE POST



DETAIL "B"

NOTES:

1. ON INTERMEDIATE PULL POST ASSEMBLIES, BRACE WIRES SHALL BE REQUIRED FOR BOTH DIRECTIONS.
2. WOVEN-WIRE FABRIC USED IN RIGHT-OF-WAY FENCE SHALL BE EITHER ALUMINUM-COATED STEEL NO. 1047-6-9 OR ZINC-COATED STEEL NO. 1047-6-9.

NO.	DATE	REVISION DESCRIPTION	BY

DIVISION OF ENGINEERING

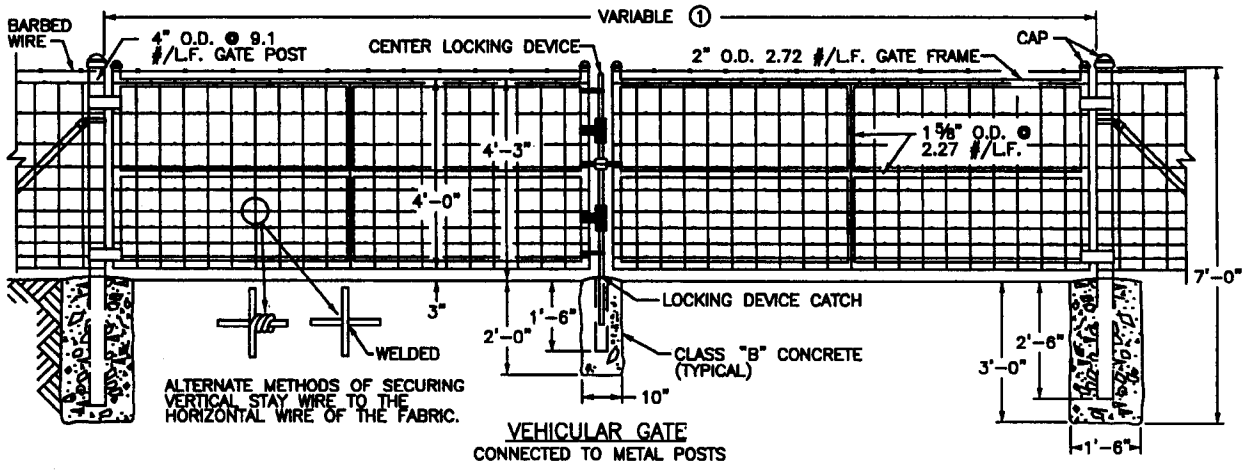
WOVEN WIRE
RIGHT-OF-WAY FENCE
TYPE 2

STANDARD DRAWING NO. 313

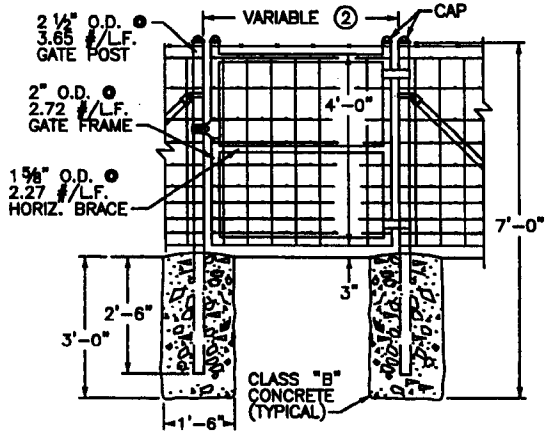
APPROVED [signature] URBAN COUNTY ENGINEER — DATE 5/1/08

[signature] COMMISSIONER — DATE 5/1/08

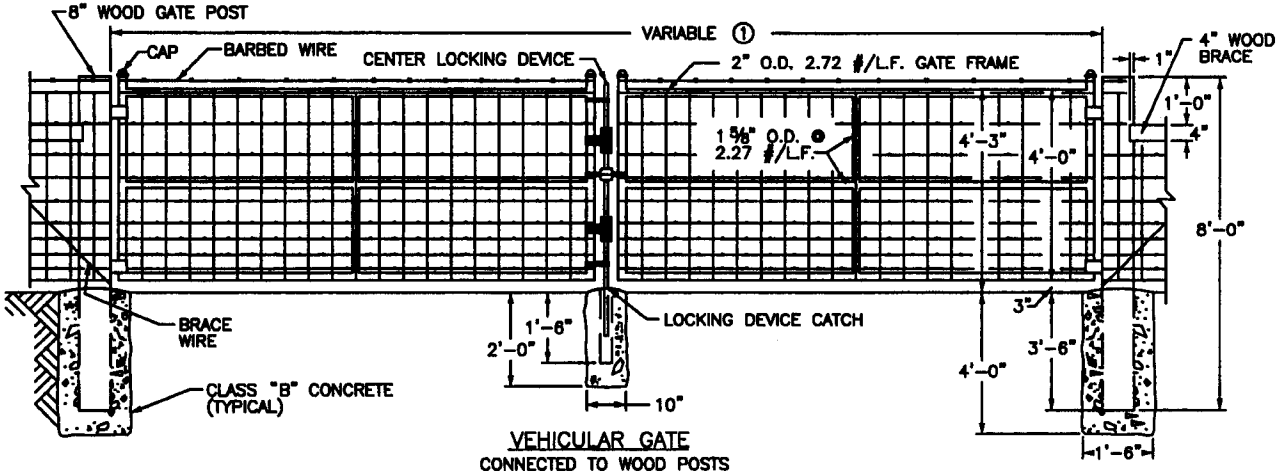
LEXINGTON-FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT



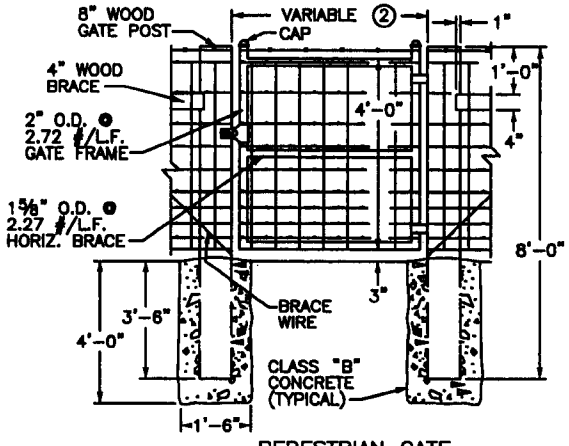
VEHICULAR GATE
CONNECTED TO METAL POSTS



PEDESTRIAN GATE
CONNECTED TO METAL POSTS



VEHICULAR GATE
CONNECTED TO WOOD POSTS



PEDESTRIAN GATE
CONNECTED TO WOOD POSTS

NOTES:

BASIS OF PAYMENT:

THE CONTRACT UNIT PRICE FOR WOVEN WIRE GATES SHALL BE:

① FEET WIDE SINGLE VEHICULAR WOVEN WIRE GATE
① FEET WIDE DOUBLE VEHICULAR WOVEN WIRE GATE
② FEET WIDE PEDESTRIAN WOVEN WIRE GATE
① – ② AS SHOWN ON PLANS

CONSTRUCTION REQUIREMENTS:

FABRIC TIE WIRES SHALL BE SPACED 12 INCHES ON CENTERS. THE CONTRACTOR IS NOT TO ORDER GATES UNTIL THEIR NECESSITY AND LOCATION HAVE BEEN CERTIFIED BY THE ENGINEER.

MATERIALS:

WOVEN-WIRE FABRIC USED IN THE GATES SHALL EITHER BE ALUMINUM-COATED STEEL NO. 1047-6-9 OR ZINC-COATED STEEL NO. 1047-6-9.

O.D. DEPICTED FOR TUBULAR POSTS IS NOMINAL – ASTM F 1083 SHALL GOVERN.

GATES SHALL HAVE HEAVY PRESSED STEEL CORNERS SECURELY RIVETED OR SHALL BE MACHINE NOTCHED AND ELECTRICALLY WELDED SO AS TO BE RIGID AND WATER TIGHT. ALL WELDED JOINTS SHALL BE CLEANED AND PAINTED WITH TWO (2) COATS OF ALUMINUM PAINT.

GENERAL:

① 6' TO 13' WIDTH FOR SINGLE GATE AND 12' TO 26' WIDTH FOR DOUBLE GATE.
② 4' TO 6' WIDTH

NO.	DATE	REVISION DESCRIPTION	BY

DIVISION OF ENGINEERING

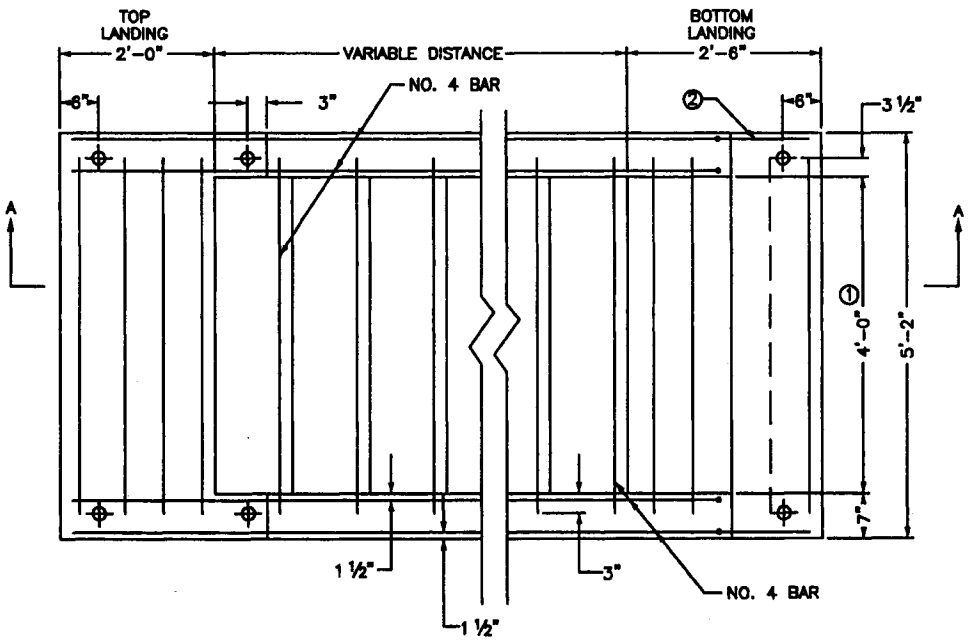
WOVEN WIRE GATES

STANDARD DRAWING NO. 314

APPROVED: 5/1/08
URBAN COUNTY ENGINEER — DATE

5/1/08
COMMISSIONER — DATE

LEXINGTON–FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT



PLAN

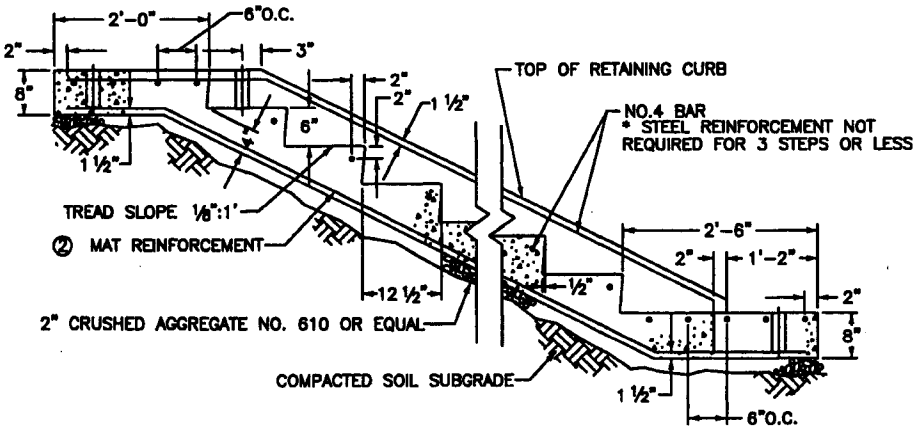
NOTES:

1. MAT REINFORCEMENT ②
   NO. 4 REINFORCEMENT BARS, LONG. BARS 6"O.C. AND TRANSV. BARS 12"O.C., MIN. GRADE 40, OR WELDED WIRE FABRIC–6X6–W4XW4, 58 LBS./100 SQ. FT.
2. NO. 4 REINFORCEMENT BARS ADDITIONALLY AS SHOWN.
3. ROUND ALL EXPOSED EDGES AND CORNERS ¼" R.
4. MAT REINFORCEMENT IN BOTTOM OF THE STEPS SHALL BE WIRE FABRIC OR BAR MAT ② .
5. HANDRAIL SHALL BE REQUIRED WITH THREE OR MORE STEPS.

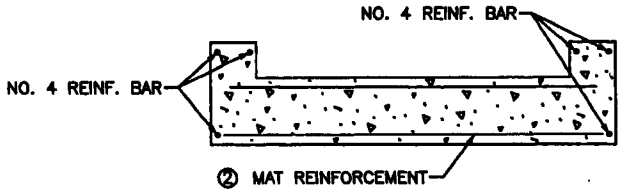
TABLE OF QUANTITIES

SLOPE	LOCATION	ADDITIONAL NO. 4 BAR REINF. (LBS)		MAT REINFORCEMENT WIRE FABRIC(SQ.FT.)		MAT REINFORCEMENT BAR MAT (LBS)		CU. YDS. CLASS "A" CONCRETE	
		4' WIDTH	①	4' WIDTH	①	4' WIDTH	①	4' WIDTH	①
2:1	BOTTOM LANDING	23.547	3.340	11.776	2.375	27.388	5.177	0.337	0.059
	INTERMEDIATE STEP	8.015	1.336	5.991	1.208	12.191	2.283	0.16	0.025
	TOP LANDING	22.483	3.340	9.504	1.917	20.708	3.897	0.265	0.051
1½:1	BOTTOM LANDING	23.603	3.340	12.602	2.542	28.613	5.400	0.36	0.062
	INTERMEDIATE STEP	7.431	1.336	5.268	1.063	11.119	2.088	0.17	0.027
	TOP LANDING	22.545	3.340	9.710	1.958	21.014	3.952	0.281	0.054

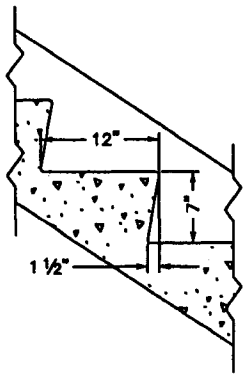
① APPROXIMATE QUANTITY TO ADD FOR EACH ADDITIONAL FOOT OF WIDTH OVER 4'–0".



SECTION A–A 2:1 SLOPE



STEP CROSS SECTION



STEP DETAIL FOR 1 ½:1 SLOPE

NO.	DATE	REVISION DESCRIPTION	BY

DIVISION OF ENGINEERING

CONCRETE STEPS

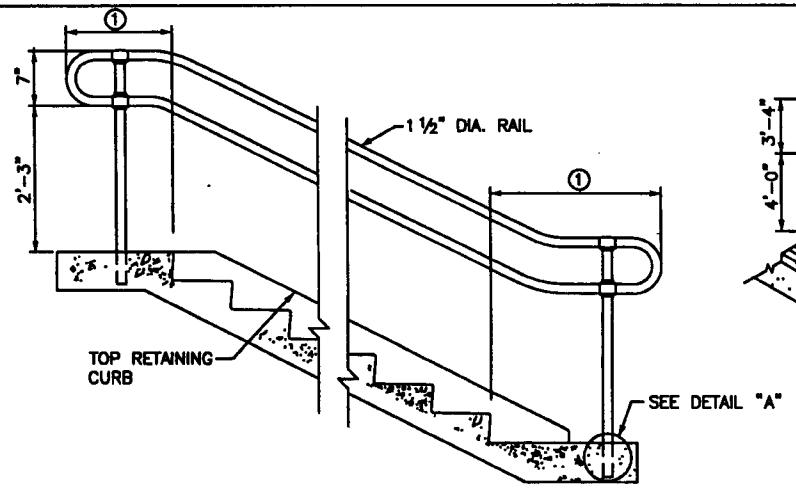
STANDARD DRAWING NO. 315

APPROVED _____ DATE 5/1/08

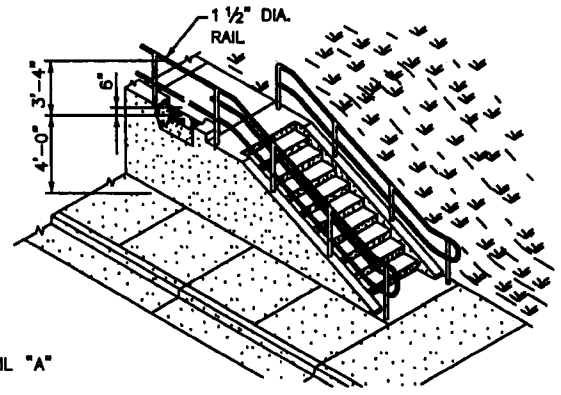
URBAN COUNTY ENGINEER

COMMISSIONER _____ DATE 5/1/08

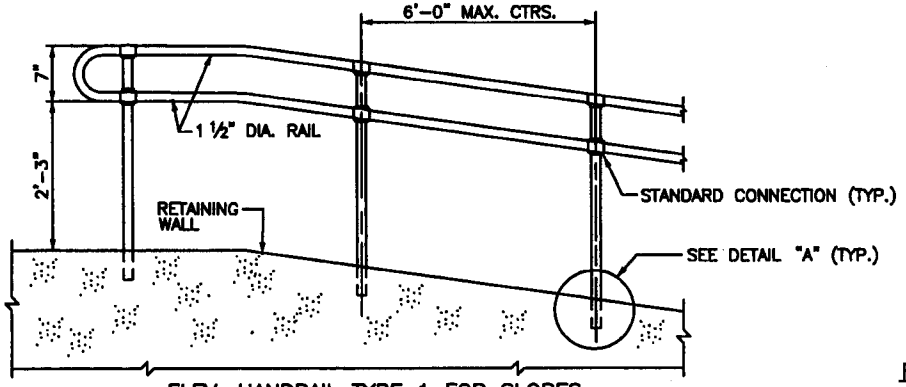
LEXINGTON–FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT



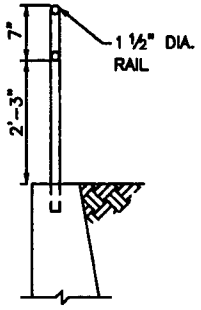
ELEVATION OF HANDRAIL TYPE 2



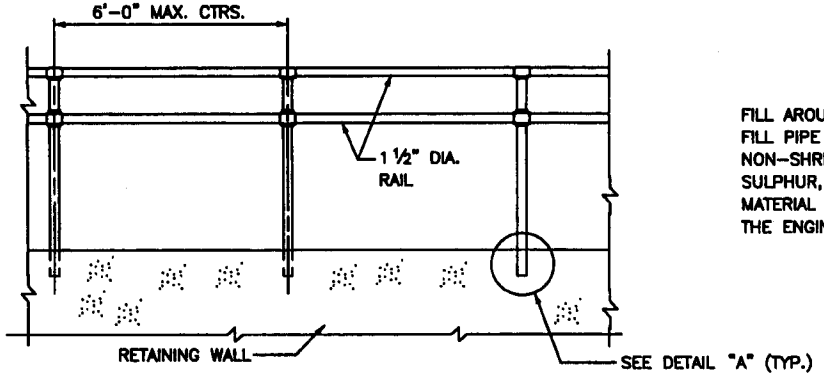
ELEV. OF HANDRAIL TYPE 1



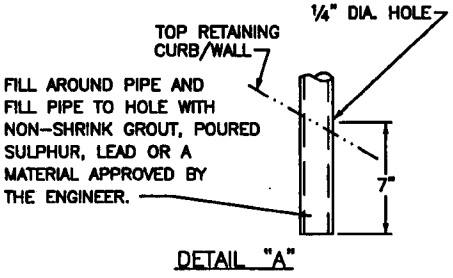
ELEV. HANDRAIL TYPE 1 FOR SLOPES



RT. SIDE ELEVATION



ELEVATION OF HANDRAIL TYPE 2



DETAIL "A"

NOTES:

1. ALL HANDRAILS SHALL COMPLY WITH THE LATEST EDITION OF THE AMERICANS WITH DISABILITIES ACT (ADA) GUIDELINES.
2. ANCHOR POST IN CORED OR FORMED HOLES (SEE DETAIL "A").
3. HANDRAIL SHALL BE REQUIRED WITH THREE OR MORE STEPS.
4. HANDRAIL USED AS A TOP HANDRAIL ON STEPS AND HANDRAIL USED ON A RETAINING WALL SHALL BE REQUIRED WHEN THE ADJACENT FLOOR, GROUND LEVEL, ROAD, WALK, ETC. IS 4' OR MORE BELOW THE TOP OF THE RETAINING WALL. HANDRAIL SHALL BE UNIFORMLY CONSTRUCTED.
5. THE TOP OF THE RETAINING WALL OR CURB SHALL BE A MINIMUM OF 6" ABOVE THE ADJOINING SIDEWALK.
6. RAILS SHALL NOT ROTATE IN FITTINGS AND SHALL HAVE WELDED CONNECTIONS.
7. THE CLEAR SPACE BETWEEN HANDRAILS AND WALL SHALL BE 1½".
8. HANDRAILS SHOULD BE CONSTRUCTED OF DN 40 SCHEDULE 40 ALUMINUM PIPE IN ACCORDANCE WITH ASTM-B221 OR B210 ALLOY 6061-T6.

SHEET NOTE: ①

① HANDRAILS SHALL EXTEND 12" BEYOND THE TOP RISER AND AT LEAST 12" PLUS THE WIDTH OF ONE TREAD BEYOND THE BOTTOM RISER. AT THE TOP, THE EXTENSION SHALL BE PARALLEL WITH THE FLOOR OR GROUND SURFACE. AT THE BOTTOM, THE HANDRAIL SHALL CONTINUE TO SLOPE FOR A DISTANCE OF THE WIDTH OF ONE TREAD FROM THE BOTTOM RISER. THE REMAINDER OF THE EXTENSION SHALL BE HORIZONTAL.

NO.	DATE	REVISION DESCRIPTION	BY

DIVISION OF ENGINEERING

HANDRAIL

STANDARD DRAWING NO. 316

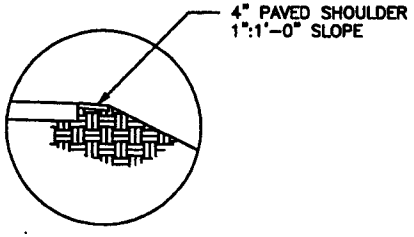
APPROVED _____ DATE 5/1/08

URBAN COUNTY ENGINEER

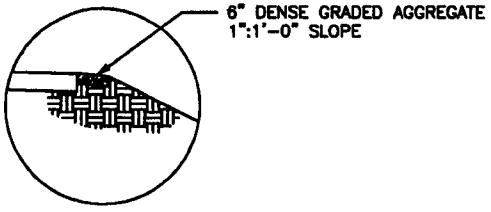
_____ DATE 5/1/08

COMMISSIONER

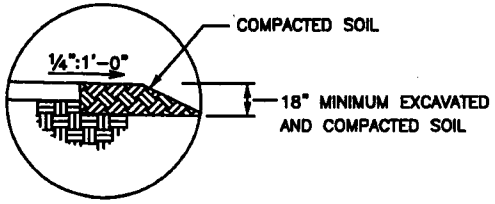
LEXINGTON-FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT



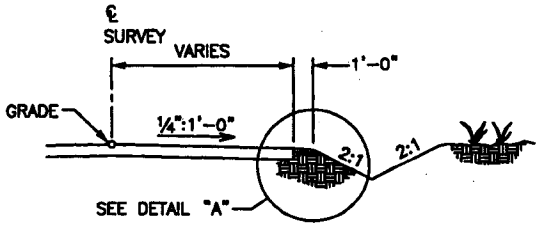
DETAIL "A"



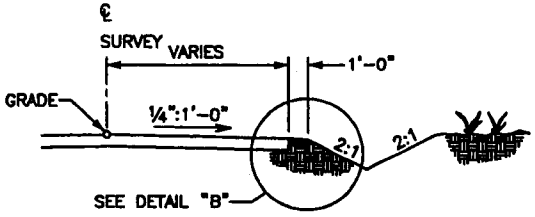
DETAIL "B"



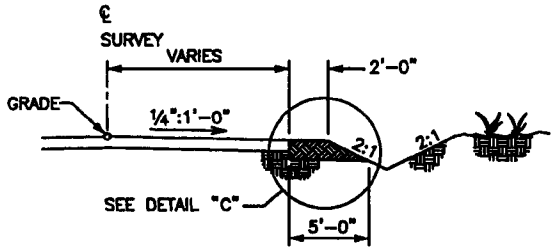
DETAIL "C"



PAVED SHOULDER



ROCK SHOULDER



SOIL SHOULDER

NOTES:

1. SLOPES AND DRAINAGE DITCHES OUTSIDE THE R/W SHALL BE APPROVED BY THE ENGINEER.
2. DRAINAGE DITCH SIDE SLOPES SHALL BE 2:1 MAXIMUM.

NO.	DATE	REVISION DESCRIPTION	BY

DIVISION OF ENGINEERING

COUNTY ROAD
TYPICAL SHOULDER SECTIONS
(MINIMUM REQUIREMENTS)

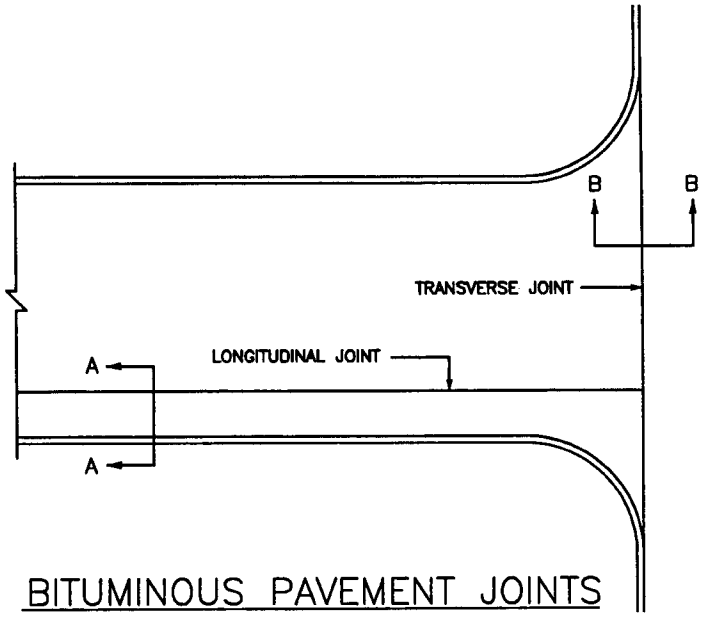
STANDARD DRAWING NO. 317

APPROVED _____ DATE 5/1/08

URBAN COUNTY ENGINEER

COMMISSIONER _____ DATE 5/1/08

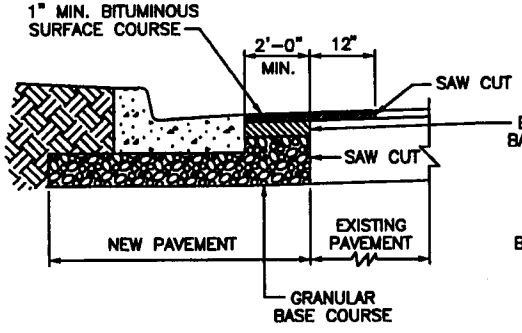
LEXINGTON–FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT



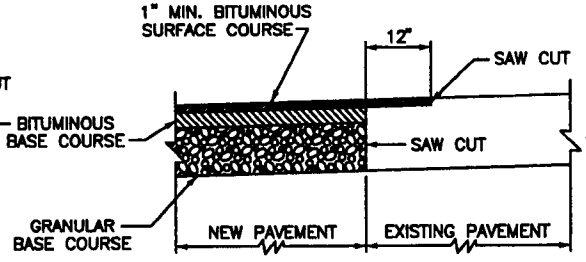
BITUMINOUS PAVEMENT JOINTS

NOTES:

1. ALL SAW-CUTS SHALL BE NEAT AND STRAIGHT.
2. IMMEDIATELY BEFORE LAYING NEW BITUMINOUS COURSES, ALL SAW CUT EDGES SHALL BE CLEANED OF DUST AND DEBRIS AND SPRAYED WITH A BITUMINOUS TACK COAT.
3. EDGE KEY SHALL NOT BE REQUIRED IF BOTH EXISTING AND NEW PAVEMENT ARE TO RECEIVE AN OVERLAY AS PART OF THIS CONTRACT.



SECTION A-A
LONGITUDINAL EDGE KEY



SECTION B-B
TRANSVERSE EDGE KEY

NO.	DATE	REVISION DESCRIPTION	BY

DIVISION OF ENGINEERING

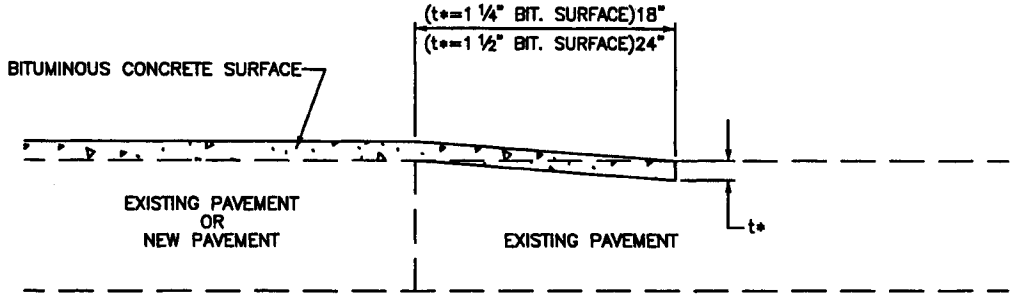
EDGE KEY

STANDARD DRAWING NO. 318

APPROVED 5/1/08
URBAN COUNTY ENGINEER DATE

5/1/08
COMMISSIONER DATE

LEXINGTON-FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT



EDGE KEY

NO.	DATE	REVISION DESCRIPTION	BY

DIVISION OF ENGINEERING

TYPICAL EDGE KEY
FOR
MINIMUM OVERLAYS,
SHORT PROJECTS,
LOW SPEED

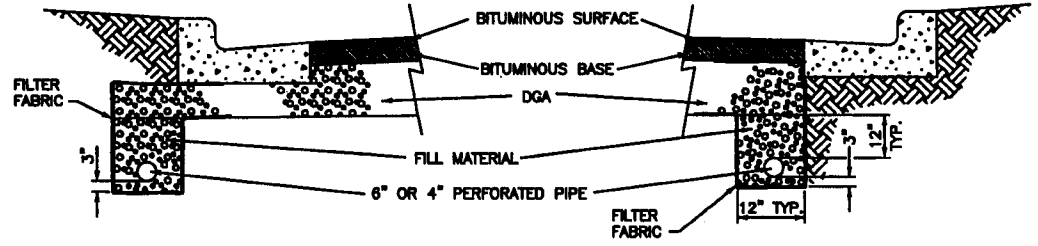
STANDARD DRAWING NO. 319

APPROVED: 5/1/08
URBAN COUNTY ENGINEER — DATE

5/1/08
COMMISSIONER — DATE

LEXINGTON–FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT

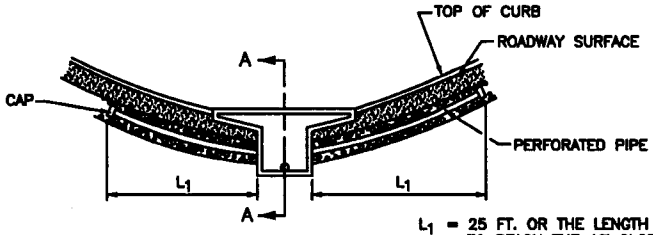
TYPICAL SECTION



NOTES:

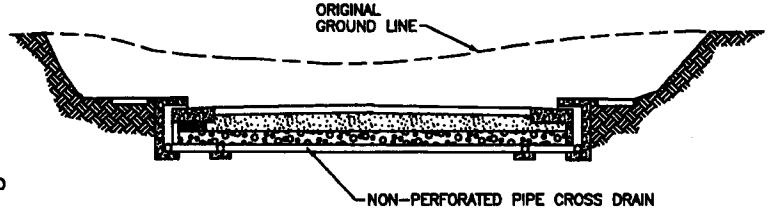
1. SUBGRADE DRAINAGE, AS DEPICTED, IS INTENDED FOR USE WITH THE SURFACING PHASE OF CONSTRUCTION, AND SHALL BE INSTALLED ONLY AFTER THE SUBGRADE HAS BEEN COMPLETED, AND PRIOR TO CONSTRUCTING PAVING MATERIALS.
2. THE CAP SHALL BE A STANDARD MANUFACTURED ITEM FURNISHED BY THE PIPE SUPPLIER.
3. TERMINATE PERFORATED PIPE IN CATCH BASIN AT AN ELEVATION WHICH PROVIDES POSITIVE DRAINAGE (MAY REQUIRE ADDITIONAL OPENING IN CATCH BASIN WALL).
4. BACKFILL TO CONSIST OF NO. 78, 8, 9M COARSE AGGREGATE OR NATURAL SAND. THE FILL MATERIAL SHALL BE THOROUGHLY COMPACTED IN LAYERS NOT EXCEEDING 6 INCHES LOOSE MEASUREMENT.
5. CONNECTIONS TO DRAINAGE STRUCTURES AND PIPE TERMINI SHALL BE NON-PERFORATED PIPE MEETING THE REQUIREMENTS OF THE PERFORATED PIPE EXCEPT FOR PERFORATIONS.
6. ALL RAISED NON-PAVED MEDIANS SHALL HAVE SUBGRADE DRAINAGE ASSOCIATED WITH CURB AND GUTTER.

TYPICAL SUBGRADE DRAINAGE LOCATIONS

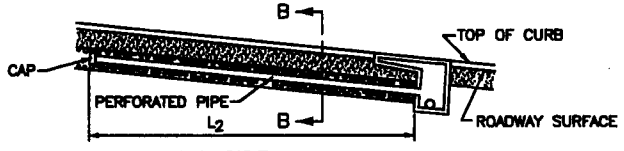


SAG VERTICAL CURVE

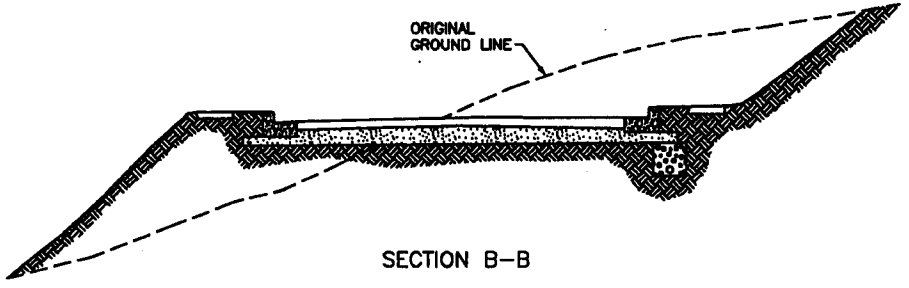
L_1 = 25 FT. OR THE LENGTH REQUIRED TO REACH THE 1% SLOPE POINT, WHICHEVER IS LARGER.



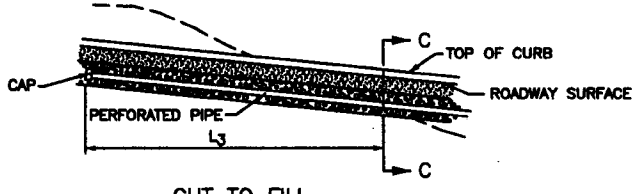
SECTION A–A



HILLSIDE L_2 = 50 FT. OR THE LENGTH TO THE CREST OF THE HILL, WHICHEVER IS LARGER.

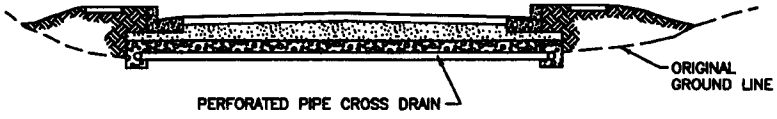


SECTION B–B



CUT TO FILL

L_3 = 25 FT. OR THE LENGTH REQUIRED TO REACH THE CREST OF THE HILL, WHICHEVER IS LARGER.



SECTION C–C

NO.	DATE	REVISION DESCRIPTION	BY

DIVISION OF ENGINEERING

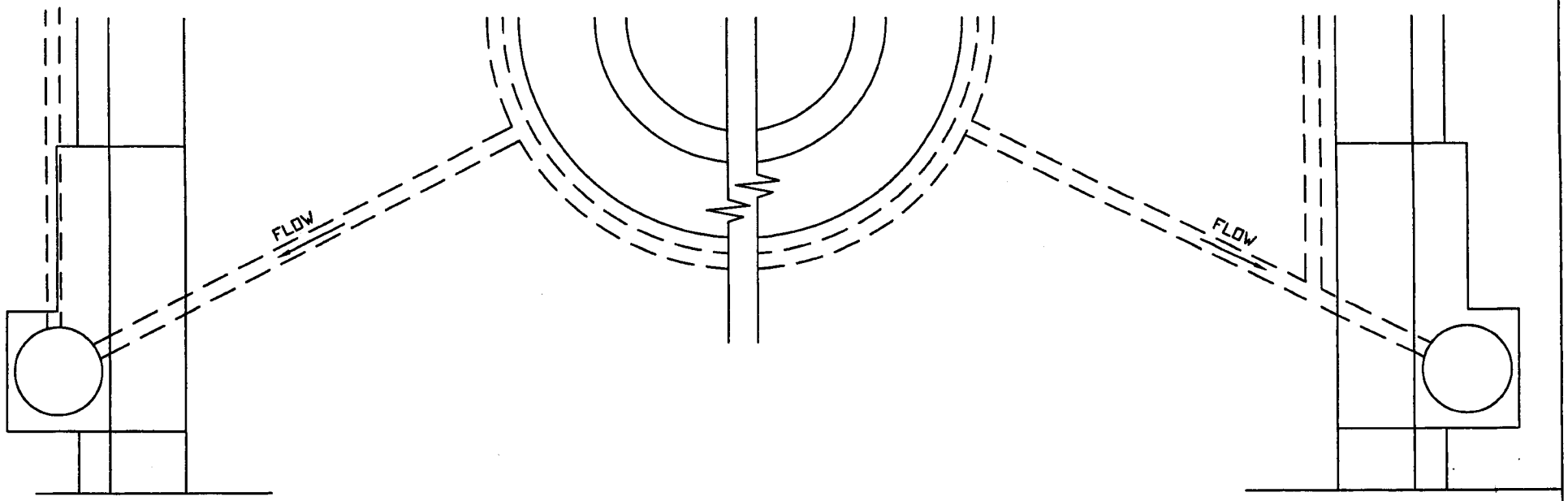
PERFORATED PIPE SUBGRADE DRAINAGE ALONG ROADWAY

STANDARD DRAWING NO. 320

APPROVED 5/1/08
URBAN COUNTY ENGINEER DATE

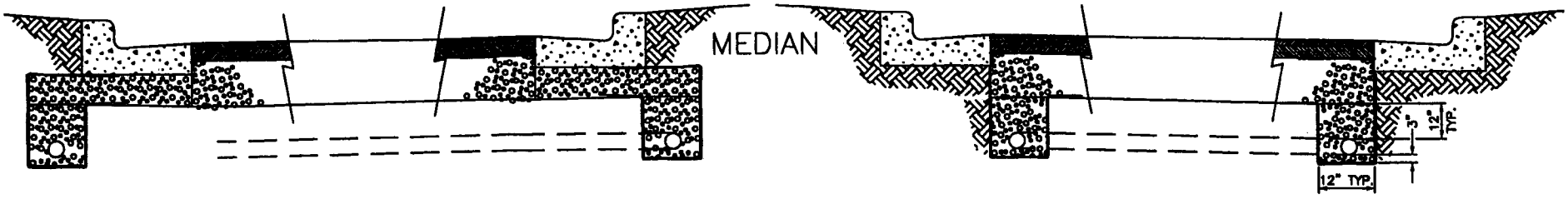
COMMISSIONER 5/1/08 DATE

LEXINGTON–FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT



CURB ON PAVEMENT

CURB ON SOIL



TYPICAL SECTION

1. For installation of perforated pipe see Detail Sheet #320
2. Perforated pipe shall completely surround all islands
3. For islands greater than 50" long or wide, perforated pipe surrounding island and leading to the curb inlet shall be 6" diameter.

NO.	DATE	REVISION DESCRIPTION	BY

DIVISION OF ENGINEERING

PERFORATED PIPE SUBGRADE DRAINAGE FOR RAISED NON-PAVED MEDIANS

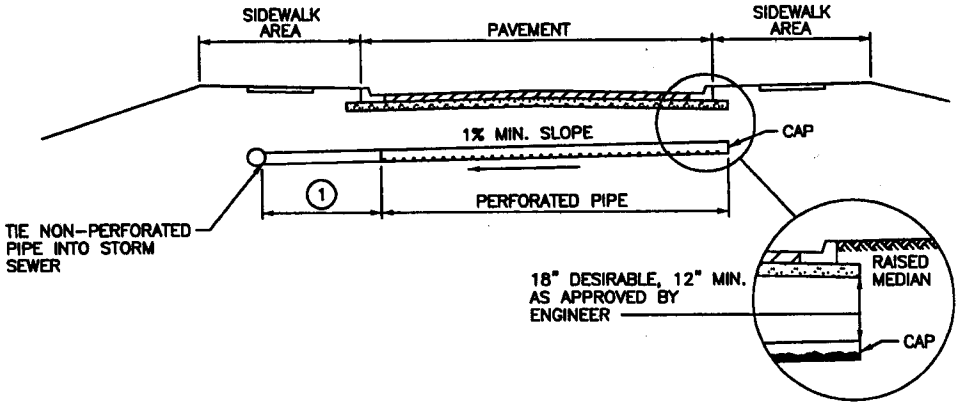
STANDARD DRAWING NO. 320-1

APPROVED: 5/1/08 DATE

URBAN COUNTY ENGINEER

COMMISSIONER 5/1/08 DATE

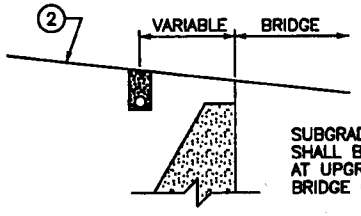
LEXINGTON-FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT



NOTES:

1. SUBGRADE DRAINAGE, AS DEPICTED, IS INTENDED FOR USE WITH THE ROADWAY CONSTRUCTION PHASE AND SHALL BE INSTALLED ONLY AFTER THE SUBGRADE HAS BEEN COMPLETED, AND PRIOR TO PLACING PAVING MATERIALS.
2. SUBGRADE DRAINAGE WILL NOT BE REQUIRED WHEN:
   A. AGGREGATE SUBGRADE OR NATURAL BANK GRAVEL IS SPECIFIED.
   B. POROUS OR FREE DRAINING SUBGRADES ARE EVIDENT.
   C. DIRECTED BY THE ENGINEER.
3. THE CAP SHALL BE A STANDARD MANUFACTURED ITEM FURNISHED BY THE PIPE SUPPLIER.
4. FLOW SHALL BE DIRECTED TOWARD THE FILL SIDE OF THE ROADWAY WHEN POSSIBLE.
5. IF ROCK IS ENCOUNTERED WITHIN 24" OF SUBGRADE, PERFORATED PIPE IS REQUIRED THE FULL LENGTH OF ROCK. POSITIVE OUTLET IS REQUIRED.
6. A MIN. OF 50' OF PERFORATED PIPE IS REQUIRED UPHILL FROM BASINS ON GRADE AND 25' OF PERFORATED PIPE IS REQUIRED EACH WAY FROM SAG BASINS.

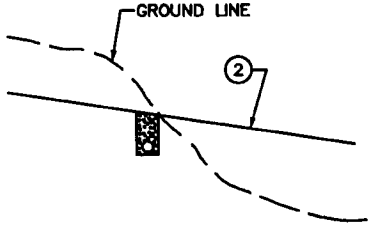
SAG VERTICAL CURVES



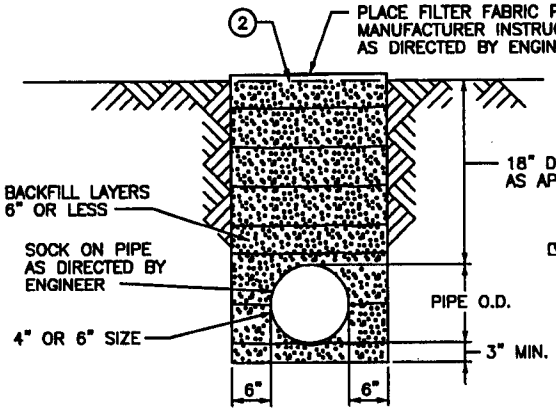
BRIDGES

(1) APPROXIMATELY 8 TO 12 FEET OF PIPE AT THE OUTLET SHALL BE NON-PERFORATED PIPE MEETING THE REQUIREMENTS OF THE PERFORATED PIPE, EXCEPT FOR PERFORATIONS.

(2) SUBGRADE ELEVATION



CUT TO FILL



TRENCH DETAIL

(3) – NO. 78, 8, OR 9M COARSE AGGREGATE. THE FILL MATERIAL SHALL BE THOROUGHLY COMPACTED IN LAYERS NOT EXCEEDING 6 INCHES LOOSE MEASUREMENT.

NO.	DATE	REVISION DESCRIPTION	BY

DIVISION OF ENGINEERING

PERFORATED PIPE FOR SUBGRADE DRAINAGE

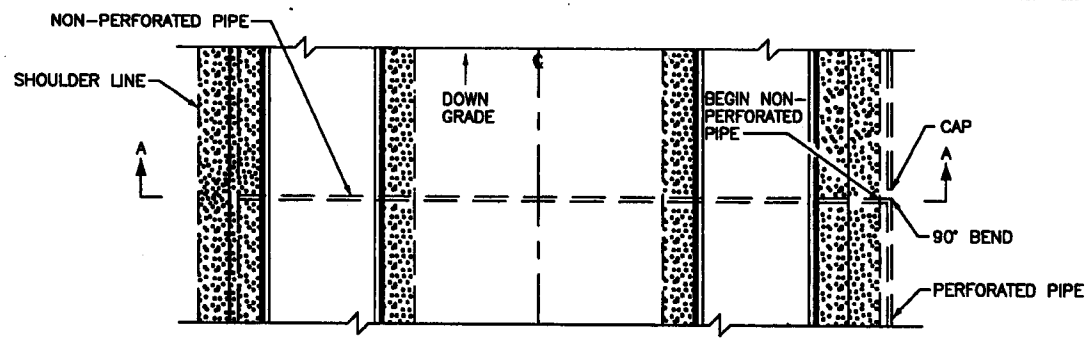
STANDARD DRAWING NO. 321

APPROVED: URBAN COUNTY ENGINEER — DATE 5/1/08

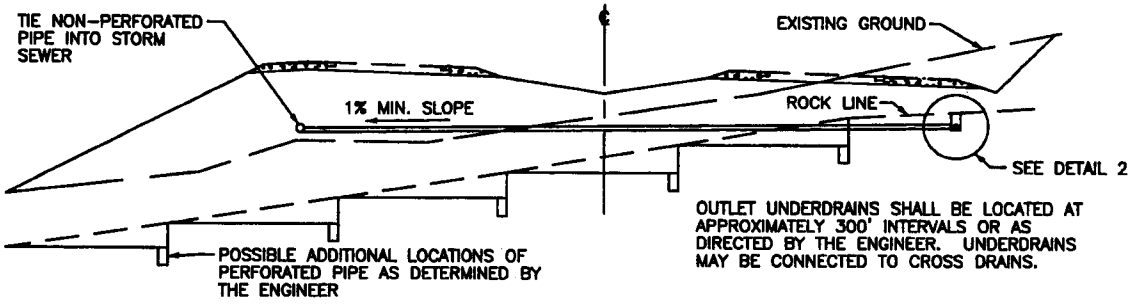
COMMISSIONER — DATE 5/1/08

TYPICAL SUBGRADE DRAINAGE LOCATIONS

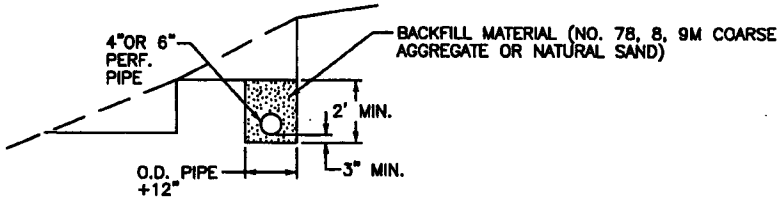
LEXINGTON-FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT



PLAN VIEW



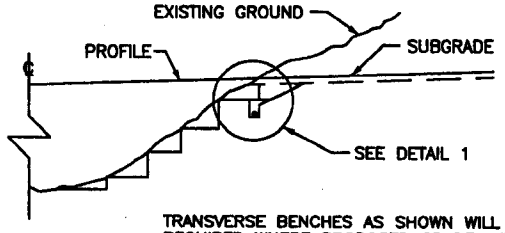
SECTION A-A



DETAIL 2

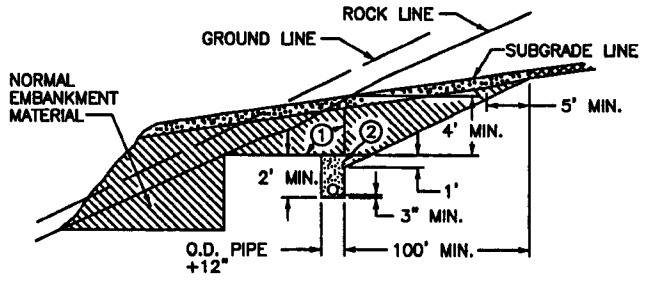
DETAIL FOR LONGITUDINAL UNDERDRAINS

DETAIL FOR TRANSVERSE UNDERDRAIN CUT TO FILL CONDITION



TRANSVERSE BENCHES AS SHOWN WILL BE REQUIRED WHERE PROPOSED GRADE INTERSECTS EXISTING GROUND.

1. UNDERDRAINS WILL BE REQUIRED ON UPGRADE BENCH. THIS PERFORATED PIPE UNDERDRAIN SHOULD BE PLACED IN ROCK OR SHALE FORMATIONS IF POSSIBLE. EXACT LOCATIONS TO BE DETERMINED BE THE ENGINEER ON CONSTRUCTION.
2. BENCHING AND UNDERDRAIN SHALL BE REQUIRED AT ALL TRANSITIONS FROM ROCK CUTS TO FILL WHETHER OR NOT UNDERDRAIN IS REQUIRED.
3. IF ROCK IS ENCOUNTERED WITHIN 24" OF SUBGRADE, PERFORATED PIPE IS REQUIRED THE FULL LENGTH OF ROCK. POSITIVE OUTLET IS REQUIRED.



DETAIL 1

SHEET NOTES:

① LIMITS OF FIRST BENCH.

② BACKFILL MATERIAL

NOTE:

1. ALL PERFORATED AND NON-PERFORATED PIPE SHALL COMPLY WITH ASTM & KDOT SPECIFICATIONS.

NO.	DATE	REVISION DESCRIPTION	BY

DIVISION OF ENGINEERING

PERFORATED PIPE UNDERDRAINS

STANDARD DRAWING NO. 322

APPROVED: URBAN COUNTY ENGINEER — DATE 5/1/08

COMMISSIONER — DATE 5/1/08

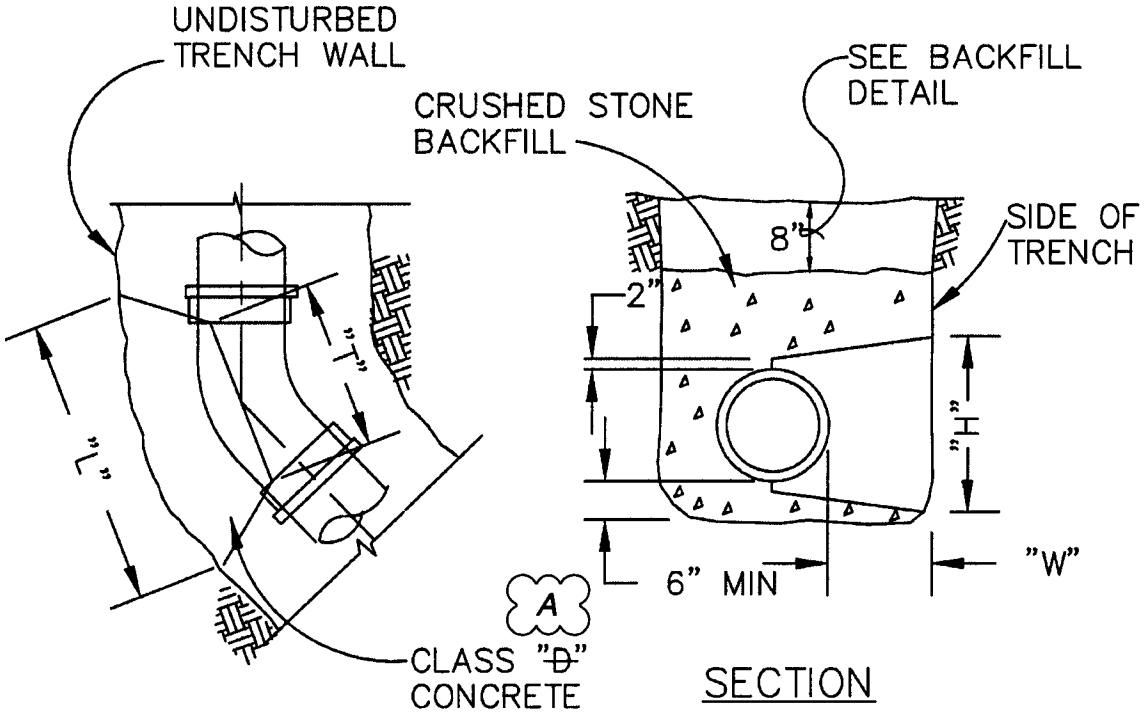
LEXINGTON-FAYETTE URBAN COUNTY GOVERNMENT, DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT

APPENDIX B

LFUCG Sanitary Sewer & Pumping Station Standard Drawings 2009

Excerpt from:
LFUCG Sanitary Sewer and Pump Station Manual, Appendix B - Drawings

* ALL PIPE AND FITTINGS TO BE BLOCKED SHALL BE WRAPPED TO PREVENT PERMANENT ENCASEMENT OF JOINTS.



PLAN

SECTION

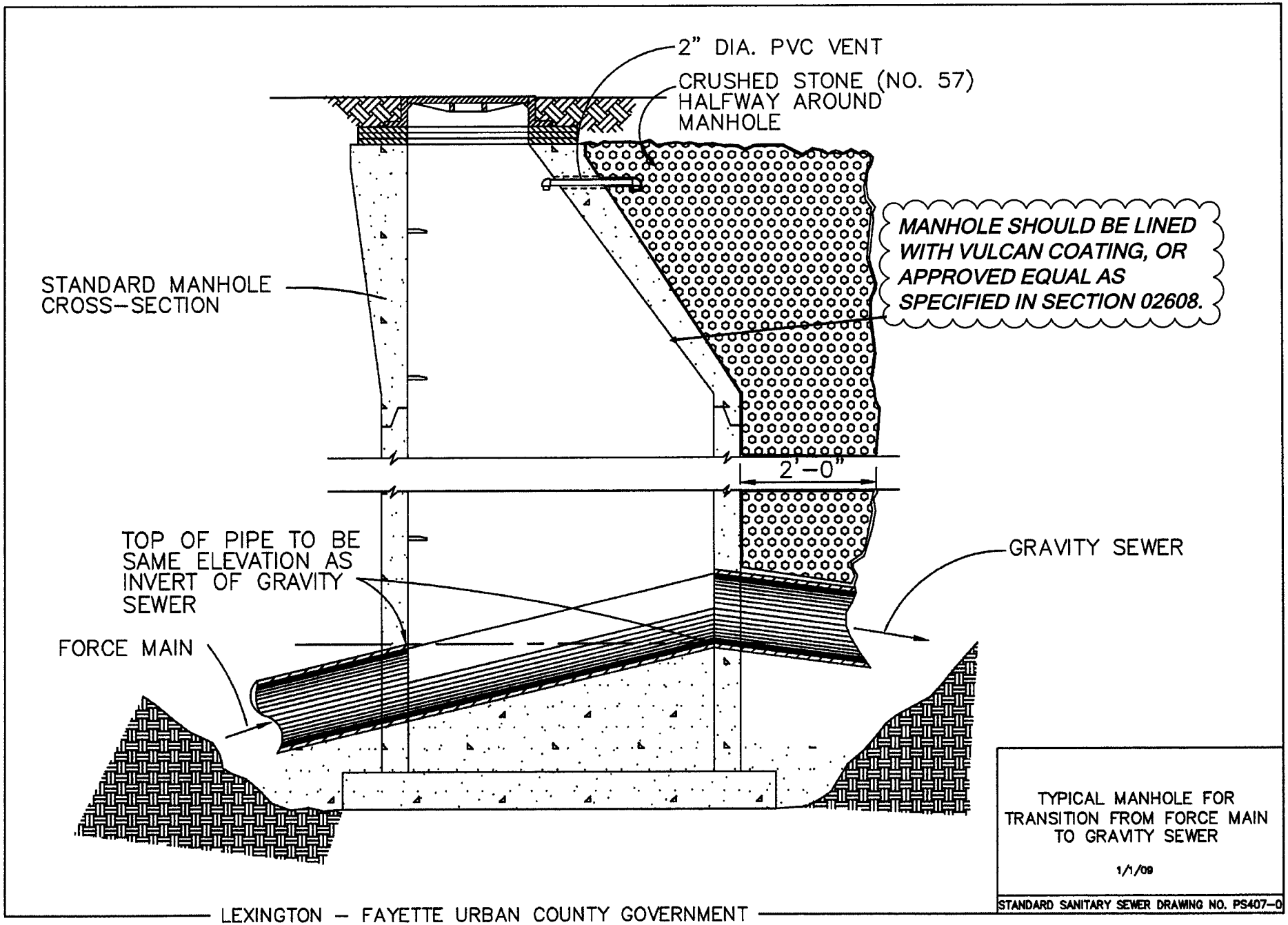
45° BEND					
SIZE D	4"	6"	8"	10"	12"
W	8"	8"	10"	12"	12"
L	14"	18"	20"	22"	27"
H	14"	16"	18"	20"	24"
T	13"	15"	16"	18"	18"

90° BEND					
SIZE D	4"	6"	8"	10"	12"
W	8"	8"	10"	12"	12"
L	14"	24"	30"	35"	40"
H	14"	16"	18"	24"	30"
T	13"	16"	18"	20"	22"

HORIZ. & VERT. BENDS & CONCRETE BACKING

1/1/09

STANDARD SANITARY SEWER DRAWING NO. PS406-0

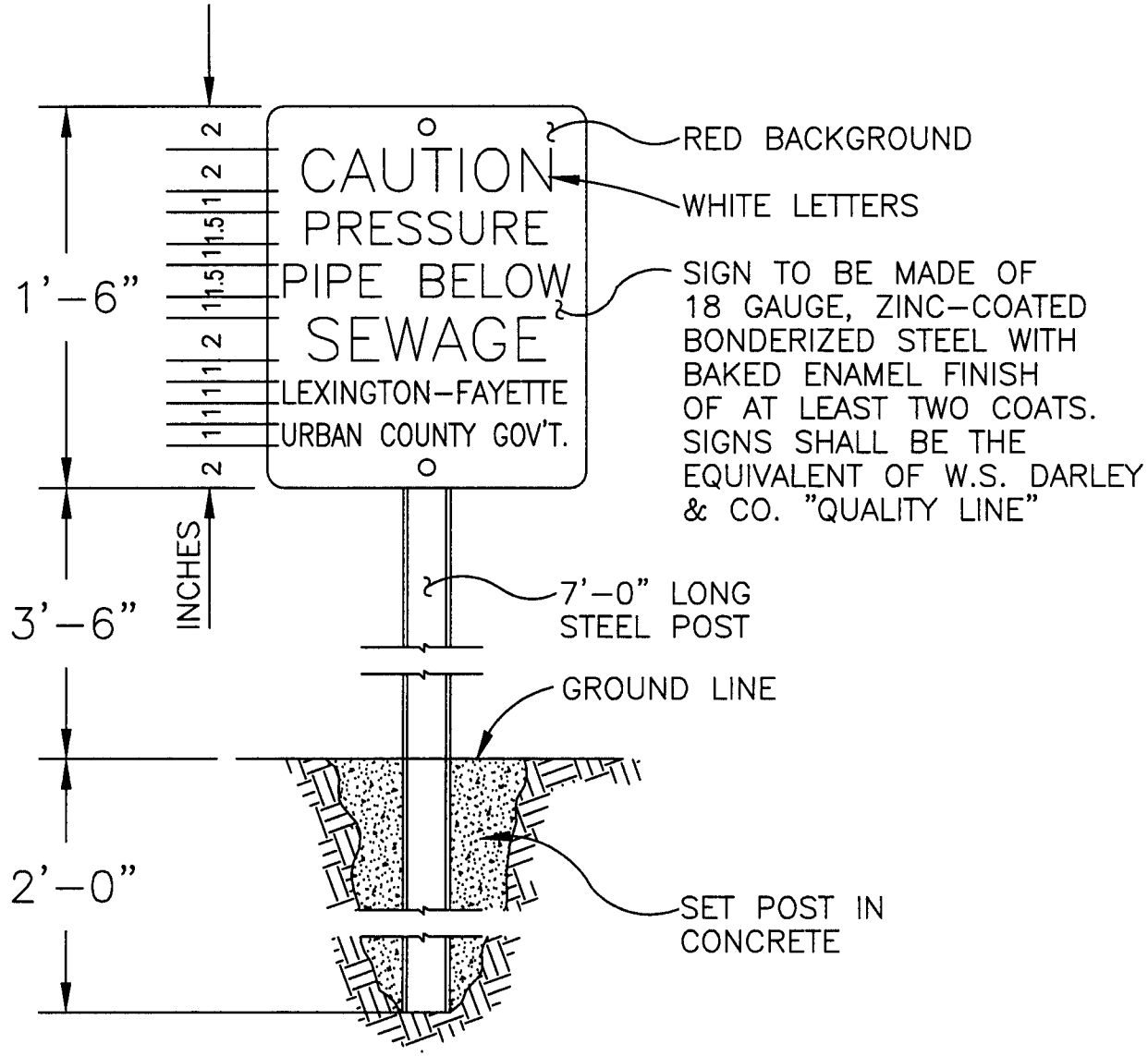


TYPICAL MANHOLE FOR TRANSITION FROM FORCE MAIN TO GRAVITY SEWER

1/1/09

STANDARD SANITARY SEWER DRAWING NO. PS407-0

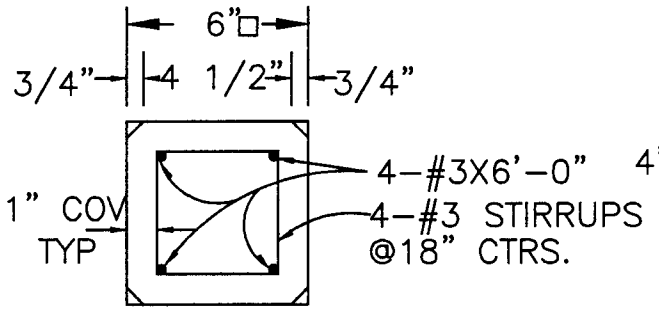
LEXINGTON – FAYETTE URBAN COUNTY GOVERNMENT



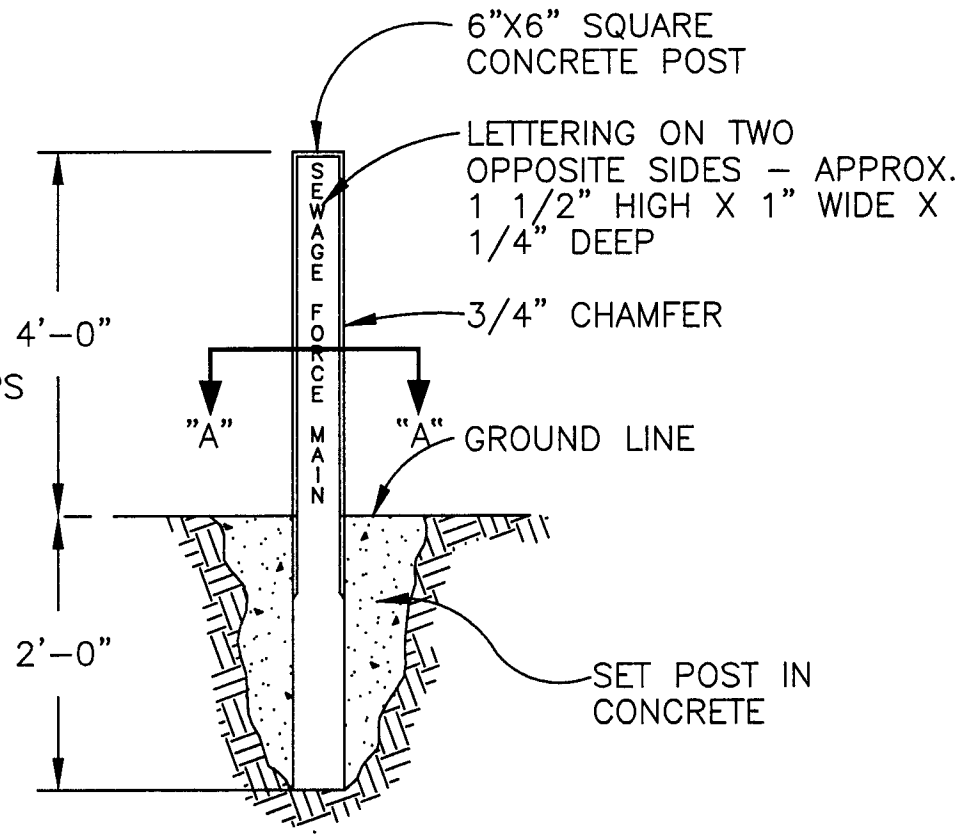
STEEL POST AND LINE MARKER

1/1/09

STANDARD SANITARY SEWER DRAWING NO. PS408-0



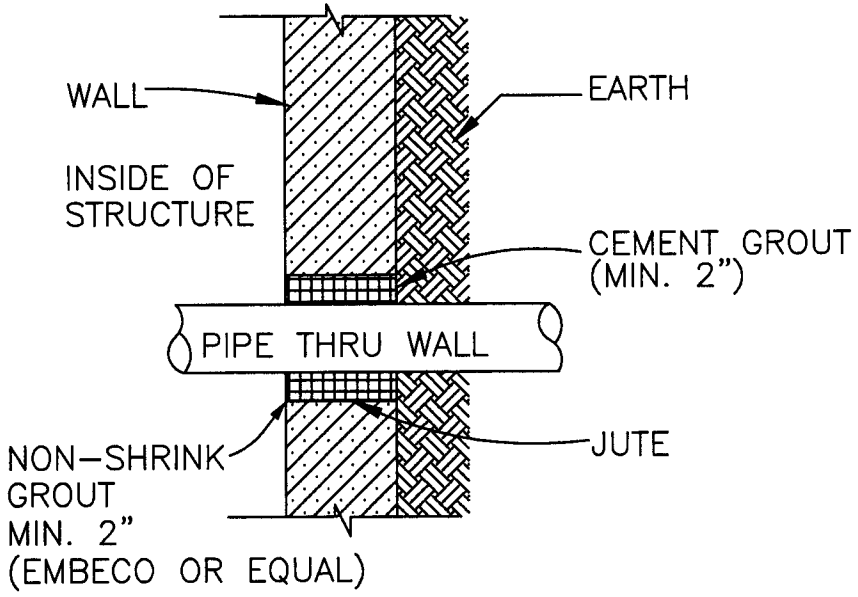
SECTION "A"

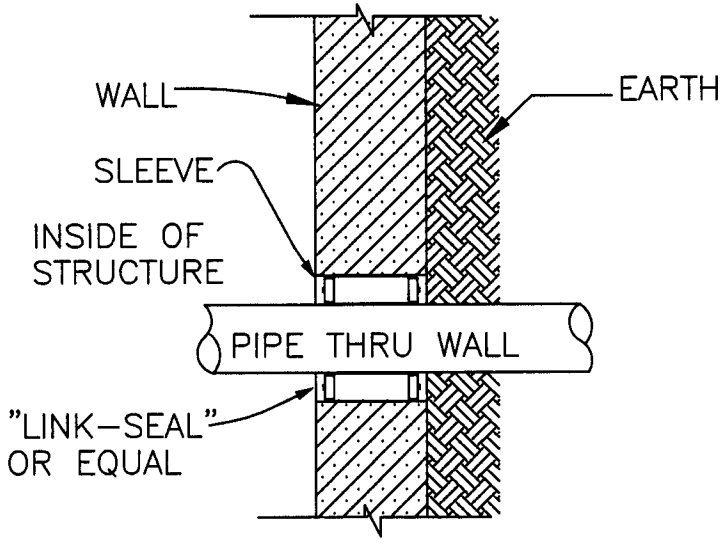


CONCRETE LINE MARKER

1/1/09

STANDARD SANITARY SEWER DRAWING NO. PS409-0

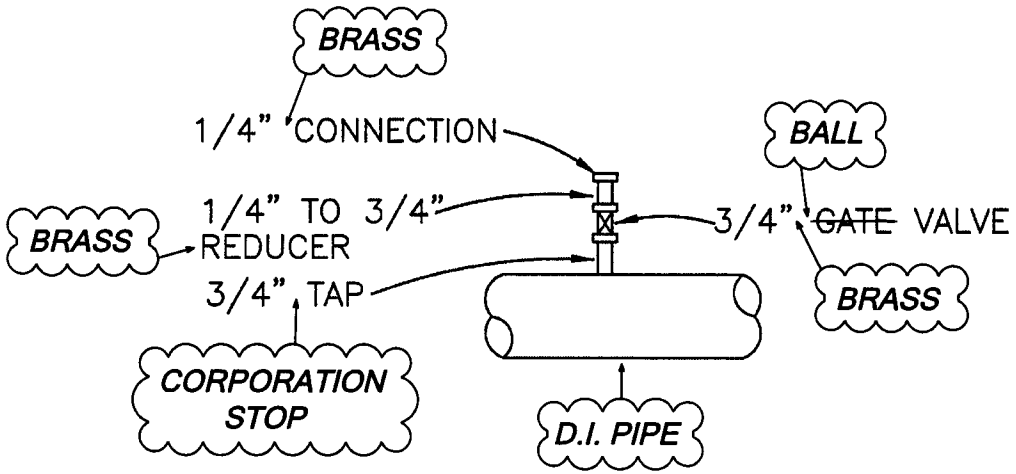




WALL PENETRATION DETAIL

1/1/09

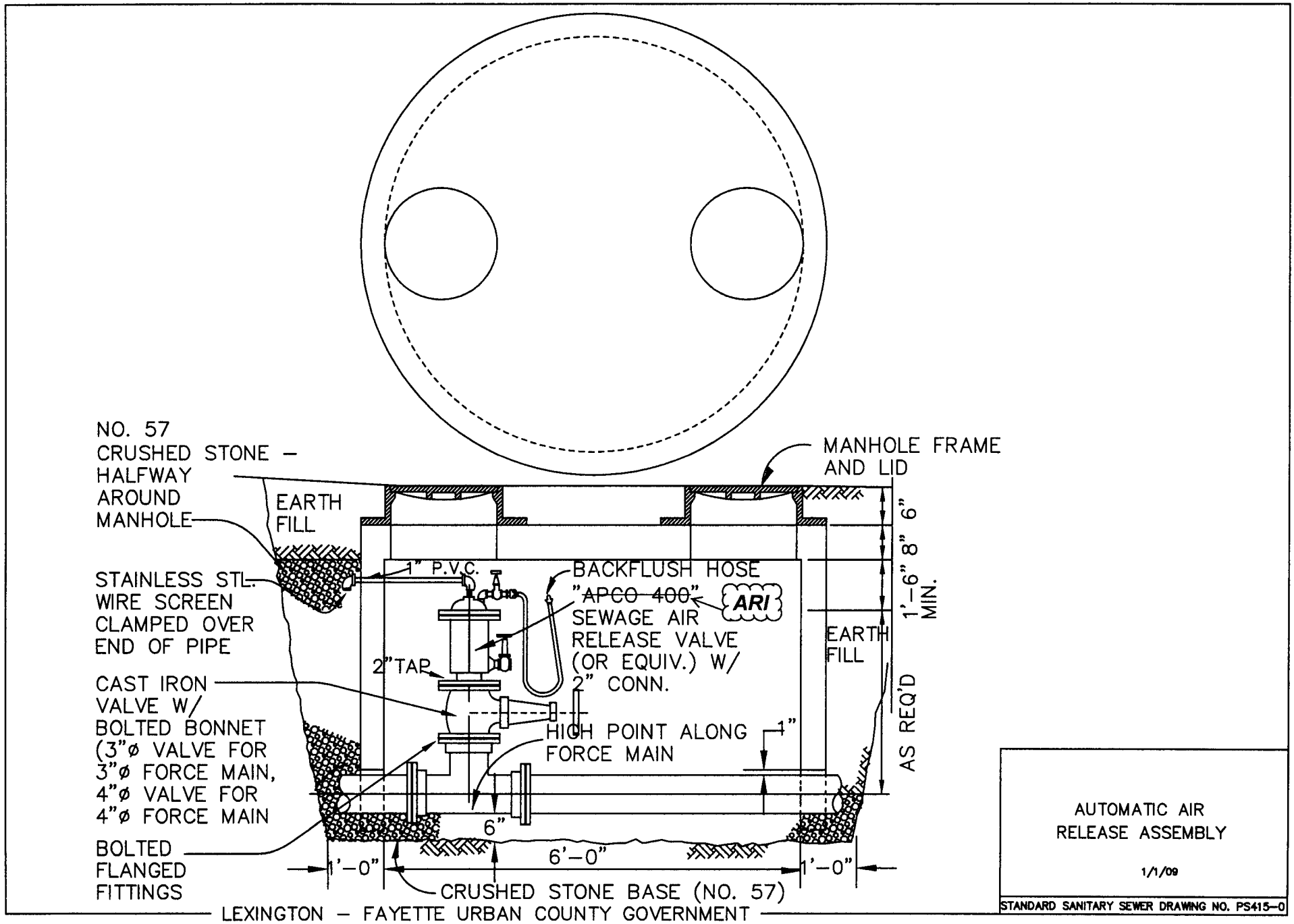
STANDARD SANITARY SEWER DRAWING NO. PS410-0

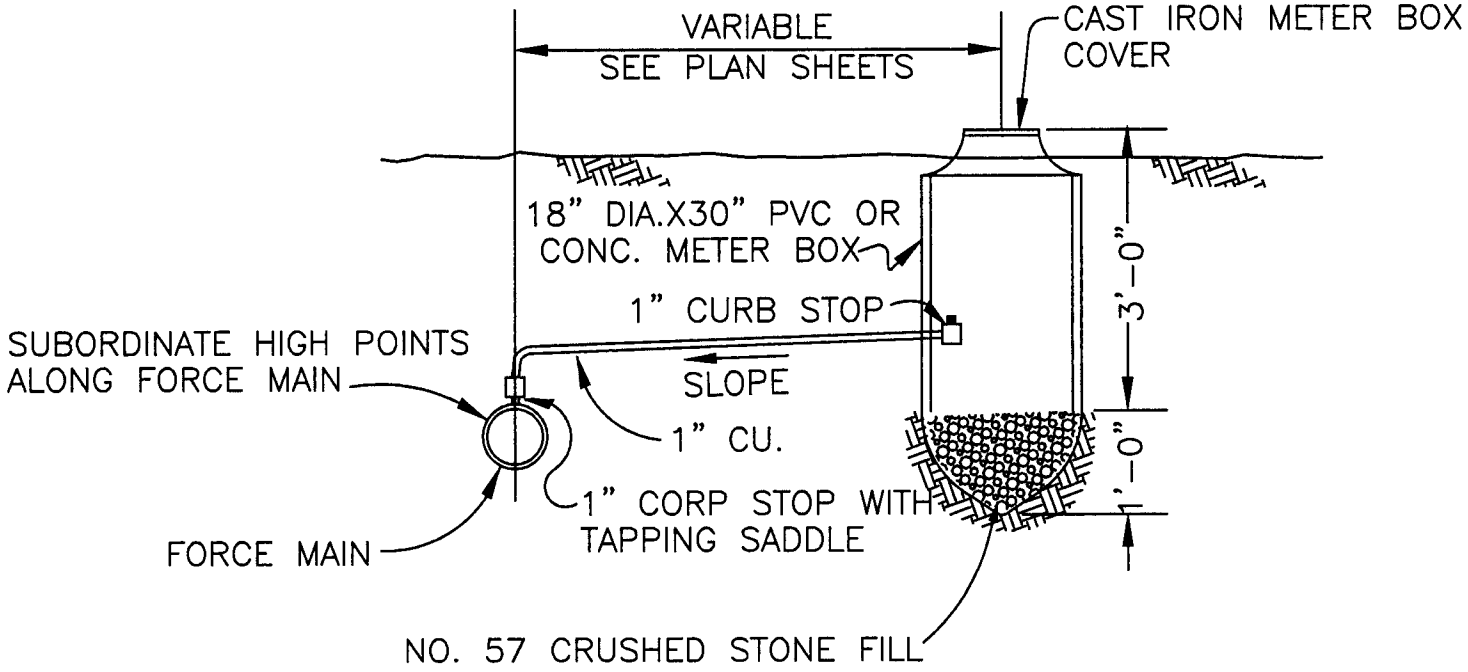


GAUGE TAP DETAIL

1/1/09

STANDARD SANITARY SEWER DRAWING NO. PS411-0

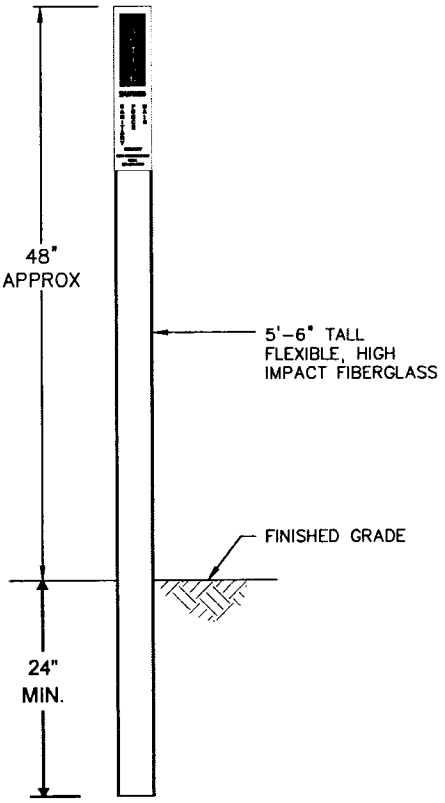

NO. 57
CRUSHED STONE –
HALFWAY
AROUND
MANHOLE
EARTH
FILL
STAINLESS STL.
WIRE SCREEN
CLAMPED OVER
END OF PIPE
CAST IRON
VALVE W/
BOLTED BONNET
(3"ø VALVE FOR
3"ø FORCE MAIN,
4"ø VALVE FOR
4"ø FORCE MAIN
BOLTED
FLANGED
FITTINGS
1" P.V.C.
2"TAP
BACKFLUSH HOSE
"APCO 400"
SEWAGE AIR
RELEASE VALVE
(OR EQUIV.) W/
2" CONN.
ARI
HIGH POINT ALONG
FORCE MAIN
1"
6"
1'–0"
6'–0"
1'–0"
CRUSHED STONE BASE (NO. 57)
MANHOLE FRAME
AND LID
6"
8"
1'–6"
MIN.
AS REQ'D
EARTH
FILL
LEXINGTON – FAYETTE URBAN COUNTY GOVERNMENT
AUTOMATIC AIR
RELEASE ASSEMBLY
1/1/09
STANDARD SANITARY SEWER DRAWING NO. PS415–0

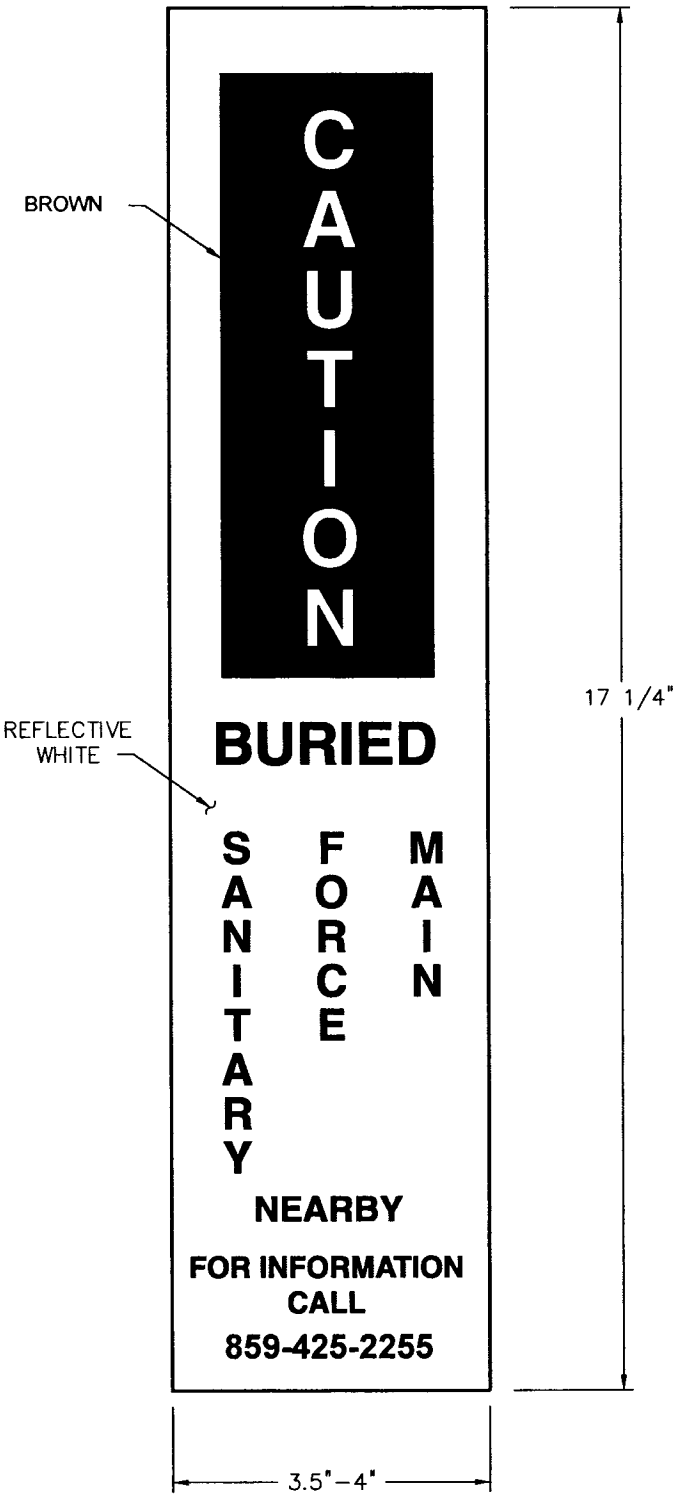


MANUAL AIR RELEASE ASSEMBLY

1/1/09

STANDARD SANITARY SEWER DRAWING NO. PS416--0

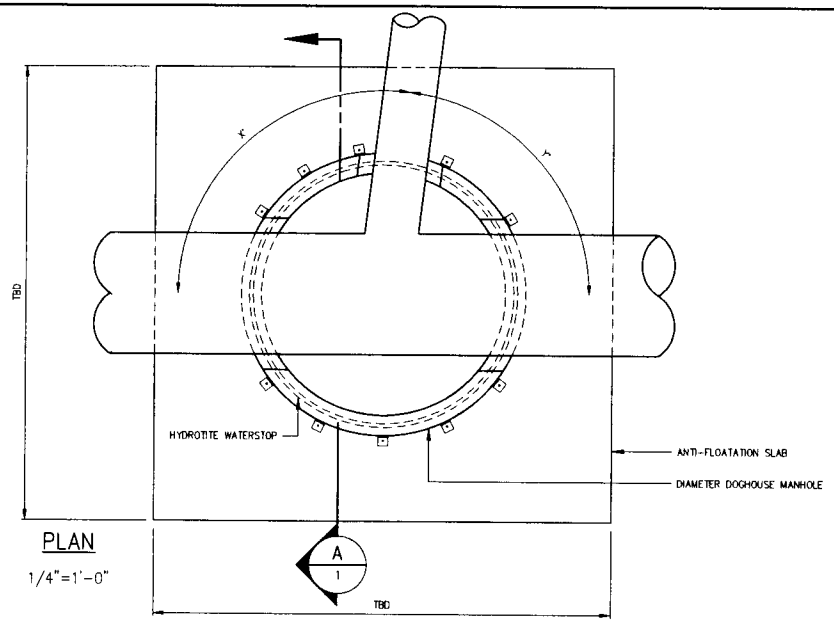




FIBERGLASS FORCE MAIN
LINE MARKER

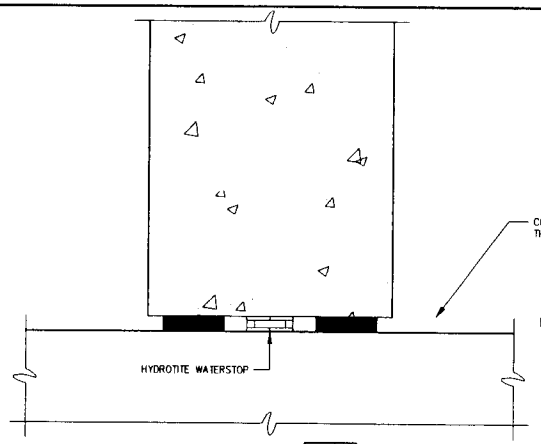
APPENDIX C

Additional Standard Details



PLAN

1/4"=1'-0"

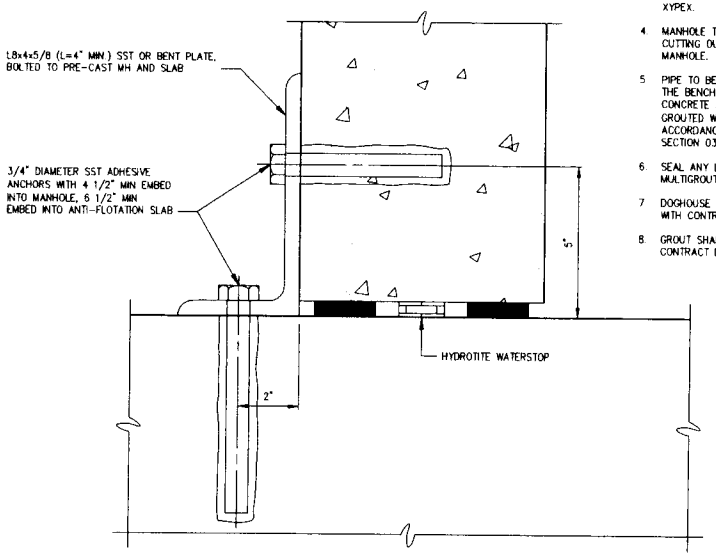


DETAIL 1

3"=1'-0"

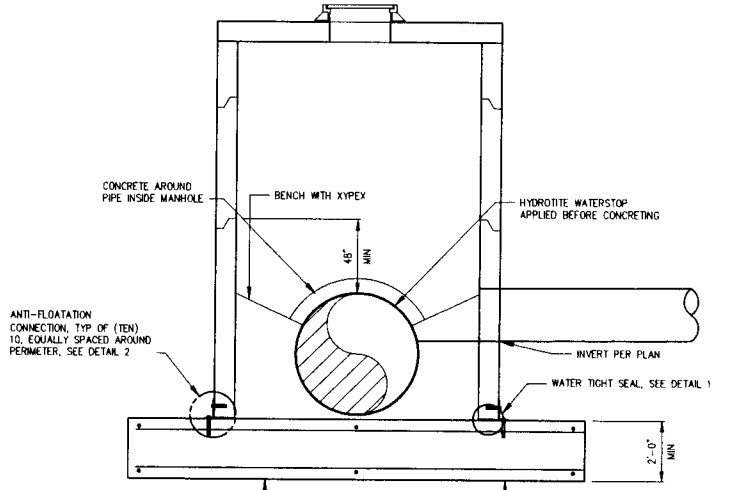
NOTES:

1. DURING CONSTRUCTION OF ANTI-FLOTATION SLAB, CONTRACTOR SHALL SUPPORT THE EXISTING SEWER AT INTERVALS NECESSARY TO MAINTAIN THE EXISTING PIPE ALIGNMENT.
2. ANTI-FLOTATION SLAB TO BE POURED ON FIRM, UNDISTURBED EARTH. IF UNDESIRABLE SOIL CONDITIONS EXIST, A MINIMUM OF SIX (6) INCHES COMPACTED LAYER OF GRAVEL SHALL BE PLACED UNDER THE ANTI-FLOTATION SLAB.
3. ANTI-FLOTATION SLAB CONCRETE SHALL BE IN ACCORDANCE WITH CONTRACT DOCUMENTS SECTION 03300, WITH MINIMUM 3,500 PSI, AND XYPEX.
4. MANHOLE TO BE VACUUM TESTED BEFORE CUTTING OUT THE PIPE ON THE INTERIOR OF THE MANHOLE.
5. PIPE TO BE CUT OUT AND REMOVED TO MATCH THE BENCH INSIDE OF THE MANHOLE. EXPOSED CONCRETE AND REINFORCING STEEL SHALL BE GROUTED WITH 1" OF NON SHRINK GROUT IN ACCORDANCE WITH CONTRACT DOCUMENTS SECTION 03600.
6. SEAL ANY LEAKS WITH AVANTI AV 202 MULTIGROUT.
7. DOGHOUSE MANHOLE SHALL BE IN ACCORDANCE WITH CONTRACT DOCUMENTS SECTION 02608.
8. GROUT SHALL BE IN ACCORDANCE WITH CONTRACT DOCUMENTS SECTION 03600.



DETAIL 2

3"=1'-0"



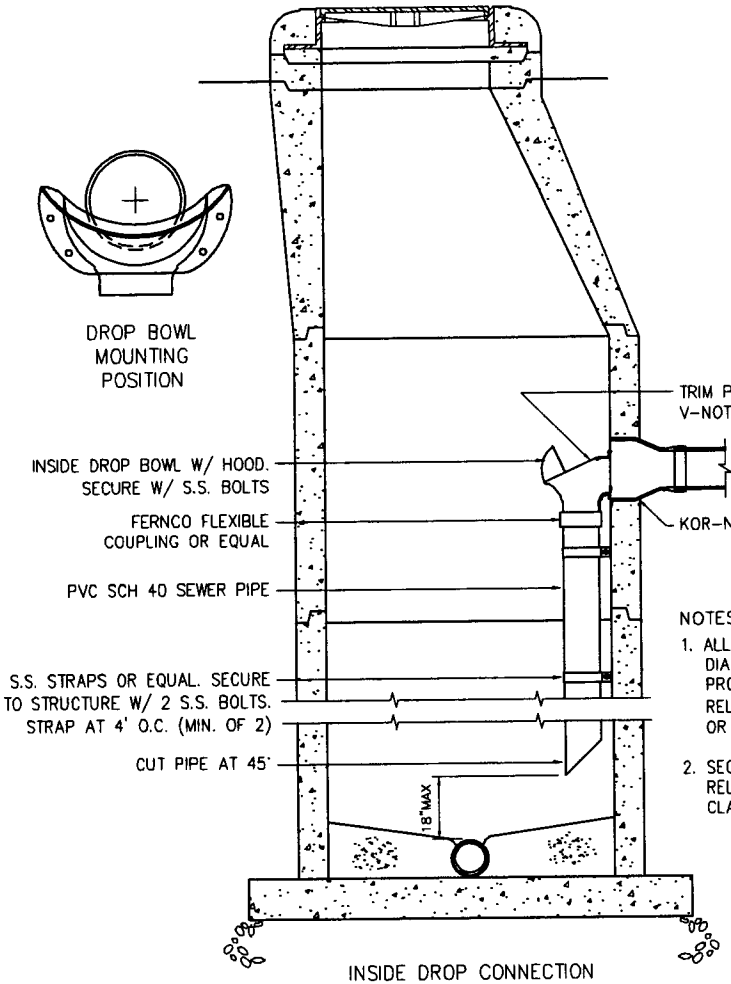
SECTION A/1

1/4"=1'-0"

HAZEN AND SAWYER
Environmental Engineers & Scientists
444 LEWIS HARGETT CIRCLE, SUITE 260
LEXINGTON, KY 40503

LEXINGTON FAYETTE URBAN COUNTY GOVERNMENT

TYPICAL DOGHOUSE MANHOLE FOR INTERCEPTOR PLAN, SECTION AND DETAILS



INSIDE DROP CONNECTION
PIPING 6"ø OR LESS

NOTES:

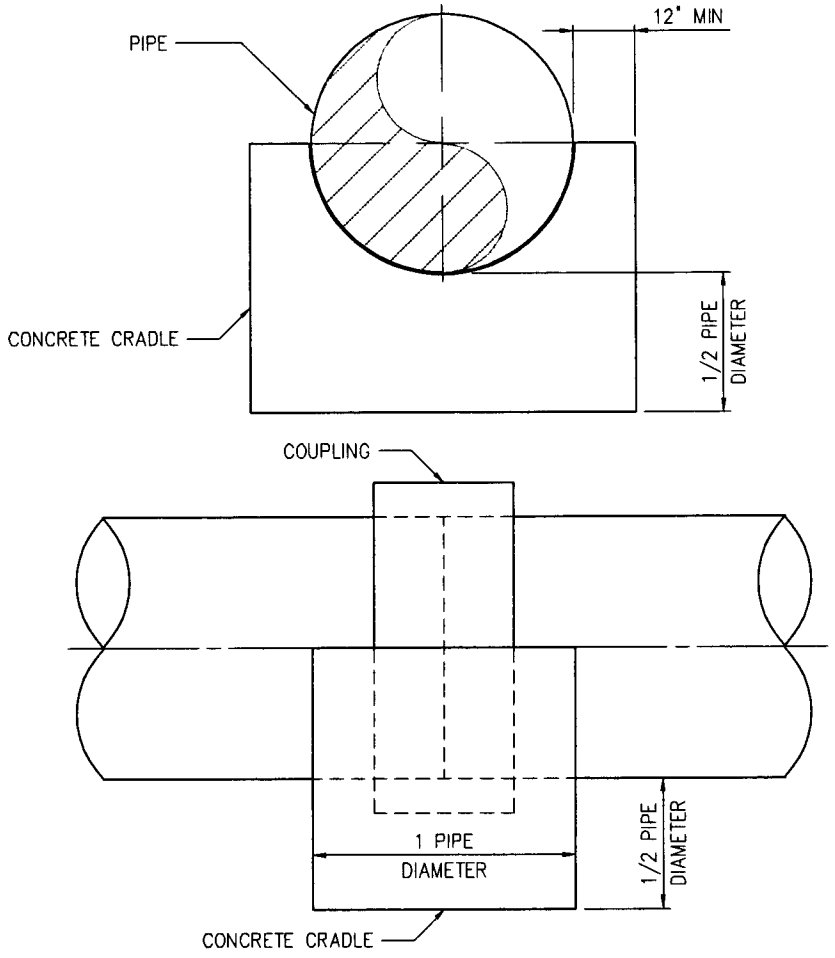
1. ALL INSIDE DROP CONNECTIONS FOR SMALL DIAMETER PIPE SHALL USE THE DROP BOWL AS PRODUCED BY:
   RELINER-DURAN, INC. (800) 434-0277
   OR EQUAL.
2. SECURE DROP PIPE TO MANHOLE WALL WITH RELINER-DURAN, INC STAINLESS STEEL ADJUSTABLE CLAMPING BRACKETS OR EQUAL.

0260109A

HAZEN AND SAWYER
Environmental Engineers & Scientists
444 LEWIS HARGETT CIRCLE, SUITE 260
LEXINGTON, KY 40503

LEXINGTON-FAYETTE URBAN COUNTY GOVERNMENT

INSIDE DROP CONNECTION PIPING



HAZEN AND SAWYER
Environmental Engineers & Scientists
444 LEWIS HARGETT CIRCLE, SUITE 260
LEXINGTON, KY 40503

LEXINGTON–FAYETTE URBAN COUNTY GOVERNMENT

BURIED CRADLE PIPE SUPPORT