and all damage to adjacent facilities or adjoining property occurring from blast cleaning or coating operations.

H. When two or more coats of coating or paint are specified, each coat shall be of a slightly different shade to facilitate inspection of surface coverage of each coat.

I. Specified film thicknesses per coat for the Service Conditions are minimum required. Contractor shall apply additional coats as necessary to achieve the specified thickness.

J. All material shall be applied as specified.

K. All welds and irregular surfaces shall receive a brush coat of the specified product prior to application of the first complete coat.

L. Cleaning and coating shall be coordinated so that dust and other contaminants from the cleaning process will not fall on wet, newly-coated surfaces.

M. Drying time between coats and surface curing shall be as recommended by the coating manufacturer depending upon field conditions of temperature and humidity. Times shall be submitted with the shop drawings based on 70°F and relative humidity of 50%.

N. In the case of enclosed areas, the forced air ventilation system shall operate continuously to provide air circulation and exhausting of solvent vapors.

3.08 Shop Coating

A. All items of equipment, or parts of equipment which are not submerged in service, shall be shop primed and then finish coated in the field, after installation, with the specified or approved color. The methods, materials, application equipment and all other details of shop painting shall comply with these specifications. If the shop primer requires topcoating within a specified period of time, the equipment shall be finish coated in the shop and then touch-up painted after installation.

B. All items of equipment, or parts and surfaces of equipment which are submerged or inside an enclosed hydraulic structure when in service, with the exception of pumps and valves, shall have all surface preparation and coating work performed in the field.

C. For certain pieces of equipment it may be undesirable or impractical to apply finish coatings in the field. Such equipment may include engine generator sets, equipment such as electrical control panels, switchgear or main control boards, submerged parts of pumps, ferrous metal passages in valves, or other items where it is not possible to obtain the specified quality in the field. Such equipment shall be shop primed and finish coated and touched up in the field with the identical material after installation. The Contractor shall require the manufacturer of each such piece of equipment to certify as part of its shop drawings that the surface preparation is in accordance with these specifications. Copies of applicable coating manufacturer's material data sheets shall be submitted with equipment shop drawings.

D. For certain small pieces of equipment the manufacturer may have a standard coating system which is suitable for the intended service conditions. In such cases, the final

determination of suitability will be made during review of the shop drawing submittals. Equipment of this type generally includes only indoor equipment such as instruments, small compressors, and chemical metering pumps.

E. Shop painted surfaces shall be protected during shipment and handling. Primed surfaces shall not be exposed to the weather for more than 6 months before topcoated, or less time if recommended by the coating manufacturer.

F. Damage to shop-applied coatings shall be repaired in accordance with these specifications and the coating manufacturer's printed instructions.

G. The Contractor shall make certain that the shop primers and field topcoats are compatible and meet the requirements of these specifications.

3.09 Protective Coating and Painting Schedule

The protective coating and painting schedule provided herein or on the drawings shall indicate the coating system to be used. The schedule shall not be construed as a complete list of all surfaces to be coated but rather as a guide as to the application of the various coating systems. All surfaces shall be coated and painted except those specifically excluded herein or on the drawings.

3.10 Color Scheme

All colors and shades of colors of all coats of paint and protective coating material shall be as selected by the Owner, except as noted below under "Pipe Color Coating". The Contractor shall submit a current chart of the manufacturer's available colors to the Owner at least forty-five days prior to the start of coating and painting operations.

3.11 Pipe Color Coding and Labeling

All exposed piping shall be color coded and labeled to conform to all OSHA requirements and "Scheme for the Identification of Piping Systems" (ANSI A13.1). "State (10) Standards" color scheme shall be used to further identify specific commodity. As a guideline the following color coding schedule is provided. Color codes shall be confirmed with Owner prior to commencing work.

A. Color Code Schedule

Item	Color Code
Aeration Air	Safety Green
Aftercooler Return	Safety Red
Aftercooler Supply	Safety Red
Air Scour	Safety Green
Alum	Safety Yellow/Red Bands
AWT Bypass	Safety Red
Belt Press Return Water	Gray

A. Color Code Schedule

Item	Color Code
Caustic Soda	Safety Orange
Chemical Drain	Safety Orange
Chlorine Gas	Safety Orange
Chlorine Liquid	Safety Orange
Chlorine Solution	Safety Orange
Chlorine Vacuum	Safety Orange
Cold Sludge	Brown
Digested Sludge	Brown
Digested Sludge Exchange	Brown
Drain	Gray
Engine Cooling Water	Safety Red
Engine Exhaust	Safety Red
Filter Backwash	Safety Red
Filter Backwash Return	Safety Red
Filter Effluent	Safety Red
Filter Influent	Safety Red
Fire Water	Safety Red
Flotation Thickener Overflow	Brown
Flotation Thickener Return	Gray
Foul Air	White
Froth Spray	Safety Red
Fuel Oil	Black
Fuel Oil Return	Black
Fuel Oil Supply	Black
Gravity Thickener Overflow	Brown
Ground Water Drainage	Gray
Grit	Brown
Grit Chamber Influent	Brown
Grit Washer Overflow	Gray
Heat Recovery Return	Safety Blue/Orange Bands
Heat Recovery Supply	Safety Blue/Orange Bands
Heated Sludge	Brown/Yellow Bands
Holding Tank Overflow	Brown
High Pressure Digester Gas	Light Yellow
High Temperature Wash Water	Safety Blue/Orange Bands
Hydrogen Peroxide	Safety Orange
Industrial Water	Safety Red
Influent Force Main	Brown

A. Color Code Schedule

Item	Color Code
Jacket Water Return	Safety Red
Jacket Water Supply	Safety Red
Liquid Propane Gas	Light Yellow
Low Pressure Digester Gas	Light Yellow
Lube Oil Return	Black
Lube Oil Supply	Black
Lube Oil Waste	Black
Methanol	Safety Yellow/Red Bands
Natural Gas	Light Yellow
Plant Air	Safety Green/Yellow Band
Plant Effluent	Safety Red
Polymer	Safety Yellow/Blue Bands
Potable Water	Safety Blue
Primary Influent	Brown
Primary Skimmings	Brown
Primary Sludge	Brown
Pumped Drainage Water	Gray
Raw Influent	Brown
Return Activated Sludge	Brown
Return Water	Safety Red
Sample	Safety Red
Sanitary Drain	Gray
Seal Water	Safety Red
Secondary Effluent	Safety Red
Secondary Skimmings	Brown
Secondary Sludge	Brown
Skimmings	Brown
Sludge Heater Bypass	Brown
Sludge Return	Brown
Sludge Transfer	Brown
Spray Wash	Safety Red
Storm Drain	Gray
Sulfer Dioxide Gas	Safety Orange
Sulfer Dioxide Liquid	Safety Orange
Sulfer Dioxide Solution	Safety Orange
Sulfer Dioxide Vacuum	Safety Orange
Tank Drain	Brown
Tertiary Effluent	Safety Red
Thickened Digested Sludge	Brown

A. Color Code Schedule

Item	Color Code
Thickened Sludge	Brown
Thickened Waste Activated Sludge	Brown
Thickener Dilution Water	Safety Red
Vent	White
Ventilation Air	White
Wash Water	Safety Red
Waste Activated Sludge	Brown
Waste Sludge	Brown

B. Label Coding

Pipe labels (or markers) shall be pressure-sensitive, self-adhesive, vinyl film pipe markers as manufactured by Seton Name Plate Corporation, or equal. Background colors, letter colors, letter heights and spacing shall conform with ANSI A13.1. Pipe designation labels and direction-of-flow arrows shall be placed at 10 foot intervals (maximum) and at every change in direction. Pipe designation wordings shall be selected by the Owner and may not correspond to standard wordings available from the manufacturer.

3.12 Cleanup

Upon completion of the work, all staging, scaffolding, and containers shall be removed from the site or destroyed in a manner approved the Owner. Coating or paint spots and oil or stains upon adjacent surfaces shall be removed and the job site cleaned. All damage to surfaces resulting from the work of these specifications shall be cleaned, repaired or refinished to the satisfaction of the Owner and at no additional cost to the Owner.

END OF SECTION

SECTION 09915
FUSION BONDED EPOXY LININGS AND COATINGS TECHNICAL SPECIFICATIONS

PART 1 - GENERAL

1.01 Description

Where specified on the Drawings or in other Sections of these Specifications, Contractor shall provide piping, fittings, valves, couplings, and appurtenances with fusion bonded epoxy linings and/or coatings. This Section specifies materials, application and testing of one part, fusion bonded, heat cured, thermosetting, 100% solid epoxy linings and coatings on carbon steel, cast iron and ductile iron piping, fittings, valves, clamp-type couplings, transition couplings, and appurtenances.

Fusion bonded epoxy shall not be applied to aluminum, brass, bronze, copper, plastic, rubber, or stainless steel surfaces.

1.02 Submittals

Contractor shall submit shop drawings in accordance with Specification Section 01300, Contractor Submittals Technical Specifications. Contractor shall submit complete information and technical data for all material and components, including, but not limited to, the following:

A. List of all project materials to receive fusion bonded epoxy linings and coatings.

B. Manufacturer's descriptive data, technical literature, and material safety data sheets for all products to be applied. As a minimum, data sheets shall contain the following information:

1. Description of the physical and chemical properties of the epoxy demonstrating compliance with the requirements herein.

2. Description of the application and curing procedure.

3. Description of the shop repair procedures to be used.

C. Coating application test records for measuring coating thickness and holiday detection for each item.

PART 2 - PRODUCTS

2.01 Fusion Bonded Epoxy

Lining and coating shall be a one part, thermosetting, heat curing, fusion bonded, dry powder epoxy resin. Fusion bonded epoxy shall be Scotchkote 134 or 206N, as manufactured by 3M, or equal. Fusion bonded epoxy shall be ANSI/NSF 61 certified, for use with potable water.

2.02 Fusion Bonded Epoxy Requirements

Fusion bonded epoxy shall meet, as a minimum, the following requirements:

A.	Dry Film Thickness:	16 mils (minimum)
B.	Adhesion (Elcometer):	3,000 psi (minimum)
C.	Shear Adhesion (ASTM D1002):	4,300 psi (minimum)
D.	Impact (Gardner 5/8 inch radius tester):	100 in-lbs (minimum)
E.	Hardness (ASTM D2583):	17 Barcol (minimum)
F.	Abrasion Resistance: (ASTM D4060; 1000g wt. / 5000 cycles)	0.115g loss (maximum)
G.	Penetration (ASTM G17):	0 % (maximum)
H.	Electric Strength (ASTM D149):	1000 Volts/mil (minimum)
I.	Cathodic Disbondment: (ASTM G8; 30 day, 5 volt, 5% NaCl)	24 mm dia. (maximum)

PART 3 - EXECUTION

3.01 Surface Preparation

A. Grind welds, sharp edges, and surface irregularities, including, but not limited to, weld splatter, slivers, scales, burrs, and gouges to create a smooth surface for application. Welds and sharp edges shall be ground to approximately 1/8 inch radius.

B. Remove oil and grease in accordance with SSPC-SP1 from surfaces all surfaces to be epoxy lined or coated with an inorganic solvent such as methyl ethyl ketone or toluene. The use of paraffin solvents, such as gasoline or kerosene, is not permitted. There shall not be any residue remaining on the surface from the cleaning solvents. If required, uniformly heat the part to remove excess oil, grease, or moisture.

C. Surfaces shall be abrasive blast cleaned to NACE No. 2/SSPC-SP10 near-white metal finish. Blasted surfaces shall have a minimum 2 mil anchor pattern. Standards for comparison shall be made available by the Contractor. After abrasive blasting surfaces, remove any residual grit and dust by air blasting.

D. Apply high temperature masking tapes, liquid release agents, or silicone plugs for threaded holes, as required and as approved by epoxy manufacturer, to protect areas of the parts not required to be epoxy lined and coated.

3.02 Application

A. Powder shall be applied to parts by means of a fluid bed, flock spray, or electrostatic spray.

B. Powder shall be applied to parts as soon as possible after surface preparation is complete to prevent the formation of rust blooms. If rust blooms form, the parts shall be re-blasted in accordance with Part 3.01 Surface Preparation, herein.

C. Parts to be epoxy lined and coated shall be preheated per manufacturer's printed instructions for the furnished epoxy material. Parts shall be heated uniformly. Heat shall not vary more than 10°F in any part of the oven.

D. Epoxy powder shall be applied in strict accordance with the coating manufacturer's printed instructions for the furnished epoxy material.

E. Epoxy powder shall be applied within specified gel time and before the parts cool to below the melting point temperature of the epoxy powder.

F. Applying a second coat of epoxy over a fully cured coat of epoxy shall not be permitted.

G. Fusion bonded epoxy lining and coating finished uniform dry thickness shall be 16 mils (minimum).

H. Fusion bonded epoxy shall be cured in accordance with manufacturer's printed instructions for furnished epoxy material. Post bake fusion bonded epoxy lined and coated parts as required to complete curing process.

3.03 Quality

Fusion bonded epoxy lining and coating finished surfaces shall be smooth and consistent, free of a granular finish, pinholes, blisters, cracks, bubbles, voids, mechanical damage, discontinuities, holidays, or any other imperfections.

3.04 Testing

A. Fusion bonded epoxy lined and coated parts shall be visually and electrically inspected for flaws and damages. Electrical inspection shall consist of a low-voltage wet sponge holiday detector.

B. Fusion bonded epoxy lined and coated parts shall be tested for thickness electrically by means of an Eddy Current Gauge or magnetically by means of a Magnetic Flux Gauge.

C. Surface preparation (sandblast) and coating application shall be inspected by an independent third party NACE licensed coating inspector. All costs for third party inspection shall be paid by the Contractor. Thickness and holiday testing shall be performed as well as required corrective work. Certified inspection test reports shall be submitted to the Owner for approval a minimum of two weeks prior to shipment of the materials to the jobsite. Owner shall be able to communicate directly with the coating inspector.

D. Precautions shall be taken during shipping and handling to protect linings and coatings.

3.05 Repairs

A. All defects shall be repaired with manufacturer approved repair materials and procedures to match furnished epoxy material.

B. Unless specified otherwise, fusion bonded epoxy lined and/or coated piping damaged in the field by cutting or welding, shall be returned to the coating applicator for shop repair with fusion bonded epoxy material.

END OF SECTION

SECTION 11005
GENERAL MECHANICAL AND EQUIPMENT TECHNICAL SPECIFICATIONS

PART 1 - GENERAL

1.01 Description

A. These General Mechanical and Equipment Specifications, which apply to all systems and equipment unless specified otherwise in the equipment Technical Specifications or on the Drawings, are hereby made a part of each and all of the separate Sections of this Specification. Contractor shall direct the attention of all subcontractors and suppliers of mechanical and related appurtenances to the provisions of the Contract Documents and this Section.

B. The Contractor shall provide all tools, supplies, materials, equipment, and all labor necessary for the furnishing, construction, installation, testing, and operation of all equipment and appurtenant work, complete and operable, all in accordance with the requirements of the Contract Documents.

1.02 Submittals

A. Shop Drawings

The Contractor shall furnish complete shop drawings for all equipment specified in the various Sections of the specifications and the Construction Drawings, together with all piping, valves, and controls for review by the Owner in accordance with Specification Section 01300.

B. Lateral Design Data

Submit with the shop drawings, details of constructions, and method of attachment for all manufactured products showing compliance with Paragraph 3.04, "Lateral Design and Restraint". Where specified in the Special Requirements, Special Construction Provisions, or Technical Specifications for certain equipment, calculations and details signed by a Professional Engineer who has demonstrated proficiency in Structural Engineering or Civil Engineering and is registered in the State of California shall be submitted. The calculations shall be performed specifically for this project, during the time frame of the project and be dated by the Engineer performing them.

C. Tools

The Contractor shall supply one complete set of special wrenches or other special tools necessary for the assembly, adjustment, and dismantling of the equipment. All tools shall be of best quality hardened steel forgings with bright, finished heads and with work faces dressed to fit nuts. The set of tools shall be neatly mounted in a labeled tool box of suitable design provided with a hinged cover.

D. Operation and Maintenance Manuals

Prepare and submit manuals covering all mechanical equipment and machinery and its electrical components in accordance with Contractor Submittals Technical Specifications.

E. Manufacturer's Certified Reports

Each equipment manufacturer, or his authorized representative, shall submit a written report stating that equipment is ready for start-up and interim operation, and a subsequent written report certifying that the equipment has been properly installed, lubricated, aligned, started-up, tested, adjusted, and operated over the equipment range (full to minimum load, speed, range); the equipment is free from any undue stress imposed by connecting piping or anchor bolts, and is ready for operation by the Owner; equipment is safe to operate and that the equipment is fully covered under the terms of the guarantee. Note that interim operation of equipment may be necessary to provide required treatment or suitable plant operation.

F. Contractor's Certification Reports

Contractor shall submit a written certification along with the manufacturer's certification for start-up and interim operation that he has examined subject equipment and confirms that it is ready for start-up and interim operation and is safe to operate.

Contractor shall submit written certification for relocated, modified, temporarily installed Owner's equipment or Contractor furnished equipment that has been installed for interim operation by the Owner stating that said equipment has been started-up, is ready for operation and is safe to operate.

G. Lifting Recommendations

Each manufacturer shall provide details for proper lifting of equipment and materials during unloading, handling, and installation. Means of lifting equipment shall not impose any undue stress to the equipment. Contractor shall strictly adhere to said manufacturers recommendations.

H. Storage Requirements

Each manufacturer shall provide details and storage of equipment and materials for protection under the specific conditions of the project site, such as rain, snow, freezing, windy, wind blown sand, high temperatures, direct sunlight, etc.

1.03 Quality

A. Factory Inspection

The Owner or its representative may inspect fabricated equipment at the factory without cost to Contractor. The Contractor shall notify the Owner in sufficient time so that factory inspection can be arranged. Factory inspection will be made after manufacturer has performed satisfactory checks, adjustments, tests and operations. Approval of

equipment at the factory only allows the manufacturer to ship the equipment to the site, and does not constitute final acceptance by the Owner.

B. Standard of Quality

Items of equipment are specified by performance and by name of a manufacturer for the purpose of establishing a standard of quality and acceptable experience. Where "or equal" or "approved equal" is specified Substitute equipment will be acceptable if it can be demonstrated to the Owner that the substitute is in strict accordance with the Specifications and equal in quality to those models specifically named. Substitutions shall be submitted in accordance with Contractor Submittals Technical Specifications. Manufacturers specified have been determined by the Owner to meet or exceed the minimum acceptable standard for the designated equipment; however, manufacturer's standard model may require optional equipment, upgrade or modification to meet the intent and requirements of the specifications. All mechanical equipment furnished under this Specification shall be new and of current design.

C. Manufacturer's Experience

Unless specifically named in the detailed Specifications, a manufacturer shall have furnished equipment of the type and size specified which has demonstrated successful operation and is in regular use.

D. Field Inspection, Start-up, and Adjustment

The Contractor shall demonstrate that all equipment meets the specified performance requirements. Contractor shall provide the services of an experienced, competent, and authorized service representative of the manufacturer of each item of major equipment who shall visit the site of Work to perform the following tasks:

1. Assist the Contractor in the installation of the equipment.

2. To inspect, check, adjust if necessary and approve the equipment installation.

3. To start-up and field-test the equipment for proper operation, efficiency, and capacity and to assure that equipment is ready and safe to operate.

4. To perform necessary field adjustment during the test period until the equipment installation and operation are satisfactory to the Owner.

5. To instruct the Owner's personnel in the operation and maintenance of the equipment. Instruction shall include step-by-step trouble shooting procedures with all necessary test equipment.

E. Costs

The costs of all inspection, start-up, testing, adjustment, and instruction work performed by said factory-trained representatives shall be borne by the Contractor. When available, the Owner's operating personnel will provide assistance in the field testing.

1.04 Equipment

A. General

All equipment furnished shall be complete, ready for installation and operation. All bolts, nuts, washers, mounting plates, bed plates, bases, anchor bolts and other miscellaneous items necessary to form a complete, installed, operational system shall be furnished whether specifically specified or not.

B. Conditions of Service

All equipment shall be capable of operating over the full range specified under the project site environmental conditions including altitude, temperature, relative humidity, freezing, or windy condition as shown on the Drawings or specified in the Special Requirements.

C. Adaptation of Equipment

No responsibility for alteration of a planned structure to accommodate substitute equipment will be assumed by the Owner. Equipment which requires alteration of the structures will be considered only if the Contractor assumes all responsibility for making and coordinating all necessary alterations. All revisions to structures, mechanical, electrical, or other work made necessary by such substitution shall be approved by the Owner and the cost of said revisions, including cost of redesign, shall be made at the Contractor's expense.

D. Motors

Ratings specified and/or shown for the proposed equipment are in accordance with the best information available to the Owner. In the event any equipment item proposed by the Contractor should require motors with larger horsepower rating than indicated on Electrical Drawings, it shall be the Contractor's responsibility to provide the proper control equipment, required modifications to motor control centers, starting equipment, feeder and branch circuits, and accessories as required to make the installation comply with the electrical code and to prevent excessive voltage drop without added cost to the Owner.

E. Match Equipment and Driver

Equipment shall be matched such that the motor rating meets or exceeds the driven equipment requirements (over its full operating range) and the motor controller, switchgear, variable speed drive, etc. meets or exceeds the motor requirements. Where the motor controller or variable speed drive will induce additional heat or otherwise cause derating of the motor, the motor shall be oversized accordingly.

F. Existing Equipment

Where equipment to be furnished is installed in an existing enclosure or adjacent to existing equipment, the Contractor shall field check the dimensions of existing

equipment, location of conduits, etc., and shall familiarize himself with all existing conditions and difficulties to be encountered in performing such work.

1.05 Guarantee and Warranties

The Contractor shall guarantee all equipment in accordance with the conditions of the Contract Documents and as specified in the Contract Appendix or Special Requirements. In addition to the general guarantee requirements, equipment guarantee shall cover faulty or inadequate design; improper assembly or erection; defective workmanship or materials; and leakage, breakage, or other failure. For equipment bearing a manufacturer's warranty in excess of one (1) year, furnish a copy of the warranty to Owner with Owner named as beneficiary.

PART 2 - PRODUCTS

2.01 General Requirements

A. Materials and Workmanship

All equipment furnished shall be new and guaranteed free from defects in materials, design, and workmanship. It shall be the manufacturer's responsibility to ascertain the conditions and service under which the equipment will operate and to warrant that operation under those conditions shall be successful. All parts of the equipment shall be amply proportioned for all stresses that may occur during fabrication, erection, and intermittent or continuous operation.

B. Standards

All equipment shall be designed, fabricated, and assembled in accordance with the best modern engineering and shop practice. Individual parts shall be manufactured to standard sizes and gages so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests. Materials shall be suitable for service conditions. Iron castings shall be tough, close-grained gray iron free from blowholes, flaws, or excessive shrinkage and shall conform to ASTM A48. Except where otherwise specified, structural and miscellaneous fabricated steel used in items of equipment shall conform to the Standards of the American Institute of Steel Construction. All structural members shall be considered as subject to shock or vibratory loads. Unless otherwise specified, all steel which will be submerged, all or in part, during normal operation of the equipment shall have a minimum nominal thickness of 1/4-inch. Provide equipment and materials suitable for the service conditions and meeting standard specifications such as ANSI, ASME, AWWA, ASTM, NEMA, CBC and UL. The location of the fabricator and his shop schedule shall be furnished to the Owner prior to the beginning of fabrication so that the Owner can schedule shop inspection.

C. Structural Steel Fabrications

Conform to "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings" of the AISC unless otherwise indicated or specified. Design all fabrications for dynamic

and vibratory loadings. Use structural steel shapes conforming to ASTM A36, A440, A500, A501, A570, A618, or equal, as applicable. Galvanize specified items in accordance with ASTM A123, A153, or A386 as applicable; use galvanized bolts and fasteners with galvanized assemblies.

D. Welding

Unless otherwise specified or shown, all welding shall conform to the following:

1. All welding shall be by the metal-arc method or gas-shielded arc method as described in the American Welding Society's "Welding Handbook" as supplemented by other pertinent standards of the AWS. Except as modified herein, welding process qualification and operator qualification shall comply with the applicable requirements of the "Code for Arc and Gas Welding in Building Construction" of the AWS.

2. Latest revision of ANSI/AWWA D100 and AWWA C206.

3. Each weld shall be uniform in width and size throughout its entire length. Each layer shall be smooth, free from slag, cracks, pinholes, and undercut and shall be completely fused to adjacent weld beads and base metal. Cover pass shall be completely free of coarse ripples, irregular surfaces, non-uniform bead pattern, high crown, deep ridges or valleys between beads, and shall blend smoothly and gradually into surface of base metal. Butt welds shall be slightly convex, of uniform height, and shall have full penetration. Fillet welds shall be of size indicated, with full throat, and with each leg of equal length. Repair, chipping, or grinding of welds shall not gouge, groove, or reduce base metal thickness.

4. All composite fabricated steel assemblies which are to be erected or installed inside a hydraulic structure, including any fixed or movable structural components of mechanical equipment, shall have continuous seal welds to prevent entrance of air or moisture.

5. In assembly and during welding, the component parts shall be adequately clamped, supported, and restrained to minimize distortion and for control of dimensions. Weld reinforcement shall be as specified by the AWS code. Upon completion of welding, all weld splatter, flux, slag, and burrs left by attachments shall be removed. Welds shall be repaired to produce a workmanlike appearance, with uniform weld contours and dimensions. All sharp corners of material to be painted or coated shall be ground to a minimum of 1/32-inch on the flat.

E. Protective Coatings

All equipment shall be painted or coated in accordance with Basic Coating and Painting Specifications for Water and Wastewater Facilities.

F. Protection of Equipment

All equipment including valves shall be boxed, crated, or otherwise protected from damage and moisture during shipment, handling, and storage. All equipment shall be protected from exposure to corrosive fumes and shall be kept thoroughly dry at all times. Pumps, motors, drives, or electrical equipment, and other equipment having anti-friction or sleeve bearings shall be stored in weather tight storage facilities prior to installation. For extended storage periods, plastic equipment wrappers should be avoided, to prevent accumulation of condensate in gears and bearings.

G. Electrical Equipment

Maintain electrical equipment, controls, and keep insulation dry at all times. Keep heaters in equipment connected and operating until equipment is placed in operation.

2.02 Lubrication

A. Lubrication Systems

Lubrication of equipment shall ensure constant presence of lubricant on all wearing surfaces. Lubricant fill and drain openings shall be readily accessible. Easy means for checking the lubricant level shall be provided. Prior to testing and/or operation, the equipment shall receive the prescribed amount and type of lubricant as required by the equipment manufacturer. Equipment lubrication systems shall be systems that require attention no more often than weekly during continuous operation, shall not require attention during start-up or shut down, and shall not waste lubricants.

B. Lubrication

Contractor shall have all moving parts of the furnished equipment lubricated prior to shipment to insure protection against corrosion during shipment, storage, and installation. Lubricants furnished by Contractor shall conform to the manufacturer's printed recommendations. Safeguard(s) shall be provided where necessary to prevent operation of the equipment without proper lubrication.

Contractor shall provide Alemite lubrication fittings at all locations on the equipment which require grease lubrication. All lubrication fittings shall be readily accessible. The grease passages and ports shall be designed so that grease is forced into the normally loaded sides of the bearings.

Contractor shall lubricate all equipment prior to start-up.

Contractor shall furnish grease lubricants for testing and initial lubrication, and for protection of wearing surfaces of equipment he furnishes during shipment and storage. Where lubricants can come in contact with potable water, the lubricant shall not have any toxic or deleterious effect on potable water and shall be of material approved by the FDA in accordance with Federal Regulation No. 121.253, Category AA.

Contractor shall furnish one year's supply of lubrication oils, grease, and other necessary lubricants including applicators and grease guns required for lubrication. All lubricants

shall be as specified by the equipment manufacturer. Contractor shall limit the various types of materials by consolidating, with the equipment manufacturer's approval, the required lubricants into the least number of different lubricants. Contractor shall coordinate with Owner to match, where possible, lubricants normally used by Owner.

2.03 Equipment Supports

A. Equipment Bases and Bedplates

Mount equipment assemblies on a single heavy cast iron or welded steel bedplate unless otherwise shown or specified. Provide bases and bedplates with machined support pads, tapered dowels for alignment or mating of adjacent items, adequate openings to facilitate grouting, and openings for electrical conduits. Continuously weld seams and contact edges between steel plates and shapes, and grind welds smooth. Do not support machinery or piping on bedplates other than that which is factory installed. Provide jacking screws in equipment bases and bedplates to aid in leveling prior to grouting. All mechanical equipment, tanks, control cabinets, motor control centers, etc. shall be mounted on raised concrete bases, unless otherwise shown or specified. Provide plates of minimum thickness of 1/4-inch. Pump bedplates shall include a drip lip and associated piping and appurtenances for directing gland leakage to a single disposal point.

B. Anchors and Sleeves

Each equipment manufacturer shall be responsible to design and specify the required anchor equipment including bolts, nuts, washers, and sleeves for securing equipment bases and bedplates to concrete bases. Loads shall be those induced by the equipment and lateral loads as specified herein. Design calculations are specifically required for certain equipment by the Special Requirements or Technical Specifications. Where specified or where specialty anchoring equipment is necessary for the equipment being furnished the anchoring equipment shall be furnished by the manufacturer. Sleeves shall be at least 1-1/2 times anchor bolt diameter. Anchor bolts shall be as specified on Drawings or, if not specified, shall be Type 316 stainless steel and of adequate length to allow for 1-1/2 inch of grout under baseplates and adequate anchorage into structural concrete unless otherwise shown or specified.

2.04 Couplings

A. Flexible couplings shall be provided between the driver and the driven equipment to accommodate angular misalignment, parallel misalignment, end float, and to cushion shock loads.

B. The Contractor shall have the equipment manufacturer select or recommend the size and type of coupling required to suit each specific application.

C. Taperlock bushings may be used to provide for easy installation and removal on shafts of various diameters.

D. Where universal type couplings are shown they shall be of the needle bearing type construction, equipped with commercial type grease fittings.

2.05 Shafting

A. General

All shafting shall be continuous between bearings and shall be sized to transmit the maximum power output of the driver. Keyways shall be accurately cut in line. Shafting shall not be turned down at the ends to accommodate bearings or sprockets whose bore is less than the diameter of the shaft. All shafts shall rotate in the end bearings and shall be turned and polished, straight, and true.

B. Materials

Shafting materials shall be appropriate for the type of service and torque transmitted. Environmental elements such as corrosive gases, moisture, and fluids shall be taken into consideration. Materials shall be as shown or specified unless furnished as part of an equipment assembly.

2.06 Bearings

A. General

Bearings shall conform to the standards of the Anti-Friction Bearing Manufacturers Association, Inc. (AFBMA). Bearings shall be as specified by the specific equipment specification and as generally specified herein.

Bearing application, fitting practice, mounting, lubrication, sealing, static rating, housing strength, and other important factors shall be considered in bearing selection.

All re-lubricatable type bearings shall be equipped with a hydraulic grease fitting in an accessible location and shall have sufficient grease capacity in the bearing chamber. All lubricated-for-life bearings shall be factory-lubricated with the manufacturer's recommended grease to insure maximum bearing life and best performance.

Bearing housings shall be of cast iron or steel and bearing mounting arrangement shall be as specified or shown, or as recommended in the published standards of the manufacturer. Split-type housings may be used to facilitate installation, inspection and disassembly.

Sleeve-type bearings shall have a Babbit or bronze liner.

B. Bearing Life

Except where otherwise specified or shown, all bearings shall have an L-10 minimum rated life expectancy corresponding to the type of service, as follows:

Type of Service	Design Life (years) (whichever comes first)	L-10 Design Life (hours) (whichever comes first)
1.	16-hour shift	10	40,000
2.	Continuous	10	60,000

2.07 Gears and Gear Drives

A. Unless otherwise specified, gears shall be machine cut, of the helical or spiral-bevel type, designed and manufactured in accordance with AGMA Standards, with a minimum service factor of 1.7, a minimum L-10 bearing life of 60,000 hours and a minimum efficiency of 94 percent. Worm gears shall not be used, unless specifically approved by the Owner.

B. All gear speed reducers or increasers shall be of the enclosed type, oil- or grease-lubricated and fully sealed, self-cooling, with a breather to allow air to escape but keep dust and dirt out. The casing shall be of cast iron or heavy duty steel construction with lifting lugs and an inspection cover for each gear train. An oil level sight glass and an oil flow indicator shall be provided, arranged for easy reading.

Where the Contractor elects to furnish equipment requiring external cooling by water or radiator he shall be responsible to furnish and install the cooling facilities necessary for proper operation.

C. Gears and gear drives as part of an equipment assembly shall be shipped fully assembled for field installation.

D. Material selections shall be left to the discretion of the manufacturer, provided the above AGMA values are met. Input and output shafts shall be adequately designed for the service and load requirements. Gears shall be computer-matched for minimum tolerance variation. The output shaft shall have 2 positive seals to prevent oil leakage.

E. Oil level and drain location relative to the mounting arrangement shall be easily accessible. Oil coolers or heat exchangers with all required appurtenances shall be furnished when necessary.

F. Where gear drive input or output shafts have to connect to couplings or sprockets supplied by others, the Contractor shall have the gear drive manufacturer supply matching key taped to the shaft for shipment.

2.08 Safety Guards

All equipment furnished by Contractor shall comply with the applicable requirements of the Safety Orders of the Division of Industrial Safety of the State of California. Copies of the Safety

Orders as available at the Printing Division, Documents Section, State of California, Sacramento, California, 95814.

Cover belt or chain drives, fan blades, couplings, exposed shafts, other moving or rotating parts and hot surfaces (exhaust pipes) on all sides with safety guards. Safety guards shall be free of all sharp edges and corners. Use corrosion-resistant materials at least equivalent to hot-dip galvanized steel. Safety guards shall be fabricated from 16 USS gage, or heavier, galvanized or aluminum-clad steel or 1/2-inch mesh galvanized expanded metal. Design guards for easy installation and removal. Provide necessary supports, accessories, and fasteners, of hot-dip galvanized steel or stainless steel. Design guards in outdoor locations to prevent entrance of rain and dripping water.

2.09 Manufacturer's Nameplates

Manufacturer shall provide Type 316 stainless steel nameplates of ample size with embossed or preprinted lettering, fastened to the equipment in a prominent place with 316 S.S. pins. On nameplates, display manufacturer, serial number, date of manufacture, model number and essential operating characteristics. Inscribe data plates with specific or directed information.

2.10 Equipment Identification Nameplates

In addition to manufacturer's nameplates specified in equipment Technical Specifications and herein, Contractor shall provide project specific equipment identification nameplates. Equipment mounted out-of-doors shall be furnished with nameplates constructed of Type 316 stainless steel with 3/8" high embossed lettering and shall be fastened to the equipment in a prominent place with 316 stainless steel pins.

Equipment mounted indoors shall be furnished with nameplates constructed of laminated engraving plastic. Nameplates shall be fastened to the equipment in a prominent place with 316 stainless steel pins. Colors, lettering, styles, and sizes shall be as selected by Owner.

Nameplates shall display the project specific identification of each equipment item. Proposed nameplate wording shall be submitted to Owner for approval.

PART 3 - EXECUTION

3.01 Coordination

Contractor shall coordinate the installation of equipment and assure compliance with Drawings. Said Drawings show in a diagrammatic form the arrangements desired for the principle apparatus, piping, and similar appurtenances, and shall be followed as closely as possible. Contractor shall take all measurements for his Work at the installation sites, verify all subcontractor and equipment drawings and be responsible for the proper installation. Specific equipment furnished may require certain modifications for installation. Contractor shall have all pertinent equipment shop drawings submitted and accepted by Owner prior to performing work impacted by said equipment.

Contractor shall coordinate, monitor, schedule the fabrication, and verify compliance with Contract Documents of equipment assembled of several components under the unit responsibility

of one manufacturer or equipment supplier. Contractor shall submit the following information to the Owner in writing on a monthly basis:

A. Shipment dates of the various components to the unit responsibility manufacturers.

B. Scheduled dates of factory tests by unit responsibility manufacturers.

C. Schedule shipment dates to site of unit responsibility items.

D. Scheduled arrival date, installation date and start-up date.

3.02 Installation

A. Inspection

Contractor shall inspect each item of equipment for damage, defects, completeness, and correct operation before installing and inspect previously installed related Work to verify that it is ready for installation of equipment. Contractor shall inspect the completed installation.

B. Preparation

Prior to installing equipment, Contractor shall ensure that installation areas are clean and that concrete or masonry operations are completed. Contractor shall maintain the areas in a broom-clean condition during installation operations. Equipment shall be cleaned, conditioned, and serviced in accordance with Instruction Manuals and the Contract Documents before installing.

C. Certification

Upon completion of equipment installation certifications from the manufacturer and the Contractor in accordance with Part 1.02 shall be submitted.

D. Equipment Installation

Contractor shall employ skilled craftsmen experienced in installation of the types of equipment specified and use specialized tools and equipment, such as precision machinist levels, dial indicators, gages, and micrometers, as applicable.

E. Anchor Bolts

Equipment shall be attached to concrete base using cast in place anchor bolts. Contractor shall set anchor bolts correctly before structural concrete is placed. Use of templates or setting drawings is required. An acceptable anchorage system is a cast in place sleeve anchor which allows adjustment as manufactured by DECO Manufacturing Co. or equal. Deferred bolting devices shall not be permitted, unless otherwise shown on Drawings.

F. Base and Bedplate Grouting

Prior to placing grout, initial fitting and alignment of connected piping shall be completed. Once equipment is leveled and aligned to the manufacturer's tolerances, base or bedplates can be grouted by filling the entire space between the base or bedplate and concrete foundation. Exposed grout, shall be troweled to a smooth dense finish, edges beveled to 45 degrees and damp cured with burlap for three days. When grout is fully hardened, Contractor shall remove jacking screws and tighten nuts on anchor bolts. Equipment alignment and level shall be checked for conformance with manufacturer's tolerances and corrective work performed as necessary.

3.03 Equipment Shop and Field Performance Testing

A. General

Equipment shall be shop tested and field tested as specified in the specific Technical Specifications.

B. Field Testing

Unless otherwise specified field testing of equipment shall be performed to demonstrate compliance with Contract Documents. Equipment operation, over the entire specified range, shall be free of vibration, noise, or cavitation. Contractor shall furnish test instruments required to confirm performance. Testing shall include the following:

1. Vibration shall be checked and recorded over the operating range and shall be equal to or less than the amplitude limits recommended by the manufacturer or as otherwise specified. As a minimum, pumping units shall meet or exceed the vibration requirements of the Hydraulic Institute Standards.

2. Equipment performance shall be documented by obtaining concurrent readings showing motor voltage and amperage, and equipment output. Readings shall be documented for at least three operating conditions. Each power lead to the motor shall be checked for proper current balance.

3. In the event any equipment fails to meet the performance requirements, it shall be modified and retested.

3.04 Lateral Design and Restraint

All manufactured equipment supplied under this Contract shall be designed, constructed and attached to resist stresses produced by seismic forces and wind forces as specified. Equipment that does not vibrate during normal operation shall be rigidly attached. Equipment that vibrates during normal operation shall be attached by means of isolators with mechanical stops that limit movement in all directions unless it can be demonstrated by calculations that such stops are not required. Equipment or portions of equipment that move during normal operation shall be restrained with mechanical devices that prevent displacement unless it can be demonstrated by calculations that such restraints are not required.

A. Calculations shall be submitted where required by the Special Requirements or Technical Specifications.

B. Minimum Lateral Forces

The minimum lateral seismic and wind forces shall be those prescribed for Essential Facilities by the California Building Code and applicable supplements as published by the California Buildings Standards Commission, 2525 Natomas Park Drive, Suite 130, Sacramento, CA 95833. Higher lateral forces shall be utilized where specified.

C. Contractor shall make submittals of shop drawings, details and data requested herein in accordance with Contractor Submittals, Specification Section 01300.

SECTION 11330
SPECIFIC ELECTRIC MOTOR DRIVEN PUMP SPECIFICATIONS
(THESE SPECIFICATIONS AUGMENT THE
BASIC ELECTRIC AND PUMPING UNIT SPECIFICATIONS)

1. **General**

Equipment furnished will be subject to ambient temperatures from 5°F to 120°F, the latter for extended periods, therefore, all equipment shall be capable of operating with said range. Factory performance test as specified shall be performed.

2. **Pump** (See Basic Pumping Unit Specifications)

a. Performance

Discharge Capacity (gpm)	Bowl Head (Feet)	Minimum Bowl Efficiency	Maximum Brake Horsepower (hp)
0	110' to 115'	N/A	N/A
400	85' to 87'	75%	12
600*	70'	80%	13.5
750	55' to 57'	75%	15

* Design condition.

Preliminary pump selection is based on the following pump manufacturer models:

Manufacturer	Model No.	No. of Stages
Flowserve	10EGY/10EMM	2 Stages

Alternative pumps will be evaluated for acceptability based on the "steepness" of the pump curve between 400 gpm and 700 gpm and the design condition 600 gpm @ 70 ft TDH.

b. Open line shaft (water lubricated), enclosed impeller vertical turbine unit.

c. Horsepower/Speed: The motor is 25 hp, 1780 rpm. The pumping unit shall not exceed 25 brake hp at any point on the entire pump curve inclusive of column, discharge head, and thrust bearing losses. Contractor is notified that the horsepower of the pumping unit is anticipated to be less than is necessary to require a 25 hp motor. The 25 hp motor is specified to provide for future pump upgrades.

d. Discharge head shall be fabricated steel or cast iron with 8" flanged outlet suitable for installation on a 36" sq. x 1-1/2" well top plate. Discharge head shall be designed and constructed to accommodate a 25 hp motor. Contractor shall drill and tap said top plate

to match well discharge head. Head shall be bolted to top plate. Discharge head shall accommodate two-piece top shaft without motor stand(s) or spacer(s).

e. Maximum Bowl Assembly Diameter: 12"

f. Number of bowls: Maximum 3

g. Impeller Type: Enclosed, polished bronze

h. Column Piping: 230' - 6" nominal, 6.625" O.D., 0.277" wall, 5' top and bottom sections and 6" diameter, 10' suction pipe with galvanized strainer

i. Line Shaft 1", Type 416 stainless steel line shaft. Contractor shall provide:

1) 2-piece top shaft and coupling
2) Dry run bearings for the upper three (3) bearings

j. Air Line and Gauge: 1/4" stainless steel tubing set bottom at 230', fastened to column with stainless steel bands at each joint. Gauge shall be 4 1/2" diameter (range 0 to 200' minimum) with fill valve, air line and pressure gauge shall be mounted to pump discharge head with rigid metal bracket

k. Static Water Level: 9 ft

l. Pumping Water Level: 24 ft (based on specific capacity listed under Item n. below)

m. Pump inlet Depth: 235 ft (bowl inlet); 245 ft (suction pipe inlet)

n. Drawdown: 15 ft (@ 600 gpm; specific capacity 39 gpm/ft)

o. Well Screen: 16" ID x 3/16" wall (copper bearing steel)

p. Fluid Pumped: Well water (chemical analysis available upon request), Specific gravity = 1.0

3. Motor

Premium efficiency vertical hollow shaft motor, 25 hp rated, WP1, 4 pole, part-winding, 3-phase, 60 cycle, 480V, 1780 rpm, 1.15 service factor, Design A or B, Class F insulation, thermal protection, motor heater, non-reverse mechanism, and steady bushing.

SECTION 11335
BASIC PUMPING UNIT SPECIFICATIONS
(ELECTRIC MOTOR DRIVEN)

All pumping units shall be comprised of vertical turbine line shaft pumps and vertical hollow shaft motors, unless specified otherwise. Other types of pumping units will be considered only for special applications for which vertical turbine pumping units are unavailable or inappropriate.

DEEPWELL VERTICAL TURBINE PUMP SPECIFICATION

1. General

Deepwell vertical turbine pumps shall be enclosed line shaft (oil lubricated) or open line shaft (water lubricated) type, whichever is specified, with aboveground flanged discharge and enclosed impellers.

All parts of the pump exposed to water shall be of stainless steel, brass, heavy cast iron, or equivalent corrosion resistant material.

Unless otherwise specified herein, all applicable provisions of AWWA E 101 (Part A), latest, are hereby made a part of these Specifications.

Pumps shall be manufactured by Floway, Goulds, Flowserve, or approved equal.

2. Pump Bowls

Bowls shall be of close-grained, gray cast iron, Class 30 or better, precision cast, free from blow holes, sand pockets, and other detrimental defects. Water passageways in said bowls shall be smooth so as to allow freedom from cavitation and permit maximum efficiency. Each bowl shall have end or side seal (or both) to prevent slippage of water between bowl and impeller.

Bowls shall be lined with vitreous porcelain enamel, or equal, to produce long effective life (said lining shall not be applied for the purpose of short time gain in efficiency). Lining, identical to that furnished hereunder, shall have been used in the field under similar conditions with satisfactory results for at least a five-year period.

Bowls shall be of such size to fit the well casing with proper clearance (net clearance of 2 inches or more). Bowls shall be capable of withstanding 1-1/2 times the pump shut-off head pressure (zero discharge) or twice the rated capacity pressure, whichever is greater. Bowl materials shall have a minimum tensile strength of 30,000 psi.

3. Pump Impellers

Impellers shall be of the enclosed type, constructed of SAE 40 bronze. They shall be balanced hydraulically and dynamically to prevent vibration and shall be smoothly finished on all surfaces for minimum friction. Impellers shall be accurately fitted and securely locked to the pump shaft. Vertical adjustment of impellers shall be possible by adjusting top shaft nut. Impellers in multi-stage pumps shall all have the same diameter and trim.

4. Pump Shaft

Pump shaft shall be constructed of AISI-410 or 416 stainless steel and shall be accurately machined to provide smooth operation. It shall easily withstand torsional loads and other stresses encountered within the pump. Pump shaft shall have adequate bearing support at every bowl section and at top bottom and case section, and shall be equipped with a suitable steel coupling for connection to the line shaft.

5. Pump Bearings

Pump bearings shall be sleeve type constructed of SAE 40, 64, 67, or 660 bronze, or approved equal. Bearing area, bearing cooling, and bearing lubrication shall be ample for long, trouble-free operation.

6. Discharge Case

Discharge case shall securely fasten the pump bowl assembly to the column piping. It shall be heavily reinforced with streamlined fluid passages and it shall contain sleeve bearings for the pump shaft. Discharge case shall be provided with a means of reducing to a minimum the leakage of water into the shaft enclosing tube. It shall have bypass ports of sufficient area to permit the escape of water that leaks through the seal bushing.

7. Suction Case

Suction case shall securely fasten the suction piping to the bowl assembly. It shall be heavily reinforced with streamlined fluid passages and it shall contain a sleeve bearing for the pump shaft which is effectively plugged at the bottom to form a grease container. A sand collar shall prevent sand from entering the suction case bearing.

8. Suction Pipe and Strainer

Unless specified otherwise, the suction pipe shall be 10 feet in length and comprised of the same material and diameter as the column piping. A cone type strainer shall be provided for attachment to the suction pipe. The strainer shall be galvanized steel, bronze, or equivalent and shall have a net inlet area of a least four times the suction pipe area. The maximum strainer opening shall not be more than 75% of the minimum opening of the water passage through the bowl or impeller.

9. Column Piping

Column piping shall be threaded pipe conforming to the following diameters and weights per foot, unless specified otherwise.

Nominal Size (Inches)	Outside Diameter (Inches)	Weight Per Foot (Pounds)
6	6.625	18.97
8	8.625	24.70
10	10.750	34.24
12	12.750	43.77
14	14.000	54.57
16	16.000	62.58

Pipe shall be furnished in interchangeable sections of 20-foot nominal length for enclosed line shaft and 10-foot length for open line shaft, with the exception of the top column section which shall be of 5-foot nominal length and the bottom column section which may be of shorter length. Column pipe sections shall be connected with threaded steel sleeve type couplings. Ends of each pipe section shall be faced normal to section axis and machined with threads to permit ends to butt to ensure proper alignment when assembled. Coating of the column piping, either interior or exterior, is not required.

10. Line Shaft

Line shaft shall be comprised of AISI C-1045 material, or approved equal. Line shaft sections excluding top and bottom sections shall match column sections (10-foot or 20-foot nominal length). Top and bottom shaft sections shall match top and bottom column sections. Unless specified otherwise, top shaft shall be two (2) piece with coupling within discharge head.

Shaft enclosing tubing shall be Schedule 80 extra heavy steel pipe, maximum 5-foot lengths. Enclosed line shafting shall be supported by bronze bearings which shall also join tube sections. Open line shafting shall be supported by rubber bearings with bronze retainers which shall also join column sections.

When enclosed line shaft is specified, molded rubber stabilizing spiders that will deform to permit proper alignment of the shafting and tubing assembly within the column shall be furnished and spaced every 40 feet maximum throughout the column length.

11. Discharge Head

Discharge head shall be constructed of high grade cast iron or fabricated steel and shall be capable of withstanding all loads imposed during normal operation. Discharge head shall be furnished with a tube tension and seal assembly, as approved by Owner, for enclosed line shaft and a stuffing box assembly for open line shaft.

Discharge head shall be suitably enclosed to prevent the entrance of dust and foreign material. Access to the tube tension and seal or stuffing box assembly shall be ample. Drain plugs shall be provided at the bottom. Unless specified otherwise, discharge head shall accommodate two (2) piece top shaft with coupling.

Discharge head shall have a standard flanged outlet of the size specified except where otherwise permitted. If the discharge flange is not the size specified, an adapter consisting of a smooth eccentric increaser (with bottoms level) or reducer (with tops level) shall be provided. Said adapter shall be flanged to mate the discharge head at one end and as specified at the other.

Discharge head assembly shall be capable of withstanding 1-1/2 times the pump shut-off head pressure (zero discharge) or twice the rated capacity pressure, whichever is greater.

Motor base, column flange face, and discharge flange face shall be accurately machined, faced, and drilled to NEMA and ASA Standards. Upon assembly, motor and discharge head shall form an integral unit.

12. Lubrication System

Oil lubrication system shall be automatic gravity feed and it shall consist of an oil reservoir, solenoid control valve, sight feed valve, and appurtenant supports and oil lines. It shall be furnished with sight glass or other plainly visible oil indicator device.

Unless specified otherwise, oil reservoir shall have a capacity of two gallons and it shall be Peerless or approved equal. It shall be mounted on the pump discharge head unless specified otherwise.

Oiler solenoid control valve shall open or close upon command of control system and it shall be ASCO 826111, or approved equal. It shall automatically start or stop the flow of lubricating oil to the bearings. It shall also permit manual operation upon control system failure. It shall be rated 120 psi minimum, 120 volt, 60 hertz, unless specified otherwise.

Oil piping shall be sized according to the viscosity of the oil recommended by the pump manufacturer and ambient temperature at the pumping unit. Said piping shall permit conveyance of full oil supply required by pumping unit.

Water lubrication system shall be automatic unless specified otherwise. It shall consist of piping or tubing from a source of water pressurized when pump is off, solenoid control valve, and appurtenant piping supports. System shall comply with pump manufacturer's recommendations for flow.

Water solenoid control valve shall open or close upon command of control system. It shall automatically start or stop the flow of water to the shaft bearings. It shall also permit manual operation upon control system failure.

13. Nameplate

Nameplate, easy to read and corrosion resistant, shall be provided with each pump and shall contain complete pump information including manufacturer, serial number, model number, capacity in gallons per minute, total dynamic head in feet, and pump speed, all at specified design point. Said nameplate shall be mounted on pump head.

BOOSTER VERTICAL TURBINE PUMP SPECIFICATION (CLOSE COUPLED)

1. General

Booster vertical turbine pumps shall be close coupled open line shaft (water lubricated) type with an aboveground flanged discharge and either enclosed or semi-open impellers.

All parts of the pump exposed to water shall be of stainless steel, brass, heavy cast iron, or equivalent corrosion resistant material.

Unless otherwise specified herein, all applicable provisions of AWWA E 101 (Part A), latest, are hereby made a part of these Specifications.

Pumps shall be manufactured by Floway, Goulds, Ingersoll Dresser, or approved equal.

2. Pump Bowls

Bowls shall be of close-grained, gray cast iron, Class 30 or better, precision cast, free from blow holes, sand pockets, and other detrimental defects. Water passageways in said bowls shall be smooth so as to allow freedom from cavitation and permit maximum efficiency. Each bowl shall have end and/or side seal to prevent slippage of water between bowl and impeller.

Bowls shall be lined with vitreous porcelain enamel, or equal, to produce long effective life (said lining shall not be applied for the purpose of short time gain in efficiency). Lining identical to that furnished hereunder shall have been used in the field under similar conditions with satisfactory results for at least a five-year period.

Bowls shall be of such size to fit the suction can with proper clearance (velocity of water between bowls and can of five (5) feet per second maximum at specified capacity). Bowls shall be capable of withstanding 1-1/2 times the pump shutoff head pressure (zero discharge) or twice the rated capacity pressure, whichever is greater. Bowl material shall have a minimum tensile strength of 30,000 psi.

3. Pump Impellers

Impellers shall be of the enclosed or semi-open type, constructed of SAE 40 bronze. They shall be balanced hydraulically and dynamically to prevent vibration and shall be smoothly finished on all surfaces for minimum friction. Impellers shall be accurately fitted and securely locked to the pump shaft. Vertical adjustment of impellers shall be possible by adjusting top shaft nut.

4. Pump Shaft

Pump shaft shall be constructed of AISI-410 or 416 stainless steel and shall be accurately machined to provide smooth operation. It shall easily withstand torsional loads and other stresses encountered within the pump. Pump shaft shall have adequate bearing support at every bowl section and at top and bottom case section, and shall be equipped with a suitable steel coupling for connection to the line shaft.

5. Pump Bearings

Pump Bearings shall be sleeve type constructed or SAE 40, 64, 67, or 660 bronze, or approved equal. Bearing area, bearing cooling, and bearing lubrication shall be ample for long, trouble-free operating life.

6. Discharge Case

Discharge case shall securely fasten the pump bowl assembly to the column piping. It shall be heavily reinforced with streamlined fluid passages and it shall contain sleeve bearings for the pump shaft.

7. Suction Case

Suction case shall securely fasten the suction bell to the bowl assembly. It shall be heavily reinforced with streamlined fluid passages and it shall contain a sleeve bearing for the pump shaft which is effectively plugged at the bottom to form a grease container. A sand collar shall prevent sand from entering the suction case bearing.

8. Suction Bell

Unless specified otherwise, a suction bell of the same material and diameter as the bowl assembly shall be provided. The suction bell inlet shall be set two (2) suction bell diameters, 18 inches minimum, from bottom of suction can.

9. Column Piping

Column piping shall be threaded pipe conforming to the following diameters and weights per foot unless specified otherwise.

Nominal Size (Inches)	Outside Diameter (Inches)	Weight Per Foot (Pounds)
6	6.625	18.97
8	8.625	24.70
10	10.750	34.24
12	12.750	43.77
14	14.000	54.57
16	16.000	62.58

Column pipe sections shall be connected with threaded steel sleeve type couplings. Ends of each pipe section shall be faced normal to section axis and machined with threads to permit ends to butt to ensure proper alignment when assembled. Coating of the column piping, either interior or exterior, is not required.

10. Line Shaft

Line shaft shall be comprised of AISI C-1045 material, or approved equal. Line shaft shall be 18 inches minimum length.

11. Discharge Head

Discharge head shall be constructed of high grade cast iron or fabricated steel and shall be capable of withstanding all loads imposed during normal operation. Discharge head shall be furnished with a shaft stuffing box, as approved by Owner, unless specified otherwise.

Discharge head shall be suitably enclosed to prevent the entrance of dust and foreign material. Drain plugs shall be provided at the bottom.

Discharge head shall have a standard flanged outlet of the size specified except where otherwise permitted. If the discharge flange is not the size specified, an adapter consisting of a smooth eccentric increaser (with bottoms level) or reducer (with tops level) shall be provided. Said adapter shall be flanged to mate the discharge head at one end and as specified at the other.

Discharge head assembly shall be capable of withstanding 1-1/2 times the pump shutoff head pressure (zero discharge) or twice the rated capacity pressure, whichever is greater.

Motor base, column flange face, and discharge flange face shall be accurately machined, faced, and drilled to NEMA and ASA standards. Upon assembly, motor and discharge head shall form an integral unit.

12. Nameplate

Nameplate, easy to read and corrosion resistant, shall be provided with each pump and said nameplate shall contain complete pump information including manufacturer, serial number, model number, capacity in gallons per minute, total dynamic head in feet, and pump speed, all at specified design point. Said nameplate shall be mounted on pump head.

13. Suction Cans

a. General

Booster pump suction cans used in conjunction with close coupled line shaft vertical turbine pumping units shall have diameter, length, lining, coating, wall thickness, orientation of suction inlet, drilling of top flange, and dimensions all as specified by Owner. Unless otherwise specified, suction cans shall be provided with all booster pumping units.

b. Suction Can Requirements

1) Can shall be sized so that velocity of water passing bowl(s) within can shall be 3 feet per second maximum at specified capacity.

2) Can shall be of sufficient length to provide for column piping of 18 inches minimum length and 18 inches minimum clearance between bottom of pump bowl assembly (suction bell or strainer, whichever is specified) and bottom of can.

3) Can inlet shall be 36 inches minimum and 60 inches maximum from bottom of can.

4) Cans shall be manufactured or 1/4 inch minimum steel plate. Cans shall be provided with suitable baffles, if necessary, to prevent excessive turbulence.

5) Can shall be cement mortar lined, 3/8 inch thick for can diameters 18 inches and less and 1/2 inch thick for can diameters over 18 inches.

6) Can shall be cement mortar coated, 5/8 inch thick for can diameters 18 inches and less and 3/4 inch thick for can diameters over 18 inches.

VERTICAL HOLLOW SHAFT ELECTRIC MOTOR SPECIFICATION

1. General

Vertical hollow shaft electric motors shall be Design B, high thrust, squirrel cage, induction type having NEMA weather protected Type I enclosures unless specified otherwise. Motors shall be built to form an integral part of pump head assembly and shall be suitable electrically and mechanically to efficiently and effectively drive pumps specified. Motors shall operate in accordance with these Specifications.

Motors shall be manufactured by General Electric Corporation, U.S. Electrical Motors Division Emerson Electric Co., or Westinghouse Electric Corporation, or approved equal. Unless specified otherwise all materials, workmanship, and tests shall conform with the applicable specifications of the National Electrical Manufacturers Association (NEMA), Institute of Electrical and Electronic Engineers (IEEE), and American Standards Association (ASA), and the Anti-Friction Bearing Manufacturers Association (AFBMA).

2. Power

Unless specified otherwise, motors shall be nameplate rated, 3 phase, 60 hertz, 460 volts.

3. Speed

Unless specified otherwise, motors shall be 4 pole and shall have no load speed of 1800 rpm.

4. Starting Characteristics

Motors rated 200 hp and smaller shall be full voltage line start and motors rated 250 hp and larger shall be part winding increment start, unless specified otherwise.

5. Efficiency

All motors shall be rated premium efficiency, unless specified otherwise. Rated efficiencies shall be based on NEMA Standard MG1-12.536. Guaranteed efficiencies shall be determined in accordance with IEEE #12, Test Method B and E, latest revision.

6. Service Factor

Rated service factor shall be 1.15 or greater.

7. **Insulation System**

All motors shall be provided with Class "F" or better insulation systems except that motor lead insulation may be Class "B" or better. Impregnating materials shall be rated Class "F" (155 degrees C) minimum. Completed windings, when tested in accordance with IEEE #57, latest revision, shall show a thermal rating of not less than 150 degrees C for 30,000 hour's life.

Windings shall be held firmly in stator slots to prevent coil shift. Sharp edges and burrs shall be removed from stator slots prior to winding or inserting coils. Slot liners and coil end phase insulation, in addition to the coating, shall be provided. Stator windings shall be of high conductivity copper magnet wire.

Completed stator windings shall be provided with a properly cured, uniform impregnation for mechanical rigidity, moisture resistance, and protection against winding failures from accumulation of foreign conductive matter. The completed insulation system shall be capable of withstanding phase-to-ground rms voltage of 600 volts continuous and 2,300 volts instantaneous (surge or transient).

8. **Temperature Rise**

Rated temperature rise above 40 degrees C ambient temperature measured by resistance at service factor load of 1.15 shall not exceed 90 degrees C.

9. **Inrush Current**

Motors rated between 10 hp and 50 hp shall be rated NEMA locked rotor Code H or better and motors rated 50 hp and larger shall be rated NEMA locked rotor Code G or better except where NEMA locked rotor Code H is specifically permitted.

10. **Load Conditions**

Actual motor loads shall not exceed the nameplate rating (horsepower) unless specified otherwise.

11. **Motor Balance**

Motors shall be dynamically balanced to a maximum of .001 inches peak to peak amplitude, especially at upper bearing housing.

12. **Bearings**

Motors shall be equipped with anti-friction type thrust and guide bearings. Angular contact ball thrust bearings shall be used in preference to spherical roller thrust bearings wherever possible. Angular contact ball thrust bearing shall be self cooled wherever possible. Water cooled angular contact ball thrust bearings shall be used only when approved by Owner. Spherical roller thrust bearings shall be water cooled.

Bearings shall be of sufficient capacity to carry all static and dynamic up and down thrust loads, both momentary and continuous, imposed by the pump. Bearings shall provide minimum 3 year B10 life (26,300 hours) based on continuous design thrust load or minimum 1 year B10

life (8770 hours) based on maximum pump shut-off thrust load, whichever is greater. Bearings shall also provide for minimum momentary upthrust equal to 30% of rated downthrust.

13. Bushings

Motors shall be equipped with lower end head shaft steady bushings unless specified otherwise.

14. Lubrication System

Motor thrust bearings shall be oil lubricated; however, motor guide bearings may be grease lubricated. Oil lubrication systems shall provide optimum lubrication of bearings. Said systems shall have sufficient oil storage and oil cooling capacity to limit oil bath temperature rise to 45 degrees C above 40 degrees C ambient temperature unless temperature rise of 50 degrees C is specifically permitted. Oil lubricated motors shall have visual level indicators and accessible fill and drain plugs. Indicators and plugs shall be located 180 degrees from pump discharge unless specified otherwise. Grease lubrication systems shall be regreasable and shall provide for automatic flushing or purging of grease cavity during regreasing.

15. Thermal Protection

Motors shall be equipped with 120 volt thermal sensors, one for each phase, affixed to or embedded in motor windings, set to open control circuit at 135 degrees C. All thermal sensor leads shall terminate in motor terminal box. Control modules and reset switches shall be furnished with the thermal sensors. The thermal sensors shall be Texas Instruments 4BA or 7BA, or approved equal. The control modules shall be Texas Instruments 50AA, or approved equal.

16. Space Heaters

Motors shall be equipped with 120 volt single phase belt type space heaters capable of raising motor temperature 10 degrees C above ambient temperature to prevent condensation. All space heater leads shall terminate in motor terminal box.

17. Non-Reverse Protection

Motors shall be equipped with non-reverse mechanisms which shall limit maximum reversal to within 10 degrees of rotation.

18. Terminal Box

Motors shall be equipped with extra large heavy duty split type conduit boxes. Unless specified otherwise, motor terminal boxes shall be located 90 degrees from pump discharge.

19. Screens

Motors shall be equipped with suitable corrosion resistant safety and rodent screens. Said screens shall not interfere with motor cooling or motor heat dissipation.

20. Nameplates

Nameplates, easy to read and corrosion resistant, shall be provided with each motor and said nameplates shall include the following information:

a. Motor Data Nameplate - Manufacturer, serial number, model number, rated horsepower, service factor, frequency, phase, load voltage, full load current, full load speed, design designation, locked rotor-code, insulation class, temperature rise, ambient temperature, thermal sensor setting, NEMA nominal efficiency, guaranteed minimum efficiency, and full load power factor.

b. Connection Data Nameplate - Motor start, motor run characteristics, and motor connection diagram.

c. Bearing Data Nameplate - Manufacturers, bearing types (thrust and guide), bearing numbers, thrust capacity, oil type, minimum operating oil viscosity, maximum operating oil bath temperature, required cooling water flow, and maximum cooling water pressure.

PUMPING UNIT REQUIREMENTS

1. Pumping Unit Contractor (Bidder)

Pumping unit Contractor shall be an authorized distributor approved by Owner. Said distributor shall have adequate service facilities within a 60 mile radius of Owner's office and shall have a service organization, machine shop facilities, and parts inventory such that servicing or replacement of pumping units can be provided with minimum delay.

2. Pumping Unit Data to be Submitted by Bidder

Bidder shall submit (with his bid) a certified pumping unit component drawing for each different pumping unit to be furnished and it shall show dimensions of pumping unit and its components including bowl assembly, column assembly, tube and shaft assembly, discharge head assembly, motor, and related appurtenances.

Bidders shall submit (with his bid) a certified pump performance curve together with design calculations for each different pump to be furnished. Each curve shall show head versus capacity, pump bowl efficiency versus capacity, brake horsepower versus capacity, overall (wire to water) efficiency versus capacity, all for full operating range specified.

Each certified pump curve shall be continuous from zero capacity to maximum pumping unit capacity on the abscissa. It shall be furnished full size on 8-1/2 inches (ordinate) x 11 inches (abscissa) paper. Bidder shall indicate certified values on each curve for the following characteristics at all specified design points since consideration will be given thereto in selecting units to be furnished.

a. Discharge capacity in gallon per minute.

b. Total discharge head in feet (bowl head).

c. Pump bowl efficiency.

d. Brake horsepower (including losses in pump, shaft, column, and head).

e. Wire to water efficiency (including losses in motor, pump, shaft, column, and head).

f. Down thrust and momentary up thrust.

g. Net positive suction head (close coupled booster application only).

Bidder shall submit (with his bid) a guaranteed motor performance curve together with other performance data for each different motor to be furnished. Each curve shall denote horsepower, service factor, efficiency, locked rotor current, and temperature rise and each curve shall show efficiency, power factor, speed, kilowatt input, current, and line voltage under operating range between full load and half load.

3. Pumping Unit Data to be Submitted by Contractor

Before the fabrication or manufacture of any selected pumping unit and appurtenance is commenced, Contractor shall submit to Owner for approval, detailed, certified factory drawings, in triplicate, of pump and motor components and materials for each different unit to be furnished. Said certified drawings shall fully describe all pump and all motor materials through the use of notes, dimensions, sections, and standards (such as ASTM) with which said materials comply. Contractor shall also submit written certification of pump head and pump bowl assembly capability to withstand specified pressures. In the absence of written certification, Contractor shall furnish test results demonstrating compliance with specified pressure requirements. Contractor shall supply to Owner, in duplicate, all necessary booklets, pamphlets, and other printed literature describing operation and maintenance of all pumping units and appurtenances supplied by him.

4. Contractor Submittals

Complete submittals (shop drawings) showing performances, fabrication, assembly, and installation, together with detailed specifications and data covering performance and materials of construction, power drive assembly, parts, devices, wiring diagrams, and other accessories forming a part of the pumping units shall be submitted per Section 01300 Contractor Submittals. Submittals shall include, but shall not be limited to, the following:

a. Submit the following minimum information for each pumping unit specified herein for the Owner's review and approval:

1) Items as specified in Section 1.03

2) Type and model number with reference to pumping units suitability for service for pumps specific intended use.

3) Assembly drawing, nomenclature and material list.

4) Type, manufacturer, model numbers, location and spacing of bearings.

5) Impeller diameter, eye area, sphere size, and identification number.

6) Maximum rotative speed.

7) Complete performance curves indicating total dynamic head, flow rate, brake horsepower, shutoff head, net positive suction head required, RPM, and efficiency.

The manufacturer shall indicate by arrows to points on the H/Q curves the limits recommended for stable operation, between which pumps are to be operated to prevent surging, cavitation, and vibration. The stable operating range shall be as large as possible and shall be based on actual hydraulic and mechanical characteristics of the units.

Provide certified performance curves prior to shipment.

8) Motor data, including the manufacturer, size, type designation, minimum guaranteed efficiency and power factor at full load, 3/4 load, and 1/2 load, locked motor current in amps, full load current in amps, the motor speed in rpm, mounting details, and other data as required in the Contract Documents.

9) Outline dimensions and weights of pumping unit components and as assembled.

10) Materials of pump construction including bowls, bowl lining, shafts bearings, impellers and castings. Written certification of pumping units capability to withstand specified pressures.

11) Protective coating of pumping unit.

12) Installation instructions.

13) Operation and maintenance manuals.

5. Pumping Unit Factory Performance Test

Each completed pumping unit (pump bowl assembly and vertical hollow shaft motor to be furnished) shall be given a certified factory performance test by pump manufacturer prior to shipment from factory. Pumping unit shall be tested at all design points for verification of certified performance curve furnished by Bidder and approved by Owner.

Tests shall be performed using suitable equipment for measuring bowl capacity, bowl head, power (input, brake, and water), and speed, all as approved by Owner. Equipment shall include a power meter for measuring input power (wire), a dynamometer for determination of pump brake horsepower, and a water meter for measuring output power (water). Contractor shall submit three copies of each certified factory performance test for acceptance by Owner. Owner reserves the right to have a representative present during any tests and to witness same.

6. Pumping Unit Installation

Contractor shall bear full responsibility for the satisfactory installation and initial operation of all pumping units furnished under these Specifications and shall provide sufficient personal supervision over all installation and start-up procedures accordingly, unless otherwise specified. Contractor shall also provide all test equipment necessary to determine initial operating performance.

During installation, Contractor shall disinfect all portions of the pump bowl assembly and column piping with a chlorine solution and method acceptable to Owner.

7. Pumping Unit Field Performance Test (Acceptance Test)

After equipment has been completely installed, field tests shall be performed by the Contractor and witnessed by Owner. Each pumping unit furnished hereunder shall be operated for a period of two weeks during which time acceptance tests may be conducted. Head capacity, overall efficiency, and input and output horsepower shall be determined for at least three different operating conditions in the operating range of the pumping unit, including the specified design point, for comparison with the certified pump curves and the factory performance test results, both as approved by Owner.

Pumping units (pump and motor) shall perform in the field substantially in accordance with the certified pump curves and the factory performance test results as adjusted for field conditions. If, in the opinion of Owner, the equipment furnished does not perform in accordance with these Specifications, Contractor shall promptly make all necessary repairs or corrections so that the equipment fully complies with these Specifications. Contractor shall remove, restore, and replace the equipment if required. Factory and field performance tests shall be rerun if necessary. Pump manufacturer's field service engineer shall assist Owner in the proper conduct of the above field acceptance tests.

8. Pumping Unit Vibration

Completed pumping unit (pump and motor) shall receive a final field trim balance, as may be required, and vibration of unit shall not exceed 0.0025 inches, peak to peak amplitude when operating. Contractor shall field measure vibration with a suitable calibrated instrument and all measurements shall be witnessed by Owner. Vibration shall be measured at motor thrust bearing housing and at any other locations on pumping unit as directed by Owner.

SECTION 13350
BOLTED STEEL WATER STORAGE TANK
TECHNICAL SPECIFICATIONS

PART 1 - GENERAL

1.01 Description

Contractor shall furnish a bolted steel water storage tank as shown on the Drawings and as specified herein. Contractor shall furnish all labor, materials, and equipment and perform all operations necessary for construction of the bolted steel water storage tank, including foundation, appurtenances, and all other necessary work as specified.

Design, fabrication, erection, installation, inspection, and testing shall comply with the applicable requirements of the American Water Works Association Standard D103, latest (AWWA D103, latest) and with the applicable requirements of the California Building Code, latest (CBC, latest), except as otherwise specifically stated herein.

Contractor shall furnish one (1) water tank with a nominal inside diameter of 24'-0" and a nominal height of 12'-0". The tank shall have a bolted steel floor.

1.02 Design Criteria

The water storage tank shall be designed in accordance with AWWA D103 and ASTM A1011 to meet or exceed the following requirements:

A. Design Loads

1. Earthquake Load

Simultaneous combination of vertical and horizontal acceleration:	Yes (no reduction)
Design basis of tank:	AWWA Standard D103 (latest)
Hoop stress combination:	Root mean square
Seismic design of roof required:	Yes
Horizontal acceleration:	0.36g
Vertical acceleration:	0.27g
Column horizontal acceleration:	N/A
Column lateral dynamic water load:	N/A

Tanks shall be anchored to resist earthquake loads where analysis dictates. Reduction of hydrodynamic hoop stress based on ductility will not be allowed.

2. Seismic Parameters - as defined by the CBC, 2007:

Seismic Category		D
Site Class		D
S_S	=	1.50g
S_1	=	0.60g
F_a	=	1.00
F_V	=	1.50
S_{DS}	=	1.00
S_{D1}	=	0.60

3. Wind Load

Wind load (horizontal and vertical) shall be based on AWWA D103, Section 3.2.4.

4. Roof Live Load

Roof load shall equal 20 lb/ft^2 of horizontal projection of tank roof. Roof load shall not be reduced.

5. Allowable Soil Bearing Capacity

Foundation shall be designed based on an allowable bearing capacity of 2,000 psf at a minimum 12" below grade. The allowable bearing capacity can be increased by one-third for wind and seismic loadings.

1.03 Submittals

Prior to commencing tank construction, Contractor shall submit to Owner three copies of the following for approval:

A. Complete detailed design calculations for tank and foundation (signed by a Registered Civil Engineer licensed in the State of California) for all requirements specified herein including dead, live, seismic, wind, and other loads.

B. Complete detailed fabrication drawings showing structural member details, foundation details, connection details, coating details, appurtenance details, all dimensions, all thicknesses, and all other pertinent data necessary to adequately describe the work.

After all documents have been approved, Contractor shall submit to Owner five complete copies of all approved submittal documents.

1.04 Quality

A. The products furnished under this section shall be by a bolted steel tank manufacturer who has been regularly engaged in the design, fabrication, and manufacture of fusion bonded epoxy lined and coated bolted steel water storage tanks. Manufacturers shall have a minimum of 10 years experience in design, fabrication, manufacture, and service

of fusion bonded epoxy lined and coated bolted steel tanks. In addition, manufacturer shall have at least five (5) fusion bonded epoxy lined and coated bolted steel tank installations in the Southern California area over the last two (2) years. Manufacturer shall provide a list of all fusion bonded epoxy lined and coated bolted steel tank installations in the last 5 years, including those in Southern California. The installation list shall include project name, tank size (dimensions and capacity), tank function, and contact names and telephone numbers. The manufacturer shall maintain a qualified staff of design, fabrication, and service personnel. The staff shall be full-time employees of the manufacturer with suitable training and qualifications.

B. The fusion bonded epoxy lined and coated bolted steel water storage tanks shall be as manufactured by Columbian TecTank or Superior Tank Company, Inc.

C. The tank erector shall have been regularly engaged for period of not less than 5 years in the erection of fusion bonded epoxy lined and coated bolted steel tanks similar to those required for this project.

1.05 Warranty

The tank manufacturer shall include a warranty for the tank materials and coating system. As a minimum, this warranty shall cover defects in material or workmanship for a period of one (1) year and corrosion of the interior and exterior tank surface for the period of five (5) years. The warranty shall be submitted for review at the same time the tank fabrication drawings are submitted.

PART 2 - PRODUCTS

2.01 Materials

All materials shall comply with AWWA D103, latest. All materials shall be new, previously unused, and in first class condition. Materials shall be shop fabricated to proper dimensions to eliminate field modifications.

Plates and sheet material shall conform to ASTM A36 or ASTM A570, Grade 30, 33, or 36.

A. Tank Configuration and Minimum Thickness

1. Roof Plates

Roof shall be designed with a conical (sloped 1:12) roof. Roof plate minimum thickness shall be 10 ga (0.1345"). The roof shall slope 1" vertical to 12" horizontal and shall not vary more than ±1" from specified slope at any point between center of the tank and the shell. Roof plate shall not vary between center of the tank and the shell. Roof plate shall not vary circumferentially more than ±1/2" (1" between high point and low point) in a 6' span.

Tank shall include a radially sectioned roof fabricated from fusion bonded epoxy lined and coated bolted steel panels, as produced by the tank manufacturer. Tank roof shall be assembled in a similar manner as the sidewall panels utilizing the same sealant and bolting techniques, to assure a weathertight assembly. The roof

shall be clear-span and self-supporting and shall transfer both live and dead loads to the tank sidewalls. The roof panels shall be supported by rafters connecting sidewall and roof panels.

2. Shell Plates

Shell plate minimum thickness shall be 10 ga (0.1345"). Shell plates shall be fabricated to the dimensions shown on the approved fabrication drawings. Shell plates shall be shop fabricated to match adjoining plates. Field cutting plate edges will not be permitted.

3. Tank Floor Plates

Tank floor plates minimum thickness shall be 10 ga (0.1345"). Floor plates shall be fabricated to the dimensions shown on the approved fabrication drawings.

4. Rafters

Rafters shall be spaced so that in the outer ring their centers shall not be more than 2 pi feet (6.28') apart, measured along the circumference of the tank. Spacing in the inner rings shall not be greater than 5.5'. Tie rods, 3/4" diameter or equivalent, shall be placed between rafters in outer rings.

Rafters shall be straight and true. Rafters shall not vary from centerline more than 1/8" in 20' or 1/4" overall. Top and bottom flanges shall be flat and undamaged. Rafters not straight or having bent or warped flanges shall be replaced prior to erection.

5. Fasteners

All bolts, nuts, and washers shall be constructed of steel, hot dip galvanized (HDG) after construction. Bolts shall be SAE Grade 2, SAE Grade 5, or SAE Grade 8. All bolts that are in contact with the stored liquid shall be provided with neoprene backed washers. Shell hardware exposed on the interior of the tank shall be encapsulated with high impact polypropylene copolymer to protect against corrosion.

6. Sealants

All tank lap joints shall be sealed with a moisture cured, polyurethane adhesive sealant compound. The sealant shall be suitable for contact with potable water and shall be certified to meet ANSI/NSF Adhesive Standard 61 for indirect adhesives.

The sealant shall be used to seal lap joints, bolted connections and edge fillets. The sealant shall cure to a rubber-like consistency, have excellent adhesion to the fusion bonded epoxy coating, low shrinkage, and be suitable for interior and exterior use.

B. Bolted Joints

All bolted joints shall comply with AWWA D103, latest, except as otherwise specifically stated herein. All vertical, horizontal, shell to roof, and shell to bottom plate joints shall be field bolted. All joints that may come in contact with water or repel water shall be sealed with a suitable gasket material and sealant.

All bolts on the vertical tank wall shall be installed such that the head portion is located inside the tank, and the washer and nut are on the exterior.

All lap joint bolts shall be properly selected such that threaded portions of the bolts are not exposed to the "shear plane" between tank sheets.

Bolt lengths shall be sized to achieve a neat and uniform appearance. Threads shall not extend beyond the nut more than 1" after torqueing.

All lap joint bolts shall include a minimum of four (4) splines on the underside of the bolt head at the shank in order to resist rotation during torqueing.

2.02 Tank Accessories

A. Accessories

Where pipe connections are shown to pass through tank panels, they shall be factory or field cut (torch cutting or welding is not permitted), and utilize an interior and exterior flange assembly. Tank shell reinforcing shall comply with AWWA D103, latest edition. Cut panel edges shall be sealed in accordance with Part 2.01A.6 of these Specifications.

All tank appurtenances supported by the tank shell and roof (pipe supports, conduit, miscellaneous brackets, etc.) shall be attached to the tank shell using factory fabricated bolted connections. Field welding to tank shell will not be permitted. Contractor shall coordinate each tank shell appurtenant connection and shell penetration required with tank manufacturer. Orientation of tank appurtenances shall be confirmed by Owner on approved fabrication drawings prior to tank fabrication.

All tank accessories and pipe spools bolted to the tank shell shall receive a fusion bonded epoxy coating (inside and outside) in accordance with Specification Section 09915 and the Contract Documents.

The following accessories shall be appurtenant to each tank, unless specified otherwise.

1. Inlet Nozzle

One flanged standard weight steel pipe inlet nozzle bolted to the tank shell shall be provided as shown on the Drawings and per tank manufacturer's requirements. Number, diameter, elevation, and projection of flanged inlet nozzles shall be as shown on the Drawings.

2. Overflow Pipe

One standard weight steel overflow pipe assembly located as shown on the Drawings. Centerline, diameter, and elevation of the overflow pipe connection shall be as shown on the Drawings.

3. Exterior and Interior Ladders

One galvanized steel exterior tank ladder with lockable intrusion door, and one interior tank ladder per tank manufacturer as shown on the Drawings.

4. Tank Drain Nozzles

Two 3" tank drain nozzles each with a 3" flanged PVC ball valve, 3" long schedule 40 pipe nipple, and PVC blind flange as shown on the Drawings.

5. Shell Manway

One 30" diameter shell manway. Location and elevation of shell manway shall be as shown on the Drawings.

6. Outlet Nozzles

One flanged standard weight steel pipe outlet nozzle bolted to tank shell shall be provided as shown on the Drawings and per tank manufacturer's requirements. Diameter, elevations, and projection of flanged outlets shall be as shown on the Drawings.

7. Roof Manway

One 30" W x 30" L (clear opening) custom roof access manway located as shown on the Drawings. Roof manway shall be constructed of aluminum and provided with stainless steel hardware. Manway shall be bolted to tank roof per tank manufacturer's requirements. Tank manufacturer shall provide customized roof plate, framing, and support system as necessary to accommodate the custom manway.

8. Roof Vent

One screen aluminum roof vent. Diameter and location of roof vent shall be as shown on the Drawings.

9. Shell Sampling Stations

Two 1" diameter steel threaded uniflanges connected to the tank shell as shown on the Drawings. Each uniflange shall be provided with 1" x 3/4" PVC dielectric reducing bushing, and 3/4" corp. stop with brass elbow and cap on the tank exterior, and 1" diameter PVC pipe spool (12" long) on the tank interior as shown on the Drawings. Contractor shall provide necessary adaptors for sampler connection.

10. Reservoir Level Transducer

a. Reservoir level transducer shall be 24-volt, 4-20 mA D.C. transducer with 1/4" NPT pressure inlet, and integrally mounted 0-100% local indicator, stainless steel diaphragm, CAD plated carbon steel body, with stainless steel bolts.

b. The reservoir level transducer shall be a two-wire water level/pressure sensing device which converts gauge pressure measurements to electronic analog signals. These transducers shall be supplied complete with isolation seals to isolate the corrosive effects of the water from any part of the transducer which may corrode. The units shall utilize solid state circuitry to convert gauge pressure linearly to 4-20 mA electronic signals.

c. The transducer output signal shall be linear with respect to water level/pressure to within 1 percent of span over a temperature range of 0° to 60°C and in the humidity conditions present in the areas of their installation.

d. Level transducer shall be mounted as shown on the drawings. When installed as shown on the drawings, zero pressure shall correspond to one foot of reservoir level.

e. The reservoir level transducer shall be scaled and calibrated for the nominal 12-foot water level. An adjustment shall be made for the actual elevation of the transducer.

f. The transmitter shall be Rosemount Model 3501-CG3A02A1J(H2)(B1)(L4)(M6) or engineer approved equivalent.

11. Liquid Level Indicator

One complete liquid level indicator, Varec Figure No. 6700 or approved equal, including mounting connections, standard pipe and fittings, half-travel aluminum gage board graduated in feet and tenths with scotchlite reflector tape on indicator at each numeral and at each foot graduation, and stainless steel float and guide wires. Location shall be as shown on the Drawings.

12. Handrail

Handrail shall be furnished on the tanks where shown on the Drawings. Handrail shall be provided in accordance with the requirements specified herein.

As a minimum, all handrails shall conform to the applicable sections of the following codes:

a. California OSHA, California Occupational Safety and Health Standards

b. A21.1 Safety Requirements for Floor and Wall Openings, Railings and Toe Boards

Provide handrail systems capable of withstanding the effects of gravity loads and the following loads and stresses within allowable limits and under conditions indicated:

a. Uniform load of 50 lb/ft applied in any direction (top rail of handrails).

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

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

All posts and rails shall be constructed of 1-1/2" diameter Schedule 40 hot-dipped galvanized steel pipe. Handrail shall be provided with two railings, top railing shall be 42" above the roof and intermediate railing shall be 24" above the roof.

Posts shall be set plumb and spacing shall be uniform with a maximum distance of 5'-0" between posts. Provide 4" x 1/4" thick toe plates between handrail posts.

13. Safety Climb Device

A safety climb device shall be provided along the full length of the inside and outside ladders (mid-height platform may be substituted in lieu of safety climb device for outside ladder). The safety climb device and fittings, bolts, nuts, and connections for the outside ladder shall be hot dip galvanized steel. The safety climb device and fittings, bolts, nuts, and connections for the inside ladder shall be type 304 stainless steel. The devices furnished shall be "SAF-T-CLIMB" as manufactured by Air Space Devices of Paramount, California, or approved equal.

Each safety climb shall be a complete "SAF-T-CLIMB" installation consisting of the required length of SAF-T-NOTCH RAIL, the appropriate type and quantity of SAF-T-CLIMB ATTACHING BRACKETS, two (2) SAF-T-LOK SLEEVES, two (2) SAF-T-BELTS, and one SAF-T-NOTCH RAIL REMOVABLE EXTENSION KIT.

2.03 Tank Foundation

A. General

As a minimum, tank foundation shall consist of an asphalt-sand pad on crushed rock base with a concrete ringwall, or a crushed rock base with a steel grade band, whichever is specified on the Drawings. The tank foundation shall be placed on material compacted to 95% minimum relative compaction.

All specified earthwork shall be performed in strict accordance with Section 02300, Basic Earthwork Specifications, and the Contract Documents.

All concrete work shall be performed in strict accordance with Section 03100, Basic Concrete Formwork Specifications; Section 03200, Basic Concrete Reinforcement Specifications; and Section 03300, Basic Concrete Specifications; and the Contract Documents.

B. Asphalt-Sand Pad on Crushed Rock Base

1. Standards

The asphalt-sand pad and crushed rock base shall comply with applicable sections of the Standard Specifications for Public Works Construction (SSPWC), latest edition, and shall have the characteristics specified herein.

2. Asphalt-Sand Pad

The asphalt-sand mixture shall be plant mixed and shall consist of sand base per Section 200 and liquid asphalt (SC 800, 7% +1% by weight) per Section 203, SSPWC. Sand gradation shall be in accordance with Table 200-1.5.5 for Portland Cement Concrete. Asphalt-and shall be hot-plant mixed, transported, and placed in accordance with all applicable provisions of these sections. The asphalt-sand mixture shall be compacted with a light weight steel wheeled roller to a minimum relative compaction of 95%. Unless specified otherwise, the compacted thickness shall be 3".

3. Crushed Rock Base

Crushed rock base shall be 3/4" maximum gradation and it shall comply with Table 200-1.2 of Section 200, SSPWC. Crushed rock base shall be compacted to 95% minimum relative compaction. Unless specified otherwise, the compacted thickness shall be 9".

4. Tolerances

The top of the asphalt-sand pad shall not vary more than +1/4" from the grade and slope specified. When completed, there shall be no free-standing liquid asphalt on the surface of the asphalt-sand mixture during reservoir construction.

C. Reinforced Concrete Ringwall

1. Concrete

Reinforced concrete ringwall shall be constructed of structural concrete placed against soil or rock below subgrade and against forms above subgrade. It shall be of the size shown on the Drawings. Surface finish shall be Class 3 on sidewall above subgrade and Class 1 on top. Top edges of ringwall shall be chamfered 1".

2. Anchor Bolts

Anchor bolts, when required, shall be placed prior to placing the ringwall. Anchor bolt positions are critical and must be set in the exact locations called for to avoid interfering with the tank shell or bottom plate. Anchor bolt locations shall be verified by Contractor before and immediately after placing the ringwall.

3. Non-Shrink Grout/Cane Fiber Joint Filler

Filler non-shrink grout or cane fiber joint shall be placed between the top of ringwall and bottom of floor plates. Non-shrink grout material shall be 1-12" thick and placed around entire ringwall circumference from the inside edge of ringwall to 2" outside of the bottom plate. Cane fiber join filler shall be 1/2" thick, and placed around entire ringwall circumference from the inside edge of ringwall to the outside of the bottom plate. Top of ringwall shall be dampened prior to placing non-shrink grout. Contractor shall adhere to all published manufacturer's installation procedures. Non-shrink grout shall be Sikagrout 212, or approved equal.

4. Tolerances

The center of the ringwall shall not vary more than ±1/2" from the radius specified. Variations in wall thickness shall not exceed ±1/2" or -0" above subgrade anywhere along circumferential length. Variations in wall thickness shall not exceed ±6" or -0" below subgrade. The top of the concrete ringwall shall be smooth and level and shall not vary more than ±1/8" in any circumferential length of 30' and the top surface shall not vary more than ±1/4" from the specified elevation.

D. Steel Grade Band

1. Grade Band

Grade band shall be 10 gauge (minimum) steel plate by 18 inches (minimum) high and attached to permanent steel stakes with hot-dipped galvanized steel bolts.

2. Steel Stakes

Steel stakes shall be hot-dipped galvanized and shall be of adequate size and embedment to maintain the grade band in a fixed and "plumb" condition based on the inside/outside finished grade elevations specified on the Drawings. Steel stakes shall not be visible after installation. Steel stakes shall be placed at intervals not exceeding 10 feet.

3. Tolerances

Grade band shall not vary more than ±1 inch from the radius specified. The top of the grade band shall be smooth and level and shall not vary more than ±1/8 inch in any thirty feet of circumferential length. It shall also not vary more than ±1/4 inch from the specified elevation shown on the Drawings.

PART 3 - EXECUTION

3.01 Protective Coatings

A. Surface Preparation

All tank plates (interior and exterior) and appurtenances to be fusion bonded epoxy coated shall receive surface preparation in accordance with Specification Section 09915. All tank plates and appurtenances shall be thoroughly washed and rinsed to remove grease, oil, and foreign matter. Parts shall be immediately oven-dried. Tank parts shall then be grit blasted to SSPC-SP10-63T (near white blast cleaning) to 1-2 mil profile.

B. Tank Plates

1. Interior Coating

All interior tank surfaces, including underneath side of tank floor plates, shall be factory-coated with a fusion bonded epoxy coating. Field coating, except for touchup, will not be permitted. The completed fusion bonded epoxy coating system shall have a minimum dry film thickness of 6.0 mils.

2. Exterior Coating

All exterior tank surfaces shall be factory-based with a fusion bonded coating system consisting of a 3 mil fusion bonded epoxy primer and a 3 mil fusion bonded polyester top coat. Field coating, except for touchup, will not be permitted. The coating system shall have a total minimum dry film thickness of 6.0 mils. Exterior tank color shall be as selected by Owner.

The same factory-coated fusion bonded epoxy coating as applied to the sheet surfaces shall be applied to all panel edges, including cut edges for appurtenances.

C. Tank Appurtenances

All ferrous metal tank appurtenances and accessories, excluding those specified to be hot-dipped galvanized, shall be fusion bonded epoxy coated per Specification Section 09915. Surface preparation and coating application shall be in accordance with said section.

D. Factory/Field Inspection

Factory coated sheets shall be inspected in the factory for thickness and color uniformity and field tested for holidays during erection. Factory inspection shall be performed by an independent, NACE-certified coating inspector retained and paid for by the Contractor. All holidays shall be repaired in accordance with tank manufacturer's written recommendations. Sheets with excessive electrical leakers shall be rejected and replaced at manufacturer's expense. Manufacturer shall submit to Owner results of factory inspection, including a diagram and tabulation of results for all areas tested for coating thickness.

E. Shipping and Erection

Factory coated tank panels shall be properly packaged and protected during shipment and erection to prevent abrasion or scratching of the finished coating. Damaged or gouged tank panels shall be replaced with new panels at no cost to the Owner.

F. Warranty

Tank manufacturer shall provide a five (5) year warranty for the coating system.

3.02 Tank Erection

The tank shall be erected in accordance with AWWA D103 and in strict accordance with the procedures outlined in the manufacturer's erection manual. All work shall be performed by an authorized dealer of the tank manufacturer, regularly engaged in erection of these tanks, using factory trained and certified erectors.

A. Tank Floor and Starter Rings

All floor bolts and bolt threads shall be covered with a plastic encapsulated nut. The plastic encapsulation shall be NSF compliant.

The starter ring shall be leveled with the maximum differential elevation within the ring not exceeding 1/8" anywhere, nor exceeding 1/16" within any 10' of length.

B. Sidewall Structure

Particular care shall be taken in handling and bolting of the tank panels, structural members, and appurtenances to avoid abrasion of the coating system.

An electrical leak test shall be performed after erection using a wet sponge nine (9) volt leak detection device. All electrical leak points found on the inside surface shall be repaired in accordance with manufacturer's published touch up procedure.

C. Roof

Tank roof shall consist of a radially sectioned roof fabricated from fusion bonded epoxy coated, bolted steel panels, as produced by the tank manufacturer, and shall be assembled in a similar manner as the sidewall panels utilizing the same sealant and bolting techniques, to assure a weather tight assembly. The roof shall be clear-span and self-supporting. Both live and dead loads shall be carried by the tank walls. The manufacturer shall furnish roof openings as shown on the Drawings and as specified herein.

3.03 Bolted Joint Inspection and Testing

All bolted joints will be visually inspected by Owners representative. Contractor shall provide scaffolding and lighting for visual inspections.

Tank bottom shall be tested by the vacuum method as described herein. Roof plates and joints between bottom plates and tank shell need not be tested.

Upon completion of bottom, Contractor shall test all bolted joints in their entirety in accordance with AWWA D103, latest, by the vacuum method utilizing a partial vacuum of at least 2 psi. All tests shall be performed in the presence of the Owner. Tank bottom and shell shall be entirely watertight.

3.04 Disinfection, Filling, Sampling, and Testing

The tank shall be disinfected after all coating work has been completed. Owner will fill tank and inspect same for leaks. If leaks are observed, Contractor shall immediately repair same.

Before filling, Owner may establish survey points on the tank for vertical control to monitor settlement of the tank on filling. Thereafter Contractor, in the presence of the Inspector, shall clean and disinfect the tank as follows:

A. Contractor shall notify Owner when interior tank sealant and caulk has cured, 14 days minimum, or longer as determined by Contractor.

B. Contractor shall pressure spray-flush all interior surfaces including top of dollar plate and interior of vents 2 times using construction water. If necessary, Contractor shall use a combination of brushing and pressure spray-flushing to clean interior of the tank. Capacity of pressure spray pump shall be such that sufficient volume, as approved by Owner, is able to extend a minimum of 5' beyond the highest surface required to be cleaned. After the tank is clean, Contractor shall drain construction water and clean tank floor of all remaining silt and debris.

C. Owner will place approximately 6" of potable or chlorinated water in the bottom of tank and Contractor shall add sufficient chlorine to produce a chlorine concentration of 100 ppm. Contractor shall then pressure spray-flush all interior surfaces 4 times using the chlorinated water. Contractor shall maintain the chlorinated water inside the tank at 50 ppm chlorine residual for 24 hours minimum. Owner will thereafter drain the tank after verification of chlorine residual. If the 50 ppm minimum chlorine residual is not maintained, Contractor shall repeat the disinfection procedure.

D. Owner will fill the tank to not more than half capacity and check settlement. Thereafter Owner will fill tank to full capacity and leave it full for 5 days minimum. Owner will inspect tank during said week for apparent leaks and settling.

E. After tank has been filled for 24 hours, Owner will take water samples for bacteriological analyses. After tank has been filled for 5 days, Owner will take water samples for volatile organic analyses. Results from said analyses will be sent to the Department of Public Health for their review and approval. If the results are not approved, Owner will drain the tank and Contractor shall force ventilate same until he again determines the coating to be cured. Contractor will be charged for all subsequent water to rechlorinate and refill tank and for all subsequent bacteriological and volatile organic analyses until the results of said analyses are approved by the Department of Public Health.

F. Owner will provide a reasonable quantity of water at no charge to Contractor for pressure flushing, chlorination, and filling tank; however, water for pressure flushing, chlorination, and filling will be limited to one event each. Owner will charge for any additional events.

3.05 Cleanup

Upon completion of the work, all staging, scaffolding, containers, steel scraps, nuts and bolts, rags, sacks, and all materials and equipment used in the performance of the work shall be removed from the site. All damage to surfaces resulting from the work shall be cleaned, repaired, or refinished to the complete satisfaction of the Owner.

END OF SECTION

SECTION 15025
BASIC PIPELINE SPECIFICATIONS

PART 1 - GENERAL

1.01 Description and Scope

Contractor shall furnish all pipe, fittings, materials, equipment, and labor and perform all operations necessary to construct pipelines and appurtenances as specified by the Owner as shown by the Drawings. Drawings shall consist of construction drawings, installation drawings, laying drawings, standard drawings, detailed drawings, layout drawings, fabrication drawings, shop drawings, and clarifying diagrams or sketches.

The Work shall consist of all traffic control (including furnishing and installing all barricades, signs, delineators, arrow boards, and flagmen); all utility location and verification (excavating, exposing, and verifying locations, depths, and dimensions of utility facilities); all pavement removal and disposal; all earthwork (including trenching, shoring, dewatering if required, blasting if required, bedding, backfilling, and compacting); furnishing and installing all pipe, fittings, appurtenances, and making all related connections; protecting in place or removing and replacing all existing utilities and public and private improvements; removing and replacing all asphalt and Portland cement concrete pavement; pavement striping and restriping as required; disinfecting and testing all pipelines; disposing of excess soil and rock material; and restoring all areas and improvements to pre-construction conditions.

Contractor shall, upon completion of pipeline construction and appurtenances required herein, initially operate all components of the Work installed or furnished and installed by him, and make any additional adjustments, corrections, repairs, replacements, and reconstructions necessary to provide the Owner with complete, correctly operating pipelines and appurtenances.

1.03 Submittals

Complete fabrication, assembly, and installation drawings, together with details and data governing materials used and other accessories furnished, shall be submitted for approval in accordance with Specification Section 01300. Data shall include, but not be limited to, the following:

A. Ductile Iron Pipe

Contractor shall furnish an Affidavit of Compliance in accordance with Section 51-5, AWWA C151, latest. Contractor shall also furnish certifications of the following:

1. Material Certification

   a. Grade of iron (chemical requirements)
   b. Flanges
   c. Nuts and bolts
   d. Flange gaskets
   e. Rubber Gaskets

2. Manufacturing Certification

a. Hydrostatic Test Reports
b. Tensile Test Reports
c. Impact Test Reports

Unless specified otherwise, Contractor shall furnish detailed installation or laying drawings showing pipe, fittings, appurtenances, station, and elevation for each fitting, and each change in alignment or slope. Contractor shall submit the installation or laying drawings to the Owner for acceptance in all cases in time sufficient to allow review and acceptance, and to accommodate the Contractor's construction schedule.

B. Welded Steel Pipe

Contractor shall furnish an Affidavit of Compliance in accordance with Section 1.12, AWWA C200, latest, and Section 1.7 AWWA C205, latest. Contractor shall also furnish certifications of the following:

1. Material Certification

a. Steel Skelp
b. Flanges
c. Nuts and Bolts
d. Flange Gaskets
e. Rubber Gaskets

2. Manufacturing Certification

a. Pipe Mill Reports
b. Production Weld Test Reports
c. Hydrostatic Test Reports
d. Outlet Reinforcement Calculations*
e. Pipe Wall Thickness Calculations*

* If not shown by the Drawings.

Unless specified otherwise, Contractor shall furnish detailed layout and shop or fabrication drawings showing pipe, lining, coating, reinforcement, joints, fittings, appurtenances, and station and elevation for each fitting and outlet and for each pipe joint at each change in pipe class, alignment, or slope. Contractor shall submit detailed layout and shop or fabrication drawings to the Owner for acceptance in all cases in time sufficient to allow review and acceptance, and to accommodate the Contractor's construction schedule.

C. Polyvinyl Chloride Pipe

Contractor shall furnish an Affidavit of Compliance in accordance with Section 6.3, AWWA C900 and C905 (latest). Contractor shall also furnish certified copies of test reports containing results of all physical and chemical tests on pipe and coupling showing compliance with AWWA C900 and AWWA C905 (latest) as modified herein.

Unless specified otherwise, Contractor shall prepare detailed installation or laying drawings showing pipe, fittings, appurtenances, station and elevation for each fitting, and each change in alignment or slope. Contractor shall submit the detailed installation or laying drawings to Owner for approval in all cases in time sufficient to allow review and approval, and to accommodate the Contractor's construction schedule.

Revisions shown on the shop drawings shall be considered changes necessary to meet the requirements of these Specifications and shall not be taken as the basis of claims for extra charges. Contractor shall accept such revisions or submit others for acceptance. When delays are caused by resubmissions of shop drawings, Contractor shall not be entitled to any damages or extensions of time for such delays.

The Owner's acceptance of detailed layout and shop or fabrication drawings shall apply only to general arrangement and general compliance and not to specific details and dimensions and their correctness and compatibility. Contractor shall correct any misfits due to any errors in the detailed shop or fabrication drawings. Any fabrication in advance of receipt of detailed layout and shop or fabrication drawings marked "Accepted" or "Furnish as Corrected" shall be at Contractor's risk. Contractor shall furnish the Owner six sets of all accepted layout and shop or fabrication drawings.

PART 2 - PRODUCTS

2.01 General

A. Construction Materials

Contractor shall furnish only approved materials as listed in the Owner's approved materials list. All materials shall be new and of the best quality for their intended use. All like materials shall be of one manufacture for any particular project.

Contractor shall, in addition to furnishing other data herein required, submit three signed and dated copies of the list of materials to be used in pipeline and appurtenance construction including but not limited to pipeline installations, pipeline valve installations, air valve installations, blowoff installations, manway installations, service installations, fire hydrant installations, and related appurtenances.

2.02 Ductile Iron Pipe

A. Scope

Ductile iron pipe and fittings shall conform with applicable provisions of AWWA C104, C105, C110, C111, C115, C150, C151, and C153, latest, as modified herein, by the Drawings, or by the Owner.

All ductile iron pipe shall be manufactured by organizations which have had not less than ten years successful experience in the manufacture of the type of pipe specified. The Owner shall approve manufacturer's product before its use.

B. Pipe

All pipe shall be ductile iron and shall conform with AWWA C151 (ANSI A21.5, and applicable portions of ASTM A536, Grade 60-42-10), latest, as modified herein by the Drawings, or by the Owner.

1. Pipe, including standard, random, and special short lengths, shall be Class 150 minimum and, unless specified otherwise, shall have push on joints. Minimum pipe wall thickness shall be as noted by the construction drawings or specified by the Owner; it shall not be less than noted by the standard drawings. Pipe wall thickness shall be increased if necessary to accommodate threads or grooves or if required for extremely shallow (less than 2.5 feet) or excessively deep (more than 14 feet) pipeline cover. 90 percent of all pipe of any specific class and size, excluding special short lengths, shall be furnished in standard lengths. The remaining 10 percent may be furnished in random lengths.

2. Standard lengths shall have nominal lengths of 18 feet up to 36 inches in diameter and 20 feet above 36 inches in diameter, plus or minus 1 inch. Random lengths of pipe may be up to 2 feet shorter than standard lengths. Special short lengths shall only be furnished where needed to accommodate specified fittings.

3. Pipe shall have an interior cement mortar lining of double thickness in accordance with AWWA C104 (ANSI A21.4), latest, except that interior mortar lining shall not be asphalt seal coated. Said lining shall be full thickness throughout pipe except for bell which shall be cleaned and lightly sprayed or brushed with an asphaltic or bituminous coating in accordance with AWWA C151 (ANSI A21.51). The interior cement mortar lining shall be moisture cured for at least two days before shipment. To prevent moisture loss during the curing period, ends of pipe shall be kept closed with plastic caps or covers which shall remain in place until installation.

   Steam curing may be substituted for moisture curing, providing one hour of steam curing is equivalent to six hours moisture curing and ambient vapor is maintained at relative humidity of 85 percent with temperature ranging between 110 degrees Fahrenheit and 150 degrees Fahrenheit for minimum steam curing period of six hours, after which exterior coating may be applied. The lining shall then be cured for another twelve hours before shipment. Other methods of curing the cement mortar lining may be used providing they are acceptable to the Owner.

   Temperature and shrinkage cracks in cement mortar lining less than 1/16 inch in width or 24 inches in length need not be repaired. Cracks wider than 1/16 inch or longer than 24 inches shall be repaired unless it can be demonstrated to the satisfaction of the Owner that the cracks will heal autogenously under continuous soaking in water.

4. Pipe shall have an exterior asphaltic or bituminous coating in accordance with AWWA C151 (ANSI A21.51), latest.

5. All pipe shall be furnished with rubber gasketed push-on type joints unless mechanical joints or flanged joints are otherwise specified or permitted. Joint restraints may be required as specified by the Owner. All joints shall comply with AWWA C111 (ANSI A21.11), latest, as approved by the Owner.

6. Rubber gaskets shall conform AWWA C111 (ANSI A21.11) latest.

7. Each pipe shall be marked with the weight, class, or nominal thickness and casting period. The manufacturers mark, year in which pipe was produced and the letters "DI" or "ductile" shall be cast or stamped on the pipe. All required markings shall be clear and legible and all cast marks shall be on or within 2 feet of bell ends.

8. Where restrained joints are required, they shall be accomplished with boltless restrained joint gaskets or components. Restrained joints shall be ductile iron in accordance with applicable provisions of AWWA C111 and C151 (ANSI A21.11 and A21.51, respectively), latest, except as to manufacturer's proprietary dimensions. Set screws shall not be utilized for any application.

   Each restrained joint for pipe 4 inches through 12 inches shall consist of a gasket system where stainless steel locking segments molded within the gasket provide restraint for pipe joints or fitting joints.

   Each restrained joint for pipe 14 inches through 24 inches shall consist of a gasket system where stainless steel locking segments molded within the gasket provide restraint for pipe joints or fitting joints, or, alternatively, a boltless restrained push-on joint system where ductile iron locking segments inserted through slots in the bell face provide positive axial lock between the bell interior surface and the spigot retainer weldment or gripper ring.

   Each restrained joint for pipe 27 inches and larger shall consist of a boltless restrained push-on joint system where ductile iron locking segments inserted through slots in the bell face provide positive axial lock between the bell interior surface and the spigot retainer weldment or gripper ring.

   All restraining components must make full contact around the circumference of the pipe, even if it has deflected. Field cut kits shall be composed of full ring gripper rings with serrated edges and shall be compatible with the pipe joints and fitting joints.

C. Fittings

All fittings shall be ductile iron except where fabricated cement mortar lined and cement mortar coated welded steel pipe fittings are specifically permitted or specified. Fabricated cement mortar lined and cement mortar coated fittings shall be flanged and they shall conform with the cement mortar lined and cement mortar coated welded steel pipe fittings specified herein.

Ductile iron fittings shall conform with AWWA C110, C111, and C153 (ANSI A21.10, A21.11, and A21.53, respectively), latest. Unless specified otherwise, fittings shall be push-on joint and comply with AWWA C111 (ANSI A21.11).

Fittings shall have an asphaltic outside coating in accordance with AWWA C110 or C153 (ANSI A21.10 or A21.53), latest, and cement mortar lining in accordance with AWWA C104 (ANSI A21.4), latest. Fittings shall have standard lining thickness and shall be seal coated with asphaltic material or other approved material. The lining process must produce a dense, compacted lining that shall be bonded to the interior of the fitting and have a smooth surface.

Where restrained joints are required, they shall be accomplished with boltless restrained joint gaskets or components and shall comply with all requirements of Part 2.02, B8 herein. Restrained joint fittings shall be of same joint design as the restrained joint pipe. Restrained joints shall be ductile iron in accordance with applicable provisions of AWWA C110 and C153 (ANSI A21.10 and A21.53), latest, except as to manufacturer's proprietary dimensions.

D. Testing

All pipe, including standard, random, and special short lengths, furnished shall be tested in the United States in accordance with AWWA C151, latest.

E. Inspection

The Owner shall at all times have the right to inspect all Work and materials during the course of manufacture. Manufacturer shall furnish the Owner reasonable facility for obtaining such information as he may desire regarding the progress and manner of the Work and the character and quality of materials used.

F. Loading, Transporting, and Unloading

After the pipe has been tested in accordance with Section 5 above, it shall be loaded on rubber-tired vehicles, and adequately supported and chocked to prevent any damage during transportation, and delivered to the Work site. During loading, unloading, and stringing operations, pipe and fittings shall be moved with care to prevent damage thereto. Unloading shall be accomplished in a workmanlike manner as directed by the manufacturer. Under no circumstances are pipe and fittings to be dropped or bumped in handling.

G. Defective or Damaged Material

Pipe and fittings shall be carefully inspected for defects. Any pipe found to be defective in workmanship or materials or so damaged as to make repair and use impossible shall be rejected and removed from the Work site.

In the event that pipe is damaged, damaged portions may be removed, as approved by the Owner, and discarded. Remaining sound portions may be used with ductile iron fittings. Contractor shall be responsible for any and all damage to material and he shall stand the

expense of repairing or replacing same. Contractor shall take proper precautions to assure that rubber gaskets are protected from oxidation or undue deterioration.

H. Special Lining

Where special lining is specified on the Drawings, fittings and pipe shall be provided with lining in accordance with Part 2.07 herein.

2.03 Welded Steel Pipe (Cement Mortar Lined and Cement Mortar Coated)

A. Scope

All welded steel pipe shall conform with applicable provisions of AWWA C200, C205, C206, C207, and C208, latest, and applicable portions of M11 "Steel Pipe Manual", latest, as modified herein, by the Drawings, or by the Owner.

All welded steel pipe shall be manufactured by organizations with at least ten years successful experience in manufacturing, fabricating, lining, and coating the type of pipe specified. Owner shall approve manufacturer's methods, equipment, facilities, and operations before performance of any work and manufacturer's completed product before its use.

Standard or special pipe sections and standard or special connections, outlets, and fittings may be manufactured at a single plant, or they may be manufactured at two separate plants (Plant 1: manufacturing of standard sections of lined, coated, and cured steel pipe consisting of steel pipe cylinder formation and lining, coating, and curing; Plant 2: fabricating special pipe sections and standard or special connections, outlets, and fittings using standard sections of manufactured lined, coated, and cured steel pipe). Special pipe sections and standard or special connections, outlets, and fittings fabricated at a separate manufacturing plant shall be comprised of standard pipe cylinders that have been formed, lined, coated, and cured at a single manufacturing plant. The separate manufacturing plant shall use facilities and methods for lining and coating repair and curing equal to the facilities and methods of the manufacturer of the standard sections of lined, coated, and cured steel pipe.

B. Pipe and Fittings

All pipe and fittings furnished shall conform with applicable provisions of AWWA C200, C205, C206, C207, and C208, latest, and applicable portions of AWWA M11, "Steel Pipe Manual", latest, as modified herein, by the Drawings, or by the Owner.

1. Pipe and fittings shall be Class 150 minimum. Minimum steel cylinder thickness shall be as noted by the construction drawings or specified by the Owner; it shall not be less than 10 gage or as noted by the standard drawings. All pipe and fittings shall be machine cement mortar lined and machine cement mortar coated.

2. Curved alignment by use of pulled joints will be permitted. Maximum pull permitted from normal closure on one side of joint shall not exceed 1/2 inch for 8 inch pipe or smaller, 3/4 inch for 10 inch through 21 inch pipe, and 1 inch for

24 inch pipe and larger. Maximum joint deflections shall not exceed manufacturer's recommendation or 3 degrees; the more restrictive or lesser deflection shall apply.

3. Where greater curvature is required, Contractor may use fabricated bends as specified by the construction drawings or ordered by the Owner. For the purpose of reducing angular deflections at pipe joints, Contractor may use pipe sections of less than standard length. Closing courses and short sections of pipe shall be fabricated and installed by Contractor as found necessary in the field.

4. All fittings shall be shop fabricated unless the construction drawings indicate that fittings may be field fabricated, Contractor describes methods of fabrication, and the Owner specifically approves field fabrication. All fittings shall be fabricated from individual pipe sections, welded together, and lined and coated as described hereafter.

5. Lining of Fittings

   a. The application of cement mortar lining to miters, angles, bends, reducers, and other special sections, the shape of which precludes application by the machine spinning process, shall be accomplished by mechanical placement, pneumatic placement, or hand application and finished to produce a smooth, dense surface.

   b. If the interior of the fitting has not been previously machine lined, wire-fabric reinforcement or ribbon-mesh reinforcement shall be applied to the interior of fittings larger than 24 inches and shall be secured at frequent intervals by tack welding to pipe, by clips or by wire. Repaired areas of machine applied linings at miters, pipe ends, outlets, and other cuts made in the lining for fabrication of the fittings need not be reinforced if the width of the repair area does not exceed 12 inches. Repairs for widths exceeding 6 inches shall be bonded to the steel and adjacent faces of the lining with an approved bonding agent.

      Immediately after lining has been completed, pipe and fittings shall be water cured without being disturbed for at least one day before applying the exterior coating, if such a coating is specified. If cement mortar coating is not specified, the lining shall be kept moist for four days before shipment. In either case, the lining shall be cured for at least four days before shipment. To prevent moisture loss during the curing period, ends of the pipe sections shall be kept closed with plastic end caps or covers which will remain in place until time of installation. The date of lining and class of pipe shall be plainly marked on the inside of each fitting.

6. Coatings of Fittings

   Mortar coating for pipe bends and other special sections not adaptable to the application of spiral-wire coating reinforcement shall be reinforced with wire fabric or ribbon mesh. The wire fabric or ribbon mesh shall be applied over the

surface of the pipe to be coated, and may be held away from the pipe shell with self-furring mesh, furring clips, or an equivalent method. The application of the mortar coating shall be by mechanical or pneumatic means to the specified thickness, except that hand application may be substituted for all specials. After the outside coating has been applied, the pipe and fittings shall be kept continually moist by continuous spraying for at least four days. Provisions shall be made to protect the coating from erosion during sprinkling. The date of coating and class of pipe shall be plainly marked on the inside of each fitting.

C Pipe Joints

Unless specified otherwise, joints shall conform to the following types. Joints shall be as specified on the construction drawings or by the Owner. All joints shall be continuity bonded.

1. Rubber Gasket Joints

All rubber gasket joints shall conform with AWWA C200, latest.

2. Flanged Joints

All flanges 4 inches through 12 inches shall conform with AWWA C207, latest, Class E (ring) or ANSI B16.5 Class 150. All flanges larger than 12 inches shall conform with AWWA C207, latest, Class E (ring). All flange bolts shall be standard hex head machine and conform with ASTM A325. All flange nuts shall be heavy hex cold pressed semi-finished steel and conform with ASTM A194-2, 2H.

All flanges shall be fully welded to pipe on both faces, one pass minimum on the inside, and two passes minimum on the outside. Pipe linings shall extend to mating faces of flanges. Bolt threads shall be lubricated with an approved anti-seize compound. Flanges together with bolts and nuts, shall be, once installed, coated with an approved bitumastic material.

3. Swedged Lap Welded Joints

Bell ends shall be formed integrally with pipe cylinders, being swedged out by machine. Bell ends shall be designed and fabricated to withstand design pressure of class of pipe specified and to permit spigot ends (plain end) to enter belled ends approximately 1 inch with clearance of approximately 1/32 inch.

4. Banded Lap Welded Joints

Where lap welded joints are required and swedged lap welded joints cannot be fabricated, belled ends shall be formed by welding steel bands to outside circumferences of plain ends of pipe. Bell ends shall be designed and fabricated to withstand design pressure of class of pipe specified and to permit spigot ends (plain ends) to enter belled ends approximately 1 inch with a clearance of approximately 1/32 inch.

5. Sleeve Couplings

Where sleeve couplings are required, they shall conform with the construction drawings. Pipe coatings at pipe ends shall be held back 12 inches and pipe shall have weld seams ground flush within 12 inches from pipe ends, unless specified otherwise. For above ground applications, pipe ends and sleeve couplings shall be painted. For below ground applications, pipe ends and sleeve couplings shall be coated with an approved bitumastic material. An approved bitumastic coating shall be substituted for mortar coating within 12 inches of pipe ends. After joints have been coupled, sleeve couplings shall be coated with an approved bitumastic material.

6. Cut-to-Fit Joints

Where cut-to-fit joints are required, they shall conform with the standard drawings and the construction drawings. Pipe coatings at cut-to-fit joints shall be held back as required to permit construction of joints; pipe coatings shall thereafter be added in the field. Field applied pipe coatings shall match manufactured pipe coatings. Contractor shall provide, at his expense, cut-to-fit joints, in addition to those specified, if necessary to accommodate his work and schedule.

7. Shop Testing of Joints and Joint Ends

Every pipe section, standard, or special, shall be hydrostatically tested after joint ends have been completely shop formed and attached in place by welding, as applicable, or dye check tested provided pipe cylinders had been previously hydrostatically tested.

D. Cement Mortar Lining and Cement Mortar Coating

1. General

Cement mortar lining and cement mortar coating shall conform with AWWA C205, latest.

2. Surface Preparation

Prior to lining and coating, pipe shall be cleaned of all loose mill scale, moisture, rust, sand, dust, oil, grease, and other deleterious or objectionable matter both inside and outside.

3. Cement Mortar Lining

a. Mortar

Mortar shall consist of one part Portland cement to three parts (by weight) clean, sharp sand. Unless specified otherwise, cement used for cement mortar shall conform with ASTM C-150, latest, Type II. Sand shall consist of clean, inert, sharp, durable material, maximum grain size

being no more than one-half specified minimum lining thickness. Mortar shall be thoroughly mixed and made workable with clear, potable water. All cement mortar shall develop a minimum compressive strength of 2,600 psi minimum at seven days and 4,500 psi minimum at twenty-eight days.

b. Application and Treatment

Cement mortar shall be applied to interior surfaces of pipe with equipment specifically designed for that purpose. Said equipment shall have a retracting feed line that will provide uniform cement mortar distribution throughout pipe length. Pipe shall be slowly rotated in horizontal position while cement mortar is being applied. Each end shall be provided with suitable end dam during spinning operation to control lining thickness and provide square-finished lining end.

Following application of mortar, pipe shall be rotated at sufficient speed to compact lining mortar. Said speed shall be maintained until all excess water has been forced to lining surface. During the spinning operation, surplus water shall be expelled from pipe by blower or other suitable means. Peripheral speed and spinning time shall be sufficient to obtain dense, well compacted lining with smooth surface free from defects. Minimum lining thickness shall be as shown by the standard drawings.

Immediately after lining has been completed, pipe shall be water cured without being disturbed for at least one day. Moisture loss shall be prevented during the curing period.

4. Cement Mortar Coating

a. Mortar

Mortar shall consist of one part Portland cement to three parts (by weight) clean, sharp sand. Materials for cement mortar coating shall be the same as materials for cement mortar lining. All cement mortar shall develop a minimum compressive strength of 2,600 psi minimum at seven days and 4,500 psi minimum at twenty-eight days.

b. Application and Treatment

After pipe interior has been lined, cement mortar shall be applied to outside of pipe through fixed nozzles to form an even, dense, and tightly adhering coating. During coating operation, pipe shall be rotated and moved beneath said fixed nozzles to obtain uniform coating free from defects. Minimum coating thickness shall be as shown by the standard drawings.

Cement mortar coating shall be reinforced with spirally wound steel (reinforcing) wire embedded midway within coating. Reinforcing wire shall be bright basic wire comprised of low carbon, open hearth steel,

unannealed after the last draw, with an approximate ultimate tensile strength of 80,000 psi. Said wire shall be No. 14 gage minimum and it shall be placed at a pitch of 1-1/2 inch maximum in the middle third of the coating.

Immediately after coating has been completed, each end of each section shall be cleansed to bare metal and cement mortar shall be troweled and shaped suitable for joint being used. All exposed bare metal shall be cleaned and coated and painted for protection against corrosion. Completed pipe shall then be water cured for at least four days without being disturbed.

E. Manufacturing Inspection

The Owner shall at all times have the right to inspect Work and materials during the course of manufacture. Manufacturer shall furnish the Owner reasonable facility for obtaining such information as it may desire regarding progress and manner of work and character and quality of materials used.

F. Loading, Transporting, and Unloading Pipe and Fittings

After pipe and fittings have been manufactured as set forth above, they shall be braced at the plant with wooden struts of adequate size to protect against excessive deflection. Each set of struts (two struts minimum to a set) shall be nailed together at right angles as a unit. Wooden wedges may be used to accomplish proper tight fit for the struts. Bracing shall be located 1 foot in from each end of each pipe section for pipe 24 inches and smaller, and additionally at mid point for pipe 30 inches and larger.

After the struts have been installed, pipe shall be loaded on rubber-tired vehicles, adequately supported and choked to prevent damage during transportation, and delivered to Work site. All bracing shall remain in place until each pipe section has been bedded and backfilled to at least 1 foot above the top of the pipe for pipe 24 inches and larger.

Plastic end caps or covers shall be placed over the ends of pipe following installation of braces to prevent moisture loss during loading, transporting, unloading, and installing; they shall remain in place until installation. If the plastic and caps or covers are damaged (perforated), they shall be replaced immediately.

During loading, unloading, and stringing operations, pipe and fittings shall be moved with care to prevent damage thereto. They shall be moved with nylon chokers or straps of sufficient width, placed at third points (one-third length of pipe from each end), to prevent damage to exterior coating, and they shall be handled in such manner to prevent damage to interior lining. Steel slings shall not be used.

Unloading shall be accomplished in a workmanlike manner by Contractor and every precaution shall be taken to prevent damage to pipe and fittings. Under no circumstances are pipe sections to be dropped or bumped in handling. Any pipe section that becomes damaged shall be repaired if possible and, if not possible in the opinion of the Owner, it shall be replaced with an undamaged pipe section. When strung, pipe shall be

adequately supported and chocked to avoid movement until it is installed. It shall also be placed to avoid damage during construction.

2.04 Polyvinyl Chloride Pipe

A. Scope

Polyvinyl chloride (PVC) pipe furnished and installed under these Specifications shall conform to applicable AWWA Standards (latest), as modified herein, by the Drawings, or by Owner.

All pipe furnished shall be manufactured by an organization which has had not less than 10 years successful experience in the manufacture of the type of pipe specified. Owner shall approve manufacturer's product before its use.

B Pipe and Couplings

All pipe and couplings furnished shall conform to AWWA C900 and C905 (latest) and the following additional requirements:

1. Unless otherwise specified or shown on Drawings, AWWA C900 pipe and couplings (4" through 12" diameter) shall be minimum Class 235 (maximum dimension ratio of 18). Polyvinyl chloride pipe shall have same dimensions as ductile iron pipe and pipe bell and pipe spigot shall have same thickness as pipe barrel.

   Standard lengths of pipe shall have nominal length of 20 feet, 0 inches, plus or minus 1 inch. Standard lengths of pipe shall be furnished with integral bells and spigots and with rubber gaskets. Couplings may be used for closures and curved alignments where permitted by Owner.

   Pipe shall have sufficient strength to withstand an internal hydrostatic pressure of four times rated operating pressure for its class per AWWA C900 (latest).

2. Unless otherwise specified or shown on the Drawings, AWWA C905 pipe and couplings (14" through 36" diameter) shall have maximum dimension ratio of 18 (Class 235). Polyvinyl chloride pipe shall have same dimensions as ductile iron pipe and pipe bell and pipe spigot shall have same thickness as pipe barrel.

   Standard lengths of pipe shall have nominal length of 20 feet, 0 inches, plus or minus 1 inch. Standard lengths of pipe shall be furnished with integral bells and spigots and with rubber gaskets. Couplings may be used for closures and curved alignments where permitted by Owner.

   Pipe shall have sufficient strength to withstand an internal hydrostatic pressure of two times rated operating pressure for its class per AWWA C905 (latest).

3. Where restrained joints are required (specified or shown on the Drawings), the restraint system shall be a split ring installed on the spigot connected to a solid back-up ring seated behind the bell. Restraint system shall be Series 1350 Uni-

Flange, Star Pipe Products Series 1100, or equal. The solid back and split rings shall apply even pressure around the pipe and provide 360° contact. Restraint device shall be ductile iron with 316 stainless steel rods and nuts. Restraint device shall be rated for full working pressure of the pipe with 2:1 factor of safety.

C. Fittings

All fittings shall be Class 150 ductile iron unless otherwise specified or shown on the Drawings.

Ductile iron fittings shall conform with AWWA C110, C111, and C153 (ANSI A21.10, A 21.11, and A21.53, respectively), latest. Unless specified otherwise, fittings shall be push-on joint and comply with AWWA C111 (ANSI A21.11).

Fittings shall have an asphaltic outside coating in accordance with AWWA C110 or C153 (ANSI A21.10 or A21.53), latest, and cement mortar lining in accordance with AWWA C104 (ANSI A21.4), latest. Fittings shall have standard lining thickness and shall be seal coated with asphaltic material or other approved material. The lining process must produce a dense, compacted lining that shall be bonded to the interior of the fitting and have a smooth surface.

Where PVC fittings are specified on the Drawings or permitted as an alternative as specified on the Drawings, fittings shall be in compliance with AWWA C907 (4" through 8"). Affidavits and testing results shall be submitted as required for PVC pipe.

Where "special lining" is specified, it shall be provided in accordance with Part 2.08 herein.

Where restrained joints are required (specified or shown on the Drawings), the system shall be suitable for mechanical joint fittings or push-on fittings and be of split ring design providing even pressure around the pipe with 360° contact. The rings shall be ductile iron and threaded rods shall be 316 stainless steel. System shall be Uni-Flange Series 1300 or equal.

D. Testing

All pipe and couplings furnished shall be tested in the United States in accordance with Section 4, AWWA C900 and AWWA C905.

E. Manufacturing Inspection and Certification

Owner shall at all times have the right to inspect all work and materials in the course of manufacture. Manufacturer shall furnish Owner reasonable facility for obtaining such information as he may desire regarding the progress and manner of the work and the character and quality of materials used.

F. Loading, Transporting, and Unloading

After the pipe has been tested in accordance with Section 5 above, it shall be loaded on rubber-tired vehicles, adequately supported and chocked to prevent any damage during transportation, and delivered to job site. All pipe and couplings (AWWA C900 and C905) shall be unloaded and stored in accordance with AWWA manual M23 (latest). During the unloading and stringing operations, the pipe shall be moved in such a manner as to prevent injury to the pipe and/or couplings. Unloading shall be accomplished in a workmanlike manner as directed by the manufacturer. Under no circumstances are pipe sections to be dropped or bumped in handling.

G. Defective or Damaged Material

The pipe and couplings shall be carefully inspected for defects. Any pipe, coupling, sleeve, or rubber ring found to be defective in workmanship or material or so damaged as to make repair and use impossible shall be rejected and removed from the job site.

In the event that pipe is damaged, the damaged portion may be removed, as approved by Owner, and discarded. Remaining sound portions may be used with ductile iron fittings or with couplings. Contractor shall be responsible for any and all damage to material and he shall stand expense of repairing or replacing same. Contractor shall take proper precautions to assure that the rubber gaskets are protected from oxidation or undue deterioration.

2.05 Valves

A. Air Valves

Air valves shall be manufactured in accordance with AWWA C512, latest, except as specified herein or as shown by the standard drawings.

Unless specified otherwise, air valves shall be combination air or combination air and vacuum valves (air, vacuum, and automatic release). They shall permit automatic escape of large quantities of air from pipeline when it is being filled, permit large quantities of air to enter pipeline when it is being emptied, and allow accumulating air to escape while pipeline is in operation and under pressure.

Air valves shall have ductile iron bodies and covers, stainless steel floats rated 1,000 psi minimum, stainless steel internal working parts, stainless steel pressure seats, and white Viton "O" rings or seats. Unless specified otherwise, air valves shall be service rated at cold water working pressure of 300 psi minimum. Unless specified otherwise, resilient seats shall be service rated for 150 psi maximum operating pressure.

Air valve interiors shall be completely fusion bonded epoxy coated (12 mils minimum) in accordance with AWWA C550, latest. The Owner shall approve epoxy coating material and methods before application. Completed coating shall be free from all defects and shall be inspected by use of low voltage holiday detectors and non-destructive thickness gauges.

Air valve inlets shall be flanged or threaded as specified and outlets shall be threaded at the same nominal sizes as the inlets, minimum. Air valves shall be subjected to factory hydrostatic test at pressure equal to 200 percent rated working pressure with no harmful deflections or other defects.

Air valve outlets shall be adequately screened to prevent entrance of foreign substances or materials. Screens shall be installed in accordance with the standard drawings. Where valves contain more than a single outlet, each outlet shall be adequately screened.

Air valves shall be tagged or labeled with the manufacturer's name, size, model number, pressure rating and other specialty features as listed above or as specified by the Owner. Contractor shall provide manufacturer's certification that all materials used in valves produced under AWWA 512, latest, conform with Section 2.1 of said standard.

Air valves shall be kept clean and free from dirt, earth, debris, and other deleterious materials prior to, during, and after installation and construction. Until in operation, each valve shall be protected by the use of an approved canvas or plastic bag or sack completely covering valve and securely fastened to valve riser.

B. Butterfly Valves (Buried Service)

Butterfly valves shall be manufactured in accordance with AWWA C504, latest, except as specified herein or as shown by the standard drawings. Butterfly valves shall be capable of buried service; they shall be equipped with valve boxes in accordance with the standard drawings.

Unless specified otherwise, butterfly valves shall be short laying length pattern with ANSI B16.1 Class 125 flanges. Butterfly valves shall have heavy duty ductile or grey iron bodies in accordance with ASTM A536 and 316 stainless steel edged ductile or grey iron discs. Valve stems, each with 2 inch square operating nut, shall turn counterclockwise to open. Unless specified otherwise, butterfly valves shall be service rated at cold water working pressure of 150 psi minimum.

Valve shafts shall be manufactured of Type 304 stainless steel with stainless steel journals. Valves shall contain synthetic rubber seats (Buna N or equal) mounted in valve bodies. Internal retaining rings and screws used with rubber seats shall be Type 304 (18-8) stainless steel.

Butterfly valves shall be epoxy coated (8 mils minimum) inside and outside in accordance with AWWA C550, latest. The Owner shall approve epoxy coating materials and methods before application. Completed coating shall be free from all defects and shall be inspected by use of low voltage holiday detectors and non-destructive thickness gages.

Butterfly valves shall be tagged or labeled with the manufacturer's name, size, model number, pressure rating and other specialty features as listed above or as specified by the Owner. Contractor shall provide manufacturer's certification that all material used in valves produced under AWWA C504, latest, conform with Section 2.2 of said standard.

C. Gate Valves (Buried Service)

Gate valves shall be manufactured in accordance with AWWA C509, latest, except as specified herein or as shown by the standard drawings. Gate valves shall be capable of buried service; they shall be equipped with valve boxes in accordance with the standard drawings.

Gate valves shall have ductile iron bodies, resilient seats, and ANSI B16.1 Class 125 flanges. Valve stems, each with 2 inch square operating nut, shall be nonrising and shall turn counterclockwise to open. Gate valves shall have "O" ring seals, non-shock cold water working pressure of 200 psi, minimum.

Gate valves shall be fusion bonded epoxy coated (8 mils minimum) inside and outside in accordance with AWWA C550, latest. The Owner shall approve epoxy coating materials and methods before application. Completed coating shall be free from all defects and shall be inspected by use of low voltage holiday detecting and non-destructive thickness gauges.

Gate valves shall be tagged or labeled by the manufacturer with the manufacturer's name, size, model number, pressure rating and other specialty features as listed above or as specified by the Owner. Contractor shall provide manufacturers certification that all materials used in valves produced under AWWA C509, latest, conform with Section 2.1 of said standard.

2.06 Services

A. Service Taps

Service taps shall be on line with meter boxes which shall be perpendicular to mains. Service and other taps shall be made not closer than 2 feet to a bell, coupling, joint, fitting, or other service. Service taps will be permitted only where complete services are to be installed. Under no circumstances will Contractor be allowed to tap existing mains which are in service. Contractor shall tap existing mains only when said mains are out of service and only when specifically permitted by the Owner.

1. Ductile Iron Pipe Mains

Service outlets on mains shall be accomplished with double strap bronze service saddles with iron pipe threads.

2. Welded Steel Pipe Mains

Service taps shall be made with couplings welded to the pipe, either during pipe fabrication or field construction, as shown by the standard drawings. Tapping shall be accomplished with a shell cutter. Care shall be exercised to minimize damage to linings and coatings. Damaged linings and coatings shall be repaired or replaced.

3. Testing and Disinfection

Service taps used for testing and disinfection shall comply with service tap requirements for ductile iron or welded steel pipe, whichever is applicable. Unless specified otherwise, they shall be made at top of pipe. Once testing and disinfection have been completed, they shall be plugged. Plug threads shall be wrapped with Teflon tape and plugged tap shall then be coated with approved bitumastic material.

B. Services Extensions

In addition to a service tap, each service shall include a corporation stop, service pipe, a meter stop, a meter box, and all other materials specified by the standard drawings. Unless specified otherwise, service piping shall be continuous from corporation stop to meter stop; it shall not be spliced.

C. Meter Boxes

Meter boxes shall be equal to and interchangeable with those shown on the standard drawings and shall be installed as shown on the standard drawings. They shall be set true to line and grade and shall be flush with concrete curbs and sidewalks.

Meter boxes shall be installed whenever services are installed, even prior to construction of street improvements including concrete curbs and sidewalks. Meter boxes shall be brought to grade upon construction of concrete curbs and sidewalks.

D. Meter Installation

Except as otherwise indicated on the construction drawings or as specified by the Owner, all meters shall be installed by the Owner following application for service in accordance with the Owner's regulations governing water service and any amendments thereto.

2.07 Special Lined Ductile Iron Pipe

Where "special lined" ductile iron pipe is specified on the Drawings, Special Requirements, or herein, or where ductile iron pipe is specified as gravity sewer; pipe and fittings shall be lined with a system to provide special corrosion resistance.

Pipe and fittings shall be as specified in Part 2.02 herein, except lining system shall be as follows:

A. Protecto 401 Ceramic Epoxy, 40 mils thick as manufactured and applied by U.S. Pipe, Pacific States Cast Iron Pipe Company, or equal.

B. Polybond Plus as manufactured and applied by American Cast Iron Pipe Company. Lining system shall consist of 5 mils fusion bonded epoxy primer and 45 mils (minimum) of fusion bonded polyethylene surface layer.

2.08 PVC Pipe with Special Lined Fittings

Where PVC pipe with "special lined" fittings is specified on the Drawings, Special Requirements, herein, fittings shall be lined with a system to provide special corrosion resistance.

PVC pipe and fittings shall be as specified in Part 2.04 herein, except fittings shall be provided with special lining system as specified in Part 2.07 herein.

PART 3 – EXECUTION

3.01 Pipeline Construction

A. Pipelines and Appurtenances

Pipelines and appurtenances shall be constructed in accordance with these Specifications and the Construction Drawings, and as specified by the Owner.

B. Valves and Appurtenances

Pipeline valves at pipeline intersections shall be connected directly to pipeline intersection fittings (cross or tee) and, unless specified otherwise, all mainline or side outlet valves shall be located 3 feet minimum from any curb face. Pipeline valves shall not be placed under curb or gutter or in parkway unless approved by the Owner.

All appurtenances, including but not limited to air valve installations, blowoff installations, and related facilities, such as fire hydrants, fire services, and water services, shall not be installed within 5 feet of curb returns, curb depressions, and driveway approaches, or in inaccessible locations or locations where interferences may restrict facility operation, unless permitted otherwise by the Owner.

Unless specified otherwise, air valve installations shall be constructed at all pipeline high spots and blowoff installations shall be constructed at all pipeline low spots. Contractor shall construct, at his expense, air valve installations and blowoff installations in addition to those specified, if necessary to accommodate his work and schedule.

C. Pipeline Length

All pipeline lengths noted by the Construction Drawings or otherwise specified or referenced shall mean net horizontal constructed lengths and said lengths shall extend through all fittings and appurtenances including bends, outlets, tees, flanges, and valves. Contractor shall provide all pipe necessary to accommodate any vertical alignment of the pipeline and said pipe shall be represented by the net horizontal constructed length.

D. Pipeline Alignment

All pipelines shall be constructed with no basic variation in horizontal alignment as shown by the Drawings or as specified by the Owner. Pipelines shall be constructed parallel with centerlines of streets or rights-of-way and appurtenances shall be

constructed perpendicular thereto unless the construction drawings specify otherwise. Pipelines may be constructed by the use of pulled joints, short joints, bevels, bends, and elbows, provided pipelines are constructed as specified.

In all non-critical areas and subject to the Owner's approval, pipelines may be constructed at variance with vertical alignment as shown by the construction drawings by the use of pulled joints, short joints, bevels, bends, and elbows provided pipelines are constructed as specified at pipeline connections and underground interferences, and where pipeline cover is limited. The Owner will not approve any variation in vertical alignment until it has determined that proposed alignment is proper and modifications are in order.

E. Pipeline Tolerances

With regard to vertical alignment, pipelines shall be constructed so that actual flow line elevations, measured at pipe joints, are within 0.1 foot of design flow line elevations. Pipelines, when installed, shall have continuous slope upgrade or downgrade, corresponding with design slope, without any high spots.

With regard to horizontal alignment, pipelines shall be constructed so that actual pipeline centerlines, measured at pipe joints, are within 0.1 foot of design pipeline centerlines. Pipelines, when installed, shall closely follow specified horizontal alignment.

Pipeline construction shall conform with Construction Drawings and layout, shop, fabrication, installation, or laying drawings (design drawings which show flow line elevations and pipeline centerlines) in accordance with the above specified tolerances. Contractor shall make or assist the Owner in making all necessary measurements, as determined by the Owner, to confirm or verify compliance with construction tolerances.

F. Pipeline Cover

Pipeline cover as shown by the Construction Drawings is hereby defined as design cover over pipeline. If field conditions determined during construction staking show that pipe grade changes are required to provide design cover, Contractor shall, at his expense, make required changes in pipeline grade and construct pipeline accordingly.

Pipeline cover from top of pipe to ground surface over pipeline shall not be less than 36 inches. Where future ground surface elevation over pipeline has been established and where actual ground surface is greater, pipeline cover shall be referenced to future (established) ground surface elevation, not actual ground surface elevation.

3.02 Survey Monuments and Construction Stakes

Contractor shall not disturb or destroy any existing monuments or bench marks. If any survey monuments or bench marks need to be removed and replaced, Contractor shall have all necessary services performed by a registered civil engineer or a licensed land surveyor. If Contractor fails to comply, the Owner will have said services performed at Contractor's expense.

Before removing any monuments in preparation for construction, Contractor shall have a registered civil engineer or licensed land surveyor set at least four ties for each monument to be

removed and replaced; after construction Contractor shall have the same registered civil engineer or licensed land surveyor replace each monument using the aforementioned ties and file a corner record for each replaced monument.

Unless specified otherwise, Contractor shall use construction stakes and cut sheets for pipeline construction and the Owner will use them for construction inspection. All construction stakes shall be set by a registered civil engineer or licensed land surveyor . The Owner must approve cut sheets before actual construction. Contractor shall protect all construction stakes set for construction and he shall restore any construction stakes destroyed or disturbed. If Contractor fails to comply, the Owner will have services performed at Contractor's expense.

3.03 Traffic Control

Contractor shall prepare, submit, and provide traffic control drawings for construction. Said traffic control drawings shall be approved by the Owner and agencies having jurisdiction over highways, thoroughfares, and streets prior to starting construction.

Traffic control requirements may be modified by the Owner or said agencies as conditions warrant. Contractor shall modify traffic control as required by the Owner or said agencies at no additional cost. Throughout the Work, Contractor shall inspect traffic control equipment (signs, barricades, arrowboards, and delineators) and shall maintain same in accordance with said traffic control drawings.

All construction signing, lighting, and barricading shall comply with State of California, Department of Transportation "Manual of Traffic Controls, Warning Signs, Lights, and Devices for Use in Performance of Work Upon Highways", latest edition.

3.04 Underground Utilities (Subsurface Installations)

Where underground utility facilities (conductors or conduits for water, gas, sewer, telephone, electric power, cable television, or other utilities) are shown on construction drawings, Contractor shall assume that service facilities (services or laterals for water gas, sewer, telephone, electric power, cable television, or other utilities) extend from each utility facility to each parcel or property whether or not service facilities are shown.

At least two working days but no more than fourteen calendar days before commencing any excavation on the Work, Contractor shall request Underground Service Alert (1-800-227-2600) and non-member companies or utilities to mark or otherwise indicate the locations of their subsurface facilities including, but not limited to, structures including vaults, main conductors or conduits, and service connections or facilities.

Contractor shall comply with applicable laws pertaining to subsurface installations, especially with respect to excavations and permits. Contractor shall specifically comply with applicable provisions of Sections 4215 through 4216.9 of the Government Code. Contractor shall take all actions necessary to maintain a valid inquiry identification number during the Work.

At least ten days in advance, or 1,000 feet minimum ahead of pipeline trenching, Contractor shall excavate, expose, and determine ("pothole") the exact locations, depths, and dimensions of each and every potential interference, including, but not limited to, all facilities shown specifically

(depth and location) on construction drawings, or which have been marked by their respective owners.

Upon learning of the existence or location of any utility facility omitted from or shown incorrectly on construction drawings, or improperly marked or otherwise indicated, Contractor shall immediately notify the Owner, providing full details as to depth, location, size, and function. Contractor shall immediately notify utility having jurisdiction over facility.

Contractor shall not interrupt or disturb any utility facility without written permission from the Utility or written order from the Owner. Where protection is required to ensure integrity of utility facilities located as shown on construction drawings or visible to Contractor or marked or otherwise indicated as stated herein, Contractor shall, unless otherwise provided, furnish and place all necessary protection at his expense.

Contractor is advised that the Owner has no knowledge or information about trench backfill conditions of utility facilities adjacent to or parallel with pipeline being constructed pursuant to these Specifications; therefore, Contractor shall protect against adjacent or parallel trench backfill failure. If adjacent or parallel trench fails, Contractor shall, at his expense, remove and replace said backfill material in accordance with trench backfill requirements herein and remove and replace asphalt concrete pavement and any other improvements damaged in connection therewith.

3.05 Storage of Equipment and Materials

Contractor shall not store equipment or materials on private or public property without written permission from property owner(s) approving such use. Said permission shall be submitted to and approved by the Owner before Contractor moves equipment or materials onto site.

Contractor shall not park equipment or store materials in public right-of-way except while performing Work. Contractor shall remove equipment from public right-of-way and place it in Contractor's storage or construction yard by the end of each work day. Contractor shall keep materials in Contractor's storage or construction yard until they are needed for the Work.

Storage site or construction yard shall be completely fenced prior to moving any equipment or materials onto site or into yard. Contractor shall control dust in construction yard at all times, from establishing construction yard through construction, and until all Work has been completed and Contractor has moved all equipment, materials, and fencing from site.

3.06 Trench Excavation

A. General

Unless specified otherwise, pipelines and appurtenances shall be installed in open trench excavations to the depth and in the direction specified by the construction drawings. Excavation for trenches shall include removal of all material of any nature as required for installation of pipe, fittings, or appurtenances and shall include blasting, either sloping or shoring, and all necessary dewatering, if any, all at Contractor's expense.

Contractor is advised that unsuitable earth may be encountered during trenching operations. Where such material is encountered, Contractor shall, at his expense, remove

such material, discard it at legal disposal site(s), and thereafter replace it with approved backfill material.

B. Excavation Safety Drawings

Before excavating any earth or soil to a depth of five (5) feet or more, Contractor shall, pursuant to Labor Code Section 6705, submit to the Owner detailed drawings (hereafter referred to as excavation safety drawings) showing design of shoring, bracing, sloping, or other provisions to be made for worker, individual, or property protection. Said excavation safety drawings shall comply with OSHA Construction Safety Orders (Cal/OSHA or Federal OSHA, whichever is applicable at time of construction) and shall be prepared and certified by a registered civil or structural engineer, engaged by Contractor at his expense, who shall affix his signature and seal to each sheet of said excavation safety drawings. Contractor shall not excavate until the Owner has received and acknowledged properly certified excavation safety drawings. Contractor shall comply with all other applicable requirements of Labor Code Section 6705 and, as therein provided, no requirements of that Section shall be construed to impose tort liability on Owner or Owner's representatives, including Owner's Engineer.

C. Trench and Bell Hole Sloping or Shoring

Trenches and bell holes shall be adequately sloped or shored so that earth will not slide or settle into trench, so that all existing improvements and utilities (above and below ground) will be fully protected from damage, and so that workers and individuals are protected from injury. At minimum, Contractor shall keep toe of trench spoil at least 5 feet from top of trench. Contractor shall assume full responsibility for all damages caused by inadequate sloping or shoring. Contractor shall make all necessary repairs or perform all reconstruction at his expense and he shall bear all other expenses resulting from such damages.

D. Trench Length, Width, and Depth

Unless specified otherwise, trenches shall be excavated not more than 1,000 feet in advance of pipe laying and open trenches shall be properly barricaded and signed as required for individual and property protection. Trenches shall not be excavated or left open nights, weekends, or holidays.

Unless specified otherwise, all pipeline trenches within pipe zone shall, wherever possible, have vertical sides and minimum widths as specified on the standard drawings, however, trenches shall be sloped or shored as required for worker, individual, and property protection.

Whenever maximum allowable trench width, as shown by the Drawings, is exceeded for any reason, the Owner may, at its discretion, require Contractor, at his expense, to cradle pipe (Class B Portland cement concrete) or to provide higher class bedding to support pipe as required to limit load on pipe to allowable supporting strength. The Owner shall approve method of support prior to its use.

Trenches shall be excavated to depths specified by or shown on construction drawings or as otherwise directed by the Owner. If trench excavation is carried below grade without

direction or permission, Contractor shall, at his expense, refill trench to proper grade with moist clean sand, sand and gravel, or other suitable material as approved by the Owner, tamped in place to 90 percent relative compaction minimum. Excess excavated material shall be incorporated in backfill or discarded at legal disposal site(s) by Contractor at his expense.

E. Excavated Materials

All material excavated from trench shall be placed for minimum obstruction to traffic (automobile and pedestrian). Gutters shall be kept clear and other provisions shall be made for street or road drainage. Excess excavated material, including material rejected by the Owner for use as backfill, shall be discarded at legal disposal site(s) by Contractor at his expense.

If pipe, fittings, or appurtenances belonging to the Owner are uncovered or removed during excavation, they shall be salvaged and deposited as directed by the Owner. If the Owner determines that certain materials need not be salvaged, said materials shall be discarded at legal disposal site(s) by Contractor at his expense.

F. Blasting

Blasting for excavation will be permitted only with approval of the Owner and only after proper precautions have been taken for protection of persons and property, provided Contractor has secured all necessary permits. Blasting shall be limited to specific periods as approved by the Owner. Any damage caused by blasting shall be repaired by Contractor at his expense. Contractor's blasting methods and procedures shall conform with State and local laws and County and municipal ordinances. Contractor shall post signs warning radio equipment operators that blasting operations are in progress and advising that radio transmissions are prohibited during blasting operations.

3.07 Trench Bedding

A. General

Trenches shall have flat bottoms conforming with grades to which pipe is to be laid. Trench bottoms shall be uniform and provide firm and uniform bearing for installed pipeline.

Pipe shall be laid so that pipe barrel bears evenly on trench bottom. Bell holes shall be excavated in trench bottom and sides as necessary to permit satisfactory construction and inspection of pipe joints.

B. Unsuitable Soil

Where unstable soil consisting of loose, soft, spongy, or organic earth is encountered, it shall be removed from trench bottom to depth determined in field by the Owner and trench shall be refilled to proper grade with moist clean sand, sand and gravel, or other suitable material as approved by the Owner, tamped in place to 90 percent relative compaction minimum. Trench bottom shall be graded flat and prepared to provide firm and uniform bearing for pipe.

Where unyielding soil consisting of rock, rocky earth, or cemented earth is encountered, it shall be removed from trench bottom to at least 9 inches below grade and trench shall be refilled to proper grade with moist clean sand, sand and gravel, or other suitable material as approved by the Owner, tamped in place to 90 percent relative compaction minimum. Trench bottom shall be graded flat and prepared to provide firm and uniform bearing for pipe.

Unless specified otherwise, Contractor shall, at his expense, remove unsuitable soil, replace it with suitable soil, and discard unsuitable soil at legal disposal site(s). Contractor shall not deposit or store unsuitable soil on private or public property without written permission of property owner(s) and without applicable governmental permits pertaining to earthwork, including compaction, and the environment. Before placing any material on private or public property, Contractor shall provide the Owner with evidence of written permission to do so and he shall then obtain the Owner's written approval for same.

3.08 Ductile Iron Pipe Installation

Pipe manufacturer, fitting manufacturer, and material supplier, in addition to the Owner and the Owner's representative, shall have access to the Work during installation. Contractor shall use assistance provided by either manufacturer or supplier where required for proper installation of pipe, fittings, or materials; however, Contractor shall limit role of either manufacturer or supplier to advisory service.

All pipe shall be laid true to line and grade and at the locations shown by the construction drawings or as specified. Pipe shall be installed in accordance with applicable provisions of AWWA C600, latest, applicable provisions of Ductile Iron Pipe Research Association "Guide for the Installation of Ductile Iron Pipe", latest, and manufacturer's directions. Bell ends shall be placed uphill unless otherwise permitted.

After pipe has been set in trench, exterior of spigot and interior of bell shall be thoroughly cleaned. Lubricant recommended by pipe manufacturer and as approved by the Owner shall be applied to rubber gasket. Lubricant shall be water soluble, nontoxic, shall impart no objectionable taste or odor to the water, shall have no deteriorating effects on the rubber gaskets, and shall not support growth of bacteria. Excess lubricant shall be removed. Pipe ends shall be aligned, and spigot shall be pulled into bell with come-along devices, or hoists with chains and slings, unless permitted otherwise. If either the pry bar or the backhoe bucket method is permitted, a timber header shall be placed between the pipe and the pry bar or backhoe bucket before the spigot is pushed into bell.

Curved alignment by use of pulled joints will be permitted. Maximum joint deflection shall be 3 degrees. For purposes of reducing angular deflections at pipe joints, Contractor may install pipe sections of less than standard length.

Whenever cutting of pipe is required, it shall be done with a special cutting tool specifically made for cutting and machining ductile iron pipe. Cut ends and rough edges shall be ground smooth and beveled for push-on joints.

Whenever specified, pipe shall be encased with 8 mil (0.2 mm) thick minimum polyethylene tube lapped 1 foot minimum, and valves and fittings shall be wrapped with polyethylene tube or with polyethylene sheets lapped 1 foot minimum. Polyethylene tube and polyethylene sheets shall be secured in place with suitable adhesive tape. All polyethylene tube and polyethylene sheet encasements shall be installed in accordance with AWWA C105, latest.

As Work progresses, a pipe cleaning tool as approved by the Owner shall be drawn through pipe to remove dirt, rocks, or other foreign material. At the end of each day's work, all openings in the pipeline shall be plugged with watertight expandable plugs or approved equal.

3.09 Welded Steel Pipe Installation

A. Pipe Installation

Pipe manufacturer, fitting manufacturer, and material supplier, in addition to the Owner and the Owner's representative, shall have access to the Work during installation. Contractor shall use assistance provided by either manufacturer or supplier where required for proper installation of pipe, fittings, or materials; however, Contractor shall limit role of either manufacturer or supplier to advisory service.

Contractor shall not move pipe using dozer blades, backhoe buckets, or the like (sharp metal surfaces). Contractor shall use nylon chokers or straps, not steel slings, in moving, placing, or setting pipe. Nylon chokers or straps shall be placed at third points (one-third length of pipe from each end).

All out-of-round pipe shall be rejected and removed from the Work site immediately. Rejected pipe shall be replaced immediately. Contractor shall not use hammers, bars, wrenches, or other tools to modify pipe ends to accommodate installation.

All pipe ends shall be secured with plastic covers. Said plastic covers shall be left in place until pipe is prepared for installation. If any plastic covers are damaged or destroyed before pipe has been installed, they shall be immediately replaced.

All pipe and fittings shall be laid true to line and grade and at the locations shown by the construction drawings or as specified. Pipe and fittings shall be installed in accordance with applicable sections of AWWA M11, "Steel Pipe Manual". Bell ends shall be placed uphill unless otherwise permitted.

All flanges shall be fully welded to pipe on both faces, one pass minimum on the inside and two passes minimum on the outside. Pipe linings shall extend to mating faces of flanges and pipe coatings shall extend to backs of flanges, tapered as necessary for installation of bolts and nuts. All exposed steel shall be field coated with an approved bitumastic material.

Special care shall be taken to avoid damaging lining or coating during lowering of pipe into trench and making of field joints. Unless specified otherwise, field joints shall be bell and spigot rubber gasket joints, continuity bonded (two evenly spaced bonding clips per joint minimum). Flanged joints, welded joints, and mechanical joints may be required for particular applications.

After pipe has been set in trench, exterior of spigot and interior of bell shall be thoroughly cleaned. Lubricant as recommended by pipe manufacturer and as approved by the Owner shall be applied to rubber gasket, and said gasket shall then be snapped into place and excess lubricant removed. Lubricant shall be water soluble, nontoxic, shall impart no objectionable taste or odor to water, shall have no deteriorating effects on the rubber gaskets, and shall not support the growth of bacteria.

Before inserting spigots into bells, to make joints, bells shall be hand mortared with quick setting non-shrink commercial grout mixed with an approved bonding agent. Once spigots have been inserted into bells, joints shall be gauged to ensure that gaskets have been properly seated.

For pipe 24 inches and larger, Contractor shall relieve (equalize) gaskets before laying to prevent gaskets from being tight on one side of pipe and slack on the other side, and adversely affecting seal. Contractor shall lift gaskets with a round blunt tool (like the shaft of a screwdriver) and roll it around the circumference of the spigot end at least once and preferably twice.

For pipe less than 24 inches in diameter, sufficient quantities of moist cement mortar shall be placed on interior joining ends of pipe to completely fill space between respective mortar linings. Moist mortar shall be placed only after respective mortar linings have been properly wetted. Moist mortar shall not be placed against dry mortar linings. Excess mortar shall be removed by drawing an approved pipe cleaning tool through the pipe after joints have been made (pipe sections have been joined). For fully welded joints, pipe sections shall be pulled together and restrained with come-along devices, or hoists with chains and slings, and mortar shall be allowed to set for twenty minutes before welding joint. Once joint has been pulled closed and cleaning tool has been drawn through pipe sections, pipe alignment shall not be adjusted, nor shall pipe be bounced or hammered. Come-along devices, or hoists with chains and slings, shall be removed only after joint has been fully welded.

For pipe 24 inches in diameter and larger, cement mortar shall be placed on interior joining ends from inside pipe after it has been set. Moist mortar shall be applied only after mortar linings have been properly wetted. Moist mortar shall not be placed against dry mortar linings. Excess mortar and debris shall be removed by hand or by other means acceptable to and approved by the Owner.

For cement mortar coated pipe, joint exteriors shall be coated with cement mortar utilizing a joint diaper. Said diaper shall be furnished by pipe manufacturer and shall be centered over joint and securely fastened to pipe. Cement mortar joint mix consisting of one part Portland cement to two parts (by weight) clean, sharp sand, shall contain just enough water to allow mix to be poured into diaper and flow around circumference of joint. Said mix shall be allowed to set prior to backfilling around joint.

Joints shall be completed to provide continuous interior lining and exterior coating. Field lining and coating must equal or exceed shop lining and coating when completed with respect to strength, uniformity, and density and there shall be no voids between lining or coating and steel cylinder.

If cement mortar lining has to be removed, Contractor shall scribe, chisel, and remove the lining using appropriate tools. If cement mortar coating has to be removed, Contractor shall first scribe, then saw cut said coating 3/4 of its thickness, and then remove coating using a chisel driven by a hammer, chipping gun, or other suitable tool. Impact shall be applied parallel with pipe barrel, not perpendicular thereto.

At the end of each day's work, all openings in the pipeline shall be plugged with watertight, expandable plugs or approved equal. Said plugs shall be secured in place so that they cannot be removed by children or animals.

B Field Welding

Whenever field welding is required, Contractor shall attach welding machine ground to pipe only with clamps or other means acceptable to the Owner unless an alternative means is specified.

Unless specified otherwise, field welded or thrust restrained joints shall consist of flanged joints or fully welded joints. All flanges shall be fully welded to pipe on both faces, one pass minimum on the inside and two passes minimum on the outside. Welded joints shall be made with pipe having ends belled for welding, or alternatively, ends belled for rubber gasket joints, provided pipe manufacturer furnished filler rods of proper diameter, length, and curvature are installed in accordance with pipe manufacturer's recommendations, as approved by Owner. Belled ends shall not be deformed to accomplish fully welded joints. Full welds for all joints shall be accomplished with two welding passes (beads) minimum.

C. Field Cement Mortar Lining and Cement Mortar Coating

Whenever field cement mortar lining and cement mortar coating is permitted by the Owner for either repair or fabrication, Contractor shall comply with the following procedures:

1. Cement Mortar Lining

   a. Contractor shall square the edge of the remaining lining, leaving no feather edge, and shall clean metal surfaces with a stiff wire brush.

   b. Contractor shall apply approved bonding agent to both steel area and edges of adjacent lining. Cement mortar shall then be applied to the area being patched and worked and finished with a trowel until smooth. Contractor shall brush on approved curing compound over the surface of the patch to prevent rapid evaporation of moisture. Otherwise, Contractor shall keep the patched mortar moist by covering it with wet burlap. The pipe shall not be moved until the cement mortar achieves its initial set, not less than three hours.

   c. Cement mortar shall consist of not less than one part cement to three parts sand, thoroughly mixed before any water addition. Cement mortar may be approved commercial, packaged dry mortar mix. Cement mortar shall be mixed separately for each area to be patched. Quantity of water

shall be just sufficient so that when mortar is firmly compressed into a ball, it will hold its shape without slump.

2. Cement Mortar Coating

a. Exterior coating which requires removal around the complete circumference of the pipe shall be repaired by:

1) Removing the coating by chipping with a hammer or chisel, squaring the edges to accept repair patch.

2) Wrapping the area with 2 x 4 x 14 GA self-furring wire mesh or an approved stucco netting and guniting the area being patched.

or

Wrapping the mesh as above and hand troweling mortar onto the area being patched.

3) Applying an approved curing compound to the patched area.

4) Avoiding movement and protecting the pipe until the cement mortar achieves its initial set, not less than three hours.

b. Exterior coating that does not extend around the entire circumference of the pipe shall be repaired by:

1) Removing the coating by chipping with a hammer and chisel, squaring the edges to accept repair patch.

2) Applying by brush an approved bonding agent to both the steel area and the edges of the remaining coating.

3) Applying cement mortar to the area being patched and thoroughly compacting it, with finished patch mounding up above and overlapping (at least 1 inch on all sides) the surrounding coating.

4) Applying an approved curing compound to the patched area. If the repair patch is made on pipe in the ditch, it shall be covered with wet burlap, heavy cloth, or similar material, and dirt shall be placed around and over the patched area by hand before proceeding with placing backfill material.

c. The cement mortar mix proportions shall be the same as for lining repair.

d. If the area to be patched exceeds over half of the pipe circumference, 2 x 4 x 14 GA self-furring wire mesh or an approved stucco netting shall be attached to the pipe prior to the application of the cement mortar.

3. Installation of Repaired Pipe

After the repaired area has achieved initial set, not less than six hours, the pipe section can be installed, providing the patched area of the coating is backfilled with water saturated or wetted soil.

3.10 PVC Pipe Installation

Pipe manufacturer, fitting manufacturer, and material supplier, in addition to the Owner and the Owner's representative, shall have access to the Work during installation. Contractor shall use assistance provided by either manufacturer or supplier where required for proper installation of pipe, fittings, or materials; however, Contractor shall limit role of either manufacturer or supplier to advisory service.

All pipe shall be laid true to line and grade and at the locations as shown by the Construction Drawings or as specified. Pipe shall be installed in accordance with AWWA C605 and Manual M23 (latest) (including AWWA C905 pipe and couplings), applicable provisions of manufacturers installation guides (latest) and manufacturer's directions. Owner shall approve manufacturer's product before its use. Contractor shall furnish Owner with two manufacturers installation guides for use during construction. Bell ends shall be placed uphill unless otherwise specified.

Unless otherwise specified or shown on the Drawings, backfill within the pipe zone shall have a minimum sand equivalent of 50 as determined by ASTM D2419 (latest).

After pipe has been set in trench, exterior of spigot and interior of bell shall be thoroughly cleaned. Lubricant recommended by pipe manufacturer and as approved by the Owner shall be applied to rubber gasket. Lubricant shall be water soluble, nontoxic, shall impart no objectionable taste or odor to the water, shall have no deteriorating effects on the rubber gaskets, and shall not support growth of bacteria. Excess lubricant shall be removed. Pipe ends shall be aligned, and spigot shall be pulled into bell with come-along devices, or hoists with chains and slings, unless permitted otherwise. If either the pry bar or the backhoe bucket method is permitted, a timber header shall be placed between the pipe and the pry bar or backhoe bucket before the spigot is pushed into bell.

Curved alignment of AWWA C900 pipe shall be accomplished by longitudinal bending of the pipe. Minimum allowable bend radii shall be as specified by the pipe manufacturer. Unless otherwise allowed by the pipe manufacturer and approved by the Owner, axial deflection at the pipe joints of AWWA C900 pipe is prohibited. Where closing sections are required, Contractor shall make all necessary measurements to select appropriate pipe lengths and closure couplings for correct installation.

Curved alignment of AWWA C905 pipe by use of longitudinal bending is prohibited; however, curved alignment by use of pulled joints will be permitted. Unless otherwise allowed by the pipe manufacturer and approved by the Owner, maximum joint deflection shall be one (1) degree. For purposes of reducing angular deflections at pipe joints and for closure sections, Contractor may install pipe sections of less than standard length. Where closing sections are required, Contractor shall make all necessary measurements to select appropriate pipe lengths and closure couplings for correct installation.

Whenever cutting of pipe is required, it shall be done with a special cutting tool specifically made for cutting and machining PVC pipe. Cut ends and rough edges shall be ground smooth and beveled for push-on joints.

Pipe locator wire (No. 14 AWS insulated copper) shall be installed in trench with pipe where shown by the Standard Drawings unless it is specifically deleted by the Construction Drawings or by Owner. It shall be held in place by looping the pipe at 20 foot intervals maximum, or as specified.

As work progresses, a pipe cleaning tool as approved by Owner shall be drawn through the pipe to remove dirt, rocks, or other foreign material. At the end of each day's work, all openings in the pipeline shall be plugged with watertight expandable plugs or Owner approved equal.

Unless specified otherwise, polyvinyl chloride pipe shall not be encased with concrete. If protection is necessary it shall be accomplished by the use of conductor casing(s) as approved by Owner.

3.11 Trench Backfill

A. General

In addition to meeting backfill requirements specified herein, Contractor shall also comply with backfill requirements established through permits issued by jurisdictions (State, County, City) having control over rights-of-way in which construction is taking place. Whenever the separate requirements conflict with one another, the more stringent shall apply. Backfill shall not commence without prior approval of the Owner.

Backfill material shall be either select excavated material, screened or washed if necessary, or commercially processed material. Backfill material shall meet separate specific requirements for backfill within pipe zone and backfill above pipe zone. Backfill material meeting pipe zone requirements may be used for above pipe zone backfill material but not the reverse.

After sheeting, shoring, or shields have been removed, all backfill material including pipe zone backfill material shall be compacted to 90 percent relative compaction minimum except that the upper 12 inches of backfill material shall be compacted to 95 percent relative compaction minimum, as verified by field compaction tests. Relative compaction shall be based on maximum dry density determined in accordance with ASTM D-1557, latest. The Owner will specify where (number & location) compaction tests are to be taken.

Unless specified otherwise, the Owner will have all necessary compaction tests performed by soils engineer of its choosing. The Owner will pay for all passing tests; Contractor shall pay for all failing tests. Contractor shall notify the Owner when any segment of backfill has been compacted and is ready for compaction testing and the Owner will then have such tests performed.

Unless determined otherwise, compaction tests will be taken along the pipeline, in the pipe zone, above the pipe zone, and at ground surface or subgrade at 300 foot intervals maximum and along all service runs and fire hydrant runs. Contractor shall assist, at no

additional cost to the Owner, soils engineer in taking all compaction tests. Contractor shall furnish all equipment (including shoring), labor, and materials needed for such assistance. Compaction testing shall be completed and accepted by the Owner prior to hydrostatic and leakage testing of pipelines and appurtenances.

Within highways, thoroughfares, and streets, Contractor shall, at the end of each work day and by 5:00 PM, unless permitted otherwise, completely backfill trenches with material sufficiently compacted to support traffic. Contractor shall then place 2 inch minimum thickness temporary asphalt concrete pavement over trench; it shall be compacted, rolled smooth with a steel wheeled pavement roller and placed flush with adjacent pavement. Contractor shall maintain and repair backfilled and paved areas to prevent potholes or pavement failures. Highways, thoroughfares, and streets shall be completely open to traffic at night (after 5:00 PM), on weekends, on holidays, and whenever Contractor is not actively working in specific area.

Contractor shall not excavate trenches or install pipe in highways, thoroughfares, and streets on weekends and holidays. Holidays include union holidays, Owner holidays, and County and municipal holidays. Contractor shall not leave any excavation open overnight or on weekends or holidays.

B. Backfill Within Pipe Zone

Unless specified otherwise, select excavated material, screened or washed if necessary, shall be used and it shall consist of moist clean, loose earth, sand, or gravel (1 inch maximum size) free of clay and silt as well as brush, roots, and organic substances.

Initial backfilling shall be performed as soon as possible after pipe has been laid. Loose, moist backfill material shall be placed in trench simultaneously on each side of pipe to a depth not greater than pipe centerline (springline) or 12 inches (loose measurement), whichever is less, and it shall then be tamped under pipe so that all voids are eliminated and material is compacted to 90 percent relative compaction minimum.

Subsequent backfilling shall be performed immediately following initial backfilling. Loose, moist backfill material shall continue to be placed in trench simultaneously on each side of pipe in lifts not exceeding 12 inches in thickness (loose measurement), with each lift being tamped, until the pipe has been covered by at least 12 inches of well compacted material. Alternatively, backfill material may be densified by water settlement until the pipe has been covered by at least 12 inches of well densified material. Backfilled material shall be tamped or settled to 90 percent relative compaction minimum.

Regardless of compaction or densification technique, care in backfilling shall be exercised to avoid any damage to pipe, fittings, and appurtenances, to avoid any damage to persons or property, and to achieve relative compaction of backfilled material of at least 90 percent minimum.

C. Backfill Above Pipe Zone

Backfill material shall consist of moist clean loose earth, sand, gravel, or rock free of clay and silt as well as brush, roots, and organic substances. From the top of selected backfill in the pipe zone to within 1 foot of ground surface or pavement subgrade, backfill material shall be free of material exceeding 8 inches in greatest dimension. It shall also be compacted to 90 percent relative compaction minimum. Within 1 foot of ground surface or pavement subgrade, backfill material shall be free of material exceeding 2 inches in greatest dimension and it shall be compacted to 95 percent relative compaction minimum. Rocks shall be mixed with suitable soil to eliminate voids; they shall not be nested. Backfill material shall be well graded.

Backfill material shall be placed in lifts not exceeding 12 inches in thickness (loose measurement) and each lift shall be compacted to 90 percent relative compaction minimum by hand tampers, pneumatic tampers, or mechanical compactors except that the upper 12 inches of backfill shall be compacted with mechanical compactors or compaction equipment, excluding stompers, to 95 percent relative compaction. Alternatively and except for the upper 12 inches of backfill, sandy, granular soils may be densified by water settlement. Trench to be backfilled by water settlement shall be diked at suitable intervals not exceeding 100 feet. Impounded water shall be of sufficient depth so that earth pushed or shoveled into trench will at all times fall into water, becoming completely saturated. If necessary, jetting may augment flooding. Backfill densified by water settlement shall be densified to 90 percent relative compaction minimum. Contractor shall use mechanical compactors or compaction equipment, excluding stompers, to achieve required compaction if required densification is not achieved by water settlement.

D. Imported Backfill Material

Whenever excavated material is unsuitable as backfill material and Contractor is unable to process or screen such material for backfill material or whenever excavated material is insufficient to accomplish backfill and Contractor must secure additional material, Contractor shall import such material and the material and its source shall be approved by the Owner.

Unless specified otherwise, imported backfill material shall be commercially processed and it shall be selected, clean, loose earth, sand, or gravel (1 inch maximum size). Said material shall be granular and it shall be free of clay, silt, and fine sand. It shall be suitable for compaction with minimum effort.

E. Backfill Completion

Where pavement is not required, trench backfill shall be brought to grade of existing surface and dressed to provide firm, stable, and even surface without ruts or irregularities. It shall conform with grades of existing surface. Where pavement is required, trench backfill shall be brought to subgrade for pavement structure. Pavement shall then be placed in accordance with paving requirements.

3.12 Field Hydrostatic Test and Leakage Test

A. Hydrostatic Test

Upon completion of pipeline construction and at least seven days after last concrete thrust device has been placed, pipelines and appurtenances constituting the Work shall be filled with water for twenty-four hours minimum. During filling, Contractor shall see that all air valves are open and operating. After pipelines have been completely filled, they shall be allowed to stand for twelve hours minimum under slight pressure for sufficient time to permit all air to escape. During that same period, Contractor shall examine all fittings, flanges, handholes, and connections for leaks. If any leaks are found, they shall be eliminated.

Test pressure, 225 psi minimum for Class 150 pipe and 150 percent of pipe class for other classes of pipe, shall then be applied to test sections as directed by the Owner. Test pressures shall be maintained for four hours minimum. Test sections will be selected which give, as nearly as possible, constant pressure throughout section being tested. Normally test pressures will be measured at lowest elevations.

B. Leakage Test

After pressure test has been satisfactorily completed, pipelines and appurtenances shall be tested for leakage at pressure equal to the pressure class of pipe. Contractor shall test pipelines and appurtenances in test sections as designated by the Owner and required pressures shall be maintained for two hours minimum during which time leakage shall be accurately measured.

Measured leakage shall not exceed the limits set by the following formula unless otherwise specified by the construction drawings.

$$L = \frac{ND(P)^{1/2}}{5000}$$

L is the allowable leakage in gallons per hour for section of pipeline being tested; N is the number of joints (rubber gasket, flanged, or mechanical joints, not swedged or banded lap welded joints) where leakage could occur in the section of pipeline being tested; D is the nominal diameter (inches) of the pipeline being tested; and P is the weighted average test pressure (psi gauge) within the section of pipeline being tested during the leakage test.

C. General Requirements

1) Required test pressures shall be applied by pump connected to pipeline sections being tested. The Owner shall approve pump connections to pipeline before testing begins. As part of the Work, and unless specified otherwise, Contractor shall install, at his expense, top outlets (service taps) required for testing.

Contractor shall provide calibrated meters for measurement of leakage, and all pumps, piping, fittings, bulkheads, plugs, valves, gages, power equipment, and manpower necessary for conducting all tests required, all at his expense.

Contractor shall furnish the Owner three copies of all records of all tests performed.

2) Unless specified otherwise, Contractor shall test against test plates for pipelines 12 inches and smaller. Contractor shall not remove said test plates until pipelines have been tested, disinfected, and accepted by the Owner.

3) Contractor, at his expense, shall locate and repair leaks or other defects which may develop or become apparent during test. Contractor shall excavate, including removal of backfill already placed, and make all repairs necessary for required water tightness, and then replace all excavated material, after which Contractor shall retest repaired pipeline section. Pipeline sections shall be repeatedly repaired and tested until they meet requirements set forth herein.

4) Pipe manufacturer and fitting manufacturer shall have free access to the Work during testing. Any improper act on the part of Contractor which the pipe and fitting manufacturer may observe shall be reported to the Owner. Pipe and fitting manufacturer shall be free to observe and verify all tests.

5) After completed pipeline and appurtenances or test sections have successfully met test requirements to the satisfaction of the Owner, the entire pipeline or each test section shall be filled or shall remain filled with water until completion of the Work, unless otherwise ordered by the Owner.

3.13 Disinfection of Pipelines and Appurtenances

Contractor shall furnish all equipment, labor, and materials for the proper disinfection (chlorination and flushing) of all pipelines and appurtenances. As part of the Work, and unless specified otherwise, Contractor shall install, at his expense, top outlets (service taps) for required disinfection and sampling. Testing and disinfection must be completed before any pipelines are connected to the existing system.

Contractor may disinfect pipelines and appurtenances either before or after they have been subjected to hydrostatic and leakage tests, unless specified otherwise. If Contractor elects to disinfect before hydrostatic and leakage tests, and he must repair or replace pipelines as a result of said hydrostatic or leakage tests, Contractor shall again disinfect all or portions of the previously tested pipelines.

Disinfection shall conform with provisions of AWWA C651, latest. The chlorinating agent, liquid chlorine or chlorine gas, shall be applied or injected as approved by the Owner at locations no more than 10 feet from existing water system as selected by or designated by the Owner. Concentration of the dosage applied to the water within the pipeline shall be at least 50 ppm and it shall not exceed 200 ppm.

Chlorinated water must be retained in the pipeline long enough to destroy all non-spore-forming bacteria. Said period shall be at least 24 hours but not more than 72 hours. After the chlorine-treated water has been retained for the required time, the chlorine residual at the pipe extremities and at other representative locations shall be at least 25 ppm.

Following chlorination, Contractor shall flush all pipelines and appurtenances in the manner and with the procedure prescribed or approved by the Owner. During flushing, all valves shall be in full open free discharge position. Flushing shall continue until all chlorine, debris, and foreign materials have been removed from pipelines and appurtenances.

If so directed by the Owner, Contractor shall remove portions of certain appurtenances such as air valve installations, blowoff installations, and service installations in order to accomplish complete flushing; Contractor shall replace same without adversely affecting disinfected pipelines and appurtenances.

Following flushing, water shall be maintained in the pipeline for at least twenty-four hours, thereafter, bacteriological samples shall be taken and analyzed by a State of California certified independent laboratory as approved by the Owner. If initial treatment fails to produce satisfactory disinfection as evidenced by bacteriological analysis, chlorination and flushing shall be repeated until acceptable results have been obtained.

Contractor shall arrange and pay for chlorine residual and bacteriological quality tests. Contractor shall obtain the Owner's prior approval of the times, places, locations, and numbers of samples or tests. The Owner shall witness all sampling. Contractor shall provide an Affidavit of Compliance (in triplicate) to the Owner evidencing satisfactory disinfection.

Following disinfection, pipelines and appurtenances shall remain isolated from any operational water system facilities until evidence has been submitted to the Owner demonstrating that said pipelines and appurtenances have been adequately and properly disinfected. Said evidence shall consist of aforementioned Affidavits of Compliance together with said bacteriological test results, as submitted by the approved certified laboratory. Normally, said pipelines and appurtenances shall be isolated for at least 48 hours, longer if so determined by the Owner.

3.14 Conductor Casings and Carrier Pipes

Wherever required, conductor casings shall be installed. Said casings shall be comprised of either welded steel pipe or reinforced concrete pipe, as specified. Conductor casings shall be bored and jacked into place unless open trench installations are permitted; conductor casings shall not be sluiced or jetted into place. Conductor casings shall be bored and jacked into place from one direction only.

Conductor casings shall be installed to the lines, grades, and depths specified. Unless specified otherwise, Contractor will be permitted a tolerance from horizontal alignment and from vertical alignment of 0.5 percent of conductor length but no more than 1 foot maximum regardless of conductor length.

Unless specified otherwise, methods and equipment used shall be as selected by Contractor and as approved by the Owner. Said approval shall not relieve Contractor of any responsibility with regard to conductor casing construction. Conductor casings shall have minimum inside diameters at least 12 inches larger than maximum outside diameters of carrier pipes.

Prior to any boring and jacking operations, Contractor shall submit to the Owner a construction plan consisting of a schedule of operations, details of methods of construction, types of equipment to be used, details of boring and jacking pit including lengths, widths and depths, and

shoring and bracing. Said construction plan shall be approved as to sufficiency by the Owner before any construction is commenced.

Boring and receiving pits shall be shored in accordance with OSHA standards. A 6 foot high chain link fence shall be erected around said pits and said pits shall be protected with Type K barriers. Barriers shall be placed to direct traffic around the pits.

Prior to constructing pits, Contractor shall excavate both sides of each crossing to determine exact locations of facilities to be crossed (horizontal and vertical). Contractor shall adjust casing locations to accommodate crossings based on Contractor's field measurements.

Contractor shall schedule his operation to prevent pits from being open on weekends or holidays. Contractor shall provide traffic control around the pits in accordance with Contractor's approved traffic control drawings.

Contractor shall take all necessary precautions to prevent subsidence of or lifting of existing roadbeds, roadways, and pavements during or following installation of conductor casings. Material excavated during boring and jacking operations shall be removed carefully so as to avoid caving. Voids created during boring and jacking shall be grouted with an approved grout from within the casing once the casing has been installed. Couplings shall be welded to steel casing to permit grouting. Following grouting, threaded plugs shall be inserted into said couplings.

After conductor casing has been constructed, carrier pipe shall be equipped with approved plastic or steel casing insulators of uniform size and spacing and then installed in conductor casing in accordance with aforementioned construction plan as approved by the Owner. Annulus between conductor casing and carrier pipe shall be filled with sand and the ends shall be capped with plastic or steel end seals or plugged with brick and mortar. Weepholes shall be placed in the bottoms of the end seals or brick and mortar plugs.

Contractor shall backfill boring and jacking pits with material specified for pipeline backfill. Said backfill material shall be compacted to the relative compaction specified which shall be not less than 90%. Contractor shall remove conductor casing and carrier pipe remnants, shoring materials, asphalt, concrete and all other Work related debris. Contractor shall restore paved surfaces.

3.15 Miscellaneous Requirements

A. Connections to Existing Watermains

The Contractor shall make all connections to existing watermains in the presence of Owner's inspector. Contractor shall obtain a water connection permit from the Owner prior to performing said connection work. Contractor shall provide all labor, equipment, and materials necessary to perform connection work, including but not limited to, isolation gate valve, fittings, and adapters.

Hydrostatic testing against isolation valves will not be allowed. Adjacent to the isolation valve, Contractor shall install a test plate for the aforementioned test and, after satisfactory test, remove said test plate and replace it with a 1/8 inch thick minimum ring gasket. The use of any other test appurtenances shall be as approved by the Owner.

B. Field Painting

Contractor shall field paint all aboveground, bare, or exposed piping and appurtenances in accordance with the applicable specifications and drawings.

END OF SECTION

SECTION 15070
MISCELLANEOUS PIPING, CHEMICAL SYSTEM PIPING, AND APPURTENANCES TECHNICAL SPECIFICATIONS

PART 1 - GENERAL

1.01 Description

Pipe shall be furnished and installed as specified in Section 15025, Basic Pipeline Specifications, and as shown on the Drawings. Where pipe is not specified therein, pipe shall be as specified herein.

Contractor shall furnish and install piping specialties as shown and specified, complete, including small steel pipe, stainless steel pipe, copper tubing, solvent-welded PVC pipe, mechanical and sleeve couplings, gaskets, bolts, insulating connections, and such other specialties as required for a complete and operable piping system in accordance with the requirements of the Contract Documents.

1.02 Reference Specification, Codes, and Standards

Commercial Standards (Latest Edition)

ASTM A53	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
ASTM A312	Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipe.
ASTM B62	Standard Specification for Composition Bronze or Ounce Metal Castings.
ASTM B88	Standard Specifications for Seamless Copper Water Tube.
ASTM D1785	Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
ASTM D2657	Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings.
ASTM D4894	Standard Specification for Polytetrafluoroethylene (PTFE) Granular Molding and Ram Extrusion Materials.

1.03 Contractor Submittals

Contractor shall submit shop drawings in accordance with the requirements of Specification Section 01300. Contractor shall submit complete information and technical data for all material and components, including, but not limited to, the following:

A. A complete list of all materials to be provided under this Section.

B. Manufacturer's descriptive data, technical literature, and catalog cuts for each material item and appurtenance.

C. Fabrication drawings for each shop fabricated pipe spool, and pipe laying drawings for each pipeline.

D. Contractor shall submit manufacturer's certification that pipe fitters for E-CTFE piping system are certified and trained in accordance with the manufacturer's installation procedures.

PART 2 - PRODUCTS

2.01 Schedule Steel Pipe

Unless otherwise shown, schedule steel pipe shall be seamless, Schedule 40, conforming to ASTM A53. Fittings 3 inch and smaller shall be threaded, Schedule 40 and shall be constructed of malleable iron. Fittings 4 inch and larger shall be flanged, welded or grooved as shown on the Drawings, smooth flow (mitered fittings are not acceptable), Schedule 40, conforming to ASTM A234 and ANSI B16.9. Flanges shall be ANSI B16.5, Class 150, slip-on or weld neck.

Fittings for galvanized steel pipe shall be Schedule 40 and shall be constructed of galvanized malleable iron, with threaded ends. Fittings for black pipe shall be Schedule 40 with threaded or welded joints, as shown on the Drawings. Belowgrade galvanized pipe shall be double wrapped with 20 mil PVC tape. Below grade black pipe shall be coated with 32 mils of a bitumastic coating prior to double wrapping.

2.02 Stainless Steel Pipe

Unless otherwise shown, stainless steel pipe shall be Grade 316, Schedule 40 conforming to ASTM A312. Fittings 2 inch and smaller shall be threaded, Class 150, Grade 316 conforming to ASTM A351 and ANSI B16.3. Fittings 2-1/2 inch and larger shall be flanged, welded, or grooved as shown on the Drawings, smooth flow (mitered fittings are not acceptable), Schedule 40, Grade 316 conforming to ASTM A403 and A774, and ANSI B16.9. Flanges shall be Class 150, slip-on or weld neck, Grade 316 conforming to ASTM A182 and ANSI B16.5.

2.03 Copper Tubing

Copper tubing shall conform to the requirements of ASTM B88 and shall be Type K, soft temper for buried tubing and hard-drawn for above-ground application. Fittings shall be soldered or sweated on and shall be of cast bronze or forged brass containing 85 percent copper.

Soldered joints for water working pressures below 100 psi shall contain 50 percent tin and 50 percent lead. For higher water working pressures and for compressed air lines, soldered joints shall contain 95 percent tin and 5 percent antimony. For oxygen service, joints shall be made with silver solder.

2.04 PVC (Polyvinyl Chloride) Pipe, Schedules 40 and 80

PVC pipe shall be made from all new rigid unplasticized polyvinyl chloride and shall be Normal Impact (Type I) to conform to the requirements of ASTM D1785, unless otherwise shown. Schedule 40 fittings shall conform to ASTM D2466, Schedule 80 socket fittings to ASTM D2467 and ASTM D2464 for threaded Schedule 80 fittings. Unless otherwise shown, joint design shall be for solvent-welded. Both pipe and fittings shall be the product of one manufacturer.

2.05 CPVC (Chlorinated Polyvinyl Chloride) Pipe, Schedules 40 and 80

CPVC pipe, for hot, corrosive solutions and where shown, shall be made from all new rigid unplasticized chlorinated polyvinyl chloride, Type IV, Grade 1 compound as stated in ASTM D1784, and shall be Schedule 40 (as minimum thickness) unless otherwise shown, and shall conform to ASTM F441. Fittings shall be the same schedule as the pipe. Schedule 80 socket fittings shall conform to ASTM F439 and ASTM F437 for threaded Schedule 80 fittings. Unless otherwise shown, joint design shall be for solvent welded construction. Both pipe and fittings shall be the product of one manufacturer.

2.06 Sleeve, Flexible, and Adapter Type Couplings

Couplings shall be of steel with steel bolts, without pipe stop, and shall be of sizes to fit the pipe and fittings shown. The middle ring shall be not less than 1/4-inch in thickness and shall be either 5 or 7 inches long for standard steel couplings, and 16 inches long for long-sleeve couplings. Bolts and nuts for exposed couplings shall be hot-dip galvanized. Bolts and nuts for buried or submerged couplings shall be of Type 316 stainless steel. Buried sleeve-type couplings shall be epoxy-coated at the factory as specified. Continuity bonds shall be provided as shown.

Where specified on the Drawings, couplings shall be harnessed to provide restraint. Harnesses shall conform to the requirements of AWWA Manual M11.

Lug material shall conform to ASTM A36 or ASTM A283 Grade C. Lug dimensions shall be as shown in AWWA Manual M11. Lugs shall be Type P for pipe sizes, 6-inch to 10-inch diameter, and Type RR for pipe sizes 12-inch diameter and greater.

Couplings shall be provided where shown on the drawings and shall be Rockwell (Smith-Blair), Dresser, or equal.

2.07 Grooved Couplings

Where specified, mechanical grooved coupling shall be self-centering and shall engage and lock the grooved pipe and pipe fitting ends in place in a positive watertight couple. Coupling housing clamps shall be fabricated in two or more parts of malleable iron castings conforming to

ASTM A47, or ductile iron castings conforming to ASTM A536. Coupling assemblies shall be securely held together by two or more steel bolts and nuts of heat-treated carbon steel. Bolts and nuts shall be in accordance with ASTM A183 and A194, Grade 2. Couplings shall hold in place a gasket designed so that internal pressure serves to increase the seal's watertightness. Unless otherwise specified, gaskets shall be Grade "E" (EPDM) in accordance with ASTM D2000. Fittings shall be of grooved-end design to accept grooved mechanical couplings without field preparation.

Couplings for grooved steel pipe shall be Victaulic Style 77, or approved equal. Couplings for ductile iron pipe shall be Victaulic Style 31, or approved equal.

Unless shown otherwise on the Drawings, grooved coupling shall not be installed below grade.

2.08 Insulating Connections

A. General

Insulating bushings, unions, couplings or flanges, as appropriate, shall be used for joining pipes of dissimilar metals, and for piping systems where corrosion control and cathodic protection are involved, or where specified on drawings.

B. Material

Insulating connections shall be of nylon, polytetrafluoroethylene (PTFE, trade name Teflon) polycarbonate, polyethylene or other non-conductive materials, and shall have ratings and properties to suit the service and loading conditions.

2.09 Unions

Unless specified otherwise, unions shall be constructed of the same material as the adjoining piping. Union pressure rating shall not be less than the connected pipe. Union seal material shall be compatible with the process fluid being conveyed by the piping.

2.10 Chemical Piping System for Sodium Hypochlorite Solution, Ferric Chloride Solution, and Sodium Hydroxide Solution

Where specified or shown on the Drawings for sodium hypochlorite solution, ferric chloride solution, and sodium hydroxide solution, pipe and fittings shall be CPVC and shall be as specified in Part 2.05, herein, and shall be suitable for the transport of 12.5 percent sodium hypochlorite solution, 37 to 42 percent ferric chloride solution, and 25 to 50 percent sodium hydroxide solution. Single wall CPVC pipe and fittings shall be Schedule 80, unless noted otherwise. Provide valves in accordance with Section 15100, Process Valves Technical Specification.

2.11 Chemical Piping System for Sulfuric Acid Solution

A. Polytetrafluoroethylene (PTFE, trade name Teflon) Pipe

Where double containment piping is not specified or shown on the Drawings for sulfuric acid solution, pipe and fittings shall be PTFE and shall be suitable for transport of 93 to 98 percent sulfuric acid solution. Pipe and fittings shall be made from all new virgin PTFE resin conforming to ASTM D4894 Type IV, and shall be Schedule 80 suitable for NPT threading. Fittings having only male NPT threaded end connections shall be made from virgin PTFE resin conforming to ASTM D4894 Type V or ASTM D4894 Type I, Grade 1. Fittings having only female NPT threaded end connections shall be made from low-creep virgin PTFE resin conforming to ASTM D4894 Type III, Grade 1. Unless otherwise shown, joint design shall be for threaded construction. Both pipe and fittings shall be the product of one manufacturer. Provide valves in accordance with Section 15100. PTFE pipe and fittings shall be Fluor-O-Flo as manufactured by Micromold, or approved equal.

B. Ethylene-Chlorotrifluoroethylene (E-CTFE, trade name Halar) Pipe

Where double containment piping is specified or shown on the Drawings for sulfuric acid solution, carrier pipe and fittings shall be E-CTFE and shall be suitable for transport of 93 to 98 percent sulfuric acid solution. Pipe and fittings shall be made from all new Halar resin produced by Solvay Solexis, no substitutes. Halar resin shall be free of chemical additives, fillers, property enhancers and reinforcements. Pipe shall be produced by extrusion process and fittings shall be injection molded. Unless otherwise shown, pipe and fittings shall be SDR 21 (maximum) and shall have a pressure rating of 150 psi for pipe sizes up to 1-1/2" and 120 psi for pipe sizes 2" and above. Unless otherwise shown, joint design shall be for butt-fusion, and as recommended by the manufacturer. Both pipe and fittings shall be the product of one manufacturer. Provide valves in accordance with Section 15100. E-CTFE pipe and fittings shall be Ultra Proline as manufactured by Asahi/America, or approved equal.

2.12 Pipe Insulation

Where specified or shown on the Drawings for pipe to be insulated, insulation shall be vitreous silicate fiber thermal insulation mat with asbestos free PTFE resin impregnated woven fiberglass fabric exterior shell. The exterior shell shall be top coated with pigmented PTFE. Insulation for valves, instrumentation, and appropriate appurtenances shall be per Section 15100. Insulation shall be suitable for outdoor installation in ambient temperature ranges of 0° to 120° F, weather proof, and UV resistant. Insulation cover shall completely cover piping and shall be capable of preventing process water from freezing. Insulation covers shall be provided with stainless steel lacing hooks and tie wire or stainless steel buckles with Velcro straps to provide simple installation and removal. Insulation material shall be Treo as manufactured by Tritex, or approved equal, and exterior shell shall be 1650T as manufactured by Lewco Specialty Products, Inc., or approved equal. Insulation covers shall be factory pre-fabricated and shall be Fluor-O-Flo as manufactured by Insultech, or approved equal.

PART 3 - EXECUTION

3.01 Installation

A. General

All piping and appurtenances shall be installed as specified herein, in accordance with the manufacturers printed instructions, and in accordance with Specification Section 15025.

B. Schedule Steel Pipe

Buried galvanized or black steel pipe shall be coated as specified in Section 09900, Basic Coating and Painting Specifications for Water and Wastewater Facilities, or provided with an extruded high density polyethylene coating with minimum thickness of 35 mils.

C. PVC and CPVC Pipe

PVC and CPVC pipe joints shall be solvent-welded in accordance with the manufacturer's instructions. Expansion joints or pipe bends shall be provided to absorb pipe expansion over a temperature range of 100 degrees F, unless otherwise shown. Care shall be taken to provide sufficient supports, anchors, and guides, to avoid stress on the piping. The Contractor shall obtain the services of the PVC and CPVC pipe supplier, to instruct the pipe fitters in the correct way of making solvent welded joints. Only clean, fresh solvent shall be used at any time.

D. Unions

In erecting screwed pipe, a sufficient number of screwed unions shall be installed to allow any section or run of pipe to be disconnected without taking down adjacent runs. In addition, at least one union shall be installed at every change in direction (horizontal and vertical) and adjacent to each valve.

E. Couplings

Pipe couplings shall be installed in strict accordance with the manufacturer's printed recommendations. Buried couplings shall be polyethylene encased in accordance with AWWA C105/A21.5-99.

F. Gaskets for Flanged Joints

Wherever blind flanges are shown, the gaskets shall consist of 1/8" thick cloth-inserted rubber or fiber sheet (no asbestos shall be allowed) which shall cover the entire inside surface of the blind flange and shall be cemented to the surface of the blind flange.

G. Insulating Connections

All insulating connections shall be installed in accordance with manufacturer's printed instructions.

H. Chemical Piping System for Sulfuric Acid Solution

1. PTFE Pipe

PTFE pipe and fittings shall be installed in accordance with the manufacturer's printed instructions. Contractor shall obtain said instructions and have same on site during work. If necessary, field cutting and threading of pipe is acceptable and shall be done in accordance with the manufacturer's printed instructions. Threading die shall not have been previously used on metal or abrasive plastic, including PVC and CPVC. All joints shall be sealed with manufacturer's recommended PTFE paste sealant. PTFE thread tape will not be acceptable. Joints shall be retightened after 24 hours (minimum) to account for creep in the piping system. PTFE pipe shall be supported in accordance with the manufacturer's recommendations. Contractor shall obtain the services of the pipe supplier to instruct the pipe fitters in the correct way of installing the piping system.

2. E-CTFE Pipe

E-CTFE pipe and fittings shall be installed in accordance with the manufacturer's printed instructions. Contractor shall obtain said instructions and have same on site during work. Pipe fitters shall be certified and trained by the manufacturer for installation of the piping system. Said certification shall be valid for a maximum of one year from the date of original certification. Pipe fitters shall construct pipe joints with manufacturer's recommended equipment and shall obtain said equipment directly from the manufacturer. Contractor shall obtain the services of the pipe supplier to instruct the pipe fitters in the correct way of installing the piping system.

3.02 Continuity Bonds

Where required by the Drawings, all joints, except field-welded joints and insulating joints, shall be continuity bonded. Bonds shall be welded to the pipe as shown, as well as all major parts of any couplings used. Bonds shall be inspected and approved by the Owner before the exterior of the pipe joint is coated. The bond shall be completely covered with protective coating material prior to backfilling of the trench.

3.03 Insulation Covers

Contractor shall field measure all piping and appurtenances required to be insulated prior to manufacturer constructing insulation covers. Manufacturer shall provide instruction to Contractor if field altering of insulation covers is required.

END OF SECTION