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.

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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

SECTION 15100
PROCESS VALVES
TECHNICAL SPECIFICATIONS

PART 1 - GENERAL

1.01 Description

Valves shall be as specified by these Specifications and as may be modified by the Special Requirements or the Drawings. Where valves are not specified herein, valves shall be as specified in the Basic Pipeline and Sewer Specifications, and as shown on the Standard Drawings. Where "Owner's Approved Materials List" is incorporated within the Contract Documents, only manufacturers listed therein shall be acceptable. Contractor shall provide all tools, supplies, materials, equipment, and labor necessary for furnishing, interior epoxy coating, exterior coating, installing, adjusting, and testing of all valves, valve operators, and appurtenant work, complete and operable, as specified herein and shown on the Drawings. Where buried valves are shown, the Contractor shall furnish and install valve boxes to grade, with covers and extensions per Standard Drawings.

1.02 Submittals

A. Shop Drawings

Contractor shall submit shop drawings in accordance with the requirements of Specification Section 01300, Contractor Submittals. Contractor shall submit complete information and technical data for all material and components, including, but not limited to, the following: fabrication, assembly, detailed specifications and data covering performance and materials of construction, parts, installation instructions, coatings, operators, valve boxes, extensions, and other pertinent data. Shop drawings shall clearly indicate size, end connections, and proposed service condition, as well as special features required for buried service.

B. Operation and Maintenance Manual

Contractor shall submit for each valve a detailed operation and maintenance manual in accordance with the requirements of Specification Section 01300.

C. Contractor shall submit manufacturer's certification that installers for the E-CTFE valves are certified and trained in accordance with the manufacturer's installation procedures.

1.03 Quality

A. All valves furnished under this Section shall be of a design and manufacture that has been used in similar applications. Manufacturers specified herein manufacture valves with acceptable quality or experience.

Manufacturers must, however, provide written confirmation that valves to be supplied meet the performance requirements specified herein and are suitable for long term operation with the proposed fluid.

B. All valves of a particular type shall be by one (1) manufacturer. In addition, valve operators for a particular type of valve shall be by one (1) manufacturer.

C. Contractor shall coordinate valves furnished with connecting piping or equipment to ensure compatible end connections and proper valve operation.

PART 2 - PRODUCTS

2.01 Pressure Rating

All process valves shall be rated for a working pressure equal to (or more than) the pressure rating of the connecting piping, minimum of 150 psi, or as specified otherwise herein or on the Drawings.

2.02 Valve Tags

Each and every valve shall be provided with a 14 gauge brass indexing tag, 1-1/2" diameter, bearing 3/16" die-stamped lettering with pipe duty designation and valve number. Exact lettering and numbering shall be as approved by Owner. Each tag shall be securely attached to its valve with a #10 single-jack brass chain or with brass bolts or screws. Each tag shall be provided with two holes for securing tag with chain, bolts, or nails. Buried valves shall have tags attached to valve box.

2.03 Operators

A. General

The operators shall be sized based on the maximum expected torque as per the valve manufacturer's recommendations. The responsibility for selection of proper operator and the valve operation therewith shall reside with the valve manufacturer/supplier.

B. Manual Operators

Manual operators, except where otherwise shown or specified, shall be worm-gear type, Limitorque T100, E-I-M Type MG, or equal and shall conform to AWWA C504, Section 3.8. The axis of the worm shaft shall remain fixed during operation. A visual OPEN/CLOSED indicator shall be an integral part of the operator. A handwheel shall be provided except where an extension stem and floor stand or valve box, tee wrench, and street box are required. Handwheels shall have OPEN and CLOSE directional arrows cast on the outer rim. Unless otherwise specified, handwheels shall have a minimum diameter of 8". Extension stems and accessories shall be sized for valve manufacturer's recommendations.

1. Gate and Globe Valves

All gate, globe, and angle valves shall be fitted with cast iron handwheels of suitable size or gear operators in accordance with AWWA C504, Section 3.8.

2. Butterfly Valves

All butterfly valves 3" and smaller in size shall be lever and locking ratchet operated and valves 4" and larger in size shall be equipped with enclosed gear and handwheel operators. The operators shall be furnished by the manufacturer of the valve, in accordance with AWWA C504, Section 3.8, who shall be responsible for the compatibility and adequacy of both the valve and operator. Valve operators shall be sized for the maximum torque developed by the maximum pressure in the pipeline in which the valve is to be used. Buried or submerged valves shall conform to AWWA C504, Section 3.8.5.3 and have properly constructed actuators for the service.

3. Plug and Ball Valves

All plug and ball valves 3" and smaller in size shall be lever and locking ratchet operated and plug valves 4" and larger in size shall be provided with enclosed gear and handwheel operators unless otherwise shown or specified. Buried or submerged valves shall conform to AWWA C504, Section 3.8.5.3 and have properly constructed actuators for the service.

4. Chainwheel Operator

All valves 6' or more above the floor level shall be provided with chainwheel operators in lieu of the handwheel operator and shall be the valve manufacturer's standard, with galvanized chain to be furnished in the length required for operation. Chainwheel operators shall conform with AWWA C504, Section 3.8.5.2.

5. Wrench Nut Operation

An AWWA nut or shaft key, as applicable, shall be provided in lieu of handwheel where required for connection to extension stem and floor stand or for buried valves. Nut shall be 2" square and shall have a flanged base upon which shall be cast an arrow at least 2" long showing direction of opening. The word OPEN shall also be cast on the flange. No submerged or buried operator shall require maintenance following installation. Suitable gaskets, O-rings, and other features shall ensure permanent water tightness. Operator shall be designed to take the load of the shaft extension.

C. Electric Operators

Where electric type operators are specified, an electric motor-operated valve control unit shall be attached to the valve operation mechanism housing by means of a flange motor adapter piece. Operator unit shall include the motor, operator unit gearing, torque switches, limit switches, auxiliary handwheel, starter, mechanical position indicator and accessories to provide a complete and operable unit. Electric operators shall conform to AWWA C540. The valve actuator motor and all electrical enclosures shall be weatherproof, NEMA 4, as a minimum. When specified, motor and all electrical enclosures shall be available to meet NEMA 6 submersible, or NEMA 7 hazardous requirements. Valve manufacturer/supplier shall be responsible to ensure proper

selection and operation of valve/operator assembly. Electric operator shall be designed for open-close operation or modulation, as specified, or as shown on the Drawings.

1. Gearing

   The power gearing shall consist of spur or helical gears of hardened alloy steel and worm gear of alloy bronze. All power gearing shall be grease or oil lubricated, in a sealed housing. Ball or roller bearings shall be used throughout.

2. Non-Modulating

   A lost-motion starting device independent of gear backlash shall be supplied as an integral part of the actuator gear train. This device shall allow the motor to attain full speed before the load is engaged. The lost-motion device shall not be incorporated in actuators supplied for modulating service.

3. Motor

   The motor shall be of the totally-enclosed, non-ventilated, high-starting torque, low-starting current type for full voltage starting. Unless otherwise specified, motor shall be suitable for operation on 480 volt, 3 phase, 60 hertz current, and have Class H insulation. The motor shall have a running torque per valve manufacturer's recommendation, and be of sufficient horsepower to open or close a valve against the maximum specified differential pressure when voltage to the motor is ±10% of nominal voltage with a factor of safety of 1.5. The motor shall be pre-lubricated and all bearings shall be of the anti-friction type. Motor rating shall be 30 minute duty.

4. Limit Switches

   Limit switches and their gearing shall be an integral part of the valve operator. The limit switch compartment shall be totally enclosed and equipped with a heater and thermostat to prevent build-up of moisture and contamination. Switches shall be SPDT and rated 10A at 120 VAC or as specified. The actuating point shall be adjustable at any point of valve travel between fully open and fully closed.

5. Torque Limiting Switches

   Torque limiting switches shall be provided and be responsive to the mechanical torque developed in seating, backseating, or by obstruction. The torque switch shall operate a calibrated dial integrally mounted and directly related to the torque output of the operator. Torque control accuracy shall be within ±5%. The use of torque wrenches for calibration shall not be required. A calibration tag stating the maximum torque output of each torque switch at 100% setting shall be permanently affixed to the torque switch dial. The torque switch shall be calibrated by use of a dynamometer in order to accurately predict the output of the actuator.

6. Handwheel Operation

A permanently attached handwheel shall be provided for emergency manual operation. The handwheel shall not rotate during electrical operation. The maximum torque required on the handwheel under the most adverse conditions specified herein shall not exceed 60 lb-ft, and the maximum force required on the rim of the handwheel shall not exceed 60 lbs. An arrow and either the word OPEN or CLOSE shall be cast on the handwheel to indicate the direction to turn said handwheel. Unless otherwise specified, handwheels shall have a minimum diameter of 8".

Electric operators shall be as manufactured by Limitorque, EIM, AUMA, Pratt, Keystone, or equal.

D. Pneumatic Operators

Where pneumatic type operators are specified, a totally enclosed pneumatic rotary actuator shall be directly attached to the valve mounting flange or top plate, without the use of special brackets, linkage or couplings. The actuator shall be of the rack and pinion type, providing constant output torque throughout travel. All units shall be factory tested to insure proper operation, and factory lubricated for actuator service life. A smooth, self-draining body shall be provided to resist moisture. The actuator shall have integral porting to eliminate external tubing. Localized mechanical position indication shall be provided and be readable from a distance of 25' by use of contrasting colors. The standard operation shall be 0-90° reversible operation for air, gas or hydraulic oil. Actuator shall be capable of operating in any valve mounting attitude, and capable of being mounted either in line or transverse to the pipeline.

Spring return shall be available for fail-safe conditions. The spring return actuator shall be capable of providing "fail-open" or "fail-closed" as required. Standard actuators shall be designed so that the spring return option can be added at a later date. Valve manufacturer/supplier shall be responsible to ensure proper selection and operation of valve/operator assembly.

1. Materials of Construction

The actuator body, end caps, and spring cartridge housings shall be made of precision extruded, hard anodized aluminum. The pistons shall be a hard anodized aluminum alloy. The actuator drive shaft and pinion shall be of hardened and tempered alloy steel. All fasteners shall be electroless nickel-plated. The piston seals and "O" rings shall be made of nitrile rubber. The bushings shall be acetal plastic for maximum efficiency and elimination of galvanic action.

2. Service Requirements

The actuator shall be suitable for operation in temperatures ranging from -13° to 200°F. The actuator shall be designed for pneumatic operation up to a maximum pressure of 125 psi. Filtered air shall not be required for proper operation. The

actuator design shall have been tested for a minimum 100,000 cycles under full load with no appreciable wear of parts.

3. Accessories

Where specified or shown, the following pneumatic operator accessories shall be provided:

a. Solenoid Valve

The solenoid valve shall be capable of being mounted directly over the actuator air ports. Unless otherwise specified, solenoid valves shall have a NEMA 4 enclosure. The solenoid valve shall be provided with a manual override (with automatic reset capability) which allows manual operation in the event of power failure. An adjustable speed control shall be provided where specified. Solenoid housings shall be provided with a 1/2" NPT conduit entry. The solenoid valves shall operate at 120 volts AC, 60 hertz, single phase.

b. Limit Switches

The limit switches shall be single pole, double throw, cam operated, adjustable throughout the 90° travel range, and rated at 15 amps for 125 or 250 VAC. Limit switches shall be pre-wired to an internal terminal strip, and conduit entry shall be 3/4" NPT. Unless otherwise specified, limit switch housing shall be rated NEMA 4. The limit switch box shall be mounted directly to the upper actuator housing.

c. Spring Return

The spring return (fail safe) option shall be of the retained, or safety cartridge type, to allow convenient and safe disassembly. Springs shall be hard drawn and annealed tempered steel.

d. Positioner

The positioner shall mount to the top of the actuator housing, and be of the rotary type, with a standard input range of 3-15 psig and with an option of 3-9, 9-15, 15-3, 15-9 psig split-range operation. The positioner shall operate on a maximum supply of 150 psig. Air consumption shall not exceed 0.7 standard cubic feet per minute in balanced condition with 60 psig supply pressure. The positioner shall be furnished with three (3) pressure gauges and all necessary mounting hardware, as a complete package.

e. Travel Stops

Travel stops for the actuator shall consist of a mounting plate, with stop cam, fitted between the base of the actuator and the valve mounting

flange, and shall be externally adjustable through the full 90° of valve travel.

Pneumatic operators shall be as manufactured by Keystone, DeZurik, or equal.

2.04 Protective Coatings

A. Interior

All interior non-working ferrous surfaces other than stainless steel shall be given an epoxy coating unless specified otherwise.

1. All valves shall be fusion bonded epoxy coated (8 to 12 mils) in accordance with AWWA C550 (latest). 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.

2. Where the manufacturer demonstrates in writing that it would be impossible to use the powder epoxy method without causing damage to the valve components, the use of a liquid epoxy will be permitted upon approval by the Owner.

3. If small local repairs are necessary, they shall be made using a liquid epoxy recommended by the manufacturer of the epoxy with which the item was initially coated. The surface shall first be hand tool cleaned in accordance with SSPC-SP2. The repair epoxy material shall be applied in accordance with the manufacturer's instructions.

4. Where factory hydrostatic testing of the valve is required the valve shall pass all tests prior to interior coating applications.

B. Exterior

All valves shall be given a shop prime coating which shall be compatible with the field applied coating system.

1. Buried Valve

   All buried valves shall be coated per Basic Pipeline Specifications. Where valves are not specified therein, buried valves shall be coated with bitumastic coating of not less than 32 mils. Prior to coating, all surfaces shall be prepared in accordance with SSPC-SP3 and manufacturer's recommendations. The two coat system shall be Tnemec 46-450, Carboline Bitumastic 50, or equal.

2. Nonburied and Immersed Valves

   All valves shall be coated as specified in Specification Section 09900, and as shown on the Drawings.

2.05 Eccentric Plug Valve

Eccentric plug valves shall be of the non-lubricated eccentric type with round or rectangular port design unless otherwise specified. The valve body and plug shall be constructed of cast iron meeting the requirements of ASTM A-126, Class B. Valve bearing shall be constructed of corrosion resistant stainless steel. Unless otherwise specified on the Drawings, the entire plug shall be completely encapsulated with Buna N rubber. Unless otherwise shown or specified on the Drawings, the valves shall be flanged with dimensions, facing, and drilling in full conformance with ANSI B 16.1, Class 125. With the plug in the full open position, valve shall have no cavities where debris can collect, have minimal head loss and be capable of passing a clean out pig with the same nominal diameter as the adjacent pipe. Valves shall be equipped with operators as shown on the Drawings and as specified herein. All eccentric plug valves shall have a pressure rating of not less than 150 psi, for bubble tight shut off. Valves shall be the product of a single manufacturer and shall be DeZurik or Pratt (no substitutes).

2.06 Flanged Butterfly Valves (316 Stainless Steel Discs)

All butterfly valves shall be short pattern, flanged, designed and manufactured in accordance with AWWA C504 (latest) unless otherwise specified herein or shown on the Drawings. Valve body and flanges shall be constructed of heavy duty ductile iron meeting the requirements of ASTM A-536 Grade 65-45-12. Flanges shall be drilled in accordance with ANSI B 16.1 standards and shall be of the short body design. The disc shall be 316 stainless steel and be securely attached to a 316 stainless steel shaft with stainless steel pins. Valves shall have sleeve type PTFE bearings, EPDM packing, and a resilient seat of EPDM material mounted in the valve body. Valves shall be rated for a minimum working pressure of 150 psi unless otherwise specified. Valves shall be equipped with operators as shown on the Drawings and as specified herein. Butterfly valves shall be the product of a single manufacturer which shall be DeZurik, Pratt, or equal.

2.07 Wafer and Lug Butterfly Valves (Aluminum-Bronze Discs)

All wafer and lug butterfly valves shall be heavy-duty, resilient seated, rated 250 psi WOG and suitable for installation between ANSI Class 125/150 flanges, unless otherwise specified herein or shown on the Drawings. Valves shall be capable of bidirectional, drip tight shut off, and dead end service to 250 psi. Valve body shall be of one piece ductile iron construction including an integrally cast top plate for direct, flush-mounting actuator and shall meet ANSI Class 125/150 flange standards with valve neck of sufficient length to allow for flange clearance and piping insulation.

Resilient seat shall be reinforced EPDM, fully isolating the valve body, stem, and journal areas from the flowing media, field replaceable, with molded-in O-rings requiring no gaskets between valve and flange face(s). Stem shall be one or two piece 316 stainless steel (or better). Disc materials shall be aluminum-bronze. All wafer and lug butterfly valves shall be the product of a single manufacturer and shall be Keystone, Demco, or equal.

2.08 Wafer and Lug Butterfly Valves (316 Stainless Steel Discs)

Unless specified otherwise, all wafer and lug butterfly valves shall be designed for installation between 125 lb. flat face or 150 lb. raised face flanges. The valve shall be non-directional and of the dry stem journal design, providing bubble-tight shut off at 200 psi differential pressure.

Valve bodies shall be gray iron or cast iron in accordance with ASTM A48 or ASTM A126. Valve bodies shall be provided with an integrally cast top plate for direct, flush-mounting of actuator, and with valve neck of sufficient length to allow for flange clearance and piping insulation. Valve stems shall be 416 stainless steel of the non-wetted two piece design with the lower stem acting as a trunnion for the valve disc and the upper stem being the drive shaft.

The valve disc shall be of a high flow design and constructed of 316 stainless steel in accordance with ASTM A351 (CF8M). The valve disc to stem engagement shall have no mechanical fasteners, allowing the valve disc to float to a perfect seal in the valve seat. The valve seat shall have a rigid phenolic backup ring with Buna-N elastomer bonded to it, rendering the valve seat suitable for pressure or vacuum service. The valve seat shall incorporate its own flange seals and they shall mate with full face or raised face flanges. The valve seat shall fully isolate the valve body, stem, and journal areas from the flowing media and shall be field replaceable.

The valve body shall incorporate O-ring secondary seals to maintain lubricant in the stem journals and eliminate exterior moisture from the stem journals.

All wafer butterfly valves shall be the product of a single manufacturer, and shall be Keystone Series 60, Demco Series NE-C, or equal.

2.09 Gate Valves (4" through 12")

Gate valves shall be resilient seated gate valve designed and manufactured in accordance with AWWA C509 (latest) unless otherwise shown on the Drawings or specified herein. Valve shall have a non-rising bronze stem, cast ductile iron body and disc in conformance with ASTM A-126, and flanges in full conformance with ANSI B 16.1, Class 125. Valve disc shall be permanently bonded with resilient material to ensure drip tight shut-off. Valves shall have two stem seal O-rings of Buna N to prevent leakage through the stem. Valves shall be rated for a minimum working pressure of 150 psi unless otherwise specified. Valves shall have operators as shown on the Drawings and as specified herein. Gate valves shall be the product of a single manufacturer and shall be M&H, Stockham, Clow, Mueller, American Darling, or equal.

2.10 Gate Valves (14" through 42")

Gate valves shall be double disc, non-rising stem type designed and manufactured in accordance with AWWA C500 (latest) unless otherwise shown on the Drawings or specified herein. Valve bodies shall be cast iron meeting the requirements of ASTM A-126, Class B, with flanges conforming to ANSI B 16.1, Class 125. Disc shall be cast iron, bronzed faced. Stem shall be bronze and have O-ring seals to prevent leakage through the stem. Valves shall be rated for a minimum working pressure of 150 psi unless otherwise specified. Valves shall have operators as shown on the Drawings and as specified herein. Valve shall be the product of a single manufacturer and shall be M&H, Kennedy, Clow, Mueller, or equal.

2.11 Swing Check Valve (3" and Smaller)

Swing check valves shall be minimum 125 lb. screwed ends and bronze construction. Valves shall have a bronze disk, stainless steel or bronze pin, and have a screwed cap to access disk. Swing check valves shall be the product of a single manufacturer and shall be by Milwaukee #509, Stockham #B-319, Crane #1707, Powell #578, or equal.

2.12 Swing Check Valves (3" and Larger)

Swing check valves shall be of the flanged body, outside lever and spring type in accordance with AWWA C508, unless otherwise specified herein or shown on the Drawings. Valves shall be fully opening, have a flanged cover piece to provide access to the disc, and be designed for minimum water-working pressure of 150 psi, unless otherwise shown. The valve body and cover shall be cast iron conforming to ASTM A-126, Class B, with flanges conforming to ANSI B 16.1, Class 125, unless otherwise specified. The valve disc shall be cast iron, ductile iron, or bronze conforming to ASTM B 62. Valve seat and rings shall be bronze conforming to ASTM B 62 or of Buna N. The hinge pin shall be of bronze or stainless steel. Valves shall be delivered to the site with the lever arm and spring adjusted for the valves installed position (vertical or horizontal). Swing check valves shall be the product of a single manufacturer and shall be Apco Valve Co., Clow, Mueller, M&H, or equal.

2.13 Plastic Ball Valves

Plastic ball valves shall be made of polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), or polypropylene (PP) as specified, shown on Drawings, and recommended by the manufacturer for the service condition specified. All valves shall have manual operators, unless otherwise specified or shown. All plastic ball valves shall be Class 150 and shall have true union ends for easy removal. The balls shall have full size ports and polytetrafluoroethylene (PTFE, trade name Teflon) seats. Where sodium hypochlorite with a concentration greater than 1% is specified, vented-type plastic ball valves shall be used. All body seals, Union O-ring seals, and stem seals shall be Viton. Valves shall be the product of a single manufacturer and shall be Hayward, Chemtrol, Asahi/American, or equal.

Where specified, pneumatically actuated ball valves shall be provided with operators in accordance with Subsection 2.03, Part D, herein. Pneumatically actuated ball valves shall be equipped with a multiport single solenoid, which shall open the valve when energized and close the valve when de-energized.

Where specified, electric motor operated ball valves shall be Electromni by Asahi/American, Hayward, Chemtrol, or equal and of construction specified herein. Valves shall be 120 volt AC energize to open and energize to close. Valves shall be provided with open indicating light on motor operator, and NEMA 4 enclosure. Where specified, valves shall be provided with limit switches for position.

2.14 Plastic Degassing Valves

Plastic degassing valves for corrosive shall be made of PVC or CPVC as specified, shown on Drawings, and recommended by the manufacturer for the service condition specified. All valves shall be installed vertically at high points of the sodium hypochlorite piping system to continuously vent the trace amounts of gas produced. Gas shall be automatically released by a

floating lever that opens when gas is present, and closes when liquid is present. All seals shall be EPDM. Valves shall be able to function properly up to 100 psi operating pressure with minimal emission of system liquid prior to sealing. The outlet port shall be piped to a U-vent in a safe area to prevent contact with the sodium hypochlorite. Valves shall be the product of a single manufacturer and shall be Plast-O-Matic or equal.

2.15 Plastic Ball Check Valves

Plastic ball check valves shall be constructed of PVC, CPVC, or PP, as specified, shown on Drawings, and as recommended by the manufacturer for the service condition specified. Valves shall be true union type for easy removal. All seals shall have PTFE O-rings. Valves shall be the product of a single manufacturer and shall be Hayward, Chemtrol, Asahi/American, or equal.

2.16 Foam Spray Nozzles

A. Quick Flush Foam Control Nozzle

Foam spray nozzles shall be furnished and installed at locations shown on the Drawings. The nozzles shall be counter balanced weighted, easy flush type. The nozzle shall be bronze construction with a neoprene rubber deflector for 2 gpm at 10 psig. A split eyelet shall be utilized on all pipes smaller than 4" in diameter. Split eyelet shall have zinc plated steel clamps and bolts with brass connector body and a Buna N clamp gasket to provide a leak proof seal. The nozzles and split eyelets shall be as manufactured by Spraying System Company, BETE Fog Nozzle, Inc., or equal.

B. Hollow Cone Foam Control Nozzle

Foam spray nozzles shall be furnished and installed at locations shown on the Drawings. Hollow cone nozzles shall produce a 90° hollow cone spray pattern at 2 gpm at 10 psi, shall be 1/4" NPT (M), and constructed of 316 stainless steel. Nozzle shall be as manufactured by Spraying System Company, BETE Fog Nozzle, Inc., or equal.

2.17 Sewage Air Release Valves

Sewage air release valves shall have an elongated body and be designed to open while pressurized, allowing entrained air in the pipeline to escape through the air release orifice. Unless otherwise specified, each unit shall be supplied with isolation valve (solid wedge gate), blowoff valve, 1/2" back flushing shutoff valve, and 5' rubber supply hose with quick disconnect couplings. The unit shall be designed for an operating pressure of not less than 125 psi. The body and cover shall be cast iron, internal float and float guide shall be stainless steel with Buna N seat, valves shall be gate type of bronze construction. Seat hardness shall be selected by the manufacturer for actual operating pressure of system. The sewage air release valve shall be manufactured by APCO by Valve and Primer Corporation, Val-Matic Valve, Multiplex Manufacturing Corporation (Crispin), or equal.

2.18 Combination Sewage Air and Vacuum Valve

Combination sewage air and vacuum valves shall have an elongated body and be of the type that automatically exhausts large quantities of air during filling of the system, allows air to re-enter during draining of the system, and allows accumulating air to escape while in operation and

under pressure. Unless otherwise specified, each unit shall be supplied with isolation valve (solid wedge gate), blowoff valve, 1/2" back flushing shutoff valve, and 5' rubber supply hose with disconnect couplings. The unit shall be designed for an operating pressure of not less than 125 psi. The body and cover shall be cast iron, internal float and float guide shall be stainless steel with Buna N seat, valves shall be gate type of bronze construction. Seat hardness shall be selected by the manufacturer for actual operating pressure of the system. Combination sewage air and vacuum valves shall be manufactured by APCO by Valve and Primer Corporation, Val-Matic Valve, Multiplex Manufacturing Corporation (Crispin), or equal.

2.19 Air Valves

Unless specified otherwise, air valves shall be combination air or combination air and vacuum valve (air, vacuum, and automatic release). They shall permit automatic escape of large quantities of air from pipeline when it is being filled, permit 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, all bronze or stainless steel internal working parts, and stainless steel pressure seats.

Air valve inlets shall be size as shown on Drawings, 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% rated working pressure with no harmful deflections or other defects.

Valves shall be as manufactured by APCO by Valve and Primer Corporation, Val-Matic Valve, Multiplex Manufacturing Corporation (Crispin), or equal.

2.20 Wye Strainers

Wye strainers shall be installed where shown on the Drawings and specified herein. Strainers shall be suitable for a minimum 150 psi working pressure unless otherwise specified. Strainers shall be cast iron with 316 stainless steel No. 40 mesh strainer screen. Wye strainers shall be manufactured by Watts, Spirax Sarco, Crane, Hayward, A.W. Cash Valve, or equal.

2.21 Globe Valve (3" and Smaller)

Globe valves shall be 150 lb., screwed ends, bronze construction with renewable PTFE or Buna N disc. Globe valves shall have a rising stem and union bonnet. Globe valves shall be the product of a single manufacturer and shall be Milwaukee #590, Stockham #B22, Crane #7, Powell #150, or equal.

2.22 Gate Valves (3" and Smaller)

Gate valves shall be 150 lb., screwed ends, bronze construction meeting the requirements of ASTM B 62. Valves shall have a rising stem, gland packed, solid wedge disc, and a union bonnet. Gate valves shall be the product of a single manufacturer and shall be Milwaukee #1151, Stockham #B-120, Crane #431, Powell #2714, or equal.

2.23 Small Pressure Reducing and Regulating Valves (Air and Water)

Pressure reducing and regulating valves shall be of the spring-loaded diaphragm type with a minimum pressure rating of 250 psi, with bronze body, nickel alloy or stainless steel seat, and threaded ends. Each valve shall be furnished with built-in or separate strainer and union ends. Valves shall provide pressure relief or regulation as required by the Drawings as specified. Valves shall be manufactured by A.W. Cash Valve Mfg. Corp., Fisher Controls Company, Mueller Company, Watts Regulator Company, or equal.

2.24 Stainless Steel Ball Valves

Ball valves shall be 150 lb (minimum), full bore, with 316 stainless steel (or better) body, ball, and stem. Ball valves shall be provided with free floating ball, reinforced PTFE (RPTFE) seats, PTFE seals, and blow-out proof stems. Ball valves 2" and smaller shall be provided with threaded ends, two-piece bodies, and stainless steel operating levers with locking device. Ball valves 3" and larger shall be provided with flanged ends, split bodies, and worm gear operator as specified herein.

Where specified for gas service (natural gas or digester gas), ball valves shall be certified fire safe to API-607, and shall be furnished with anti-static devices.

Ball valves shall be the product of a single manufacturer and shall be as manufactured by GWC Valve International, Inc., or equal.

2.25 Solenoid Valves

Solenoid valves shall be of the size, type, and class shown and shall be designed for not less than 150 psi water-working pressure. Valves for water, air, or gas service shall have brass or bronze body with, unless specified otherwise, screwed ends, stainless steel trim and spring, PTFE or other resilient seals with material best suited for the temperature and fluid handled. Solenoid valves in corrosive environment shall have stainless steel bodies. For chemicals and all corrosive fluids, solenoid valves with PTFE bodies and springs or other suitable materials shall be used. General purpose enclosures for indoors shall be NEMA type 2. For explosion proof, corrosive, special purpose, or outdoor locations NEMA type 4, 7, 8, 9, 9E, 9F, or 9G enclosures shall be used, as applicable. All coil ratings shall be for continuous duty. For electrical characteristics see electrical drawings or specifications.

For general duty valve shall be as manufactured by Automatic Switch Co. (ASCO), Model "RED HAT", Skinner Valve Division of Honeywell, Model "LANCER", Magnatrol Valve Corporation, or equal.

For corrosive fluids valves shall be as manufactured by Valcor Engineering Corporation, Asahi/American, or equal.

2.26 Cast Iron Knife Gate Valves

Knife gate valves shall be bonnetless wafer type, with resilient seat and a rated pressure of 150 psi. Gate, outside trim, bolting, stem, and yoke shall be constructed of Type 316 stainless steel. Valve body and packing gland shall be of cast iron and ductile iron with plastic coating respectively. Resilient seat shall be HYCAR and packing shall be TFE impregnated synthetic.

Gates shall be finish-ground on both sides to prevent packing or seat damage. Actuator shall be handwheel. Port design shall be full round. Valves shall be manufactured by Red Valve, DeZurik, ITT Industries or equal.

2.27 Stainless Steel Knife Gate Valve

Knife gate valves shall be bonnetless wafer type, constructed entirely of Type 316 stainless steel, with resilient seat and a rated pressure of 150 psi. Valve body, gate, outside trim, packing gland, bolting, stem, and yoke shall be constructed of Type 316 stainless steel. Resilient seat shall be HYCAR and packing shall be TFE impregnated synthetic. Gates shall be finish-ground on both sides to prevent packing or seat damage. Actuator shall be handwheel. Port design shall be full round. Valves shall be manufactured by Red Valve, ITT Industries or equal.

2.28 Shut-Off Valves for Sulfuric Acid Solution

A. Plastic Valves for PTFE Piping System

Where PTFE piping is specified for sulfuric acid solution, valves shall be plug valves and shall be made from low-creep virgin PTFE resin conforming to ASTM D4894 Type III, Grade 1. Plug shall be of one-piece design. Unless noted otherwise, plug valves shall be two-way valves and have quarter turn manual operators for full-closed and full-open positions. Plug valves shall have female NPT connections. Plug valves shall be full port through the orifice equal to the area of Schedule 80 pipe. Pressure rating for plug valves shall be equal to or greater than the connection piping. Plug valves shall be Fluor-O-Valve as manufactured by Micromold, or approved equal.

B. Plastic Valves for E-CTFE Piping System

Where ethylene-chlorotrifluoroethylene (E-CTFE, trade name Halar) piping is specified for sulfuric acid solution, valves shall be ball valves and 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. Unless noted otherwise, ball valves shall be two-way valves and have quarter turn manual operators for full-closed and full-open positions. Valves shall have true union ends for easy removal. Valves shall have elongated spigot ends for butt fusion welding. The balls shall have full size ports through the orifice and PTFE seats. Valve stems shall have double O-rings and be of blowout-proof design. Pressure rating for ball valves shall be 150 psi (minimum). Ball valves shall be Halar ball valves as manufactured by Asahi/America, or approved equal.

C. Metal Valves

Metal valves for sulfuric acid solution shall be ball valves and shall be 150 lb (minimum), full bore, with Alloy-20 body, ball, and stem. Ball valves shall be provided with free floating ball, RPTFE seats, PTFE seals, and blow-out proof stems. Ball valves 2" and smaller shall be provided with threaded ends, top entry bodies, and stainless steel operating levers with locking device. Ball valves 3" and larger shall be provided with flanged ends, top entry bodies, and worm gear operator as specified herein.

Manufacturer shall confirm the materials specified herein are suitable for the service condition specified.

Ball valves shall be the product of a single manufacturer and shall be as manufactured by Apollo Valves, or equal.

2.29 Diaphragm Check Valves for Sulfuric Acid Solution Piping System

Check valves for sulfuric acid solution shall be made from all PTFE construction. Check valves shall have female NPT connections. Check valves shall utilize a flexible elastomeric disk for the sealing action. The disk shall be self centering and shall always seal in the same position. Check valves shall be installed vertically to utilize gravity to seal the disk to the seat. Pressure rating for check valves shall be 100 psi (minimum) at 75° F. Check valves shall be Series CKD compact diaphragm check valves as manufactured by Plast-O-Matic, or approved equal.

2.30 Metal Shut-Off Valves for Sodium Hypochlorite Solution

Metal valves for sodium hypochlorite solution shall be ball valves and shall be 150 lb (minimum), full bore, with Hastelloy-C body, ball, and stem. Ball valves shall be provided with free floating ball, RPTFE seats, PTFE seals, and blow-out proof stems. Ball valves 2" and smaller shall be provided with threaded ends, top entry bodies, and stainless steel operating levers with locking device. Ball valves 3" and larger shall be provided with flanged ends, top entry bodies, and worm gear operator as specified herein.

Manufacturer shall confirm the materials specified herein are suitable for the service condition specified.

Ball valves shall be the product of a single manufacturer and shall be as manufactured by Apollo Valves, or equal.

2.31 Metal Shut-Off Valves for Ferric Chloride Solution

Metal valves for ferric chloride solution shall be ball valves and shall be 150 lb (minimum), full bore, with titanium body, ball, and stem. Ball valves shall be provided with free floating ball, RPTFE seats, PTFE seals, and blow-out proof stems. Ball valves 2" and smaller shall be provided with threaded ends, top entry bodies, and stainless steel operating levers with locking device. Ball valves 3" and larger shall be provided with flanged ends, top entry bodies, and worm gear operator as specified herein.

Manufacturer shall confirm the materials specified herein are suitable for the service condition specified.

Ball valves shall be the product of a single manufacturer and shall be as manufactured by Apollo Valves, or equal.

2.32 Metal Shut-Off Valves for Sodium Hydroxide Solution

Metal valves for sodium hydroxide solution shall be ball valves and shall be 150 lb (minimum), full bore, with 316 stainless steel body, ball, and stem. Ball valves shall be provided with free floating ball, PTFE seats, PTFE seals, and blow-out proof stems. Ball valves 2" and smaller shall

be provided with threaded ends, top entry bodies, and stainless steel operating levers with locking device. Ball valves 3" and larger shall be provided with flanged ends, top entry bodies, and worm gear operator as specified herein.

Manufacturer shall confirm the materials specified herein are suitable for the service condition specified.

Ball valves shall be the product of a single manufacturer and shall be as manufactured by Apollo Valves, or equal.

2.33 Insulation Covers

Where specified or shown on the Drawings for valves, instrumentation, and various appurtenances 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 piping shall be per Specification Section 15070. 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 the valve, instrumentation, or appurtenances 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 covers and shall be as manufactured by Insultech, or approved equal.

PART 3 - EXECUTION

3.01 Installation

All valves shall be installed in accordance with the manufacturer's recommendation, the Construction Drawings, Standard Drawings, and Contract Specifications. Valves shall be kept clean and free from dirt, earth, debris, and other deleterious materials prior to, during, and after installation and construction.

A. Buried Valves

Buried valves shall be firmly supported in place by compacted backfill to preclude strain on the pipe connections. Valve boxes shall be checked for centering plumb over the wrench nut and ensure that the box cover is flush with the finish grade. Interior of valve box shall be cleaned of all foreign material before installation. The valve shall be inspected in the opened and closed positions to ensure all parts are in working condition. Valve shall be installed in accordance with the Standard Drawings.

Unless otherwise specified, flange bolts shall be standard hex head machine per ASTM A325. Nuts shall be heavy hex cold-press semi-finished steel per ASTM A194-2, 2H. Threads shall be lubricated with an approved anti-seize compound. All exposed steel shall be field coated with an approved bitumastic.

B. Aboveground Valves

Aboveground valves shall be rigidly held in place using supports and hangers. The stem orientation shall provide ease of operation, clearance, and be approved by the Owner.

Unless otherwise specified, flange bolts shall be standard hex head machine per ASTM A325. Nuts shall be heavy hex cold-press semi-finished steel per ASTM A194-2, 2H. Threads shall be lubricated with an approved anti-seize compound.

C. Air Valves (Potable and Sewage Service)

Until placed in operation, each valve shall be protected by the use of an approved canvas or plastic bag or sack completely covering the valve and securely fastened to valve riser.

Air valve outlets, including combination air and vacuum valve outlets/inlets, shall be adequately screened to prevent entrance of foreign substances or materials. Where valves contain more than a single outlet, each outlet shall be adequately screened. Screens shall be installed in accordance with the Standard Drawings.

Where Standard Drawings have not been provided for air valve installation, each air valve outlet shall be equipped with standard weight pipe nipples, 90° street elbows (two total) of the same size as the outlet, and a screen. Each screen shall be constructed of 22 gauge stainless steel wire cloth banded with 1/2" wide stainless steel bands to a 10 gauge expanded stainless steel mesh cylinder (3/4" opening). The expanded stainless steel mesh cylinder shall be a minimum of 4" diameter and 5" long, tack welded to 10 gauge stainless steel round plates at each end. Unless specified otherwise, the standard weight pipe nipples and 90° street elbows shall be hot dipped galvanized.

D. Plastic Valves for Sulfuric Acid Solution

1. PTFE Valves

PTFE valves shall be installed in accordance with the manufacturer's printed instructions. Contractor shall obtain said instructions and have same onsite during work. All joints shall be sealed with manufacturer's recommended PTFE paste sealant. Teflon thread tape will not be acceptable. Joints shall be retightened after 24 hours (minimum) to account for creep in the piping system.

2. E-CTFE Valves

E-CTFE valves shall be installed in accordance with the manufacturer's printed instructions. Contractor shall obtain said instructions and have same onsite during work. Installers shall be certified and trained by the manufacturer for installation of the valves. Said certification shall be valid for a maximum of one (1) year from the date of original certification. Installers shall construct pipe to valve joints with manufacturer's recommended equipment and shall obtain said equipment directly from the manufacturer. Contractor shall obtain the services of the valve supplier to instruct the installers in the correct way of installing the valves.

3.02 Insulation Covers

Contractor shall field measure all valves 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

SECTION 16040
ELECTRICAL SHORT CIRCUIT/COORDINATION STUDY, ARC FLASH HAZARD STUDY, AND FIELD TESTING OF ELECTRICAL SYSTEM TECHNICAL SPECIFICATIONS

PART 1 - GENERAL

1.01 Scope - Short Circuit/Coordination Study

The Contractor shall provide short circuit and protective device evaluation and coordination study to verify electrical protective devices selected and selective tripping coordination for proposed facilities.

The evaluations and study shall include all portions of the existing and proposed electrical distribution system from the normal power source or sources down to and including the smallest adjustable trip circuit breaker in the distribution system. Normal system connections and those which result in maximum fault conditions shall be adequately covered in the study.

The study shall be performed, stamped and signed by a registered electrical engineer in the State of California. Credentials of the individual(s) performing the study and background of the firm shall be submitted to the Owner for approval prior to start of the work. A minimum of five (5) years experience in power system analysis is required for the individual in charge of the project. The firm performing the study shall provide assistance during start up as required.

The Engineer performing the system studies shall furnish the Contractor with a listing of the required data immediately after award of the contract and the Contractor shall expedite collection of the data to assure completion of the studies prior to final approval of the distribution equipment shop drawings and/or release of the equipment for manufacture.

1.02 Scope - Arc Flash Hazard Study

Contractor shall provide an Arc Flash Hazard Study to determine potential arc flash incident energies, arc flash boundaries, shock hazard boundaries and required personal protective equipment (PPE) for all energized electrical equipment, and arc flash and shock hazard warning labels.

The study shall include all electrical equipment from the normal power source or sources to and including all electrical panels with voltage greater than 24 volts.

The study shall be performed, stamped, and signed by a registered electrical engineer in the State of California. Credentials of the individual(s) performing the study and background of the firm shall be submitted to the Owner for approval prior to start of work. The firm performing the study shall provide assistance during startup as required.

The engineer performing the study shall furnish Contractor with a listing of the required data immediately following award of the Contract, and Contractor shall expedite collection of the data to assure completion of the study prior to final approval of the electrical equipment shop drawings and/or release of the equipment for manufacture.

1.03 Scope - Field Testing and Verification

Contractor shall provide the services of an independent testing consultant to field verify that all protective devices are set in accordance with the accepted short circuit/coordination study requirements and recommendations. In addition, the consultant shall perform resistance testing of ground systems to confirm compliance with NEC and electric utility requirements and other testing as specified herein, and verify that arc flash and stock hazard warning labels have been installed.

PART 2 - PRODUCTS

2.01 Short Circuit and Protective Device Evaluation and Coordination Study

A. General

1. The short circuit study shall be performed in accordance with the latest applicable IEEE and ANSI standards. Provide calculation methods and assumptions, the base per unit quantities selected, one-line diagrams, source impedance data including power company system characteristics, typical calculations, tabulations of calculation quantities and results, conclusions, and recommendations. Calculate short circuit interrupting and momentary (when applicable) duties for an assumed 3-phase bolted fault at each supply switchgear lineup, unit substation primary and secondary terminals, low-voltage switchgear lineup, switchboard, motor control center, distribution panelboard, pertinent branch circuit panelboard, and other significant locations throughout the system. Provide a ground fault current study for the same system areas, including the associated zero sequence impedance data. Include in tabulations fault impedance, X to R ratios, asymmetry factors, motor contribution, short circuit kVA, and symmetrical and asymmetrical fault currents.

2. In the protective device evaluation and coordination study include utility company device characteristics, system medium-voltage equipment relay and device characteristics, low-voltage equipment circuit breaker trip device characteristics, pertinent transformer characteristics, pertinent motor and generator characteristics, and characteristics of other system load protective devices. Include at least all devices down to largest branch circuit and largest feeder circuit breaker in each motor control center, and main breaker in branch panelboards.

   Provide time-current curves graphically indicating the coordination proposed for the system. Include with each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered by that particular curve sheet. Include a detailed description of each protective device identifying its type, function, manufacturer, and time-current characteristics. Tabulate recommended device tap, time dial, pickup, instantaneous, and time delay settings.

Include all adjustable settings for ground fault protective devices. Include manufacturing tolerance and damage bands in plotted fuse characteristics. Show transformer full load and 150, 400, or 600 percent currents, transformer magnetizing inrush, ANSI transformer withstand parameters, and significant symmetrical and asymmetrical fault currents. Terminate device characteristic curves at a point reflecting the maximum symmetrical or asymmetrical fault current to which the device is exposed.

3. When emergency generator is provided, include phase and ground coordination of the generator protective devices. Show the generator decrement curve and damage curve along with the operating characteristic of the protective devices. Obtain the information from the generator manufacturer and include the generator actual impedance value, time constants and current boost data in the study. Do not use typical values for the generator.

4. For motor control circuits, show the MCC full-load current plus symmetrical and asymmetrical of the largest motor starting current and time to ensure protective devices will not trip during major or group start operation.

B. Study Report

1. The results of the power system study shall be summarized in a final report. Six (6) bound copies of the final report shall be submitted to Owner.

2. The report shall include the following sections:

a. Descriptions, purpose, basis and scope of the study.

b. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties, and commentary regarding same.

c. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, fuse selection, and commentary regarding same.

d. Fault current calculations including a definition of terms and guide for interpretation of computer printout.

C. Modifications Required by Study

The Contractor shall coordinate the study results with the manufacturer and supplier of the electrical equipment to incorporate the recommendations and modifications therein, prior to fabrication.

2.02 Arc Flash Hazard Study

A. General

1. The Arc Flash Hazard Study shall be performed in accordance with the latest applicable NFPA, IEEE, and ANSI Standards. Provide calculation methods and

assumptions, typical calculations, tabulations of calculation quantities and results, conclusions, and recommendations.

2. Calculate equipment arc gap.

3. Calculate bolted and estimated arcing fault current at the fault point.

4. Calculate trip time, opening time, and total clearing time (total arc time) of the protective device.

5. Calculate worst-case arc flash boundary for each bus/panel.

6. Calculate worst-case arc flash hazard energy in cal/cm^2 for each bus/panel.

7. Determine worst-case Personal Protective Equipment (PPE) for each bus/panel.

8. Calculate shock hazard approach boundaries (limited approach boundary, restricted approach boundary, and prohibited approach boundary).

9. Provide recommendations to reduce arc flash hazard energy and exposure.

B. Study Report

1. The results of the Arc Flash Hazard Study shall be summarized in a final report. Six (6) bound copies of the final report shall be submitted to the Owner.

2. The report shall include the following sections:

   a. Descriptions, purpose, basis, and scope of study.

   b. Tabulations of equipment arc gap and bolted and estimated arcing fault current at the fault point.

   c. Tabulations of trip time, opening time, and total clearing time (total arc time) for each protective device.

   d. Tabulations of worst-case arc flash hazard incident energy and worst-case PPE for each bus/panel.

   e. Tabulations of shock hazard approach boundaries (limited approach boundary, restricted approach boundary, and prohibited approach boundary).

   f. Recommendations to reduce arc flash hazard energy and exposure.

C. Warning Labels

1. Warning labels shall be 4" x 6" UV resistant vinyl labels (white label with orange warning stripe and black letters). Sample warning label is presented at the end of this section.

2. Firm performing the Study shall provide labels to Contractor.

3. For outdoor electrical panels (NEMA 1 MCC in NEMA 3R wrapper), warning labels shall be provided on both outer and inner doors.

   Each outer door section shall be provided with a warning label stating "WARNING, ARC FLASH AND SHOCK HAZARD, APPROPRIATE PPE REQUIRED".

   Each inner door, behind each set of outer doors, shall be provided with one warning label every four feet. Inner warning labels shall include the following information:

   a. "WARNING, ARC FLASH AND SHOCK HAZARD, APPROPRIATE PPE REQUIRED".

   b. Flash hazard boundary.

   c. Cal/cm^2 flash hazard for worst-case.

   d. Worst case PPE level and list required PPE.

   e. Shock hazard when cover is removed.

   f. Limited approach distance and list required PPE.

   g. Restricted approach distance and list required PPE.

   h. Prohibited approach distance and list required PPE.

4. For all electrical panels without a NEMA 3R wrapper (stand-alone panels), one warning labels shall be provided every four feet. Warning labels shall include the following minimum information:

   a. "WARNING, ARC FLASH AND SHOCK HAZARD, APPROPRIATE PPE REQUIRED".

   b. Flash hazard boundary.

   c. Cal/cm^2 flash hazard for worst-case.

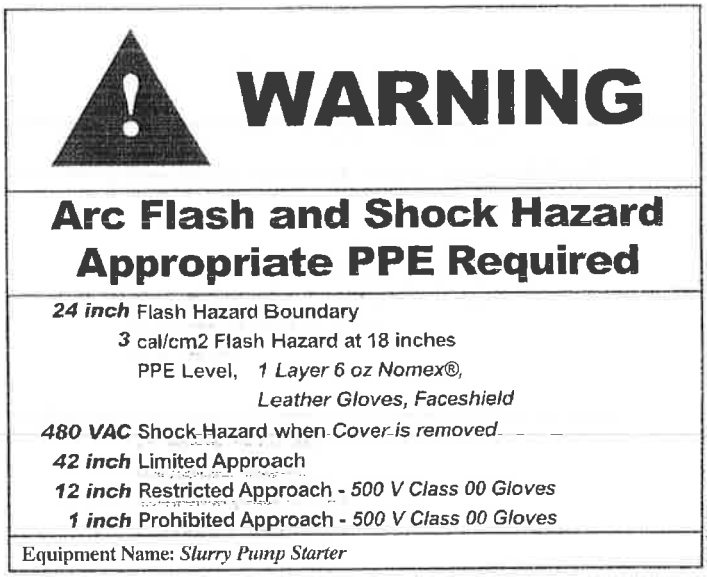
   d. Worst case PPE level and list required PPE.

   e. Shock hazard when cover is removed.

f. Limited approach distance and list required PPE.

g. Restricted approach distance and list required PPE.

h. Prohibited approach distance and list required PPE.



PART 3 - EXECUTION

3.01 Field Settings and Testing

A. General

Prior to energizing facilities, final testing shall be performed by the Contractor and witnessed by the field testing consultant. Testing shall be performed to confirm compliance with Contract Documents, NEC, and to permit energizing the equipment including the "green tagging" of the electrical service.

B. The Contractor shall perform field adjustments of the protective devices as required to place the equipment in final operating condition. The settings shall be in accordance with the approved short circuit study, protective device evaluation study, and protective device coordination study. The testing consultant shall witness the settings and confirm same.

C. Necessary field settings of devices and adjustments and minor modifications to equipment to accomplish conformance with the approved short circuit and protective device coordination study shall be carried out by the Contractor at no additional cost to the Owner.

D. Field testing consultant shall measure and record the resistance of the ground systems.

Field testing consultant shall confirm proper torque of wire lug connections to the main switchgear, power distribution sections, MCC, lighting panels, and check for loose wiring connections.

Field testing consultant shall meggar test each motor at 500 Volts and 1000 Volts and report results.

The field testing consultant shall verify proper short circuit duty and amperage rating of all devices and bussing.

E. The field testing consultant shall verify that arc flash and shock hazard warning labels shave been installed in accordance with the requirements of Part 2.02.C, herein.

3.02 Field Testing Report

The field testing consultant shall provide a detailed report showing all test results and showing that settings of protective devices are in compliance with the coordination study. The report shall state adequacy of grounding systems and protective device settings and indicate the facilities are in compliance with NEC and ready to be energized. Report shall be submitted to the Owner for acceptance as a submittal document.

3.03 Utility Company Approval

Unless otherwise noted, copies of the final report shall be submitted to the Owner for submittal to the utility company for their review and approval. Report shall demonstrate that the service is ready to be energized and include suitable test results meeting the utility's requirements.

END OF SECTION

SECTION 16050
BASIC ELECTRICAL MATERIALS AND EQUIPMENT SPECIFICATIONS

PART 1 - GENERAL

1.01 Description

The Contractor shall furnish all labor, equipment, and materials to provide complete and operable electrical system(s), all in accordance with the requirements of the Contract Documents.

1.02 Reference Codes and Standards

All electrical equipment and materials, including the design, construction, and installation thereof, shall comply with the following codes and standards (latest editions), as applicable. Where two codes or standards are at variance, the most stringent requirements shall govern:

A. National Electric Code (NEC).

B. Basic Electrical Regulations, Title 24, State Building Standards, California Administrative Code.

C. Low Voltage Electrical Safety Orders, Title 8, Division of Industrial Safety, State of California.

D. City and County Electrical Codes.

E. American National Standards Institute (ANSI).

F. National Electrical Manufacturers Association (NEMA).

G. National Fire Protection Association (NFPA).

H. Underwriters Laboratories, Inc. (UL).

I. Occupational Safety and Health Act (OSHA) Safety and Health Standards (29CFR1910 and 29CFR1926), State Building Standards, and applicable local codes and regulations.

All equipment and material furnished by the Contractor shall be listed by and shall bear the label of Underwriters Laboratories, Inc. (UL) or of an independent testing laboratory acceptable to the local agency with jurisdiction over the electrical work.

1.03 Submittals

A. Shop Drawings

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

1. Catalog data including catalog cut sheets, bulletins, brochures, etc. Applicable sizes, model numbers, and options shall be clearly marked and delineated.

2. Connection diagrams, terminal diagrams, and internal wiring diagrams.

3. Equipment and material temperature limitations.

4. Drawings for all grounding work not specifically shown.

5. Nameplates for all electrical panels, including nameplate material, lettering height, and proposed inscriptions.

B. Operation and Maintenance Manuals

Contractor shall submit detailed Operation and Maintenance Manuals for each item of equipment in accordance with the requirements of Specification Section 01300, "Contractor Submittals".

C. Record Drawings

Contractor shall maintain and keep current a complete record set of construction drawings showing every change from the Contract Drawings and Specifications and the exact locations, sizes, and types of equipment and material installed. Record drawings shall show all conduit runs (sizes and number), circuits, and conductors (sizes and numbers). Record drawings shall show depths and routing of all concealed and below grade electrical installations. Record drawings shall be available to the Owner during construction and shall be delivered to the Owner upon project completion.

1.04 Delivery, Storage, and Handling

A. Delivery

Deliver electrical materials and equipment in manufacturer's original cartons and containers with seals intact. Deliver conductors on sealed reels. Deliver large multi-component equipment in sections to facilitate field handling and installation.

B. Storage

Unless designed for outdoor exposure, store electrical equipment and material of the ground and under cover. Equipment and material shall be protected from weather, corrosion, contamination, and deterioration. Dents, marred finishes, and other damage shall be repaired to its original condition or replaced as directed by the Owner.

C. Handling

All equipment and material shall be handled in accordance with the manufacturer's recommendations. Large or heavy items shall be lifted at the points designed by the manufacturer. Equipment and material shall be handled and installed as necessary to prevent damage.

1.05 Public Utilities

A. Contractor shall obtain electrical service requirements from public utility furnishing electrical power to the project. Contractor shall coordinate installation of power service with public utility. Contractor shall obtain, at his expense, all permits, licenses, and inspections required for electrical construction work by public utilities having jurisdiction.

B. Contractor shall furnish and install all service conduit, fittings, transformer pad(s), manholes, vaults, grounding, and conductors not furnished by the serving utility.

PART 2 - PRODUCTS

2.01 General

All equipment and materials shall be new, shall be listed by UL, and shall bear the UL label, where UL requirements apply. All equipment and material shall be of industrial grade and be capable of long term, reliable, and trouble-free service. Similar equipment and material items shall be products of the same manufacturer.

2.02 Grounding

A. Grounding and grounding components shall comply with the applicable requirement of the NEC, Article 250.

B. Grounding cable shall be stranded copper and shall be sized in accordance with Code requirements when sizes are not shown on the Drawings. Contractor shall submit shop drawings for all grounding work not shown on the Drawings.

C. Grounding rods shall conform to ANSI/UL 467 and shall be copper-clad steel, 3/4-inch (minimum) in diameter and 10 feet (minimum) in length. Rods shall be driven in the ground at least 9' -6" deep.

Provide the number of rods required to obtain proper ground resistance, as applicable to all manholes, padmount switches, transformers, service entrances, etc.

D. Ground rod mechanical connector bodies shall be manufactured from high strength, high conductivity cast copper alloy material. Bolts, nuts, washers and lockwashers shall be made of silicon bronze and supplied as a part of the connector body and shall be of the two bolt type.

Split bolt connector types are not allowed.

The connectors shall meet or exceed the requirements of UL 467 and be clearly marked with manufacturer and conductor size.

E. Ground rod compression connectors shall be manufactured from pure wrought copper. The conductivity of this material shall be no less than 99% by IACS standards.

The connectors shall meet or exceed the performance requirements of IEEE 837, latest revision. The connectors shall be clearly marked with the manufacturer and conductor size.

The installation of the connectors shall be made with a compression, tool and die system, as recommended by the manufacturer of the connectors. Each connector shall be factory filled with an oxide-inhibiting compound.

2.03 Manholes and Pull Boxes

A. Manholes and Pull-Boxes shall be of precast concrete, designed for H-20 traffic loading. Concrete sections shall be modular with tongue and groove joints. A continuous waterproof gasket shall be provided at all section and slab joints. Manhole and Pull-Box minimum inside dimensions shall be as shown on the Drawings. Manholes and Pull-Boxes shall be equipped with galvanized steel pulling irons opposite each ductbank entrance. Manholes and Pull-Boxes shall be provided with a sump opening and one (1) one-inch ground rod opening in the base section. Sump opening shall be provided with cast iron perforated cover. Manhole and Pull-Boxes shall be placed on a 12" thick crushed rock base.

B. Manhole covers shall be cast iron, 30" round (minimum), designed for H-20 traffic loading, and supported on the necking section. Pull-Box covers shall be hot dipped galvanized, checkered plate steel suitable for H-20 traffic loading (unless noted otherwise), and bolted down to cast-in-place hot dipped galvanized steel frames with stainless steel hardware. Manhole and Pull-Box covers shall be marked "High Voltage Electric", unless noted otherwise.

C. Manholes and Pull-Boxes shall be provided with cable supports as required to support cable at 3-foot (minimum) intervals. Cable supports shall be fabricated from hot dipped galvanized or fiberglass strut channel and attached to slotted galvanized steel channel cast-in-place inserts. Provide glazed porcelain insulators with channel clamps for support channels. Strap cable to insulators with plastic tie wraps. All phase and ground cables in each circuit shall be kept together and contained on/in the porcelain cable supports. No phase cable shall be run separate from the other two phases and ground.

D. Manholes and Pull-Boxes shall be provided with knockouts for connections to all underground conduit and ductbanks. Ductbank entrances shall be grouted flush with non-shrink grout. Ducts and conduits shall be terminated with flush-end bells.

E. One ground rod shall be provided for each manhole and pull-box, unless otherwise noted.
Provide #4/0 bare stranded copper ground wire completely around the inside perimeter of each manholes and pull-box and anchor to walls. Connect the ground wire to the

ground rod. Bond the bare copper ground wire to any splice shield wires, ground wires, cable racks, cover frames, sump frames and other metal items in the manholes. All separate ground wires accompanying circuits shall be grounded in each manhole passed through.

F. Manholes and Pull-Boxes shall be manufactured by Brooks, Quikset, or equal.

2.04 Conduit

A. General

Each length of conduit shall bear the UL label and be a minimum size of ¾", unless noted otherwise. Elbows shall be standard radius sweeps meeting the requirements of the NEC.

B. Rigid Steel Conduit

1. Rigid steel conduit shall be Schedule 40 steel, pipe size, finished inside and out by hot-dipped galvanizing, and shall conform with ANSI C80.1 and UL. All rigid steel conduit in direct contact with the ground or concrete shall be protected by double wrapping with 20 mil PVC tape.

2. Couplings shall be galvanized steel.

3. Insulating Bushings: threaded malleable iron with thermoplastic liner.

4. Insulated Grounding Bushings: threaded malleable iron body with insulated thermoplastic liner throat and "lay-in" ground lug with compression screw.

5. Insulated Metallic Bushings: threaded malleable iron body with plastic insulated throat.

6. Running threads are not acceptable.

C. PVC Coated Rigid Steel Conduit

1. Conduit shall be Schedule 40 steel, pipe size, finished inside and out by hot-dipped galvanizing, and shall conform with ANSI C80.1 and UL. A PVC coating of 40 mils (minimum) thickness shall be bonded to the outer galvanized surface of the conduit and a urethane coating shall be applied to the interior surface of the conduit. The bond between the PVC coating and the conduit surface shall be greater than the tensile strength of the plastic. A PVC jacketed coupling shall be furnished with each length of conduit. PVC coated rigid steel conduit and fittings shall be manufactured by Robroy, Occidental, or equal.

2. Conduit fittings shall be PVC coated and furnished by the same manufacturer as the conduit to provide a complete and compatible protective system. PVC coated fittings and couplings shall have specially formed sleeves to tightly seal to conduit PVC coating. The sleeves shall extend beyond the fitting or coupling

a distance equal to the conduit outside diameter or two inches, whichever is greater.

D. Rigid Non-Metallic Conduit

1. Conduit shall be UL listed, sunlight resistant, Schedule 40 polyvinyl-chloride (PVC) conduit, rated for 90^0 C conductors, and manufactured to NEMA TC-2 standards.

2. Couplings and connectors shall be of the same manufacturer as the conduit and shall be joined as recommended by the manufacturer. All PVC conduits shall be terminated with approved connectors or end bells.

E. Electrical Metallic Tubing (EMT)

1. Conduit shall be formed of cold rolled strip steel, electroplated, and shall meet ANSI and UL requirements.

2. Couplings shall be electroplated steel, UL listed rain and concrete tight.

3. Connectors shall be gland compression type with insulated plastic throat.

F. Liquid-Tight Flexible Metallic Conduit

1. Conduit shall be liquid tight and shall have an interlocking flexible galvanized steel core with permanently bonded continuous exterior gray PVC jacket. Exterior jacket shall be moisture and oil-proof, and UV protected. A copper bonding conductor shall be included between the segments. Interior surfaces shall be smooth and offer minimum drag to pulling conductors. Liquid-tight flexible metallic conduit shall be as manufactured by Anaconda, Electroflex, or equal.

2. Connectors shall be the screw clamp or screw-in (Jake) variety with cast malleable iron bodies and threaded male hubs with insulated throats or insulated bushings. Liquid-tight fittings shall be of cadmium plated cast malleable iron, with insulated throat, with provisions for grounding.

2.05 Non-Metallic Cable Tray

A. General

Non-metallic cable tray shall be ladder-type conforming to applicable sections of NEMA FG-1 and ASTM E-84. Non-metallic cable tray system shall be constructed of fire-retardant polyester resin. All composite material shall be provided with an ultra-violet light inhibiting chemical additive and meet ASTM E-84, maximum 25 flame spread (Class 1 rating).

Cable tray load class shall be selected based upon the weight of specified cables/conductors shown on the Drawings with a 25% additional weight allowance for future cables/conductors while maintaining a minimum safety factor of 1.5.

The non-metallic cable tray system shall be as manufactured by Enduro Composite Systems, Inc., or equal.

B. Construction

Unless specified otherwise, cable tray shall conform to the following dimensional requirements:

Nominal Width	= 12" minimum
Cable Loading Depth	= 4" minimum
Rung Spacing	= 6" maximum
Fitting Radius	= 12" minimum

Cable tray side rail members shall turn inward. Rungs and side members shall be connected by both mechanical and chemical (adhesive) means. All bonded connections shall be sanded to maximize adhesion and structural integrity. The cable tray interior shall be clear of all projections or sharp objects. All straight sections and fittings shall be pre-drilled to accept connector plates. All cut ends and drilled holes (factory and field) shall be sealed with resin coating.

All fittings shall be designed and installed so as to have the same load carrying capacity as straight sections. Unless specified otherwise, all fittings shall be concentric curved molded type, not mitered.

C. Connections, Accessories, and Supports

Connector plates shall be fiberglass and designed to transfer cable tray loads to the support system. Fasteners for connector plates shall be Type 316 stainless steel or FRP studs and hex nuts as required.

Where specified on the Drawings, cable trays shall be provided with fiberglass flat covers.

Cable tray support systems shall be constructed of polyester or vinyl ester resin strut channels (single or double channel as necessary) and appurtenances. Support spacing shall be in accordance with the cable tray manufacturer's printed recommendations for the specified loads.

Cable tray manufacturer shall provide all clamps, support assemblies, and appurtenances necessary for the installation of a complete cable tray system.

2.06 Non-Metallic Wireway

A. General

Non-metallic wireway shall be solid bottom type construction with minimum wall thickness of 0.1875 inches. Covers and cover splice plates shall be snap-on type construction requiring no installation fasteners.

The wireway system shall conform to the applicable sections of NEC Article 362.

The non-metallic wireway system shall be as manufactured by Enduro Composite Systems, Inc., or equal.

B. Construction

Wireways, covers, and connector plates shall be pultruded utilizing polyester resin with UV light inhibiting additives and exterior nexus veil coverage.

All composite material shall meet ASTM E84, maximum 25 flame spread rating.

All cut ends and drilled holes (factory and field) shall be sealed with resin coating.

C. Connections, Accessories, and Supports

Connector plates shall be fiberglass and designed to transfer wireway loads to the support system. Fasteners for connector plates shall be Type 316 stainless steel or FRP studs and hex nuts as required.

Wireways shall be provided with fiberglass flat snap-on/snap-off covers.

Wireway support systems shall be constructed of polyester or vinyl ester resin strut channels (single or double channel as necessary) and appurtenances. Support spacing shall be in accordance with the wireway manufacturer's printed recommendations for the specified loads.

2.07 Conductors and Cable

A. General

Cables and wires shall be new, stranded conductors, solid copper, not smaller than #12 AWG (except shielded control wire) unless otherwise shown on Drawings. Insulation shall bear manufacturer's trademark, insulation designation, voltage rating, and conductor size at regular intervals. Each type of cable or wire shall be the product of a single manufacturer.

B. Conductors

Conductors for power service, power feeders, power circuits, and lighting feeders, lighting circuits, and control circuits shall be stranded copper, rated 600 volt, with 75^0 C THWN insulation, UL approved, for installation underground, in concrete, in masonry, or in wet locations. Minimum conductor size shall be # 12 AWG.

C. Shielded Cable

Shielded cable shall consist of minimum 3 #16 AWG, stranded, tinned-copper conductors, individually insulated with 25 mils of polyethylene and 100% aluminum foil tape. Unless otherwise shown on the Drawings, shielded cable shall be used for all 4-20 ma signals. Cable shall be manufactured by Belden, or equal.

D. Color Coding

System conductors shall be factory color coded by integral pigmentation with a separate color for each phase and neutral, or by an approved colored marking tape at all terminations and in all junction boxes, pull-boxes, and manholes. Each voltage system shall have a color coded system that shall be maintained throughout the project. Approved colored marking tape is as follows:

System	Service	Color
120V, 1 Phase, 2 wire	Line	Black
	Neutral	White
208V, 3 Phase, 4 wire	Phase A	Black
	Phase B	Red
	Phase C	Blue
	Neutral	White
480V, 3 Phase, 4 wire	Phase A	Brown
	Phase B	Orange
	Phase C	Yellow
	Neutral	White
All	Ground	Green & Bare Copper

2.08 Switches and Relays

A. Toggle Switches

Local single pole switches shall be flush tumbler type AC rated, quiet type, heavy duty, 20 amp minimum, rated 120/277 volt, back or side wired with binding screws. Switches shall conform to NEMA WD-1 specifications. Two pole three way and other switches shall be similar. Switches shall be as manufactured by Hubbell, Bryant, or equal.

B. Relays

Control relays shall be rated 120VAC with minimum 10A contacts, unless otherwise noted on the Drawings. All control relays and relay timers shall be DIN rail mounted, with instantaneous reversible contacts, 8 or 11 pin base type only.

2.09 Receptacles

A. General Purpose

General purpose receptacles shall be duplex, 3-wire grounding type, rated 125 /250 volt, AC, 20 amp minimum, NEMA 5-20R, back or side wired with binding screws, as manufactured by Hubbell, Bryant, G.E, or equal.

B. Ground Fault Interrupter (GFI)

GFI receptacles shall be NEMA 5-20R configured and shall mount in a standard device box. Units shall trip at 5 milliamperes of ground current and shall comply with NEMA WD-1-1.10 and UL 943. GFI receptacles shall be capable of individual protection as well as downstream protection.

2.10 Device Boxes, Junction Boxes, and Fittings

A. Device Boxes (General Purpose - Indoors or Outdoors)

Unless otherwise noted on the Drawings, device boxes shall malleable iron constructed with zinc or cadmium plating and enamel finish, minimum single gang size, deep box type, with treaded hubs and solid gasketed cover. Device boxes shall be properly sized for required circuitry or splicing. Surface mounted boxes shall be furnished with mounting lugs. Where located outdoors, device boxes shall be waterproof. Device boxes shall be Crouse-Hinds FD, Appleton FD, or equal.

B. Junction Boxes (General Purpose - Indoors or Outdoors)

Unless otherwise noted on the Drawings, junction boxes shall be malleable iron constructed, rain tight, dust tight, minimum size 4"x4"x3", drilled and tapped or field installed with slip holes (alternate hub plates are acceptable). Junction boxes shall be properly sized for the number and sizes of conductors and conduit entering the box and required splicing. Provide feet where necessary for surface mounting. Junction boxes shall be Crouse-Hinds WAB, Appleton RS, or equal.

C. Device Boxes (Wet or Corrosive Locations)

Where specified on the Drawings, device boxes shall be constructed of 316 stainless steel, minimum single gang size, deep box type, with gasket and 316 stainless steel solid cover. Device boxes shall be properly sized for required circuitry or splicing. Surface mounted boxes shall be furnished with mounting lugs or feet. Device boxes shall be NEMA 4X as manufactured by BEL Products, Inc., Cushing Manufacturing Co., or equal.

D. Junction Boxes (Wet or Corrosive Locations)

Where specified on the Drawings, junction boxes shall be constructed of 316 stainless steel, with gasket and 316 stainless steel solid cover. Junction box minimum size shall be 4"x4"x3". Junction boxes shall be properly sized for required circuitry or splicing.

Provide feet where necessary for surface mounting. Junction boxes shall be NEMA 4X as manufactured by BEL Products, Inc., Cushing Manufacturing Co., or equal.

E. Fittings

Conduit fittings shall be provided where shown on the Drawings or required to facilitate installation of the electrical conduit and equipment.

1. Metallic fittings shall be constructed of malleable iron with zinc or cadmium plating and enamel finish, with gasket and cast cover. Fittings shall be Condulet Type as manufactured by Crouse-Hinds, Appleton, or equal.

2. Non-metallic fittings shall be compatible with the non-metallic conduit used and shall be of the same manufacturer.

3. Fittings shall be of the shapes, sizes, and types required to facilitate installation or removal or conductors and cables from the conduit, cable tray, and wireway systems.

4. Connectors, couplings, locknuts, bushings, and caps used with Rigid Steel conduit shall be threaded and thoroughly galvanized. Bushings shall be insulated.

5. Metallic conduit unions shall be "Erickson" couplings, or approved equal. Running threads are not acceptable.

6. Connectors for liquid-tight flexible metallic conduit shall be liquid tight with insulating bushings and provision for ground continuity.

2.11 Disconnect Switches

A. Switch Interior

Dead-front construction with hinged arc suppressor and switch blades which are fully visible in the "OFF" position and with door open.

B. Switch Mechanism

Switches shall be quick-make and quick-break with arc quenching and ambient temperature compensated overload devices. Switch operating handle and mechanism shall be provided with a dual cover interlock to prevent unauthorized opening of the switch door in the "ON" position or closing the switch mechanism while the door is open. Switch operating handle shall be capable of being padlocked in the "OFF" position. Switches shall be manufactured by General Electric, Westinghouse, Square D, or equal.

C. Ratings

Switches shall be horsepower rated for the operating voltage and with fused or non-fused arrangements as shown on the Drawings.

D. Enclosures

Unless otherwise noted on the Drawings, for interior locations enclosures shall be NEMA 12 panels with hinged covers and padlockable hasps. Switches in exterior locations shall be provided with gasketed NEMA 3R enclosures with hinged covers and padlockable hasps.

2.12 Low-Voltage Cable Splices

Low-voltage cable splices and terminations shall be rated at not less than 600 Volts. Splices in conductors No. 10 AWG and smaller shall be made with an insulated, solderless, pressure type connector, conforming to the applicable requirements of UL 486A. Splices in conductors No. 8 AWG and larger shall be made with noninsulated, solderless, pressure type connector, conforming to the applicable requirements of UL 486A and UL 486B. Splices shall then be covered with an insulation and jacket material equivalent to the conductor insulation and jacket. Splices below grade or in wet locations shall be sealed type conforming to ANSI C119.1 or shall be waterproofed by a sealant-filled, thick wall, heat shrinkable, thermosetting tubing or by pouring a thermosetting resin into a mold that surrounds the joined conductors.

2.13 Miscellaneous Equipment and Material

A. Concrete Anchors

Type 304 (or better) stainless steel expansion anchors (wedge or sleeve) shall be used to for mounting all electrical conduit, boxes, and equipment. NO type of explosive anchor will be permitted.

B. Conduit Straps

Where specified on the Drawings, conduit straps shall be malleable iron constructed, one-hold type strap with cast clam-backs and spacers as required.

C. Channel (Unistrut) Supports

Unless otherwise specified, support channel (Unistrut) shall be single strut type, 1-1/2" x 1-1/2", 12 gauge hot dipped galvanized steel with 17/32" diameter bolt holes on 1-1/2" centers.

D. Nameplates

Nameplates shall be provided for all electrical panels, stations, and equipment furnished by the Contractor. Nameplates shall be engraved laminated plastic, with 1/4" high white lettering on black background. Nameplates shall indicate equipment and its function. Nameplates shall be securely fastened with stainless steel drive screws or escutcheon pins.

E. Panelboard Labeling

Panelboard circuits shall be labeled clearly indicating which piece of equipment, outlet, lighting, receptacle, etc. is powered by the respective circuit. Labeling shall be arranged in numerical order.

F. Conductor and Terminal Markers

Conductor and terminal markers shall be self-adhering, pre-printed cloth or vinyl.

PART 3 - EXECUTION

3.01 General

A. Prefabricated Material and Equipment

Installation of all prefabricated items and equipment shall conform to the requirements of the manufacturer's specifications and installation instructions. When code requirements apply to installation of materials and equipment, the more stringent requirements, code, or manufacturer's specifications and installation instructions shall govern the work.

B. Power Supplies to Mechanical Equipment

1. An electric power supply, including conduit, any necessary junction or outlet boxes, and conductors and connections shall be furnished and installed by Contractor for each item of mechanical equipment.

2. Circuit breakers or fused disconnect protection shall be provided for each separate item of mechanical equipment shown on the Drawings, or specified in the Basic or Technical Specifications.

3. Power supplies to individual items of equipment shall be terminated in a suitable outlet or junction box adjacent to the respective item of equipment, or a junction box provided by the manufacturer of the equipment. Sufficient lengths of conductor at each location shall be provided to permit connection to equipment without damaging the conductors.

3.02 Conduit Installation

A. General

1. Contractor shall install conduit and electrical equipment in locations that will cause minimal interference with the maintenance and removal of mechanical equipment. Conduits and connections are shown schematically on the Drawings. Contractor shall run conduit in a neat manner parallel or perpendicular to walls and slabs, and wherever possible, installed together in parallel runs supported with Unistrut type support system. All conduits shall be installed straight and true with reference to the adjacent work.

2. Unless noted otherwise on the Drawings, conduits shall be concealed in walls or in cast-in-place concrete slabs. Concealed conduits shall be run in as direct a route as possible and with bends of large radii. Floor penetrations shall be made only at specific approved locations; other penetrations are prohibited. Conduits shall be rigidly secured in position by means of approved clamps.

3. Locations of conduit runs shall be planned in advance of the installation and coordinated with the ductwork, plumbing, ceiling, and wall construction in the same areas, and shall not unnecessarily cross other conduits or pipe, nor prevent removal of nor block access to mechanical or electrical equipment.

4. Unless noted otherwise on the Drawings, buried conduit shall be installed with a minimum of 24" cover. All conduit trenches shall be compacted to a minimum of 90% relative compaction. Compaction in the pipe zone shall be accomplished by water jetting imported sand, one sack sand slurry cement, or equal, placed to 6" above top of conduit. Buried conduit shall be installed using approved spacers and cradles, properly supported/anchored and at sufficient intervals to prevent movement during backfill operations (maximum spacing of five feet). Where change in direction is required, long radius elbows shall be installed. Prior to installation of conductors in underground conduits, a testing mandrel not less than six (6) inches long and with a diameter 1/4 inch less than the conduit diameter shall be drawn through after which a stiff bristle brush of the proper size for the conduits shall be drawn through until the conduits are free of all sand and gravel.

5. Unless noted otherwise on the Drawings, conduits cast in, under, or through concrete walls, slabs, or masonry walls shall be Rigid Steel.

6. Unless noted otherwise on the Drawings, buried conduit shall be Rigid Non-Metallic or Rigid Steel. Transition from PVC to Rigid Steel shall be made at the horizontal leg of the buried conduit bend.

7. Unless noted otherwise on the Drawings, exposed or above grade conduit shall be Rigid Steel.

8. Spare conduits shall extend a minimum of 3" above concrete slab or wall, and be provided with threaded cap and polyethylene pull rope with 100-pound (minimum) tensile strength.

9. All conduits shall be tightly sealed during construction by use of conduit plugs or "pennies" set under bushings. All conduit in which moisture or any foreign matter has collected before pulling conductors shall be cleaned and dried to the satisfaction of the Owner.

10. Conduits shall be securely fastened to cabinets, boxes, and gutters using locknuts (one inside and one outside enclosure for rigid conduit, one inside enclosure for EMT) and an insulating bushing or specified insulated connectors. Grounding bushings or bonding jumpers shall be installed on all conduits terminating at concentric knockouts.

B. Rigid Steel Conduit

Rigid Steel conduit installations below grade, and cast in, under, or through walls or slabs shall be double wrapped with 20-mil PVC tape. Running threads and threadless couplings will not be acceptable. Where necessary for connecting conduit, UL listed couplings or unions shall be used. All ends and joints shall be reamed smooth after cutting.

C. Electrical Metallic Tubing (EMT)

EMT conduit shall only be installed where specifically shown on the Drawings. EMT conduit, where specified, shall be furnished with weatherproof fittings.

D. Liquid-Tight Flexible Metallic Conduit

Liquid-tight flexible conduit shall be installed in all locations for connections to equipment, including, but not limited to: motors, HVAC equipment, automatic valves, and similar devices.

E. Rigid Non-Metallic Conduit

Unless noted otherwise on the Drawings, Schedule 40 PVC conduit may be used underground. PVC conduits shall not be run exposed.

F. Supports

1. All raceway systems shall be secured to building structures using specified fasteners, clamps, Unistrut, and hangers spaced according to NEC requirements.

2. Exposed conduit shall be supported with channel supports spaced per NEC requirements (8'-0" maximum spacing) and within 18" of couplings, bends, boxes, etc., unless otherwise shown on the Drawings.

3. Multiple conduit runs shall be supported using "trapeze" hangers, consisting of approved channels suspended on steel rods from ceiling inserts located not more than eight (8) feet apart. Sizes of channels and rods shall be selected as recommended by the manufacturer for span and loading conditions.

G. Termination and Joints

1. Raceways shall be joined using specified couplings or transition couplings where dissimilar raceway systems are joined.

2. Conduit terminations exposed at weatherproof enclosures and cast outlet boxes shall be made watertight using approved connectors and hubs.

3. Expansion couplings shall be installed where any conduit crosses a building separation or expansion joint, including joints in footings and gradebeams.

4. Approved cable-sealing bushings shall be installed on all conduits originating from roof and terminating in switchgear, cabinets, or gutters inside the building.

5. Conduit bodies (Condulets) are not acceptable as enclosures for splices.

6. At all conduit terminations and boxes, conductors shall be protected by a fitting equipped with a plastic bushing having a smoothly rounded insulating surface.

3.02 Conductor and Cable Installation

A. General

1. Conductors shall not be installed in conduit runs until all work is completed for each individual conduit run. Care shall be taken in pulling conductors such that insulation is not damaged. UL approved pulling compounds shall be used.

2. Unless noted otherwise on the Drawings, all conductors or cables shall be installed in conduit or electrical enclosures.

3. All cables shall be installed and tested in accordance with manufacturer's requirements and warranty.

B. Splicing and Terminating

1. All aspects of splicing and terminating shall be in accordance with cable manufacturers published procedures.

2. All splices in outlet boxes with connectors as specified herein shall be made up with separate tails of correct color. At least six (6) inches of tails packed in box after splice is made up shall be provided.

3. All conductor and cable in panels, control centers and equipment enclosures shall be bundled and clamped.

C. Identification

1. All branch-circuits shall be securely tagged, noting the purpose of each. Conductors shall be marked with vinyl wrap-around markers. Where more than two conductors run through a single outlet, each circuit shall be marked with the corresponding circuit number at the panelboard.

2. Conductors size #6 AWG and larger shall be color coded using specified phase color markers and identification tags.

3. All terminal strips shall have each individual terminal identified with specified vinyl markers.

4. Inside of all junction box cover plates shall be identified via felt-tip pen or decal label, denoting the panel and circuit numbers and voltage contained in the box.

5. All receptacles and switches shall be decal labeled on the plate, denoting the panel and circuit number.

D. Connections to Circuit Breakers, Switches, and Terminal Strips; Stranded Copper Conductors

1. #12 through 8 AWG: Conductor shall be terminated in locking tongue style, pressure type, compression lugs, unless clamp type connection for stranded conductor is provided with device.

2. #6 AWG and larger: Conductor shall be terminated in one-hole flat-tongue style, compression type lugs, or by connectors supplied by the manufacturer.

E. Joints in Conductors in Dry Locations, Copper Conductors

1. #8 AWG and smaller: Conductors shall be twisted and secured with cap or twist-on, expandable spring type solderless connectors.

2. #6 AWG and larger: Conductor shall be joined with split bolt connectors or compression sleeves. Joints shall be insulated with rubber tape and protected with half-lapped layers of vinyl plastic electrical tape. Insulation may also be provided by UL listed pre-manufactured components such as heat-shrink or cold-shrink devices.

F. Joints in Conductors in Moist Locations, Copper Conductors

1. #8 AWG and smaller: Conductor shall be securely joined as specified above, then encapsulated in epoxy (Scotchcast or approved equal).

2. #6 AWG and larger shall be joined as specified above, and suitably water treated.

G. Grounding

Enclosures of equipment, raceways and fixtures shall be permanently and effectively grounded. A code-sized, copper, insulated green equipment ground shall be provided for all branch circuit and feeder runs. Equipment ground shall originate at panelboard ground bus and shall be bonded to all switch and receptacle boxes and electrical equipment enclosures. Ground terminals on receptacles shall be connected to the equipment grounding conductor by an insulated copper conductor.

H. Signal Wiring

Conductor used for alarm and control signal applications shall be identified at both ends and referenced to appropriate as-built drawings. Control wiring shall be numerically or otherwise coded in accordance with as-built control diagrams

3.03 Installation of Boxes and Wiring Devices

A General

1. All outlets shall be surface mounted with walls, ceilings, and floors, except where specified to be finish flush.

2. No unused openings shall be left in any box. Close-up plugs shall be installed as required to seal openings.

3. Exposed outlet boxes and boxes in damp and wet locations shall be provided with gasketed cast metal cover plates.

B. Box Layout

1. Outlet boxes shall be installed at the locations and elevations shown on the Drawings or specified herein. Adjustments to locations shall be made as required by structural conditions and to suit coordination requirements of other trades.

3.04 Transformer Installation

A. Primary shall be connected to minimum value taps during construction period and prior to initial building start-up.

B. Voltage readings shall be made and tap connections adjusted to nominal voltage during final construction review and prior to building occupancy.

C. Transformers shall be installed on vibration pads designed to suppress the transformer vibrations. Pads shall be selected and arranged in accordance with the weights of the transformers.

D. Conduit connections that will prevent transmission of the transformer vibrations to the conduit system shall be installed.

E. Transformers installed against a wall shall have readily accessible primary and secondary terminals.

3.05 Protection

Conduits, junction boxes, outlet boxes, and other openings shall be kept closed to prevent entry of foreign matter. Fixtures, equipment, and apparatus shall be covered and protected against dirt, paint, water, chemical or mechanical damage, before and during the construction period. Damaged fixtures, apparatus, or equipment shall be restored to original condition prior to final acceptance, including restoration of damaged shop coats of paint. Brightly finished surfaces and similar items shall be protected until in service. No rust or damage will be permitted.

3.06 Workmanship

A. Preparation, handling, and installation shall be in accordance with manufacturer's written instructions and technical data particular to the product specified and/or approved, except as otherwise specified.

B. Work shall be furnished and placed in coordination and cooperation with other trades.

C. Work shall conform to the National Electrical Contractor's Association Standard of Installation for general installation practice.

END OF SECTION

SECTION 16410
DISTRIBUTION SWITCHBOARDS AND MOTOR CONTROL CENTERS TECHNICAL SPECIFICATIONS

PART 1 - GENERAL

1.01 Scope

The Contractor shall furnish and install the free standing dead front type low voltage (600 volt) distribution switchboards, motor control centers, and utility service equipment, as specified herein and shown on the Drawings.

1.02 Quality

A. The low-voltage distribution switchboard assembly and all components shall be designed, manufactured, and tested in accordance with standards of NEMA PB-2 and UL Standard 891.

B. The Motor Control Centers (MCC) and all components shall be designed, manufactured and tested in accordance with standards of NEMA, ANSI, and UL 845.

C. For the equipment specified herein, the manufacturer shall be ISO 9000, 9001 or 9002 certified.

D. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Owner, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

E. Unless noted otherwise, manufacturer shall be Cutler-Hammer/Westinghouse, Allen-Bradley, General Electric, Square D, or approved equal.

1.03 Submittals

All submittals shall be in accordance with the requirements of Specification Section 01300.

A. Shop Drawings

Contractor shall submit complete information, drawings, and technical data for all equipment and components, including, but not limited to, the following:

1. Drawings showing elevations, floor plan, top view, anchorage and conduit entry/exit locations

2. Single line and unit wiring diagrams depicting internal and remote devices

3. Nameplate schedule

4. Starter and component schedule

5. Assembly ratings including:

   a. Short circuit rating
   b. Voltage
   c. Continuous current

6. Major component ratings including:

   a. Voltage
   b. Continuous current
   c. Interrupting ratings

7. Cable terminal sizes

8. Busway connection

9. Connection details between close-coupled assemblies

10. Composite floor plan of close-coupled assemblies

11. Key interlock scheme drawing and sequence of operations

12. Descriptive bulletins

13. Product sheets

14. Lateral design and equipment anchorage details, prepared and stamped by a licensed engineer, registered in the State of California

15. Installation information prior to shipment

B. The following information shall be submitted for record purposes prior to project completion.

1. Final as-built Drawings and wiring diagrams

2. Certified production test reports

C. Operation and maintenance manuals shall include the following information:

1. Instruction books and/or leaflets

2. Drawings and information required by above

3. Renewal Parts list showing the important maintenance items which will need to be available for proper maintenance and to provide normal equipment life

1.04 Delivery, Storage, and Handling

Equipment shall be handled and stored in accordance with manufacturer's written instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment. Where stored out of doors, space heaters and thermostat controls shall be energized.

1.05 Measurements

Contractor shall verify equipment proposed shall fit into the available space, coordinate installation and notify the Owner of any interferences or conflicts in the distribution and MCC system power and control wiring.

PART 2 - PRODUCTS

2.01 Ratings

A. The distribution switchboard(s) and MCC shall be rated to withstand mechanical forces exerted during short circuit conditions when connected directly to a power source having minimum available fault current of 65,000 amperes symmetrical at rated voltage unless shown otherwise on the Drawings. Voltage rating shall be 600 volts, unless indicated otherwise on the Drawings.

B. The MCC shall be 600 volt class, suitable for operation on a three-phase, 60-Hertz system. The system operating voltage and number of conductors shall be as indicated on the Drawings.

2.02 Distribution Switchboard Construction

A. Refer to Drawings for actual layout and location of equipment and components; current ratings of devices, bus bars, and components; voltage ratings of devices, components and assemblies; interrupting and withstand ratings of devices, buses, and components; and other required details.

B. Distribution switchboard(s) shall be as manufactured by Cutler-Hammer/Westinghouse, General Electric, Square D, or equal.

C. Standard Features

1. Switchboards shall be fully self-supporting structures with 90-inch tall vertical sections (excluding lifting eyes and pull boxes) with the required number of vertical sections bolted together to form a rigid assembly arrangement. The sides and rear shall be covered with removable bolt-on covers. All edges of front covers or hinged front panels shall be formed. Provide adequate ventilation within the enclosure.

2. Switchboards shall be NEMA 1 or NEMA 3R non-walk-in deadfront construction as shown on the Drawings. NEMA 3R construction shall be as listed below.

3. Switchboard frame shall be die formed, 12 gauge steel with reinforced corner gussets. Frame shall be rigidly bolted to support cover plates (code gauge steel), bus bars and installed devices during shipment and installation.

4. All sections may be rolled, moved, or lifted into position. Switchboards shall be capable of being bolted directly to the floor without the use of floor sills.

5. All switchboard sections shall have open bottoms and removable top plates to install conduit.

6. Unless noted otherwise on the Drawings, switchboard sections shall be front-access only. Front-access only switchboard sections shall be front and rear aligned for placement against a wall. Where specified on the Drawings as front and rear access, switchboards shall be front and rear aligned.

7. Switchboards shall be UL listed.

8. Switchboards that are series rated to short circuit requirements shall be appropriately labeled. Tested UL listed combination ratings shall be included in UL recognized Component Directory (DKSY2).

9. All covers shall be fastened by hex head bolts.

10. Provide hinged doors over metering compartments and individually mounted device compartments. All doors shall have concealed hinges and be fastened by hex head bolts.

11. Switchboard protective devices shall be furnished as listed on Drawings and specified herein, including interconnections, instrumentation, and control wiring. Switchboards and devices shall be rated for the voltage and frequency listed on the Drawings.

12. Switchboard current ratings, including all devices, shall be based on a maximum ambient temperature of 25°C per UL Standard 891. With no derating required, temperature rise of switchboards and devices shall not exceed 65°C in a 25°C ambient environment.

13. Switchboard Service Entrance sections shall comply with UL Service Entrance requirements including a UL service entrance label, incoming line isolation barriers, and a removable neutral bond to switchboard ground for solidly grounded wye systems.

14. The group mounted feeder breaker and/or main devices within switchboards shall be circuit breakers only. Mounting for the group mounted devices shall be by bolted connections. No plug-in type connections shall be used for current carrying components.

D. The assembly shall be provided with adequate lifting means.

2.03 Distribution Switchboard Bus

A. All bus bars shall be silver plated copper. Main horizontal bus bars shall be mounted with all three phases arranged in the same vertical plane. Bus sizing shall be based on NEMA standard temperature rise criteria of 65 degrees C over a 40 degrees C ambient temperature outside the enclosure. Minimum bus rating shall be as specified on the Drawings.

B. A copper ground bus (minimum 1/4 x 2 inch) shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchboard.

C. All hardware used on conductors shall be high-tensile strength and zinc plated. All bus joints shall be provided with conical spring type washers.

2.04 Distribution Switchboard Wiring/Terminations

A. Small wiring, necessary fuse blocks and terminal blocks within the switchboard shall be furnished as required. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.

B. Mechanical type terminals shall be provided for all line and load terminations suitable for copper or aluminum cable rated for 75 degrees C of the size as indicated on the Drawings.

C. Lugs shall be provided in the incoming line section for connection of the main grounding conductor. Additional lugs for connection of other grounding conductors shall be provided as indicated on the Drawings.

D. All control wire shall be type SIS, bundled and secured with nylon ties. Insulated locking spade terminals shall be provided for all control connections, except where saddle type terminals are provided integral to a device. All current transformer secondary leads shall first be connected to conveniently accessible short circuit terminal blocks before connecting to any other device. All groups of control wires leaving the switchboard shall be provided with terminal blocks with suitable numbering strips. Provide wire markers at each end of all control wiring.

2.05 Molded Case Circuit Breakers

A. Molded case circuit breakers shall provide circuit overcurrent protection with inverse time and instantaneous tripping characteristics. Ground fault protection shall be provided where shown on the Drawings and as specified herein.

B. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be nonwelding silver alloy, and arc extinction shall be accomplished by means of DE-ION arc chutes. A push-to-trip button on the front of the circuit breaker shall provide a local manual means to exercise the trip mechanism.

C. Circuit breakers shall have a minimum symmetrical interrupting capacity matching the distribution switch board or MCC where installed or as shown on the Drawings.

D. Circuit breakers, 400 ampere frame and below, shall be provided with thermal-magnetic trip units and inverse time-current characteristics unless otherwise shown on the Drawings.

E. Circuit breakers, 600 ampere through 2500 ampere frame and circuit breakers used as main to disconnect utility power, shall be provided with microprocessor-based RMS sensing trip units.

1. Each molded case circuit breaker microprocessor-based tripping system shall consist of three current sensors, a trip unit, and a flux-transfer shunt trip. The trip unit shall use microprocessor-based technology to provide the adjustable time-current protection functions. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time delay settings are reached.

2. Interchangeable rating plugs shall establish the continuous trip ratings of each circuit breaker. Rating plugs shall be fixed or adjustable as indicated. Rating plugs shall be interlocked so they are not interchangeable between frames, and interlocked such that a breaker cannot be closed and latched with the rating plug removed.

3. The microprocessor-based trip unit shall have thermal memory capabilities to prevent the breaker from being reset following an overload condition until after a preset time delay.

4. When the adjustable instantaneous setting is omitted, the trip unit shall be provided with an instantaneous override. Internal ground fault protection adjustable pick-up ratings shall not exceed 1200 amperes. Provide neutral ground fault current sensor for four wire loads.

5. Breakers shall have built-in test points for testing the long time delay, instantaneous, and ground fault functions of the breaker by means of a 120-volt operated test set. Provide one test set capable of testing all breakers 400 ampere frame and above.

6. System coordination shall be provided by the following microprocessor-based time-current curve shaping adjustments:

   - Adjustable long time pick-up and delay
   - Adjustable short time pick-up and delay, with selective curve shaping
   - Adjustable instantaneous pick-up
   - Adjustable ground fault pick-up and delay, with selective curve shaping

F. Where shown, provide circuit breakers UL listed for application at 100% of their continuous ampere rating in their intended enclosure.

G. Provide shunt trips, bell alarms, and auxiliary switches as shown on the Drawings.

2.06 Bolted Pressure Switches

A. Where shown on the Drawings, fusible bolted pressure switches protective devices shall be bolted pressure contact type and shall be UL listed.

B. Switches shall be furnished with Class L fuse clips. Switch contact interrupting capacity shall be twelve times the continuous rating of the switch.

C. Fuse access door shall be mechanically interlocked with the operating handle and shall have provisions for padlocking the switch in the open position.

D. The switch shall utilize a stored energy dead front operating mechanism compressed and released by the operating handle, to provide quick positive switching action independent of the speed of the operating handle.

E. Switches shall be electrically tripped unless shown otherwise on the Drawings. Electrically tripped switches shall be designed to be closed only after the opening spring has been charged, ready for electrical opening by solenoid or manual opening by the mechanical push-button.

F. Supply electrically tripped switch(es) with the following accessories where indicated on the Drawings:

1. Ground fault protection including Test Panel.

2. Single phase protection to open the switch(es) upon loss of any phase from the source.

3. Blown Fuse Protection to open the switch upon blowing of one or more of the fuses.

G. Provide Class L fuses as shown on the Drawings.

2.07 Quick-Make/Quick-Break Fusible Switches

A. Protective devices shall be quick-make/quick-break fusible switches as manufactured by Cutler-Hammer/Westinghouse, Allen-Bradley, Square D, or equal. Fusible switches, 100 amperes through 600 amperes frames, shall be furnished with rejection Class "R" or "T" type fuse clips unless otherwise specified. Fusible switches, 800 amperes through 1200 amperes, shall be furnished with Class L fuse clips. Switches shall incorporate safety cover interlocks to prevent opening the cover with the switch in the "ON" position or prevent placing the switch in the "ON" position with the cover open. Provide defeater for authorized personnel. Handles shall have provisions for padlocking and shall clearly indicate the "ON" or "OFF" position. Front cover doors shall be padlockable in the closed position.

B. The 400 through 1200 ampere switches shall be designed to accommodate UL listed shunt trip. Where shown on the Drawings, furnish the following accessories:

1. UL listed 120 volt AC shunt trip.

2. Zero sequence ground protection system including test panel. Ground fault relay shall include separate time and current pick-up adjustments.

2.08 MCC Construction

A. MCC shall be provided as shown on the Construction Drawings and as specified herein. MCC shall comply with the requirements of NEMA ICS 2, the NEC, and U.L. 845. Wiring shall be NEMA Class 11, Type B. MCC shall be as manufactured by Cutler-Hammer/Westinghouse, Allen-Bradley, General Electric, or Square D, no substitutes.

B. Structures shall be totally enclosed deadfront, free-standing assemblies. They shall be 90± inches high and 21± inches deep. Each structure shall be minimum 20± inches wide and wider where shown on the Drawings, or where required to house components shown on the Drawings. Structures shall contain a horizontal wireway at the top, isolated from the horizontal bus and shall be readily accessible through a hinged cover. Adequate space for conduit and wiring to enter the top or bottom shall be provided without structural interference.

C. Compartments for mounting control units shall be incrementally arranged such that not more than twelve Size 1 starters can be mounted within each vertical structure. Guide rails shall be provided.

D. A vertical wireway with minimum of 35 square inches of cross sectional area shall be adjacent to each vertical unit and shall be covered by a hinged door. Wireways shall contain steel rod cable supports.

E. All full voltage starter units through NEMA Size 5 shall be of the drawout type. Drawout provisions shall include a positive guide rail system and stab shrouds to absolutely ensure alignment of stabs with the vertical bus. Drawout units shall have a tin-plated stab assembly for connection to the vertical bus. No wiring to these stabs shall extend into the bus compartment. Interior of all units shall be painted white for increased visibility. Units shall be equipped with side-mounted, positive latch pull-apart type control terminal blocks rated 600 volts. Knockouts shall be provided for the addition of future terminal blocks. In addition, a master terminal block, when Type C wiring is specified, shall be drawout and shall be located in the bottom wireway, readily accessible through a hinged cover. All internal control wire to be 14 gauge minimum.

F. All drawout units shall be secured by a spring-loaded quarter turn indicating type fastening device located at the top front of the unit. Each unit compartment shall be provided with an individual front door.

G. An operating mechanism shall be mounted on the primary disconnect of each starter unit. It shall be mechanically interlocked with the unit door to prevent access unless the disconnect is in the OFF position. A defeater shall be provided to bypass this interlock. With the door open, an interlock shall be provided to prevent inadvertent closing of the

disconnect. A second interlock shall be provided to prevent removal or re-insertion of the unit while in the ON position. Padlocking facilities shall be provided to positively lock the disconnect in the OFF position with from one to three padlocks with the door open or closed. In addition, means shall be provided to padlock the unit in a partially withdrawn position with the stabs free of the vertical bus.

2.09 MCC Bus

A. Each structure shall contain a main horizontal copper tin plated or copper silver plated bus, with minimum ampacity rating of 600 amperes or as shown on the Drawings. 1200 amp horizontal bus shall be provided for meter and distribution panel. The horizontal bus shall be rated at 50 degrees C temperature rise over a 40 degree C ambient temperature in compliance with UL standards. Vertical busses feeding unit compartments shall be copper and shall be securely bolted to the horizontal main bus. All joints shall be front accessible for ease of maintenance. The vertical bus shall have a minimum rating of 300 amperes for front mounted units. 600 amp vertical bus shall be provided for meter and distribution panel.

B. Isolation of the vertical bus compartment from the unit compartment shall be by means of a full height insulating barrier. This barrier shall be a single sheet of glass reinforced polyester with cutouts to allow the unit stabs to engage the vertical bus. Provide snap-in covers for all unused openings.

C. Busses shall be braced for minimum 65,000 amperes RMS symmetrical unless shown otherwise on the Drawings.

2.10 MCC Motor Controllers (Combination Starters)

Motor controllers shall consist of combination starter units with motor circuit protectors, molded case circuit breakers, or fusible switches and motor starters with thermal bimetallic overload relays, or current sensor type with microprocessor control.

Specific type of short circuit protection, line starter, and auxiliary equipment shall be as specified herein and shown on the Drawings.

Combination starter units shall be of the type shown on the Drawings and shall be full voltage non-reversing, rated minimum 65,000 amperes RMS, symmetrical at 480 V unless shown otherwise on the Drawings.

A. Motor Circuit Protectors shall be as manufactured by Cutler-Hammer/Westinghouse, Allen Bradley, Square D, or equal.

The motor circuit protection shall provide adjustable magnetic protection and be provided with pin insert to stop magnetic adjustment at 1300% motor nameplate full load current to comply with NEC requirements. All combination starter units shall have a "tripped" position on the unit disconnect and a push-to-test button on the motor circuit protector. Motor circuit protectors shall include transient override feature for motor inrush current.

B. Fusible Switches

Fusible switches shall be quick-make, quick-break, with Class R type fuse clips and dual element time delay fuses.

C. Molded Case Circuit Breakers

Molded case circuit breakers shall be thermal magnetic type per Section 2.05 herein, and shall only be provided where specifically specified on the Drawings.

D. Motor starters shall be electrically operated, electrically held, three-pole assemblies with arc extinguishing characteristics and shall have silver-to-silver renewable contacts. They shall have provisions for a total of eight NO or eight NC auxiliary contacts. The overload protection shall consist of the following types as specified on the Drawings:

1. Motor Starter with Integral Current Sensor and Overload Device

Overload protection shall consist of one current sensor located in each phase monitored by a microprocessor that yields a time current curve closely paralleling that of motor heating damage boundary, accurate to 2%. Running overload protection shall be DIP switch selectable for the specific motor full load amperes within the starter range. Provide DIP switch selectable overload trip class of 10, 20, and 30. Line starters shall be Cutler-Hammer/Westinghouse "Advantage", Square D "Motor Logic", Allen Bradley "SMC", or equal, and shall provide the following features:

a. Motor starters shall monitor current in each phase to provide phase loss and phase unbalance protection, such that if the unbalance on any of two phases is greater than 30% of the DIP switch selected trip rating, a phase loss/unbalance trip occurs. Provide phase loss/unbalance protection which requires no time delay for reset.

b. Motor starters shall provide Class II ground fault protection. Ground fault protection shall be set at 20% of maximum continuous ampere rating and have a start delay of 20 seconds, and a run delay of 1 second to prevent nuisance trip on starting.

c. Microprocessor shall measure control circuit voltage and prevent closing of the coil on low voltage (78 volts AC) and/or high voltage (135 volts AC) conditions which are outside of the coil ratings.

d. Microprocessor shall apply voltage to the coil such that a guaranteed maximum of 2 milliseconds of main contact bounce occurs on contactor closure.

e. Microprocessor shall continuously measure coil circuit voltage and current so as to maintain constant coil power at a level to maintain main contact closure and minimize coil power consumption.

f. Provide a Metering Module for each starter capable of displaying cause of trip, current at time of trip, and current in each phase.

2. Motor Starters with Separate Electronic Current Sensor and Overload Device

Overload protection shall consist of a solid state electronic overload relay suitable to measure current, current versus time, and unbalanced phase current with current transformers as required. Number of windings and calculations for setting shall be submitted to Owner by the Contractor.

3. Motor Starters with Thermal Bimetallic Overload Relay

Overload protection shall consist of thermal bimetallic ambient compensated type overloads. Sizes shall be determined by the Contractor based on characteristics of actual motor furnished.

E. Each starter (unless otherwise shown) shall be equipped with indicating lights, selector switches, elapsed time meter, and auxiliary contacts, as shown on the Drawings. Number of auxiliary contacts shall be as required for specific motor control. In addition, 2NO and 1NC spare contacts shall be provided.

2.11 Power Meter, Monitor, and Protection Device

A. Where indicated on the Drawings, provide a digital line Meter, Monitor, and Protection (MM&P) device, having the features and functions specified below. The MM&P shall consist of a single microprocessor-based unit capable of monitoring and displaying the functions listed below with the accuracy indicated; the MM&P shall auto range between Units, Kilo-units, and Mega-units. The MM&P shall provide the adjustable protection functions indicated and the capability to communicate data via twisted pair network. The MM&P shall be UL recognized, CSA certified, and also meet ANSI Standard C37.90. The MM&P shall be as manufactured by Cutler-Hammer/Westinghouse, Allen-Bradley, or Square D, no substitutes.

Metered Values (Accuracy % Displayed Value)	Protective Functions
AC Phase Amperes (1%)	Voltage Phase Loss (less than 50% RMS)
AC Phase Voltage (1%)	Current Phase Loss (1/16 largest phase)
Watts (2%)	Phase Voltage Unbalance (5 to 40% - 5% steps)
Vars (2%)	Phase Voltage Reversal
Power Factor (4%)	Overvoltage (105 to 140% - 5% steps)
Frequency (0.5%)	Undervoltage (95-60% - 5% steps)
Watt-hours (2%)	Time Delay for Overvoltage, Undervoltage,
Watt Demand (2%) with (5-, 10-, 15-, 30-min. interval)	and Phase Unbalance (0 to 8 sec. - 1 sec. steps)

B. Input ranges of the MM&P shall accommodate external current transformers with ranges from 100/5 through 5000/5 amperes. Provide three (3) external current transformers with rating as indicated on the Drawings or sized for incoming service. Potential transformers shall be self included and fused up to 600 volts. Above 600 volts, provide fused external potential transformers. Synchronizing pulse input shall be provided and when activated shall override the preset watt demand interval and let the utility control the demand window.

C. Control power shall be capable of being supplied from the monitored incoming AC line without the need for a separate AC supply control circuit.

D. Outputs shall have separate Form C (NO/NC) trip and alarm contacts with ratings of 10 amperes at 115/240-volt AC or 30-volt DC resistive. In addition, provide a separate Form C (NO/NC) contact to provide a programmable kilowatt-hour pulse output.

E. The display face shall be membrane type and rated suitable for NEMA 3R and NEMA 12 mounting. The MM&P shall have a durable 6-digit LED display screen. The display screen and LEDs shall indicate both cause of trip and alarm conditions. Unit shall be mounted in the switchgear or MCC section door as shown on the Drawings.

F. Provide an addressable communication card capable of transmitting all data, including trip data over a compatible two-wire local area network to a central personal computer for storage and/or printout.

G. MM&P shall be furnished in a drawout case. Provide test plugs for all circuits.

2.12 Power Monitor

The electrical service power failure protection system consists of an electronic device which provides protection against three-phase electrical motor loss due to power failure conditions. Power failure conditions include: low voltage, phase loss, unbalanced voltage and phase reversal. The power failure protection device (power monitor) shall be Shark 100, Model 100-60-10-V3-D2-48SP-X J, no substitutes.

Contractor shall install the power failure protection system as shown on the Drawings or specified in the Technical Specifications and Special Requirements. The protection system shall monitor electrical line side power of specified equipment or facilities. The power failure protection system shall automatically stop all electrical motors upon output relay deactivation (unstable power conditions) and shall transmit a power failure alarm signal to the local RTU (where specified).

2.13 MCC Incoming Feeder Terminations and Device

Incoming conductors shall terminate within the control center on a main lug, or main breaker termination point. Main lug terminations shall have adequate dedicated space for the type and size of cable used and the lugs shall be standard mechanical screw type with anti-turn feature.

2.14 Ventilation and Heating

A. Switchboards and MCC sections shall be provided with thermostatically controlled space heaters to prevent condensation and thermostatically controlled forced air ventilation for cooling. Heating and ventilation shall be as designed by the manufacturer, unless shown specifically on the Drawings. Ventilation openings, including fans shall be provided with washable air filters.

B. Forced air ventilation shall be provided by supply air fans unless otherwise shown on the Drawings.

Supply air fans shall be rated 100 CFM (minimum) at 1/8 inch WC static pressure and shall be provided with louver (grill) inlet, inlet filter, and gasketing for weather-proof construction.

C. Air exhaust openings shall consist of louver (grill), filter, and gasketing for weather-proof construction.

D. Filters shall be aluminum mesh, washable, and shall be furnished with two bottles of spray adhesive.

E. Control power transformers with primary and secondary fuse protection shall be provided as required for proper operation of the heating and ventilating equipment unless Drawings show otherwise. Supply voltage shall be 120 volts, 60 Hz.

2.15 Utility Metering and Main Disconnect

A. Main Service

Where shown on the Drawings, main service shall consist of pull section, service (metering) section, and main disconnect. Equipment shall include a separate, barriered-off, utility metering compartment complete with hinged sealable door as approved by the utility company. Bus work shall include provisions for mounting utility company current transformers, potential transformers, potential taps, test devices, and metering as required by the utility company. Provide Service Entrance Label and provide necessary applicable service entrance features per NEC, local code requirements, and utility company requirements.

B. Main Disconnect

Main disconnect shall be molded case circuit breaker or bolted pressure switch as shown on the Drawings with ground fault protection system.

C. Ground Fault Indicate and Test System

The 600 volt, 60 Hz ground fault protection system shall consist of a current sensor enclosing all phase and neutral conductors of the circuit to be monitored, appropriate relaying equipment to provide for desired ground fault current sensitivity and time-current response characteristics, and equipment to trip the main disconnect. Installation of the equipment shall be in accordance with the manufacturer's recommendations.

1. Current Sensor

A sensitive current sensor shall be provided of sufficient size to encircle the phase and neutral conductors. Current sensor output shall be coordinated with the required input to the relay. A test winding shall be included to simulate the flow of ground fault current through the current sensor in order to test the operation of the ground fault protection system including sensor pick-up, relay, and circuit protective device (main disconnect) operation. The frame or the current sensor shall be so constructed that one leg can be opened to allow removal or installation around the cable or bus without disturbing the cable or requiring drop-links in the bus.

2. Ground Fault Relay

The relay shall be solid state for maximum reliability, except that a coil operated output relay shall be provided to control 120 volt power to operate the circuit protective device (main disconnect). The ground fault relay shall require no external source of power for tripping the associated protective device, drawing all the energy needed for proper operation of the ground fault protection system directly from the output of the current sensor.

Adjustable pickup current sensitivity for ground fault currents from 200 amperes to 1,200 amperes shall be provided. A calibrated dial shall be provided for setting the current pickup point in the field. Settings for individual relays shall be coordinated. Time delay provided by the relay circuitry shall be nominally one second and shall be permanently calibrated to preclude tampering after installation. A self-contained test circuit which will test all components including sensor, relay, and trip mechanism and a test coil in the current sensor shall be incorporated in the system.

The circuit protective device (main disconnect) shall be provided to open the circuit for normal switching, overload, short circuit, or ground fault. It shall include a ground fault trip mechanism for activation by the ground fault relay which, operating in conjunction with an interposing relay and auxiliary power source, will release a stored-energy device to open the switch. The ground fault trip mechanism shall be capable of operating at 55% of rated voltage to provide satisfactory operation under reduced voltage that might accompany a ground fault condition. In addition, the trip mechanism shall be equipped to operate by remote tripping such as by a float switch. The switch interrupting rating shall be coordinated with the time delay of the relay to insure that the switch is capable of interrupting any current it may be required to open.

2.16 Customer Metering

Where shown on the Drawings, provide a separate customer metering compartment with front hinged door with microprocessor-based metering system, complete with current transformers and potential transformers including primary and secondary fuses.

2.17 Enclosures

A. Switchboard and MCC enclosures shall be as specified on the Drawings and shall be suitable for the proposed location. As a minimum, switchboards shall be housed in NEMA 1 enclosures and MCC shall be housed in NEMA 12 or NEMA 1 gasketed enclosures.

B. Outdoor switchboards and MCC enclosures shall be NEMA 3R as follows:

1. Enclosures shall be non-walk-in and meet applicable NEMA 3R requirements of UL.

2. Enclosures shall have NEMA 3R wrap roof sloping downward toward rear.

3. Outer sections shall be the same widths as indoor structures, except each end of the outdoor assembly shall have an end trim.

4. The enclosure shall be provided with bolt on rear covers for each section.

5. Doors shall have provisions for padlocking and be located as shown on the Drawings.

2.18 Nameplates

Engraved nameplates, mounted on the face of the assembly, shall be furnished for all main and feeder circuits, starter compartments, and control compartments as indicated on the Drawings. Nameplates shall be laminated plastic, black characters on white background, and secured with stainless steel screws. Characters shall be 3/16 inch high, minimum. Nameplates shall give item designation as shown on the Drawings, and shall be approved by the Owner prior to fabrication. Furnish master nameplate giving switchboard designation, voltage ampere rating, short circuit rating, manufacturer's name, general order number and item number.

2.19 Finish

The finish shall consist of a coat of thermosetting, polyester powder paint applied electrostatically to pre-cleaned and phosphatized steel and aluminum for internal and external parts. The coating shall have minimum thickness of 1.5 mils and corrosion resistance of 600 hours to 5% salt spray. Color shall match other enclosures (existing or new). If necessary to match color, manufacturer shall coat complete assemblies with 1.5 mil thick exterior finish spray coat of air drying high-gloss enamel. Color of indoor enclosures shall be ANSI-49 Light Gray, unless specified otherwise. Exterior of outdoor enclosures, including all NEMA 3R enclosures shall be white.

PART 3 - EXECUTION

3.01 Factory Testing

A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be performed in accordance with the latest version of ANSI and NEMA standards.

The switchboards and MCC shall be completely assembled, wired, adjusted and tested at the factory. After assembly, the complete switchboard(s) shall be tested for operation under simulated service conditions to assure the accuracy of the wiring and the functioning of all equipment. The main circuits shall be given a dielectric test of 2200 volts for one minute between live parts and ground and between opposite polarities. The wiring and control circuits shall be given a dielectric test of 1500 volts for one minute between live parts and ground.

B. The manufacturer shall provide three (3) certified copies of factory test reports to Owner for approval prior to shipment.

3.02 Installation

A. The Contractors shall install all equipment per the manufacturer's written recommendations and the Drawings.

B. Each assembly shall be provided with adequate lifting means and shall be capable of being moved into installation position and bolted directly to a concrete foundation.

3.03 Field Quality Control

A. Contractor shall provide the services of a qualified factory-trained manufacturer's representative to assist the Contractor in installation and start-up of the equipment specified under this section. The manufacturer's representative shall provide technical direction and assistance to the Contractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein.

B. The following minimum work shall be performed by the Contractor under the technical direction of the manufacturer's service representative.

1. Rig the assembly into final location and install on level surface.

2. Check all removable cells and starter units for easy removal and insertion.

3. Perform insulation tests on each phase and verify low resistance ground connection on ground bus.

4. Connect all power wiring and control wiring and verify basic operation of each starter from control power source.

5. Torque all bolted connections made in the field and verify all factory bolted connections.

6. Calibrate any solid-state metering or control relays for their intended purpose and make written notations of adjustments on record drawings. Perform startup of any solid-state starters and adjustable frequency drives.

3.04 Field Adjustments and Testing

A. Follow the manufacturer's instructions and the Contract Documents concerning any short circuit device settings, heater selection, timing relays, or startup of components.

B. Contractor shall coordinate and set circuit breaker tripping sequence from main service circuit breaker to individual motors.

C. Follow the minimum requirements as stipulated in the NETA testing procedure for motor control center assemblies.

D. Generate a field report on tests performed, test values recorded, adjustments, etc., and provide same to Owner for review and approval.

3.05 Manufacturer's Certification

A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted, and tested in accordance with the manufacturer's recommendations. Equipment shall be inspected prior to the generation of any reports.

B. The Contractor shall provide three (3) copies of the manufacturer's representative's certification to Owner.

3.06 Instruction

After the equipment has been installed, tested, and adjusted, and placed in satisfactory operating condition, the equipment manufacturer shall provide classroom instruction to Owner's operating personnel in the use and maintenance of the equipment. Two (2) hours of instruction shall be provided unless otherwise specified. Contractor shall give the Owner formal written notice of the proposed instruction period at least two weeks prior to commencement of the instruction period. Scheduled training shall be at a time acceptable to the Owner and the manufacturer. During this instruction period, the manufacturer shall answer any questions from the operating personnel. The manufacturer's obligation shall be considered ended when he and the Owner agree that no further instruction is needed.

END OF SECTION

SECTION 17000
GENERAL INSTRUMENTATION AND CONTROL COMPONENTS TECHNICAL SPECIFICATIONS

PART 1 - GENERAL

1.01 Description

Contractor shall furnish, install, coordinate, design, fabricate, startup, and place into service instrumentation and controls for the project to provide complete and operable systems as specified in the Contract Documents. Contractor shall provide and designate Electrical and Instrumentation Subcontractors to perform said work. Instrumentation Subcontractor shall be responsible to perform engineering and design of control panels and components, select equipment and controls to interface with various instrumentation and control equipment, package systems, furnished and manufactured motor control centers, and instrumentation centers. Instrumentation Subcontractor shall design and prepare or coordinate preparation of control and interconnect diagrams.

Instrumentation Subcontractor shall coordinate with the Owner or Owner's SCADA Subcontractor who will be providing work on the Plant's SCADA System to provide the interface necessary for control of the proposed facilities.

Instrumentation Subcontractor shall coordinate services of manufacturer's engineering representatives for services during installation, startup, operation, and instruction of Owner for instrumentation and control equipment.

Instrumentation Subcontractor shall coordinate work so that all components of the instrumentation system, including primary measuring, indicating, transmitting, receiving, recording, totalizing, controlling, alarming devices, and all appurtenances are completely compatible and shall function as specified, and shall furnish and install such additional equipment and accessories to meet this requirement at no cost to the Owner.

Electrical Subcontractor shall subcontract the work specified herein to a qualified Instrumentation Subcontractor. All work performed is the responsibility of the Contractor even though references are made herein to work requirements and responsibilities of the Electrical and Instrumentation Subcontractors.

1.02 Performance Specifications and Drawings

Equipment control/monitoring systems shall be furnished and installed to provide equipment performance, operation control, and/or monitoring functions as specified on Drawings and in specific equipment technical specifications. Control schematic drawings, where provided, show control loops and control panels with component locations. Instrumentation Subcontractor shall prepare all wiring and control diagrams, and computer programs, and furnish and install all instrumentation and control components to provide said specified performance and operation.

1.03 Instrumentation and Control Components

Instrumentation and control components shall be as specified herein, per Technical Specifications and Special Requirements, and as shown on the Drawings or manufacturer shop drawings where included in these Contract Documents. Not all products specified herein are necessarily required for this project.

1.04 Submittals

The Instrumentation Subcontractor shall prepare and submit, through the Contractor, complete and organized shop drawings as specified herein. Shop drawings shall be in accordance with the requirements of Specification Section 01300, "Contractor Submittals".

Shop drawings shall include the interface between instruments, motor starters, control valves, variable speed drives, chemical analyzers, flow meters, chemical feeders, Owner furnished equipment, and other equipment related to the instrumentation and control system.

Shop drawings prepared by the MCC and other electrical equipment suppliers shall be reviewed and approved by the Instrumentation Subcontractor. Said subcontractor shall date and sign shop drawings prior to submittal to the Owner for review.

Shop drawings shall be submitted in complete bound sets indexed by specification and description of the items being submitted. Manufacturer's specification or data sheets shall be clearly marked to delineate the options or styles to be furnished. Only complete systems, not pieces of equipment from various systems shall be submitted. Submittals shall show dimensions, physical configurations, methods of connecting instruments and control equipment together, mounting details, single loop system drawings, and wiring schematics in conventional ladder diagram form. Control program for programmable controllers (if specified) shall be submitted in conventional ladder diagram form with complete labeling and comments. Fabrication data, nameplate, legends, and control panel internal wiring, including material specifications, shall be submitted.

Submit data for each item of equipment which summarizes the specified features and include such other necessary data as would provide a complete specification for reordering an exact duplicate of the original item from the manufacturer.

Submit, for approval, a written plan for demonstrating that each system of equipment meets the specified operational requirements. Submit a written plan for procedures to be used in final operation testing of entire systems. As-built drawings and operation and maintenance manuals shall be submitted.

1.05 Quality Assurance

A. Qualification and Manufacturers

Instrumentation Subcontractor shall have been regularly engaged in providing similar equipment on a single system responsibility basis for municipal water and wastewater projects of similar or larger magnitude. Personnel employed for system engineering, supervision, startup, operational testing, and training shall be regularly employed and trained by the Instrumentation Subcontractor. The Instrumentation Subcontractor shall

be responsible for the technical supervision of the installation to ensure that it is proper in all respects.

B. Standard of Quality

Equipment of the types and sizes specified which has been demonstrated to operate successfully shall be furnished. Substitution of equivalent equipment will be permitted as specified per Section 01300, Contractor Submittals Technical Specifications.

C. Coordination with Electrical Subcontractors and Suppliers

Prior to installation of any conduit the Instrumentation Subcontractor shall verify conduit size and conduit runs with the Electrical Subcontractor, and equipment suppliers for specific equipment to be furnished, and notify the Owner of any conflicts or deviations prior to installation.

D. Instrumentation Subcontractor's Certifications

Prior to startup and initial operation of instrumentation and control equipment, the Instrumentation Subcontractor shall submit a written report stating that equipment has been coordinated, calibrated, properly installed, and is ready for startup. After startup and when equipment is ready to be operated, the Instrumentation Subcontractor shall submit a written report for the instrumentation and control equipment and associated field instruments certifying that the equipment is ready to be operated, is safe to operate and has been checked, inspected, calibrated, and adjusted as necessary; has been operated under maximum power variation conditions and operated satisfactorily; and is fully covered under the terms of the guarantee.

PART 2 - PRODUCTS (Not all products specified herein are necessarily required for this project.)

2.01 General

A. Where shown on the Drawings, specified by the Special Requirements, Technical Specifications, or Detailed Provisions, the instrumentation and control components shall be as specified herein.

B. All meters, instruments, and other components shall be the most recent field proven models marketed by their manufacturers at the time of submittal of the shop drawings.

C. All panel mounted instruments shall have matching style and general appearance.

D. Instruments performing similar functions shall be of the same type, model, or class, and shall be of one manufacturer.

E. All outdoor instrumentation shall be suitable for operation in the ambient conditions at the equipment installation locations. Heating, cooling, and dehumidifying devices shall be incorporated with the outdoor instrumentation in order to maintain it within its rated environmental operating ranges. The Contractor shall furnish and install all power wiring for these devices (e.g., heaters, fans, etc.). NEMA rated outdoor enclosures suitable for the environment shall be furnished.

F. All instrumentation in hazardous areas shall be intrinsically safe and shall be approved for use in the particular hazardous (classified) location in which it is to be installed.

G. Analog measurements and control signals shall be electrical as indicated herein, and shall vary in direct linear proportion to the measured variable, except as noted. Electrical signals outside control board(s) shall be 4 to 20 milliamperes DC except as otherwise noted.

2.02 Control Panels

Unless otherwise specified or shown on the Drawings, indoor control panels shall be NEMA Type 12 enclosures and outdoor control panels shall be NEMA Type 12 enclosures with drip shields for rain tight construction. Enclosures shall be single or double door, single or dual access as shown on the Drawings. As a minimum, each enclosure shall be furnished with interior back panels, and padlockable door handles.

Free standing control panel enclosures shall be as manufactured by Hoffman, Robroy Industries, Inc., or equal and shall be securely anchored to the floor with a minimum of four stainless steel anchor bolts in each section. Free standing control panel enclosures 72" and less in height shall be provided with floor stand kits (12" height, minimum).

Surface or wall mounted enclosures shall be as manufactured by Hoffman, Robroy Industries, Inc., or equal and shall be anchored to the wall with a minimum of four 3/8" diameter stainless steel anchor bolts.

Where control panels are part of the MCC line up, they shall match the MCC equipment in height, depth, and color.

2.03 General Instrumentation Enclosure Components and Requirements

A. General

General electrical components shall be as shown on the Drawings, and specified in Section 16050, equipment technical specification sections, and herein.

B. Signal Isolators, Converters, and Power Supplies

Signal isolators shall be furnished and installed in each measurement and control loop, wherever required to ensure adjacent component impedance match, or where feedback paths may be generated. Signal converters shall be included where required to resolve any signal level incompatibilities. Signal power supplies shall be included, as required by the manufacturer's instrument load characteristics, to ensure sufficient power to each loop component.

C. Nameplates

Nameplates shall be provided for instruments, function titles for each group of instruments, and other components mounted on the panel fronts as shown on the Drawings. A nameplate shall be provided for each signal transducer, signal converter,

signal isolator, electronic trip, and the like, mounted inside the panel(s). These shall be descriptive, to define the function and system of such element. These nameplates shall be of the same material as those on the panel fronts. Nameplates shall be fabricated from laminated engraving plastic. Colors, lettering, styles, and sizes shall be as shown on the Drawings or as selected by the Owner. Adhesives are not acceptable for attaching nameplates. Nameplates shall be attached with stainless steel fasteners.

D. Terminal Blocks

Terminal blocks shall be molded plastic with barriers and box lug terminals, and shall be rated 15 amperes at 600-Volts. White marking strips, fastened securely to the molded sections, shall be provided, and wire numbers or circuit identifications shall be marked thereon with permanent marking fluid.

E. Signal and Control Circuit Wiring

1. Wire Type and Sizes

Where conductors are within the control panel, they shall be flexible stranded copper machine tool wire; these shall be UL listed Type MTW and shall be rated 600-Volts minimum 14 AWG. Shielded cables shall be No. 16 AWG minimum as manufactured by Belden, Carol Cable Co., or equal. Where conductors are run to MCC sections or to field locations, they shall be stranded copper minimum 12 AWG of the UL type specified on the Drawings or by the Basic Electrical Specifications.

2. Wire Insulation Colors

Conductors supplying 120-Volts AC power on the line side of a disconnecting switch shall have a black insulation for the ungrounded conductor. Grounded circuit conductors shall have white insulation. Insulation for ungrounded 120-Volt AC control circuit conductors shall be red. All wires energized by a voltage source external to the Control Board(s) shall have yellow insulation. Insulation for all DC conductors shall be blue.

3. Wire Termination

Conductors from field components or from MCC sections shall terminate in the control panels at terminal blocks. Control circuit wiring shall connect from terminal blocks to relays, controls, and programmable controllers.

4. Wire Marking

Each signal, control, alarm, and indicating circuit conductor connected to a given electrical terminal point shall be designated by a single unique number which shall be shown on all shop drawings. These numbers shall be marked on all conductors at every terminal using white numbered wire markers which shall be plastic-coated cloth, Brady Type B-500, Thomas and Betts "E-Z Code," or equal, or shall be permanently marked heat-shrink plastic.

F. Forced Air Ventilation System

Forced air ventilation system, thermostat controlled, shall include the following:

1. Exhaust Louvers

   Exhaust louvers shall include louver plate kits with fitted air filters as manufactured by Design Air, Dayton, or equal. Louvers shall be sized to provide maximum air velocity of 500' per minute.

2. Air Supply Fan

   Air supply fan shall be Dayton propeller type suitable for 110 volt power with weather-proof inlet louver, screen, and filter. Locate air supply fan at bottom of panel. Air supply fan shall be sized to provide minimum of 15 air changes per hour at static pressure of 0.25" or that created by system, which ever is greater.

3. Thermostat

   Thermostat shall be line voltage Dayton attic fan type, or equal with 15°F differential to turn on at 105°F and off at 90°F.

Manufacturer shall submit data to support ventilation equipment selection.

2.04 Solenoid Valves

Solenoid valves shall be packless construction, two-way, three-way, or four-way as required, and shall be correctly sized for the application, unless specifically sized on the Drawings. They shall be for normally energized or de-energized operation as shown on the Drawings. Valve bodies shall be forged brass unless otherwise recommended by the manufacturer for a particular application. The solenoids shall be rated for continuous operation at 115% of rated voltage. They shall be AC or DC current operated as specified or required. AC current coils shall have a shading ring. DC current operated coils shall be provided with a spark suppression device. If this device polarizes the coil, a reverse polarity protection diode shall be provided to prevent damage in the event of accidental reverse voltage application. Polarity of the coil shall be clearly marked on the terminals. All coils shall be housed in NEMA 4 cases with provision for 1/2" electrical conduit connection.

2.05 Thermostats

Thermostats shall be single stage or two stage (as required) cooling, line voltage type, 120V with contacts rated minimum 16 amps and minimum 3°F differential and setting range 30°F to 100°F. Thermostats shall be heavy duty, rated for minimum 3/4 horsepower motor starting, and shall be as manufactured by Dayton, Honeywell, or equal.

2.06 Float Switches and Intrinsically Safe Relays (Not Required)

Float switches shall be designed for operation in raw sewage, constructed of high impact corrosion resistant polypropylene. Cable shall be minimum 18 gauge multistrand PVC jacketed

cable (oil and water resistant). Float switch shall be rated minimum 4 amps at 120 VAC. Each float switch shall be utilized for one operation. Single float switch shall not be used as example for pump start and stop.

Float switches shall be as manufactured by FLYGT Corporation, Warrick Controls, Anchor Scientific Inc., Consolidated Electric Co., or equal.

Unless otherwise specified, each float switch shall be provided with an intrinsically safe relay complete with reduced voltage transformer and contacts. Intrinsically safe relays shall be Warrick Series 17, Gems Safe-Pak, or equal, and shall be Factory Mutual or UL listed for explosion proof service.

2.07 Timers

Timers for ventilation equipment shall be 0 to 24 hour type with tabs permitting 15 minute interval settings. Timers shall be 120V, 60 Hz, single phase, with contacts rated at a minimum of 5 amps when operating control circuit for 3 phase equipment or rated to start minimum 1 horsepower motor when starting equipment motor directly.

2.08 Pressure Gauges

Unless otherwise shown or specified, pressure gauges shall be weatherproof and provided with 4-1/2" dials, 1/4" threaded connections, epoxy coated aluminum cases with safety glass windows, 316 stainless steel shut-off valves, 316 stainless steel pulsation dampeners (except where diaphragm seals are required), and 316 stainless steel close nipples. Bourdon tubes, bellows or diaphragm, and socket and tip shall be 316 stainless steel. Gauges subject to shock or vibration shall be wall mounted or attached to galvanized channel floor stands and connected to equipment by flexible connectors.

Gauges shall be calibrated to read in applicable units, with an accuracy of ±1%, to 150% of working pressure or vacuum of the monitored medium.

Pressure gauges shall be as manufactured by Ashcroft, Marshalltown, or equal.

2.09 Diaphragm Seals (Not Required)

Where shown on the Drawings or specified elsewhere, diaphragm seals shall be provided between the process medium and the pressure sensing element (e.g. gauge, transmitter, or switch). Unless otherwise specified, diaphragm seals shall have 316 stainless steel diaphragms and bottom housings. Bottom housings shall be provided with 1/4" flushing connection, 316 stainless steel shut-off valve, and 316 stainless steel close nipples.

Diaphragm seals shall be as manufactured by Ashcroft, Marshalltown, or equal.

2.10 Pressure and Differential Pressure Switches

Pressure and differential pressure switches shall utilize bourdon tubes, diaphragms, or bellows as the sensing/actuating element. Unless otherwise specified, the sensing/actuating element material shall be 316 stainless steel. The set point shall be readily field adjustable over the range

specified. Switches shall have deadband adjustable up to a maximum of 100% of switch range. Switches shall be SPDT, rated for 10A at 120 VAC. Switch enclosures shall be rated NEMA 4X. Switch pressure connection shall be 1/4" FNPT. Process connections shall be 1/2" NPT, and shall be provided with 1/2" diameter 316 stainless steel shut-off ball valves, 316 stainless steel pulsation dampeners (except where diaphragm seals are required), and 316 stainless steel close nipples. Provide 316 stainless steel threaded reducer and 1/4" diameter 316 stainless close nipple to transition from 1/2" diameter process connection appurtenances to 1/4" switch pressure connection.

Pressure switches and differential pressure switches shall be Model 836 as manufactured by Allen Bradley (no substitutes).

2.11 Pressure Transmitters (Not Used, Use Pressure Transmitter Specified in Section 13350)

2.12 Differential Pressure Transmitters (Not Required)

Differential pressure transmitters shall be electronic two wire devices with the following features: adjustable span, zero and damping adjustments, integral indicator scaled in engineering units, solid state circuitry and 4-20 mA output. Accuracy shall be ±0.25% of span. Overrange capacity, without affecting calibration, shall not be less than 150% of maximum range. Span shall be field adjustable over at least a 4 to 1 range. Process wetted materials shall be 316 stainless steel. Body material shall be 316 stainless steel. Process connections shall be 1/4" or 1/2" NPT. Fill fluid, unless otherwise specified, shall be silicone oil. Transmitter housing shall be epoxy coated low copper aluminum alloy and rated NEMA 4X. A three (3) valve manifold shall be provided with the transmitter. Manifold wetted surface materials shall be 316 stainless steel.

Pressure transmitters shall be as manufactured by Foxboro (no substitutes).

2.13 Flexible Sleeve Pressure Sensors (Not Required)

Flexible sleeve pressure sensors shall be of flow through design with a Buna N flexible sleeve that completely isolates the process fluid from the sensor body. The inside diameter of the sensor shall provide uninterrupted flow, with no dead ends or crevices. Pressure shall be transmitted to the instrumentation by a captive fluid (ethylene glycol or silicone oil) located behind the flexible sleeve. The sensor body shall have an auxiliary tapped and plugged port for filling. Pressure sensors shall be factory filled, calibrated, and tested at instrument mid-range. Unless otherwise specified, instrument full range shall be 150% of working pressure of the monitored medium.

Pressure sensors 2" and smaller shall be provided with carbon steel housings and threaded ends (NPT). Pressure sensors larger than 2" shall be provided with carbon steel housings and end flanges (ANSI 150 lb through bolt holes).

Flexible sleeve pressure sensors shall be as manufactured by Red Valve Company, Inc., Ronningen-Petter, or equal.

2.14 Ultrasonic Liquid Level and Flow Measurement System (Not Required)

A. General

Where ultrasonic type level system is specified in the Special Requirements or shown on the Drawings for pump control, level sensing or flow, the liquid level measurement system shall be of the ultrasonic type and shall consist of a microprocessor based electronic controller, a non-contacting transducer, and cable from transducer to controller. The electronic controller shall be capable of receiving, processing, and transmitting ultrasonic signals. All operating parameters shall be entered via the controller keypad. For liquid level, the controller shall, upon demand, display current head, temperature, and distance from transducer to liquid level and flow rate.

The liquid level measurement system for pump control or level measurement shall be Milltronics MultiRanger 100 as manufactured by Siemens (no substitutes).

The flow measurement system shall be Milltronics Open Channel Meter OCM III as manufactured by Siemens (no substitutes).

B. Service

The transducer shall be capable of submergence without degradation. Transducer shall function over an ambient temperature range of -40 °F to 200°F, and shall be rated by FM and CSA for Class I and II hazardous environments. Controller shall function over an ambient temperature range of 15°F to 122°F.

C. Performance

The transducer shall transmit and receive an acoustic signal to accurately measure liquid level over a range of 0' to 30'. Point of zero reference shall be operator adjustable. The output signal shall be proportional to level from 0 to 100% with a resolution of ±0.1%. The transducer shall be provided with integral temperature sensor for speed-of-sound compensation. The transducer shall be the Echomax XPS Series with a 6° beam angle.

D. Level Measurement Features

1. Controller shall be provided with output indicating meter with four character LCD display programmable in engineering units of: feet, inches, or percent of span.

2. Interconnecting Cable: Cable between transducer and controller shall be supplied with unit, and shall be suitable for a maximum system length of 1,000'. Contractor shall verify length of cable required for each specific installation. Cable shall be installed in a single run with no splices.

3. Discrete Outputs: Controller shall provide up to five discrete outputs, each adjustable over entire scale range.

4. Alarms: Alarms shall be programmable for level, rate of change of level, differential level, or loss of echo.

5. Alarm Messages: Loss of echo and cable circuit open or shorted.

E. Flow Measurement Features

1. Suitable for flow element as specified on the Drawings, flume or weir type.

2. LCD 5 x 7 display with two lines to read flow and total flow.

3. Three alarm/control relays adjustable over the level range.

4. Flow and total flow read-out shall be field adjustable to read in units, gpm, MGD, or cfs.

F. Controller Interface

1. Controller Output: 4-20 mA DC output, current isolated, into a maximum of 600 ohms (return to ground).

2. Power Supply: Unit shall operate on 120V, 60 Hz power, unless otherwise specified.

3. Discrete Outputs: Form "C" SPDT relays, 5 amps (continuous), non-inductive, 250 VAC.

4. Controller shall be provided with necessary output functions and communication interfaces to enable implementation of control and monitoring operations as specified in Section 17010, Plant SCADA System Technical Specifications, and/or shown on the Drawings.

G. Controller Enclosure

Controller shall be mounted in a NEMA 4 enclosure, unless otherwise specified. Enclosure shall be wall mounted. Where controller is located in a control panel, it shall be panel-mount type (flush door mount) in the control panel door.

Exposed controllers shall be provided with stainless steel, sheet metal sun shields (24 gauge, minimum). Sun shields shall be open at the front and bottom, and shall be of sufficient size to allow access to controller for operation and maintenance. Free edges shall be rolled. Sun shields shall be constructed without sharp edges and corners.

2.15 Submersible Level Measurement System (Not Required)

Where specified on the Drawings, the liquid level shall be monitored by submersible level transmitter with lightening/surge protection, furnished and installed per manufacturer's requirements. The system shall be suitable for operation in water or wastewater, and shall be as manufactured by Esterline Pressure Systems (KPSI), or equal. As a minimum, the level measurement system shall include the following components:

A. Model 705 Level Transducer suitable for wastewater (NEC Classification, Class 1, Division 2 Atmosphere) with 009 Lightening/Surge Arrestor.

B. Polyurethane-Jacketed Vented Cable with Series 815 Aneoid Bellows and Bellows mounting bracket.

C. Model 3019 Panel-Mounted (Flush Door Mount) Meter and Power Supply with 4-20 mA output to the Control Panel RTU.

The KPSI Level Measurement System shall be furnished and installed as shown on the Drawings and per the manufacturer's printed recommendations.

Unless specified otherwise, the level transducer shall be capable of withstanding over-pressurization of up to 5 times the specified monitoring range without damage.

2.16 Power Monitor/Phase Failure Protection System

Where shown on the Drawings, electrical power failure protection system consisting of an electronic device shall provide protection against three-phase electrical motor loss due to power failure conditions. Power failure conditions include: low voltage, phase loss, unbalanced voltage and phase reversal. Unless shown otherwise, the power failure protection device shall be Model EAC-800 as manufactured by Watsco Components Inc., MotorSaver Model 250A as manufactured by SymCom, Inc., or equal.

Contractor shall install the power failure protection system as shown on the Drawings or specified in the Technical Specifications. The protection system shall monitor electrical line side power of specified equipment, MCC, or facilities. The power failure protection system shall automatically stop all electrical motors upon output relay deactivation (unstable power conditions) and shall transmit a power failure alarm signal to the local RTU (where specified). The device shall be provided with an adjustable time delay and automatically reset to allow equipment to restart without manual reset.

2.17 Motor Amperage/Voltage Monitoring System

The motor amperage/voltage monitoring system shall consist of a microprocessor based, self-contained, door mounted unit capable of monitoring and displaying the following parameters:

AC amperes (±1% accuracy) phases A, B, and C
AC voltage (±1% accuracy) phases A-B, B-C, C-A, A-N, B-N, and C-N
Kilovolts
Kiloamps

The device shall receive voltage and current signals for continuous monitoring of system data. The program directing the monitoring functions shall be permanently stored in the device.

The device shall be capable of transmitting all data to a local remote terminal unit (RTU) for display, storage, and/or printout. The device shall be provided with a communication module for transmitting data in RS232C format to a local RTU.

External potential transformers shall not be necessary for applications in which the monitored AC line is 600 VAC, or less. The device shall be powered by separate 120/240 VAC control power. Contractor shall provide the necessary control power transformer if sufficient capacity is not available in the switchgear lighting panel.

The device shall be provided with external fuses for voltage connections. The device shall be provided with three (3) external current transformers. The fuse rating and current transformer ratio shall be as required. Current transformers shall have thermal and mechanical ratings and insulation class not less than those of the associated circuit breakers. Current transformers shall be mounted on motor power cables, and shall be installed in a manner which allows proper access for maintenance. Device installation, including RS232C cable selection, shall be in accordance with the manufacturer's recommendations.

The motor amperage/voltage monitoring system shall be Westinghouse IQ Data (No substitutions).

2.18 Radar Liquid Level Measurement System (Not Required)

A. General

The radar liquid level measurement system shall continuously monitor the liquid level within a tank or pressure vessel. The measurement system shall be of the pulse radar type and shall consist of a non-contacting sensor, a remote microprocessor based electronic display unit, a intrinsically safe separator, and cable from sensor to display. The radar liquid level measurement system shall be as manufactured by Ohmart/Vega or equal.

B. Sensor

1. The sensor shall transmit and receive a radar signal to accurately measure liquid level over a range of 0 to 40 feet, unless specified otherwise. The sensor shall operate in a frequency range of approximately 6 GHz and shall have low sensitivity to foam and surface agitation.

2. The sensor shall be a 4-20 mA, two-wire, loop powered device. Power supply for two-wire loop shall be via the remote display unit. The sensor output signal shall be proportional to level from 0 to 100% with an accuracy of ±0.1%.

3. The sensor antenna shall be capable of submergence without degradation. Sensor housing shall be constructed of aluminum with powder coating and shall be rated NEMA 4X. Sensor housing cable entry shall be 1/2" NPT.

4. Sensor wetted parts shall be 316L stainless steel. Sensor shall be provided with a horn antenna and antenna extension, and 6" 150 lb, ANSI B16.5 flange for connection to the tank or vessel. The sensor horn antenna diameter and length of antenna extension shall be as required based on the tank or vessel geometry, including diameter, sensor flanged nozzle location, and flanged nozzle size and length.

5. Sensor shall function over an ambient and process fluid temperature range of 0°F to 200°F, and a working pressure range of 0 psig to 200 psig.

6. The sensor shall be rated by FM for use in NEC Class I, Division 1, Groups A through D hazardous environments.

7. The sensor shall be Ohmart/Vega Model Vegapuls 66. The sensor shall be provided with Ohmart/Vega's interface adapter and adjustment software to allow connection of a portable PC to the sensor. All operating parameters shall be adjustable from a portable PC. The interface adapter shall be permanently mounted within the control panel. Manufacturer shall coordinate interface adapter installation with the panel fabricator.

C. Remote Display Unit

1. The remote display unit shall be provided with output indicating meter with LCD display capable of indicating tank or vessel level in units of feet, inches, or percent of span.

2. Point of zero reference shall be operator adjustable. The output signal shall be proportional to level from 0 to 100% with an accuracy of ±0.1%.

3. Display unit shall function over an ambient temperature range of 15°F to 122°F.

4. Power Supply: Unit shall operate on 120V, 60 Hz power, unless otherwise specified.

5. The remote display unit shall provide the power for the sensor two-wire loop. The two-wire loop shall be provided with an intrinsically safe separator, which shall be installed in the control panel. The intrinsically safe separator shall provide galvanic separation between intrinsically safe and non-intrinsically safe circuits and shall be furnished by radar liquid level measurement system manufacturer.

6. Interconnecting Cable: Cable between sensor and remote display unit shall be supplied with the unit. Contractor shall verify length of cable required for each specific installation.

7. Analog Output: Remote display unit shall provide a 4-20 mA DC output, current isolated analog signal to the control panel (RTU).

8. Discrete Outputs: Controller shall be provided with four "on" and "off" relay pairs providing up to eight (8) discrete outputs, each adjustable over entire scale range.

9. Remote display unit shall be provided with a NEMA 1 enclosure. The remote display unit shall be Ohmart/Vega Model Vegadis 371. Enclosure shall be front panel mounted within the control panel.

2.19 Circular Chart Recorders (Not Required)

Circular chart recorders shall be microprocessor-based with input resolution of 0.01% of operating gain span. Recorder(s) shall be flush mounted in panel doors, operate on 120 VAC, 60 Hz power, and use 10" (nominal) diameter circular charts and disposable cartridge type inking. Recorder(s) shall accept either current (4-20 mA) or voltage (0-5 VDC) signal input. Recorder(s) shall be configured to match the monitoring instrument indicator calibration specified.

Unless otherwise specified, recorder(s) shall be provided with seven day circular charts. One input/pen is required. Each recorder shall be furnished with two extra sets of pen cartridges and 100 circular charts.

Recorder(s) shall be USABlueBook Stock No. MC-28493 as manufactured by Partlow, no substitutes.

2.20 Free Chlorine Residual Analyzer (Not Required)

The chlorine analyzer shall employ a DPD colorimetric method of measurement using DPD indicator and a buffer solution and be capable of measuring free or total residual chlorine by changing the indicator and buffer solutions. A measurement shall be taken every 2.5 minutes and results displayed by a three digit LED readout in the range of 0 to 5 mg/L. The analyzer shall be designed for 30-days unattended operation and use only one (1) pint of each reagent per month.

Operating at a wavelength of 510 nm, the instrument shall be constructed to measure a sample blank before each sample measurement to provide automatic zero reference to compensate for sample color and turbidity and changes in light intensity due to voltage fluctuations or lamp aging. The instrument shall provide resolution of 0.01 mg/L, repeatability within $\pm$ 0.05 mg/L and accuracy better than $\pm$ 5% of reading or $\pm$ 0.05 mg/L whichever is greater.

The analyzer shall be microprocessor-controlled and provide alarm and recorder outputs. The microprocessor shall monitor analyzer functions and activate a system warning for minor variations in analyzer performance or a system alarm for major variations. A system alarm shall shut down the analyzer until corrective action is taken. The microprocessor also shall provide self-diagnostic functions accessible through the keyboard. Two fully adjustable sample concentration alarms shall be provided. A local LED indicator and an SPDT normally open/normally closed dry contact relay rated at 5 A resistive load at 230 VAC shall be provided for each system and sample concentration alarm.

Recorder outputs shall be selectable for 0-10 mV, 0-100 mV, 0-1 V or 4-20 mA. Recorder span minimum and maximum values shall be operator programmable at the keyboard over the entire operating range. The analyzer also shall provide for the addition of an optional RS-232C serial interface.

The chlorine analyzer shall be housed in an ABS plastic, IP62 enclosure rating with two clear polycarbonate windows and be designed for wall mounting. The analyzer shall operate on 120 VAC, 60 Hz, single phase power.

The analyzer/controller shall be the CL17 Chlorine Analyzer (120 VAC) as manufactured by Hach Company.

2.21 Door Mounted Limit Switches

Door mounted limit switches shall be corrosion-resistant and hermetically sealed, suitable for service in moist or dusty environments. Limit switches shall be screw-fastened surface-mount type. Limit switch assembly shall include cover, spacer and stainless steel mounting screws. Switches shall accommodate door misalignment and make/break distances up to 3/4 inches. Limit switches shall be Model LS/200LS/1LS19 as manufactured by Micro Switch (No substitutes).

2.22 Chemical Additive Flow Monitoring System (Not Required)

The chemical additive flow monitoring system shall consist of a velocity boosting/flow pulsation dampening device and a fluid flow sensor. The flow monitoring system shall be installed on the discharge piping of chemical feed pumps.

The velocity boosting/flow pulsation dampening device shall be the Veloci Tee Flow Conditioner as manufactured by Fluid Components Intl., or equal. The velocity booster/flow pulsation dampening device shall be constructed of PVC. Pipe connection size shall be selected to match chemical feed pump discharge piping. Contractor shall provide all necessary adapters and fittings required for connection to piping.

Fluid flow sensor shall be flow rate temperature sensing device, suitable for sensing flow rate of 0.004 to 0.5 fps and activating a relay, for chemical fluids with temperature range of -10°F to 200°F. Sensor shall be rated for minimum pressure of 300 psi and have an accuracy of ±2 percent over an operating temperature of ±50°F. Unless otherwise specified, sensor wetted parts shall be constructed of Hastelloy C. Manufacturer shall confirm in writing that the sensor wetted parts are suitable for continuous operation with the specified chemical fluid at the specified concentration and temperature. Piping connections shall be 3/4" NPT, unless otherwise specified. Length of sensor probes shall be suitable for extension into the velocity boosting/flow pulsation dampening device.

Flow sensor controller shall be provided with NEMA 4X enclosure and a relay contact which closes upon sensing flow. Input power shall be 115 volts AC with LED to indicate relay position.

Fluid flow sensor shall be Model FLT 93 as manufactured by Fluid Components Intl., or equal.

2.23 Chemical Storage Tank Liquid Level Measurement System (Not Required)

A. General

Where ultrasonic type level system is specified in the Special Requirements or shown on the Drawings for chemical storage tank level sensing, the liquid level measurement system shall be of the ultrasonic type and shall consist of a microprocessor based electronic controller, a non-contacting transducer, and cable from transducer to

controller. The electronic controller shall be capable of receiving, processing, and transmitting ultrasonic signals. All operating parameters shall be entered via the controller keypad. For liquid level, the controller shall, upon demand, display current head, temperature, and distance from transducer to liquid level.

The liquid level measurement system shall be Milltronics MultiRanger 100 as manufactured by Siemens or DataView as manufactured by Flowline (no substitutes).

B. Service

The transducer shall be capable of submergence without degradation. Transducer shall function over an ambient temperature range of -5°F to 140°F, and shall be rated by FM Class I and II hazardous environments. Controller shall function over an ambient temperature range of 15°F to 122°F.

C. Performance

The transducer shall transmit and receive an acoustic signal to accurately measure liquid level over a range of 0' to 30'. Point of zero reference shall be operator adjustable. The output signal shall be proportional to level from 0 to 100% with a resolution of ±0.2%. The transducer shall be provided with integral temperature sensor for speed-of-sound compensation. The transducer shall be manufactured of materials that are resistant to the specific chemical within the tank. Manufacturer shall submit data sheets to demonstrate same. Unless noted otherwise on the Drawings, the transducer shall be suitable for mounting to top of the tank on a flanged opening. The transducer beam angle shall be a maximum of 6°. The transducer shall be the Echomax ST-H as manufactured by Siemens or Echospan as manufactured by Flowline.

D. Level Measurement Features

1. Controller shall be provided with output indicating meter with four character LCD or LED display programmable in engineering units of: feet, inches, or percent of span, and shall be provided with high and low tank level alarms.

2. Interconnecting Cable: Cable between transducer and controller shall be supplied with unit, and shall be suitable for a maximum system length of 1,000'. Contractor shall verify length of cable required for each specific installation. Cable shall be installed in a single run with no splices.

3. Discrete Outputs: Controller shall provide up to four discrete outputs, each adjustable over entire scale range.

4. Alarms: Alarms shall be programmable for level, rate of change of level, differential level, or loss of echo.

5. Alarm Messages: Loss of echo and cable circuit open or shorted.

E. Controller Interface

1. Controller Output: 4-20 mA DC output, current isolated, into a maximum of 750 ohms (return to ground).

2. Power Supply: Unit shall operate on 120V, 60 Hz power, unless otherwise specified.

3. Discrete Outputs: Form "C" SPDT relays, 5 amps (continuous), non-inductive, 250 VAC.

4. Controller shall be provided with necessary output functions and communication interfaces to enable implementation of control and monitoring operations as specified in Section 17010, Plant SCADA System Technical Specifications, and/or shown on the Drawings.

F. Controller Enclosure

Controller shall be mounted in a NEMA 4 enclosure, unless otherwise specified. Enclosure shall be wall mounted, unless otherwise specified. Where controller is located in a control panel, it shall be panel-mount type (flush door mount) in the control panel door.

Exposed controllers shall be provided with stainless steel, sheet metal sun shields (24 gauge, minimum). Sun shields shall be open at the front and bottom, and shall be of sufficient size to allow access to controller for operation and maintenance. Free edges shall be rolled. Sun shields shall be constructed without sharp edges and corners.

PART 3 - EXECUTION

3.01 General

The Instrumentation Subcontractor shall perform work and provide services as specified herein and per Sections 16010 and 16050. It is the general intent of this Contract that furnishing all equipment instrumentation and controls; all field wiring, conduit installation, and wiring external to the MCC, control panels and electrical equipment shall be furnished and installed by the Electrical Subcontractor. It is intended that the design or the coordination of design of controls within motor control center(s) and control panels and compatibility of design with equipment and equipment systems and programming of programmable controllers and control system startup shall be the responsibility of the Electrical and Instrumentation Subcontractors.

The Instrumentation Subcontractor's attention is directed to the electrical and mechanical details of this project. Referral to these portions of the Contract Documents shall be required in order to understand the full intent and scope of work required.

3.02 Control Panel Signal And Control Circuit Wiring

A. Wiring Installation

All wires within control panels shall be run in plastic wireways. Wiring run from components on a swing-out panel to other components on a fixed panel shall be made up in tied bundles. These bundles shall be tied with nylon wire ties, and shall be secured to panels at both sides of the "hinge loop" so that conductors are not strained at the terminals.

Wiring run to control devices on the front panels shall be tied together at short intervals with nylon wire ties and secured to the inside face of the panel using epoxy adhesive, T & B or Panduit. Standard adhesive mounts are not acceptable.

Wiring to rear terminals on panel-mount instruments shall be run in plastic wireways secured to horizontal brackets run above or below the instruments in about the same plane as the rear of the instruments.

Conformance to the above wiring installation requirements shall be reflected by details shown on the shop drawings for the Owner's review.

B. Wire Marking

Each signal, control, alarm, and indicating circuit conductor connected to a given electrical point shall be designated by a single unique number which shall be shown on all shop drawings. These numbers shall be marked on all conductors at every terminal using white numbered wire markers which shall be plastic-coated cloth, or permanently marked heat-shrink plastic.

3.03 Installation, Calibration, Testing, Startup, And Instruction

A. General

Under the supervision of the Instrumentation Subcontractor, all systems specified herein shall be installed, connected, calibrated, tested, and started in coordination with the equipment manufacturer and the Owner. This shall include final calibration in concert with equipment specified elsewhere in these Contract Documents.

B. Factory Testing of Control Panels

Instrumentation Subcontractor shall verify wiring continuity and panel operation by simulated inputs and outputs to assure controls are operable and meet the requirements of these Specifications.

C. Manufacturer's Engineering Representative

The services of manufacturer's engineering representative especially trained and experienced in the installation of the equipment shall be provided to supervise the installation, be present when the instruments and equipment are first put into operation,

and inspect, check, adjust as necessary, and calibrate the instruments. All costs for representative's services shall be included in the Contract Price.

D. Certify Proper Installation

After all installation and connection work has been completed, the Instrumentation Subcontractor shall check it all for correctness, verifying polarity of electric power and signal connections, making sure all process connections are free of leaks, and all other similar details. The manufacturer's representative shall certify in writing to the Instrumentation Subcontractor that for each loop or system checked out, that equipment is installed properly and ready for startup. See item 1.05D herein for Instrumentation Subcontractor's Certification.

E. Calibration

All instruments and systems shall be calibrated after installation, in conformance with the component manufacturer's instructions by the Instrumentation Subcontractor and manufacturer's representative. Those components having adjustable features shall be set for the specific conditions and applications of the project, and shall be within the specified limits of accuracy. Elements and equipment which cannot achieve proper calibration or accuracy, either individually or within a system, shall be replaced.

F. Startup and Instruction

When all systems have been assessed by the Contractor to have been successfully carried through complete operational tests with not less than a minimum of simulation, and the Owner concurs in this assessment, plant startup can follow. Fifteen days (minimum) prior to startup, Owner's operating and maintenance personnel shall be instructed in the functions and operation of each system and shall be shown the various adjustable and set point features which may require readjustment, resetting or checking, recalibration, or maintenance by them from time to time. Instruction shall include interactions of the systems, operations, shutdowns, alarms, failure, and controls. This instruction shall be scheduled at a time arranged with the Owner at least two weeks in advance. Instruction shall be classroom type for the minimum hours as specified by the Special Construction Provisions and/or each Equipment Technical Specification or Detailed Provision. Instruction shall be given by the Instrumentation Subcontractor and other qualified persons who have been made familiar in advance with the systems in this plant.

END OF SECTION

SECTION 17151
IN-LINE PROPELLER METERS
TECHNICAL SPECIFICATIONS

PART 1 - GENERAL

1.01 General Requirements

Contractor shall furnish and install in-line propeller meters, instrumentation, and all appurtenances suitable for operation with water and/or treated wastewater at process temperatures, complete and operable, all in accordance with the requirements of the Contract Documents. Motors shall be gear head design or flexible cable magnetic driven design unless specified otherwise on the drawings or by the Special Requirements.

All in-line propeller meters furnished under this specification shall be the responsibility of a single supplier and of a single manufacturer. Meters shall be as manufactured by McCrometer.

1.02 Submittals

A. Shop Drawings

Contractor shall submit shop drawings in accordance with the Contractor Submittals Technical Specifications and shall include, but not be limited to, the following:

1. Details of all components of all meters including detailed installation instructions.
2. Certified curves indicating flow versus differential pressure.
3. Electrical schematics and instrumentation specifications.
4. Meter cable.

B. Operation and Maintenance Manual

Contractor shall submit a detailed operation and maintenance manual for the flow metering system(s) specified herein.

PART 2 - PRODUCTS

2.01 In-Line Propeller Meters

A. General

The flow meter shall be designed to operate continuously at any flow rate within the rated range. Flow meters shall comply with the applicable provisions of AWWA C704, unless more stringent requirements are specified herein. Meter accuracy shall be ±2% of rate at any flow from the minimum rating to 150% of maximum rating. The meter shall be wet flow calibrated at a certified test facility to an accuracy of ±0.25% and traceable

to the National Bureau of Standards. Two copies of the certified accuracy test records taken at minimum, intermediate, and maximum AWWA flow ranges of the meter shall be furnished to the Owner. Propeller meters, meter-mounted indicators, totalizers, and transmitters, or any combination thereof, shall be by a single manufacturer. Remote-mounted instrumentation shall be mounted as shown on the Drawings and/or specified herein.

B. Schedule of In-Line Propeller Meters

The Contractor shall furnish and install in-line flanged tube straightening propeller meter with local indicator, totalizer pulse signal, and 4-20 ma flow transmitter.

Location	Meter Display	Size (In.)	Indicator Flow Range (GPM)	Pressure Rating (PSI)	Type	Electronic Output
Well	Flow Indicator & Totalizer	8"	0-1500	150	Flanged Tube	4-20 ma, Pulse

Totalizer shall read GALLONS x 1000. Meter shall be of the low velocity construction and have an accurate (2%±) range of 150 gpm to 2000 gpm. 4-20 ma flow signal and pulse signal shall be connected to the RTU panel terminal strip.

Propeller meter shall be Model MW 500 as manufactured by McCrometer.

2.02 Materials and Construction

A. Gear Drive Type Meter Mechanism

The meter head shall be mounted on a flanged connection (with o-ring seal and stainless steel bolts) for ease of removal from the pipe, for inspection or service. The meter head shall consist of a cast iron or steel cover plate; bronze or cast iron gear box; stainless steel, delrin, hard rubber or ceramic wetted working parts, and injection molded thermoplastic propeller. For each meter, manufacturer shall provide a separate solid cover plate for removal of meter head and mechanism. Cover plate shall allow continued operation of meter tube at maximum working pressure without meter head and mechanism. The drive mechanism shall include stainless steel gears and shafting. The meter shall have an indicator dial and shall be equipped with a magnetically driven 6-digit straight reading totalizer (with center sweep test hand), with a 4-20 mA-dc and/or scaled pulse output transmitter as specified herein or on the Drawings, protected by all metal, or sealed, injection molded plastic register box and cover assembly, with padlocking hasp. The indicator-totalizer-transmitter enclosure shall be rated NEMA 3R, minimum. Zero and span shall be field adjustable and not cause loss of local totalitarian while in operation. Power supply shall be provided for meters as required to provide functions specified.

B. Flexible Cable Magnetic Drive Meter Mechanism

The register shall be driven by a flexible steel cable encased in a protective vinyl liner. Stainless steel bearings shall support the propeller and allow it to freely rotate. Two permanent magnets on either side of the solid, one piece diaphragm, shall transmit the rotation of the propeller to the flexible drive cable and prevent the process fluid from entering the hermetically sealed cable and register areas. Stainless steel bearings that support the impeller shall be lubricated at the factory. A bearing shield shall retain lubrication and prevent entry of materials and fluids into the bearing chamber. The bearing housing shall be of brass with all stainless steel ball bearings. The impeller shaft, bearing spacers and seal sleeve are 316 stainless steel.

C. Metering Tube or Saddle

Meters, 2" to 4" in size, shall be furnished with straightening vanes in cast iron tubes lined with stainless steel, or fusion epoxy coating. The ends shall be flanged to ANSI standards. Meters 6" through 36" in size shall be furnished with either saddles and straightening vanes, or with flanged tubes with integral vanes as shown on the drawings. The 6" to 36" tubes with straightening vanes shall be fabricated of carbon steel. Meters, 42" to 72" in size, shall be furnished with saddles and straightening vanes. The internal and external of the meter tube, including straightening vanes, and meter head shall be blasted to near white metal and coated with 12-15 mils of fusion-bonded epoxy coating, conforming to NSF Standard 61.

D. Meter with Electronic Output

Where specified with electronic output, a meter module for each meter shall be furnished and installed. Meter module shall provide digital indicator, totalizer pulse signal, and 4-20 ma flow signal and shall be mounted in wall mounted enclosure or panel mounted as specified on the drawings. Module shall be complete with built-in power supply.

E. Meter Signal Cable

Signal cable shall be as recommended by the meter manufacturer. Unless meter manufacturer has special cable requirements, cable shall be two conductor shielded No. 16 Belden cable or equal, or as specified on the drawings.

PART 3 - EXECUTION

3.01 Installation

A. In-line propeller meters and all appurtenant work shall be installed in strict accordance with the manufacturer's printed instructions and under the supervision of the manufacturer's representative.

B. The meters shall be installed in easily accessible locations for ease of reading and maintenance. Meters shall be installed in accordance with manufacturer's recommended straight approach and straight downstream piping dimensions. Meters shall be firmly supported from the structure or from the floor with approved supports. Meters shall be installed to provide full-line flow at all times.

3.02 Testing

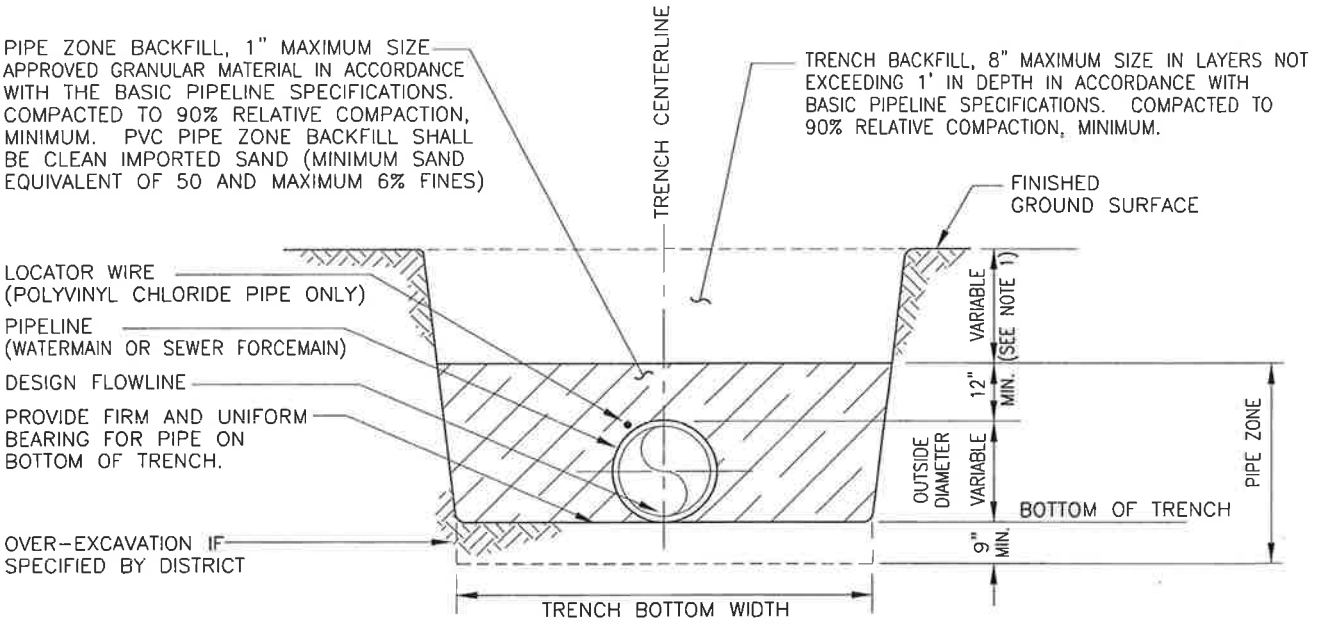
A. Meters shall be prepared for operational use in accordance with manufacturer's instructions, including factory calibration.

B. Each meter shall be subjected to an operating test over the total range of capability of the meter. Where applicable, tests shall be conducted in accordance with the Test Code of the Standards of the Hydraulic Institute. The Contractor shall obtain copies of factory test certifications and shall notify the Owner at least two weeks in advance of all tests to be conducted on site.

END OF SECTION

DRAWINGS

7/26/2011 4:6



PIPE DIAMETER (INCHES)	TRENCH BOTTOM WIDTH	
	MINIMUM (FEET)	MAXIMUM (FEET)
12 OR LESS	2.0	2.5
16	2.5	3.5

NOTES:

1) PIPELINE (WATERMAIN OR SEWER FORCEMAIN) COVER SHALL BE 42" MINIMUM UNLESS SPECIFIED OTHERWISE.

2) TRENCH SIDES SHALL BE SLOPED OR SHORED IN ACCORDANCE WITH CAL OSHA CONSTRUCTION SAFETY ORDERS FOR TRENCH DEPTHS 5' AND GREATER.

3) ALL EXISTING PAVEMENT SHALL BE SAWCUT PRIOR TO TRENCHING, AND WHERE TRENCH SIDES SLUFF AND PAVEMENT BREAKS AWAY, IT SHALL BE SAWCUT AGAIN PRIOR TO PERMANENT PAVEMENT REPAIR.

4) WHENEVER EXISTING CURBS ARE BEING USED FOR GRADE CONTROL, PIPELINES SHALL BE LAID ON PROJECTED CONTINUOUS SLOPES THROUGH LOCALIZED HILLS, HUMPS, AND MOUNDS SUCH AS STREET INTERSECTIONS AND CHANNEL BERMS. PIPELINE GRADES SHALL BE SELECTED TO MAINTAIN MINIMUM COVER WITH CONTINUOUS PIPELINE SLOPE. PIPELINE TRENCH DEPTHS SHALL BE INCREASED TO ACCOMPLISH SAME AND PIPELINE COVER SHALL BE INCREASED ACCORDINGLY.

5) FOR WATERMAINS, WHENEVER EXISTING UTILITY FACILITIES, EXCEPT SEWERS, ARE ENCOUNTERED, WATERMAIN SHALL CLEAR THEM BY 12" MINIMUM, BOTH HORIZONTALLY AND VERTICALLY. WATERMAINS SHALL CLEAR SEWERS IN ACCORDANCE WITH STANDARD DRAWING W1010. FOR SEWER FORCEMAINS, WHENEVER EXISTING UTILITY FACILITIES, EXCEPT WATERMAINS, ARE ENCOUNTERED, SEWER FORCEMAINS SHALL CLEAR THEM BY 12" MINIMUM, BOTH HORIZONTALLY AND VERTICALLY. SEWER FORCEMAINS SHALL CLEAR WATERMAINS IN ACCORDANCE WITH STANDARD DRAWING S2020. SPECIFIED CLEARANCES OR SEPARATIONS SHALL NOT BE REDUCED UNLESS ORDERED OR PERMITTED BY DISTRICT. PIPELINES (WATERMAINS AND SEWER FORCEMAINS) SHALL NOT BE IN CONTACT WITH OR REST AGAINST OTHER UTILITY FACILITIES.

6) WHERE BOTTOM OF EXCAVATION IS IN ROCK WHICH CANNOT BE EXCAVATED TO PROVIDE UNIFORM BEARING FOR THE PIPE, TRENCH SHALL BE OVER-EXCAVATED 9" MINIMUM AND REFILLED WITH SELECT EXCAVATED MATERIAL OR IMPORTED BACKFILL MATERIAL COMPACTED TO 90% MINIMUM RELATIVE COMPACTION.

7) LOCATOR WIRE FOR POLYVINYL CHLORIDE PIPE SHALL BE INSULATED 14 GAUGE COPPER WIRE. IT SHALL BE CONTINUOUS ALONG THE PIPELINE, LOOPED AROUND THE PIPE AT EACH JOINT, AND LOOPED INTO VALVE BOXES WITHIN 12" OF THE SURFACE AND WITH 3' OF SLACK.

APPROVED:

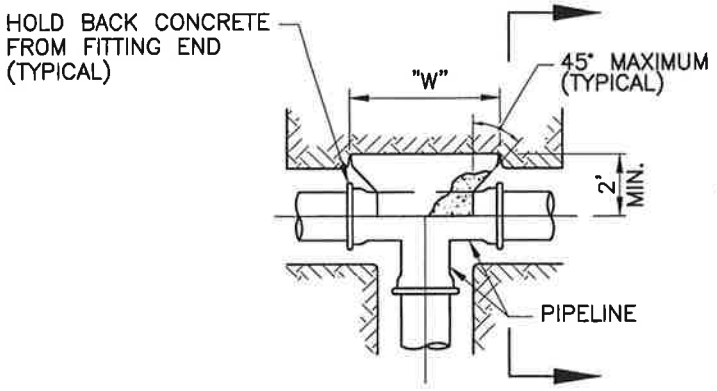
ASSISTANT GENERAL MANAGER/
DISTRICT ENGINEER

DATE: JANUARY 2005

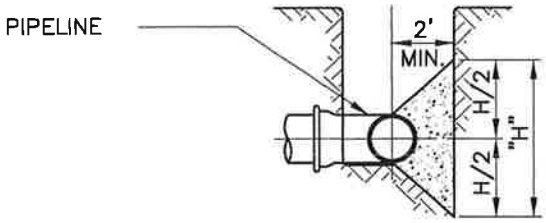
RUBIDOUX COMMUNITY SERVICES DISTRICT

PIPELINE TRENCH

STANDARD DRAWING | G20

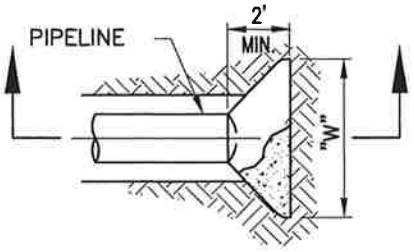


PLAN



SECTION

TEE THRUST PROTECTION



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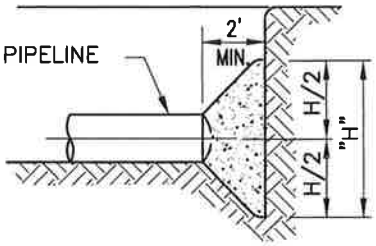
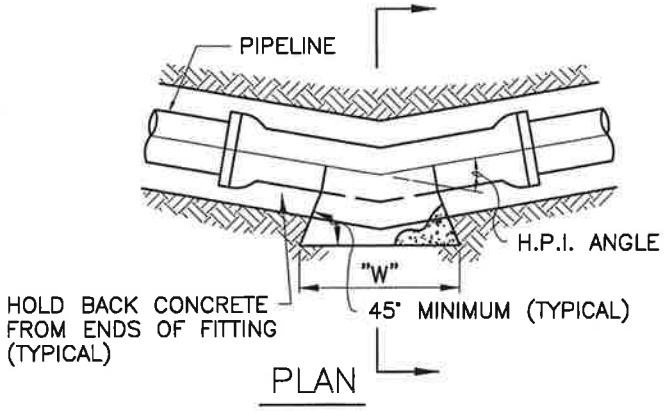


SECTION

END THRUST PROTECTION



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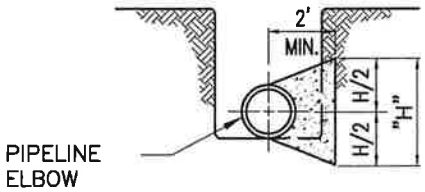


SECTION

HORIZONTAL BEND THRUST PROTECTION

NOTES:

1) THRUST BLOCK SIZES SHOWN ARE MINIMUM AND ARE BASED ON A HORIZONTAL BEARING CAPACITY OF 1500 PSF. CONTRACTOR SHALL RETAIN A REGISTERED GEOTECHNICAL ENGINEER TO DETERMINE ALLOWABLE HORIZONTAL BEARING CAPACITY. IF SAID CAPACITY IS LESS THAN 1500 PSF, THE CONTRACTOR SHALL FURNISH CONCRETE THRUST BLOCKS OF THE APPROPRIATE SIZE.
2) BLOCK CONCRETE SHALL BE CLASS C IN ACCORDANCE WITH BASIC CONCRETE SPECIFICATIONS.
3) BLOCKS SHALL BE FORMED WITH TRIMMED EARTH, SAND BAGS, OR LUMBER TO ACHIEVE REQUIRED CONFIGURATION. ALL LUMBER SHALL BE REMOVED PRIOR TO BACKFILLING.
4) BLOCKS SHALL BEAR AGAINST UNDISTURBED EARTH OR REPLACED EARTH HAVING 95% RELATIVE COMPACTION, MINIMUM.
5) BACKFILL AROUND AND OVER BLOCKS SHALL BE COMPACTED TO 95% RELATIVE COMPACTION, MINIMUM.
6) COMPACTED EARTH SHALL EXTEND TO DEPTH AND WIDTH (W) OF BLOCK AND TO DISTANCE W/2 BEFORE AND PAST BLOCK.
7) UNDER CERTAIN CIRCUMSTANCES, FULLY WELDED JOINTS FOR WELDED STEEL PIPE, FLANGED JOINTS OR RESTRAINED JOINTS FOR DUCTILE IRON PIPE, OR RESTRAINED JOINTS FOR POLYVINYL CHLORIDE PIPE MAY BE USED IN LIEU OF THRUST BLOCKS. SAID APPLICATION SHALL BE APPROVED BY DISTRICT.

APPROVED:

ASSISTANT GENERAL MANAGER/
DISTRICT ENGINEER

DATE: JANUARY 2005

RUBIDOUX COMMUNITY SERVICES DISTRICT

CONCRETE THRUST PROTECTION

STANDARD DRAWING

G40
SHEET 1 OF 2

CONCRETE THRUST PROTECTION TABLE			
PIPE SIZE INCHES	TYPE OF FITTING	THRUST BLOCK DIMENSIONS	
		CL. 150 PIPE H'xW'	CL. 200 PIPE H'xW'
16	TEE & END	5.0x 7.0	5.0x 9.5
16	5°–25° H.P.I.	3.0x 5.0	4.0x 5.0
16	26°–45° H.P.I.	4.0x 7.0	5.0x 7.5
16	46°–70° H.P.I.	5.0x 8.0	6.0x 9.0
16	71°–90° H.P.I.	5.0x10.0	6.0x11.0
12	TEE & END	4.0x 5.0	4.5x 6.0
12	5°–25° H.P.I.	3.0x 3.0	3.0x 4.0
12	26°–45° H.P.I.	3.0x 5.0	4.0x 5.0
12	46°–70° H.P.I.	4.0x 5.5	4.5x 6.5
12	71°–90° H.P.I.	4.0x 7.0	4.5x 8.0
8	TEE & END	3.0x 3.0	3.5x 3.5
8	5°–25° H.P.I.	2.0x 2.0	2.0x 2.5
8	26°–45° H.P.I.	2.5x 3.0	3.0x 3.0
8	46°–70° H.P.I.	3.0x 3.5	3.5x 4.0
8	71°–90° H.P.I.	3.5x 4.0	4.0x 4.5
6	TEE & END	2.0x 3.0	2.5x 3.0
6	5°–25° H.P.I.	1.0x 2.5	1.5x 2.0
6	26°–45° H.P.I.	2.0x 2.0	2.0x 3.0
6	46°–70° H.P.I.	2.0x 3.0	2.5x 3.5
6	71°–90° H.P.I.	2.5x 3.0	3.0x 3.5
4	TEE & END	1.0x 2.5	1.5x 2.5
4	5°–25° H.P.I.	1.0x 1.0	1.0x 1.5
4	26°–45° H.P.I.	1.0x 2.0	1.5x 2.0
4	46°–70° H.P.I.	1.5x 2.0	1.5x 2.5
4	71°–90° H.P.I.	1.5x 2.5	2.0x 2.5

APPROVED:

ASSISTANT GENERAL MANAGER/
DISTRICT ENGINEER

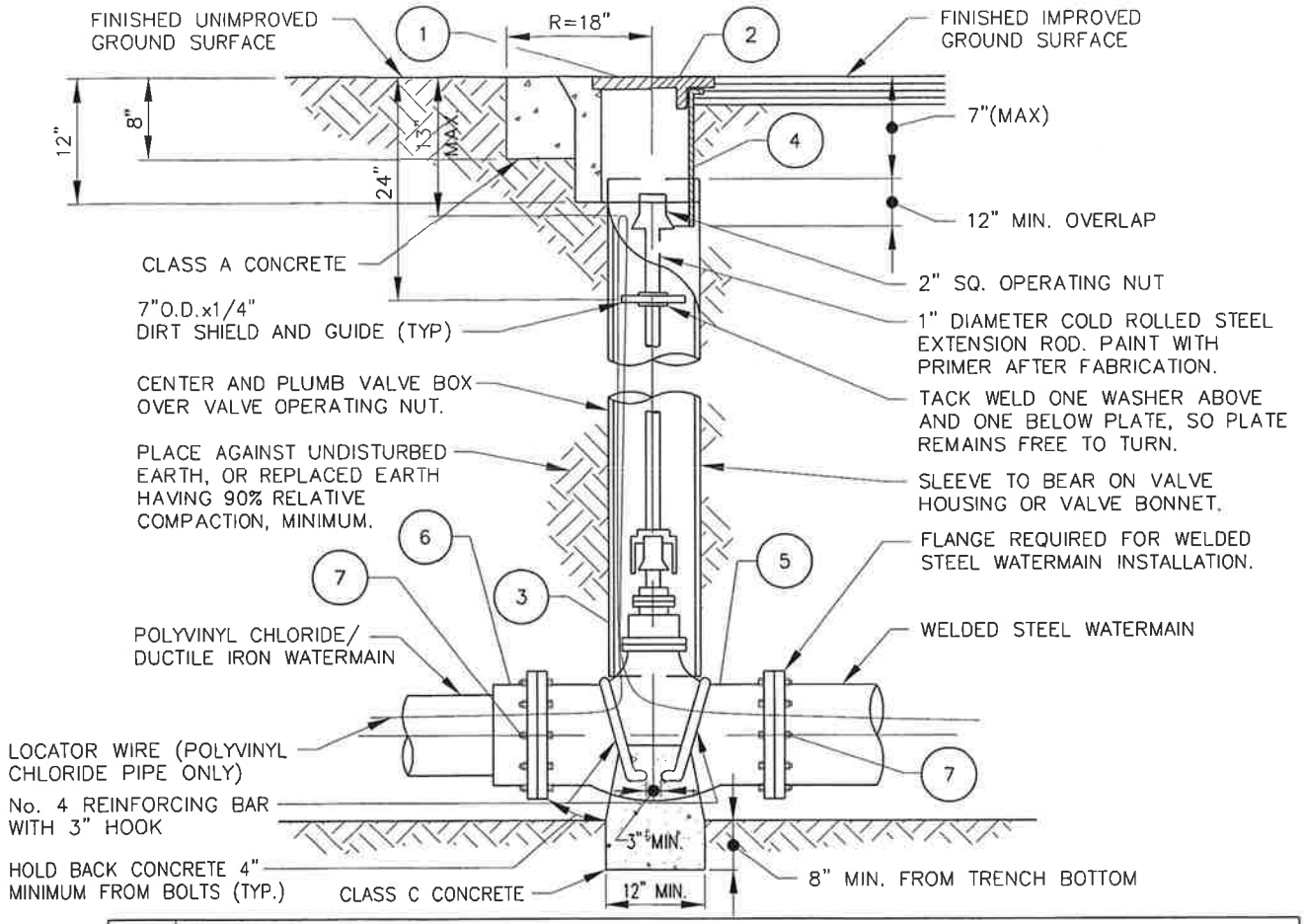
DATE: JANUARY 2005

RUBIDOUX COMMUNITY SERVICES DISTRICT

CONCRETE THRUST PROTECTION

STANDARD DRAWING

G40



ITEM	DESCRIPTION
1	TRAFFIC BOX COVER FOR UNIMPROVED SURFACE (TRIANGULAR COVER WITH FRAME) – COVER MARKED "RCSD".
2	TRAFFIC BOX COVER FOR IMPROVED SURFACE (CIRCULAR COVER WITHOUT FRAME) – COVER MARKED "RCSD".
3	VALVE BOX EXTENSION, 8"I.D. SDR 35 POLYVINYL CHLORIDE PIPE.
4	18 GAUGE x 18" LONG GALVANIZED STEEL SLEEVE WITH 1-1/2" OVERLAP AND 1/2" LIP (FLARE) ON ONE END.
5	GATE VALVE SHALL HAVE FLANGED DUCTILE IRON OR CAST IRON BODY WITH RESILIENT SEAT. VALVE STEM SHALL BE NONRISING WITH 2" SQUARE OPERATING NUT AND SHALL TURN COUNTER-CLOCKWISE TO OPEN. VALVE SHALL HAVE "O" RING SEALS AND NON-SHOCK COLD WATER WORKING PRESSURE OF 200 P.S.I..
6	FLANGE BY TYTON JOINT ADAPTER REQUIRED FOR POLYVINYL CHLORIDE OR DUCTILE IRON WATERMAIN.
7	BOLTS SHALL BE STANDARD HEX HEAD MACHINE PER ASTM A325. NUTS SHALL BE HEAVY HEX COLD-PRESSED SEMI-FINISHED STEEL PER ASTM A194-2, 2H. THREADS SHALL BE LUBRICATED WITH AN APPROVED ANTI-SEIZE COMPOUND. ALL EXPOSED STEEL SHALL BE FIELD COATED WITH AN APPROVED BITUMASTIC.

NOTES:

1) EXTENSION ROD REQUIRED WHENEVER TOP OF VALVE IS 3' OR MORE BELOW FINISHED GROUND SURFACE. REQUIRED LENGTH FOR EXTENSION ROD SHALL BE DETERMINED BY FIELD MEASUREMENT. EXTENSION ROD OPERATOR NUT SHALL BE 18" BELOW FINISHED GRADE. EXTENSION ROD SHALL BE SECURED TO VALVE OPERATING NUT BY WELDING A BEAD ON THE INSIDE OF THREE WALLS OF THE EXTENSION NUT CAP.

2) CHISEL 1-1/2" MINIMUM "V" ON ADJACENT CURB FACE WITH APPROXIMATE DISTANCE TO VALVE BOX, 2 LOCATIONS.

3) AIR VALVE VALVE BOX COVERS SHALL BE PAINTED TAN, FIRE HYDRANT VALVE BOX COVERS SHALL BE PAINTED YELLOW; ALL OTHER VALVE BOX COVERS SHALL BE PAINTED BLUE, ALL IN ACCORDANCE WITH BASIC PAINTING SPECIFICATIONS.

4) LOCATOR WIRE FOR POLYVINYL CHOLRIDE PIPE SHALL BE INSULATED 14 GAUGE COPPER WIRE. IT SHALL BE CONTINUOUS ALONG THE PIPELINE, LOOPED AROUND THE PIPE AT EACH JOINT, AND LOOPED INTO VALVE BOXES WITHIN 13" OF THE SURFACE AND WITH 3' OF SLACK.

APPROVED:

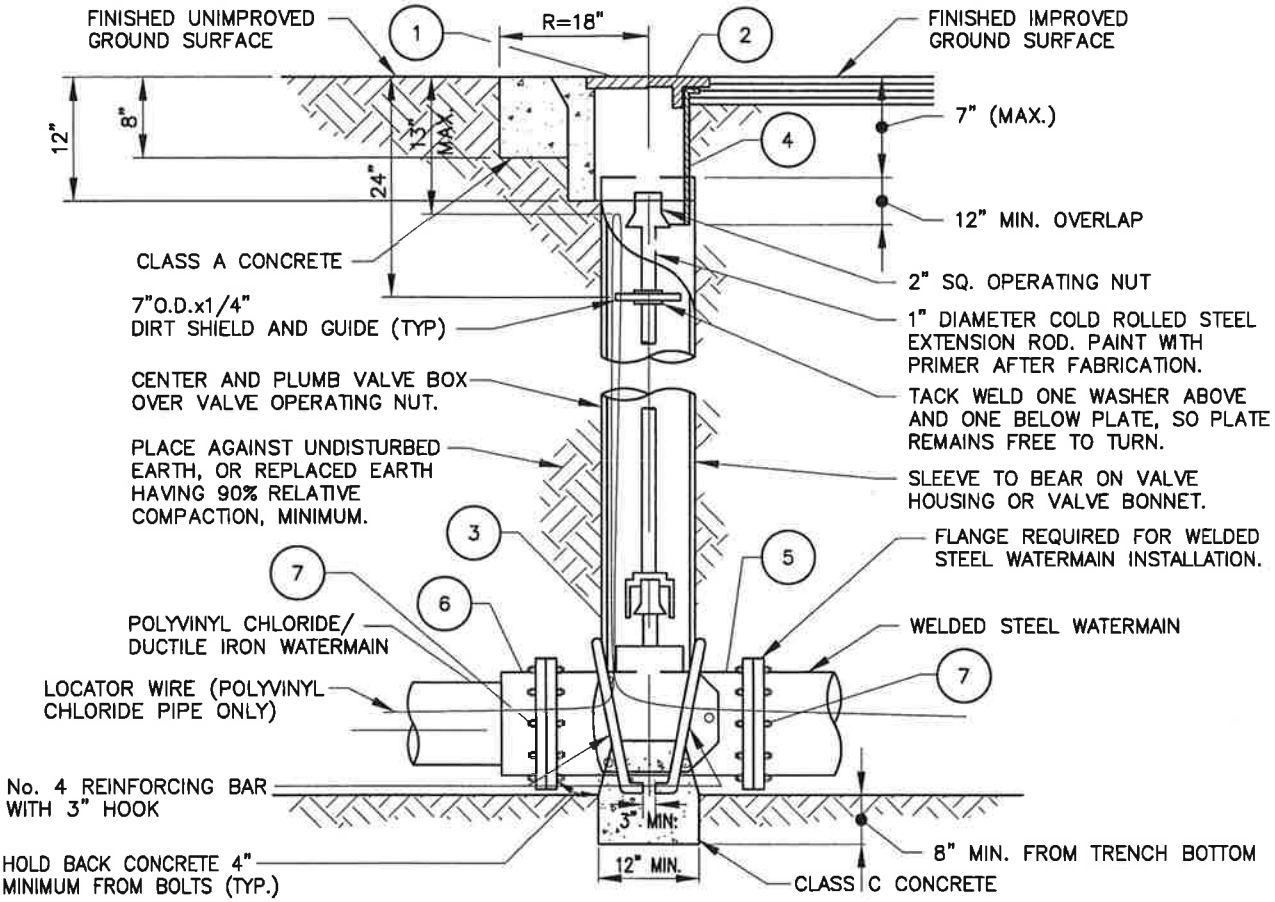
ASSISTANT GENERAL MANAGER/ DISTRICT ENGINEER

DATE: JANUARY 2005

RUBIDOUX COMMUNITY SERVICES DISTRICT

GATE VALVE INSTALLATION

STANDARD DRAWING | W1020



ITEM	DESCRIPTION
1	TRAFFIC BOX COVER FOR UNIMPROVED SURFACE (TRIANGULAR COVER WITH FRAME) – COVER MARKED "RCSD".
2	TRAFFIC BOX COVER FOR IMPROVED SURFACE (CIRCULAR COVER WITHOUT FRAME) – COVER MARKED "RCSD".
3	VALVE BOX EXTENSION, 8"I.D. SDR 35 POLYVINYL CHLORIDE PIPE.
4	18 GAUGE x 18" LONG GALVANIZED STEEL SLEEVE WITH 1–1/2" OVERLAP AND 1/2" LIP (FLARE) ON ONE END.
5	FLANGED BUTTERFLY VALVE, SHORT BODY. VALVE STEM SHALL TURN COUNTER–CLOCKWISE TO OPEN. VALVE OPERATORS SHALL BE PLACED ON STREET OR EASEMENT CENTERLINE SIDE OF VALVE.
6	FLANGE BY TYTON JOINT ADAPTER REQUIRED FOR POLYVINYL CHLORIDE OR DUCTILE IRON WATERMAIN.
7	BOLTS SHALL BE STANDARD HEX HEAD MACHINE PER ASTM A325. NUTS SHALL BE HEAVY HEX COLD–PRESSED SEMI–FINISHED STEEL PER ASTM A194–2, 2H. THREADS SHALL BE LUBRICATED WITH AN APPROVED ANTI–SEIZE COMPOUND. ALL EXPOSED STEEL SHALL BE FIELD COATED WITH AN APPROVED BITUMASTIC.

NOTES:

1) EXTENSION ROD REQUIRED WHENEVER TOP OF VALVE IS 3' OR MORE BELOW FINISHED GROUND SURFACE. REQUIRED LENGTH FOR EXTENSION ROD SHALL BE DETERMINED BY FIELD MEASUREMENT. EXTENSION ROD OPERATOR NUT SHALL BE 18" BELOW FINISHED GRADE. EXTENSION ROD SHALL BE SECURED TO VALVE OPERATING NUT BY WELDING A BEAD ON THE INSIDE OF THREE WALLS OF THE EXTENSION NUT CAP.
2) CHISEL 1–1/2" MINIMUM "V" ON ADJACENT CURB FACE WITH APPROXIMATE DISTANCE TO VALVE BOX, 2 LOCATIONS.
3) VALVE BOX COVERS SHALL BE PAINTED BLUE, IN ACCORDANCE WITH THE BASIC PAINTING SPECIFICATIONS.
4) LOCATOR WIRE FOR POLYVINYL CHORIDE PIPE SHALL BE INSULATED 14 GAUGE COPPER WIRE. IT SHALL BE CONTINUOUS ALONG THE PIPELINE, LOOPED AROUND THE PIPE AT EACH JOINT, AND LOOPED INTO VALVE BOXES WITHIN 13" OF THE SURFACE AND WITH 3' OF SLACK.

APPROVED:

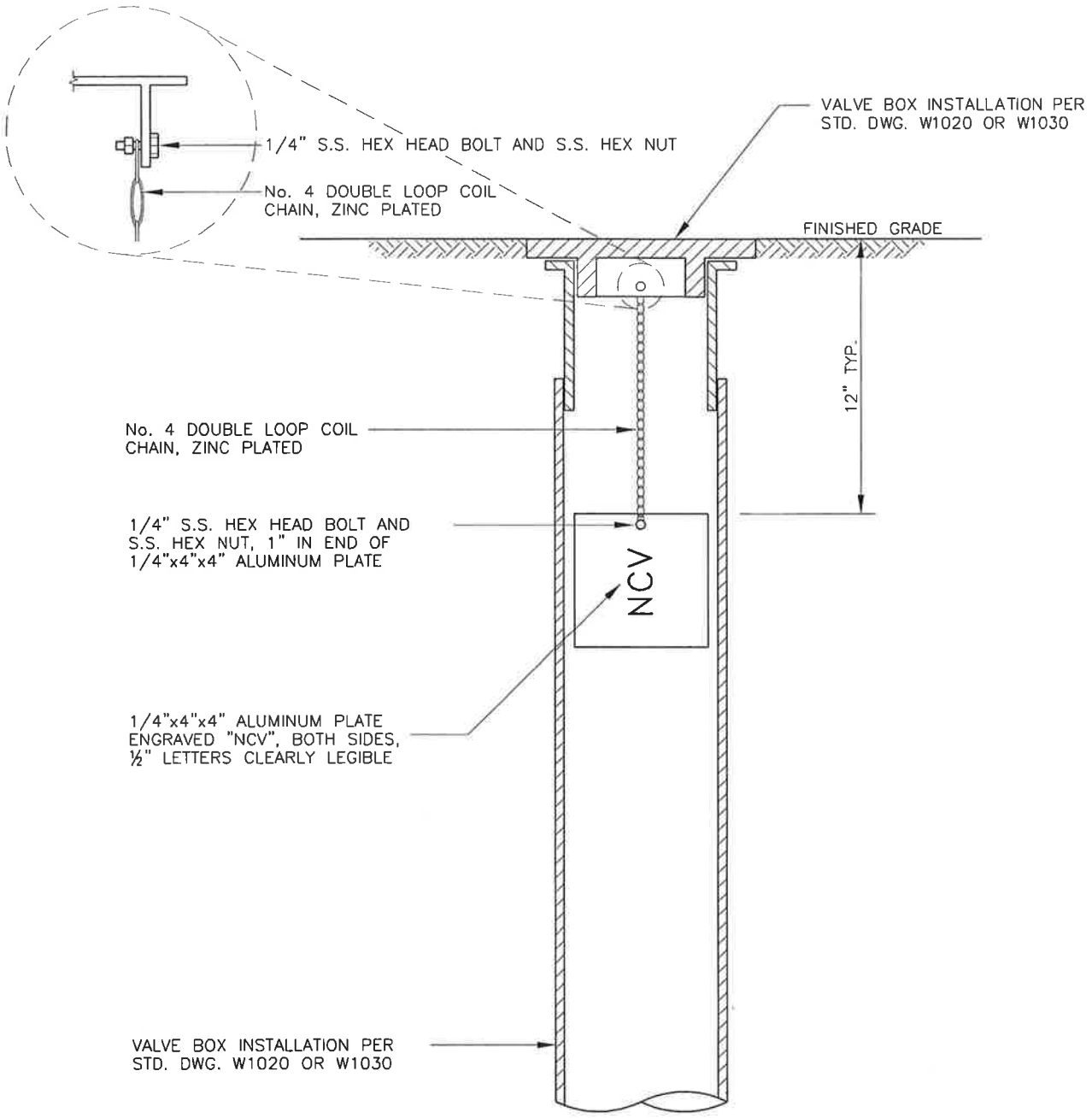
ASSISTANT GENERAL MANAGER/ DISTRICT ENGINEER

DATE: JANUARY 2005

RUBIDOUX COMMUNITY SERVICES DISTRICT

BUTTERFLY VALVE INSTALLATION

STANDARD DRAWING | W1030



APPROVED:

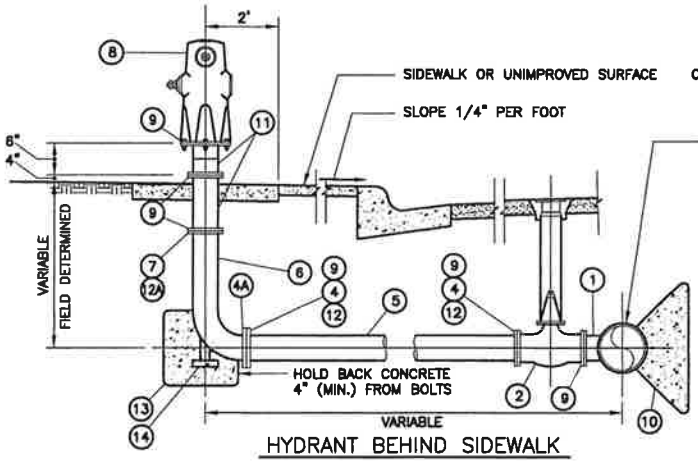
ASSISTANT GENERAL MANAGER/
DISTRICT ENGINEER

DATE: JANUARY 2005

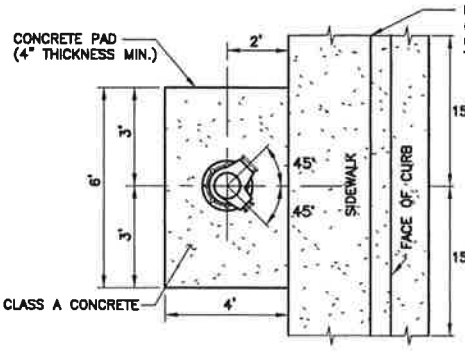
RUBIDOUX COMMUNITY SERVICES DISTRICT

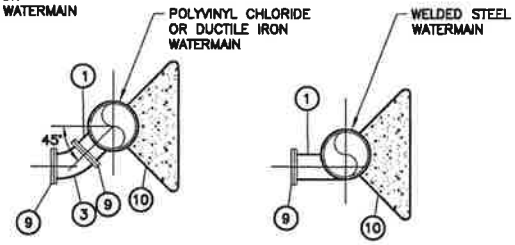
NORMALLY CLOSED VALVE BOX INSTALLATION

STANDARD DRAWING | W1040



HYDRANT BEHIND SIDEWALK





OPTIONAL COMBINATION
FIRE HYDRANT AND BLOWOFF INSTALLATION

ITEM	NUMBER REQUIRED	DESCRIPTION
1	1	6" FLANGED DUCTILE IRON TEE FOR POLYVINYL CHLORIDE OR DUCTILE IRON WATERMAINS, OR 6" FLANGED SIDE OUTLET FOR WELDED STEEL WATERMAIN. FOR COMBINATION FIRE HYDRANT AND BLOWOFF INSTALLATION, SIDE OUTLET SHALL BE TANGENTIAL ON WELDED STEEL WATERMAIN.
2	1	6" FLANGED GATE VALVE INSTALLATION PER STANDARD DRAWING W1020.
3	1	6" FLANGED 45° DUCTILE IRON ELBOW.
4	3	6" A.W.W.A. CLASS E RING FLANGE (NOT REQUIRED FOR POLYVINYL CHLORIDE PIPE OPTION).
4A	1	6" A.W.W.A. CLASS E RING FLANGE
5	VARIES	6" DIAMETER 10 GAUGE CEMENT MORTAR LINED AND CEMENT MORTAR COATED WELDED STEEL PIPE OR 6" C900 CLASS 200 POLYVINYL CHLORIDE PIPE WITH UNIFLANGE SERIES 900 ADAPTER FLANGE.
6	1	6" DIAMETER STANDARD WEIGHT CEMENT MORTAR LINED AND CEMENT MORTAR COATED WELDED STEEL PIPE WITH SMOOTH 90° ELBOW.
7	1	6" 6 BOLT FLANGE (1-5/16" THICK AND DRILLED TO MATCH 6 BOLT BREAKOFF CHECK VALVE ASSEMBLY FLANGE). SHIP FLANGE LOOSE.
8	1	WET BARREL FIRE HYDRANT WITH 6" 6 BOLT FLANGED INLET, ONE 4" PUMPER OUTLET AND ONE 2-1/2" HOSE OUTLET.
9	–	A325 BOLTS.
10	–	CONCRETE THRUST PROTECTION PER STANDARD DRAWING G40.
11	1	BREAK-OFF CHECK VALVE WITH 6 BOLT PATTERN FLANGES (DRILLED TO MATCH 6 BOLT HYDRANT FLANGE).
12	–	2' CUT-TO-FIT (NOT REQUIRED FOR POLYVINYL CHLORIDE PIPE). SHIP FLANGE LOOSE.
12A	–	2' CUT-TO-FIT. SHIP FLANGE LOOSE.
13	–	CONCRETE THRUST PROTECTION, 2-1/2' CUBE. CONCRETE SHALL BE CLASS C.
14	1	STEEL BASE (1/4" THICK).

NOTES:

1) FIRE HYDRANT LOCATIONS NOTED HEREON ARE GENERAL. SPECIFIC LOCATIONS SHALL CONFORM TO THE REQUIREMENTS OF AGENCY HAVING FIRE PROTECTION RESPONSIBILITY (COUNTY OF RIVERSIDE). SAID AGENCY SHALL APPROVE ALL FIRE HYDRANT LOCATIONS.
2) PAINT ALL MATERIAL ABOVE GROUND WITH TWO COATS OF SAFETY YELLOW PAINT.
3) BLUE REFLECTORIZED STREET MARKER SHALL BE SET OPPOSITE FIRE HYDRANTS.
4) BOLTS SHALL BE STANDARD HEX HEAD MACHINE PER ASTM A325. NUTS SHALL BE HEAVY HEX COLD PRESSED, SEMI-FINISHED STEEL PER ASTM A194, 2H. THREADS SHALL BE LUBRICATED WITH AN APPROVED ANTI-SEIZE COMPOUND. ALL BURIED EXPOSED STEEL SHALL BE FIELD COATED WITH AN APPROVED BITUMASTIC.
5) CURB IN FRONT OF FIRE HYDRANT (15' EACH SIDE) SHALL BE PAINTED RED IN ACCORDANCE WITH BASIC PAINTING SPECIFICATIONS.
6) IF NO CURB EXISTS, HYDRANT SHALL BE INSTALLED 2' FROM PROPERTY LINE OR AS DIRECTED BY DISTRICT.

APPROVED:

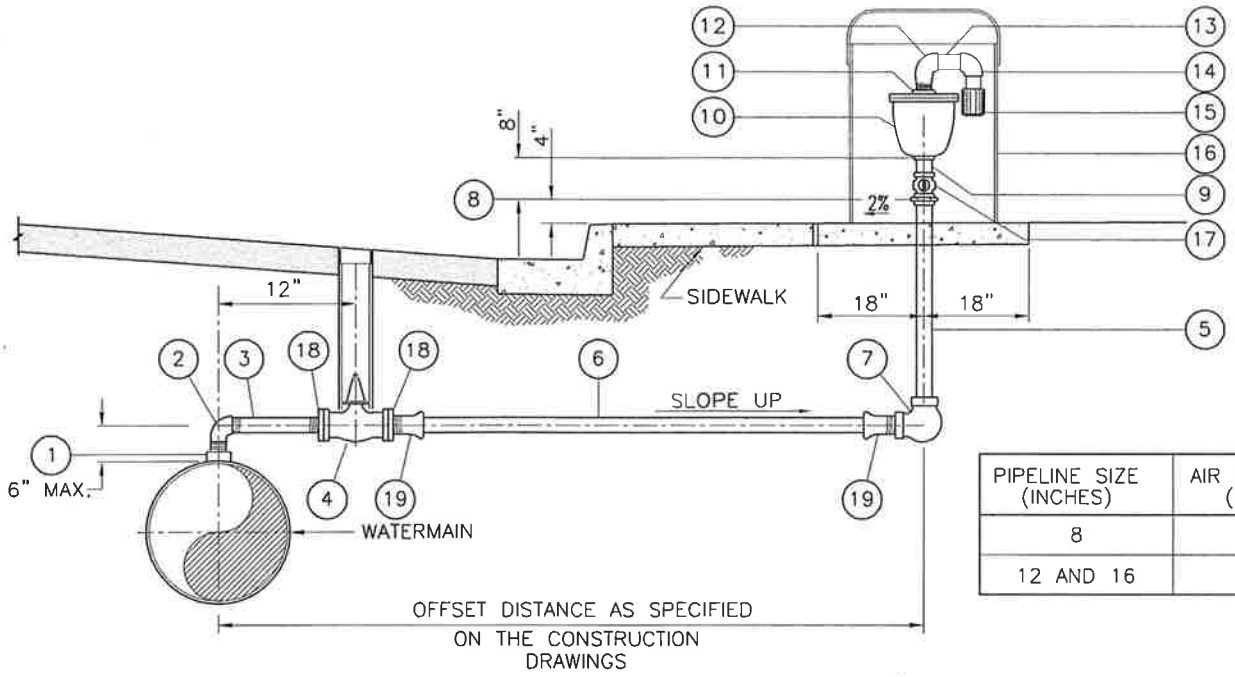
ASSISTANT GENERAL MANAGER/
DISTRICT ENGINEER

DATE: JANUARY 2005

RUBIDOUX COMMUNITY SERVICES DISTRICT

6" RESIDENTIAL FIRE HYDRANT INSTALLATION

STANDARD DRAWING | W1050



PIPELINE SIZE (INCHES)	AIR VALVE SIZE (INCHES)
8	1
12 AND 16	2

ITEM	NO. REQ'D.	DESCRIPTION
1	1	2" TOP OUTLET PER STANDARD DRAWING W1090.
2	1	2" BRASS 90° STREET ELL.
3	1	2" BRASS NIPPLE.
4	1	2" FLANGED GATE VALVE INSTALLATION PER STANDARD DRAWING W1020.
5	1	2" BRONZE RISER (MALE IPT BOTH ENDS).
6	VARIES	2" TYPE "K" SOFT COPPER TUBING (WITHOUT INLINE COUPLINGS).
7	1	2" STANDARD WEIGHT BRONZE ELL.
8	1	2" STANDARD WEIGHT BRONZE UNION.
9	1	2"x 1" BRONZE BELL REDUCER AND 1" CLOSE NIPPLE (FOR 1" AIR VALVE ONLY).
10	1	COMBINATION AIR RELEASE AND VACUUM VALVE, SIZE AS SPECIFIED.
11	1	1" STANDARD WEIGHT GALVANIZED STEEL CLOSE NIPPLE AND 1"x2" STANDARD WEIGHT GALVANIZED STEEL INCREASER (FOR 1" AIR VALVE ONLY).
12	1	2" STANDARD WEIGHT GALVANIZED STEEL 90° STREET ELL.
13	1	2" STANDARD WEIGHT GALVANIZED STEEL NIPPLE.
14	1	2" STANDARD WEIGHT GALVANIZED STEEL 90° ELL.
15	1	2" AIR VALVE SCREEN.
16	1	AIR VALVE COVER AND CONCRETE PAD PER STANDARD DRAWING W1080.
17	1	2" CORPORATION STOP (MALE IPT BOTH ENDS).
18	2	2" THREADED FLANGE.
19	2	2" MALE IPT x COPPER TUBING COMPRESSION JOINT ADAPTER.

NOTES:

1) EXPOSED PIPING, AIR VALVE, AND AIR VALVE COVER SHALL BE PAINTED TAN IN ACCORDANCE WITH BASIC PAINTING SPECIFICATIONS.

2) PIPE THREADS SHALL BE CLEAN, SHARP, AND SEALED WITH APPROVED JOINT COMPOUND.

3) PIPE SHALL BE WRAPPED WITH BITUMASTIC TAPE (20 MIL THICK, 60% LAPPED).

4) IF NO CURB EXISTS, AIR VALVE SHALL BE INSTALLED 2' FROM PROPERTY LINE OR AS DIRECTED BY DISTRICT.

APPROVED:

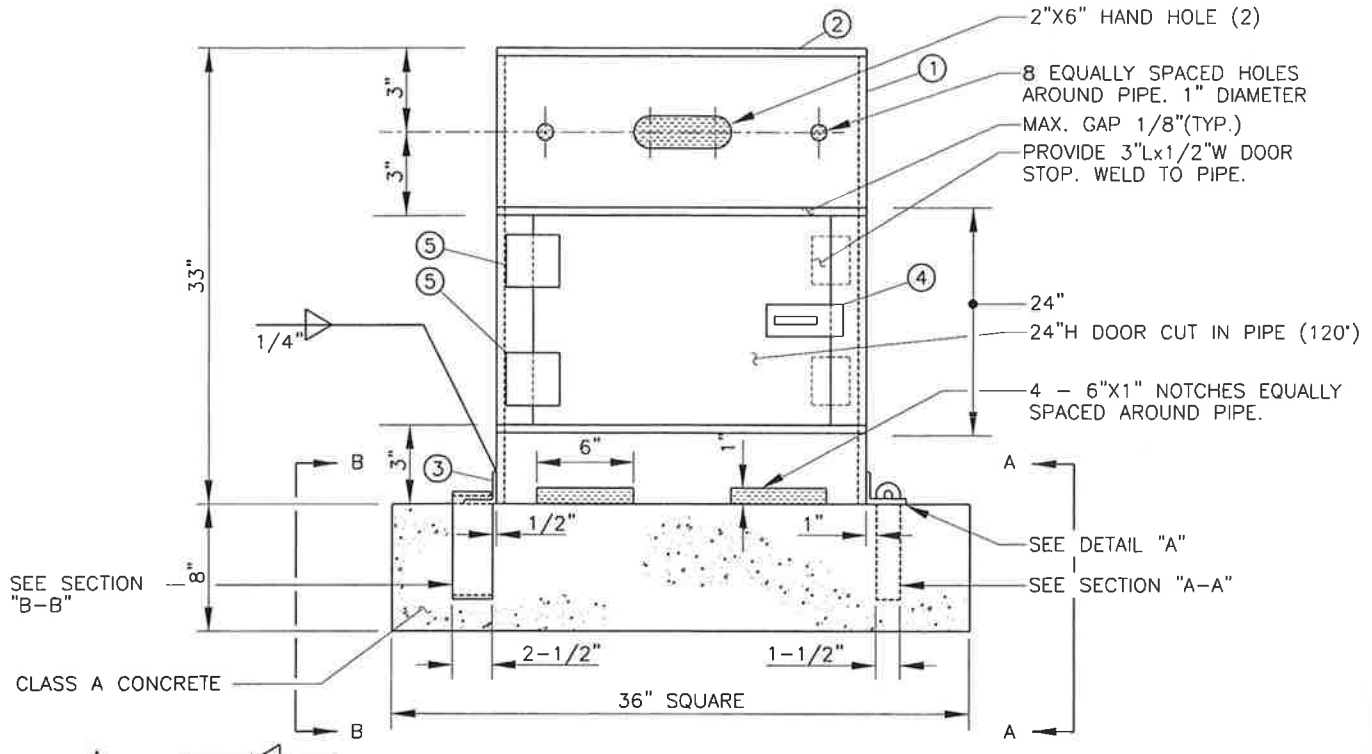
ASSISTANT GENERAL MANAGER/
DISTRICT ENGINEER

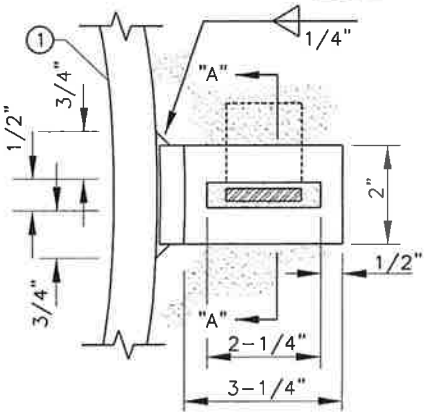
DATE: JANUARY 2005

RUBIDOUX COMMUNITY SERVICES DISTRICT

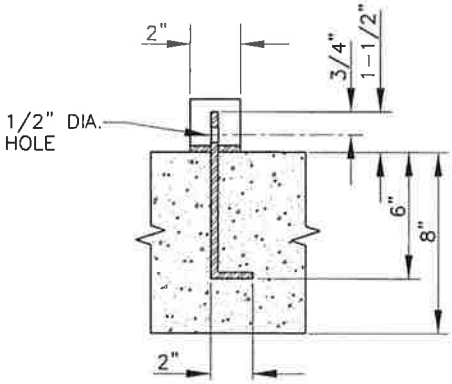
1" OR 2" AIR VALVE INSTALLATION

STANDARD DRAWING | W1070

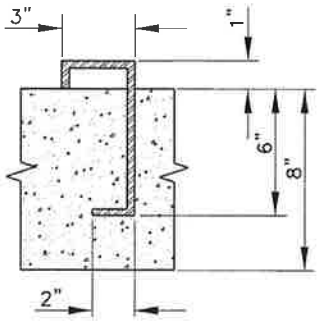




DETAIL "A"



SECTION "A–A"



SECTION "B–B"

ITEM	DESCRIPTION
1	20" DIAMETER–12 GA. STEEL PIPE.
2	3/16" PLATE WELDED TO 20" DIAMETER PIPE.
3	4"X2"X1/4" STEEL PLATE WELDED TO 20" DIAMETER PIPE.
4	3–15/16"Lx1–3/8"W S.S. LATCHING SAFETY HASP WELDED TO PIPE AND DOOR.
5	4"Hx4"W S.S. SURFACE HINGE WITH NON–REMOVABLE PIN HINGES WELDED TO PIPE AND DOOR.

NOTES:

1) COVER AND BRACKETS SHALL BE PAINTED TAN IN ACCORDANCE WITH BASIC PAINTING SPECIFICATIONS.
2) BRACKETS SHALL BE CONSTRUCTED OF 1/4" STEEL.

APPROVED:

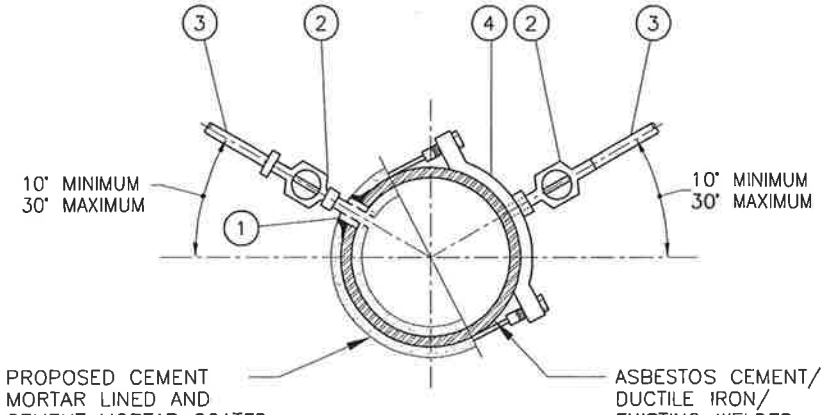
ASSISTANT GENERAL MANAGER/
DISTRICT ENGINEER

DATE: JANUARY 2005

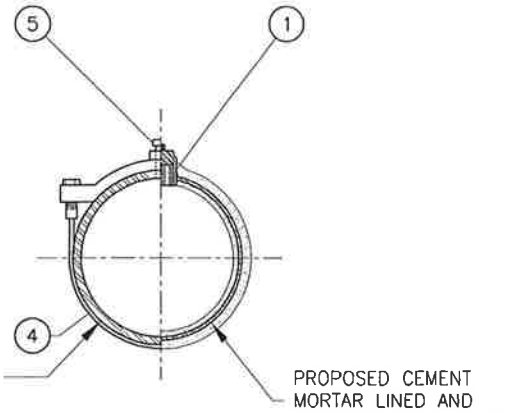
RUBIDOUX COMMUNITY SERVICES DISTRICT

1" AND 2" AIR VALVE COVER

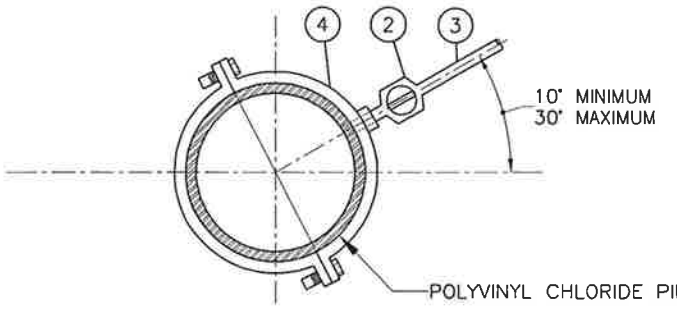
STANDARD DRAWING | W1080



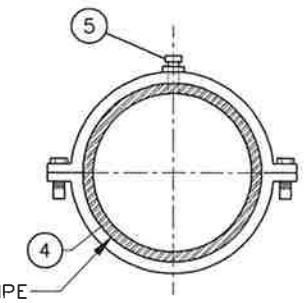
SERVICE CONNECTION



TOP OUTLET



SERVICE CONNECTION



TOP OUTLET

ITEM	NO. REQ'D.	DESCRIPTION
1	1	EXTRA HEAVY HALF COUPLING (IPT) WELDED TO PROPOSED STEEL WATERMAIN. REPAIR CEMENT MORTAR COATING AFTER INSTALLATION.
2	1	FOR 1" SERVICE CONNECTION, INSTALL INSULATED CORPORATION STOP (MALE IPT INLETxCOPPER TUBING COMPRESSION JOINT OUTLET). FOR 2" SERVICE CONNECTION INSTALL INSULATED BUSHING AND CORPORATION STOP (MALE IPT INLETxCOPPER TUBING COMPRESSION JOINT OUTLET).
3	1	TYPE "K" SOFT COPPER TUBING, ONE PIECE (VARIABLE LENGTH).
4	1	DOUBLE STRAP (IPT) BRONZE SERVICE SADDLE FOR DUCTILE IRON, ASBESTOS CEMENT, AND EXISTING WELDED STEEL WATERMAIN. FOR POLYVINYL CHLORIDE WATERMAIN, BRONZE SADDLE AND SILICON BRONZE BOLTS, "O" RING TYPE BUNA–N GASKET.
5	1	STANDARD WEIGHT BRASS SQUARE HEAD PLUG.

NOTES:

1) SERVICE AND OTHER TAPS SHALL NOT BE MADE CLOSER THAN 2 FEET TO A BELL, COUPLING, JOINT, FITTING, OR OTHER SERVICE.

2) PIPE THREADS SHALL BE CLEAN, SHARP, AND SEALED WITH AN APPROVED JOINT COMPOUND.

3) TOP OUTLET MAY BE USED BY CONTRACTOR FOR TESTING AND DISINFECTION AS SPECIFIED BY DISTRICT. PROVIDE CURB OR CORPORATION STOPS FOR TESTING AND DISINFECTION. CONTRACTOR SHALL REPLACE STOPS WITH PLUG AFTER SUCCESSFULLY TESTING AND DISINFECTING PIPELINE.

APPROVED:

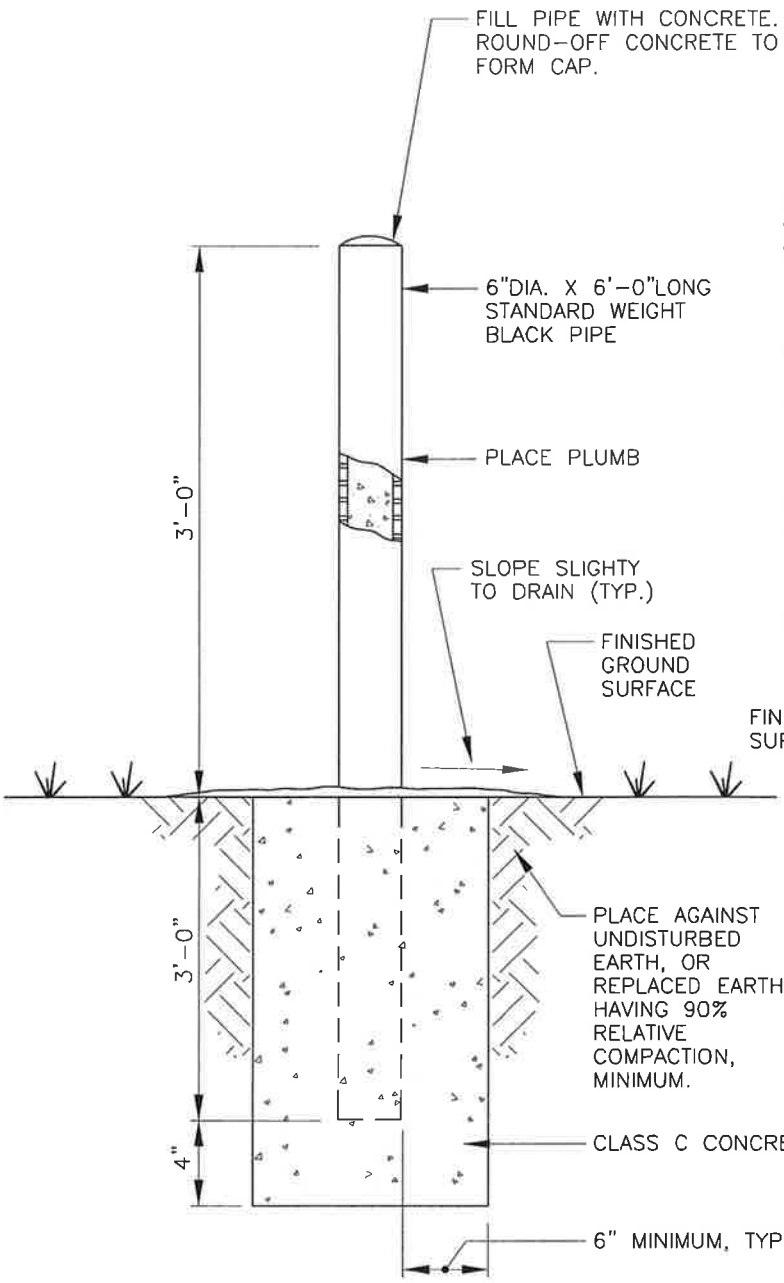
ASSISTANT GENERAL MANAGER/
DISTRICT ENGINEER

DATE: JANUARY 2005

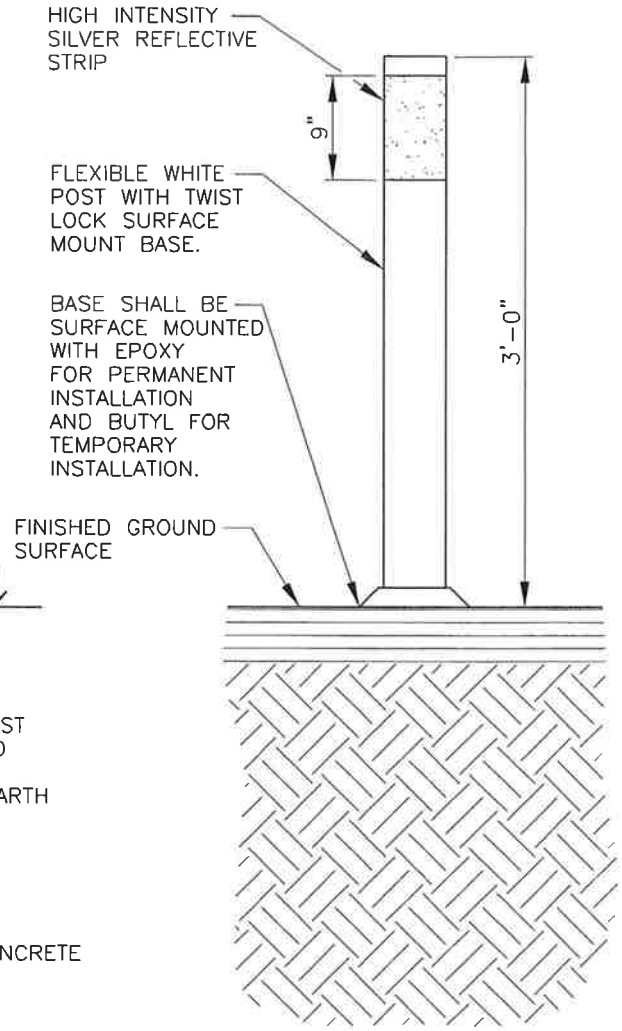
RUBIDOUX COMMUNITY SERVICES DISTRICT

1" AND 2" SERVICE CONNECTION AND TOP OUTLET

STANDARD DRAWING W1090



GUARD POST



FLEXIBLE DELINEATOR

NOTES:

1) GUARD POST SHALL BE PAINTED YELLOW IN ACCORDANCE WITH THE BASIC PAINTING SPECIFICATIONS.

2) GUARD POST AND FLEXIBLE DELINEATOR SHALL BE LOCATED AS SPECIFIED BY DISTRICT.

APPROVED:

ASSISTANT GENERAL MANAGER/
DISTRICT ENGINEER

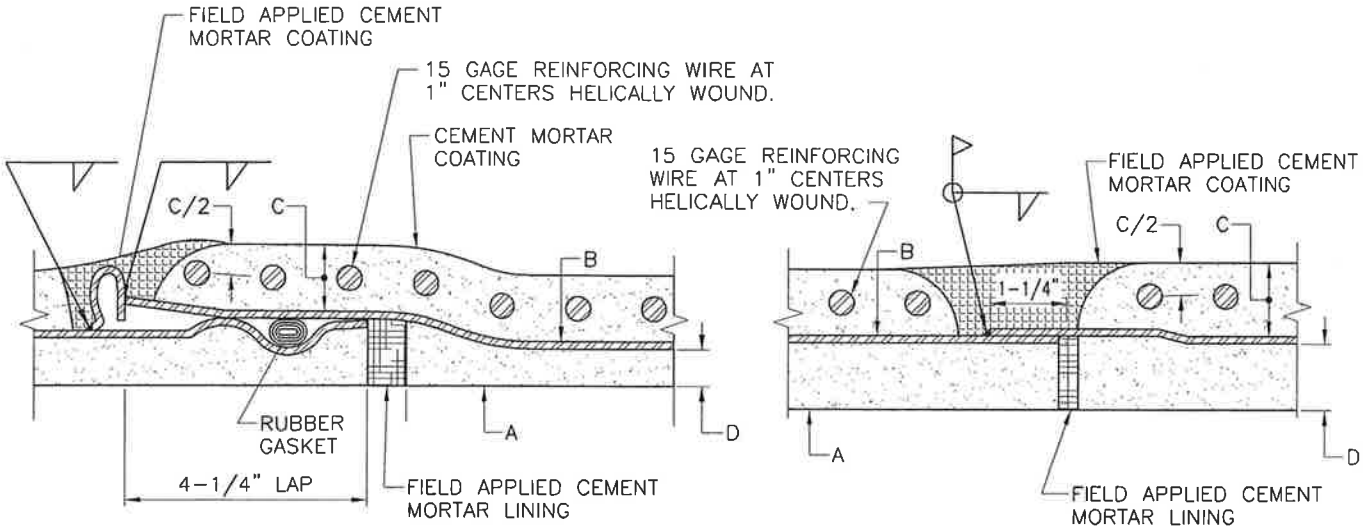
DATE: JANUARY 2005

RUBIDOUX COMMUNITY SERVICES DISTRICT

GUARD POST / FLEXIBLE DELINEATOR INSTALLATION

STANDARD DRAWING | W1160

CEMENT MORTAR LINED AND CEMENT MORTAR COATED PIPE



BELL AND SPIGOT JOINT

LAP WELDED BELL AND SPIGOT JOINT

NOMINAL DIAMETER (INCHES) A	MINIMUM OUTSIDE CYLINDER DIAMETER (INCHES) B	MINIMUM COATING THICKNESS (INCHES) C	MINIMUM LINING THICKNESS (INCHES) D	MINIMUM CYLINDER THICKNESS CLASS 150 (INCHES)
4	4.89 O.D.	3/4"	0.3125	0.1345
6	6.89 O.D.	3/4"	0.3125	0.1345
8	8.89 O.D.	3/4"	0.3125	0.1345
12	12.89 O.D.	3/4"	0.3750	0.1345
16	17.02 O.D.	3/4"	0.3750	0.1345

NOTES:

1) PIPE SHALL CONFORM WITH APPLICABLE PROVISIONS OF AWWA C200, C205, C206, C207, AND C208, LATEST, AND APPLICABLE PROVISIONS OF M11 "STEEL PIPE MANUAL", LATEST, AS MODIFIED HEREIN.

2) NOMINAL DIAMETER SHALL CONSTITUTE MINIMUM INSIDE DIAMETER.

3) CYLINDER DIAMETER SHALL BE AS SHOWN HEREON OR AS REQUIRED TO OBTAIN NOMINAL PIPE DIAMETER.

4) MAXIMUM NOMINAL LAYING LENGTH SHALL BE 40' EXCEPT WHERE OTHERWISE SPECIFIED.

5) STEEL CYLINDER WALL THICKNESS SHALL NOT BE LESS THAN THE THICKNESS LISTED IN TABLE HEREON, REGARDLESS OF YIELD POINT OF STEEL (YIELD POINT SHALL BE 30,000 P.S.I. MINIMUM).

6) JOINTS SHALL BE RUBBER GASKET BELL AND SPIGOT AS SHOWN HEREON OR LAP WELD BELL AND SPIGOT, UNLESS SPECIFIED OTHERWISE.

7) 2 BONDING CLIPS REQUIRED PER JOINT (NOT REQUIRED AT LAP WELDED BELL AND SPIGOT JOINT). STEEL BONDING CLIP MATERIAL SHALL BE ASTM A366 (COMMERCIAL QUALITY).

APPROVED:

ASSISTANT GENERAL MANAGER/
DISTRICT ENGINEER

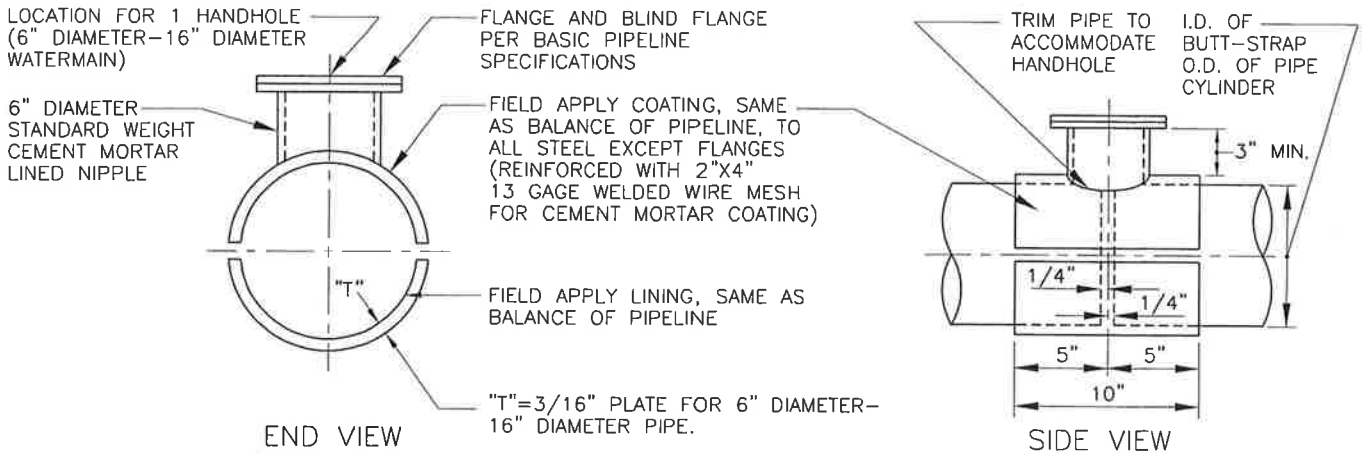
DATE: JANUARY 2005

RUBIDOUX COMMUNITY SERVICES DISTRICT

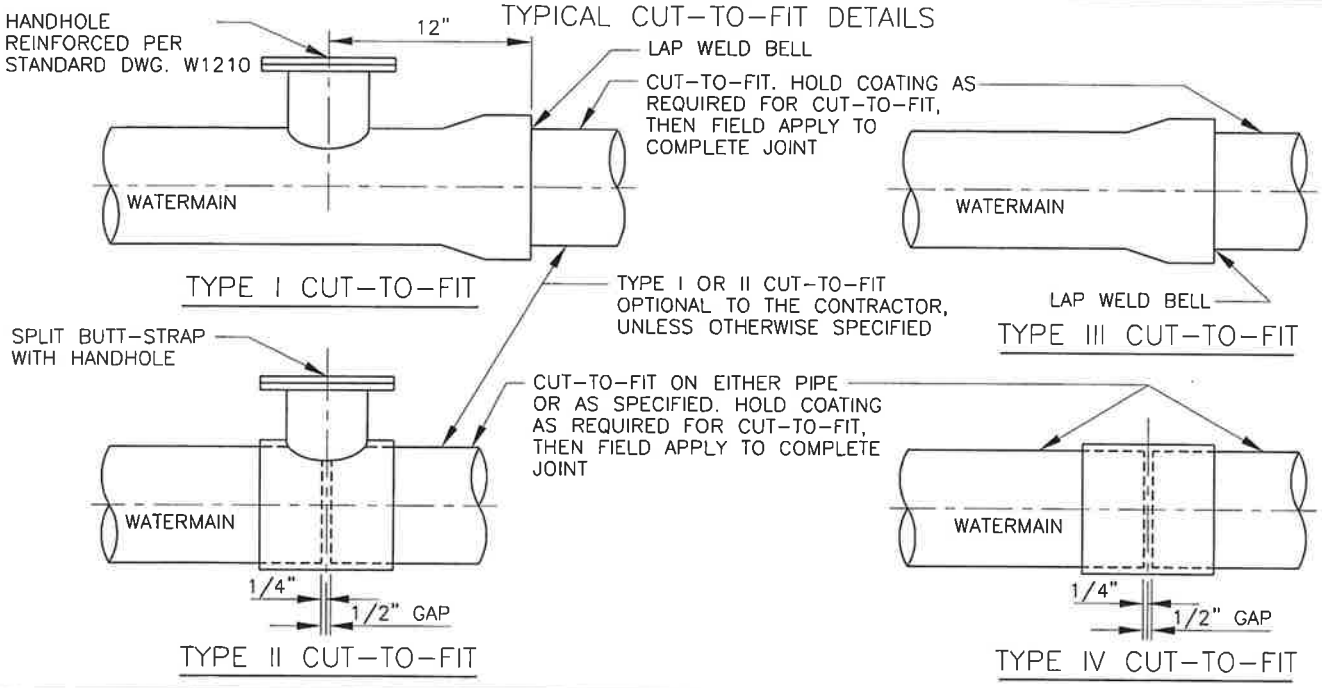
WELDED STEEL PIPE DETAILS

STANDARD DRAWING | W1200

TYPICAL BUTT-STRAP WITH HANDHOLE

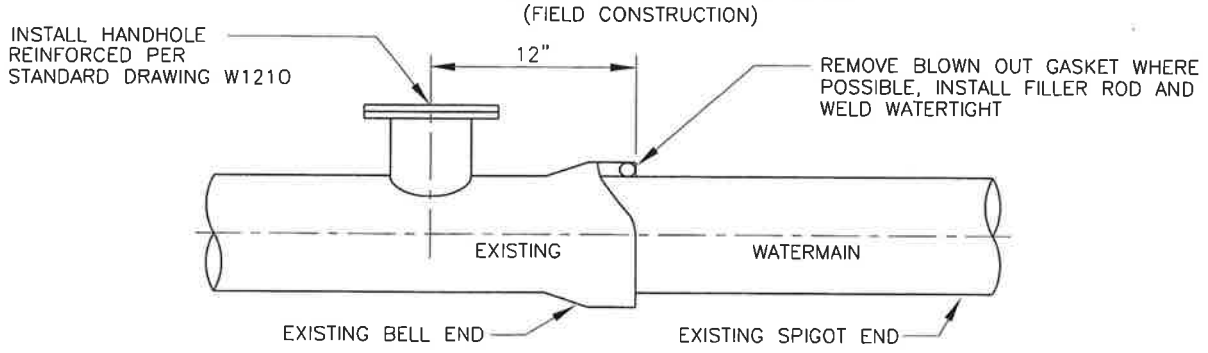


TYPICAL CUT-TO-FIT DETAILS



TYPICAL JOINT REPAIR DETAIL

(FIELD CONSTRUCTION)



APPROVED:

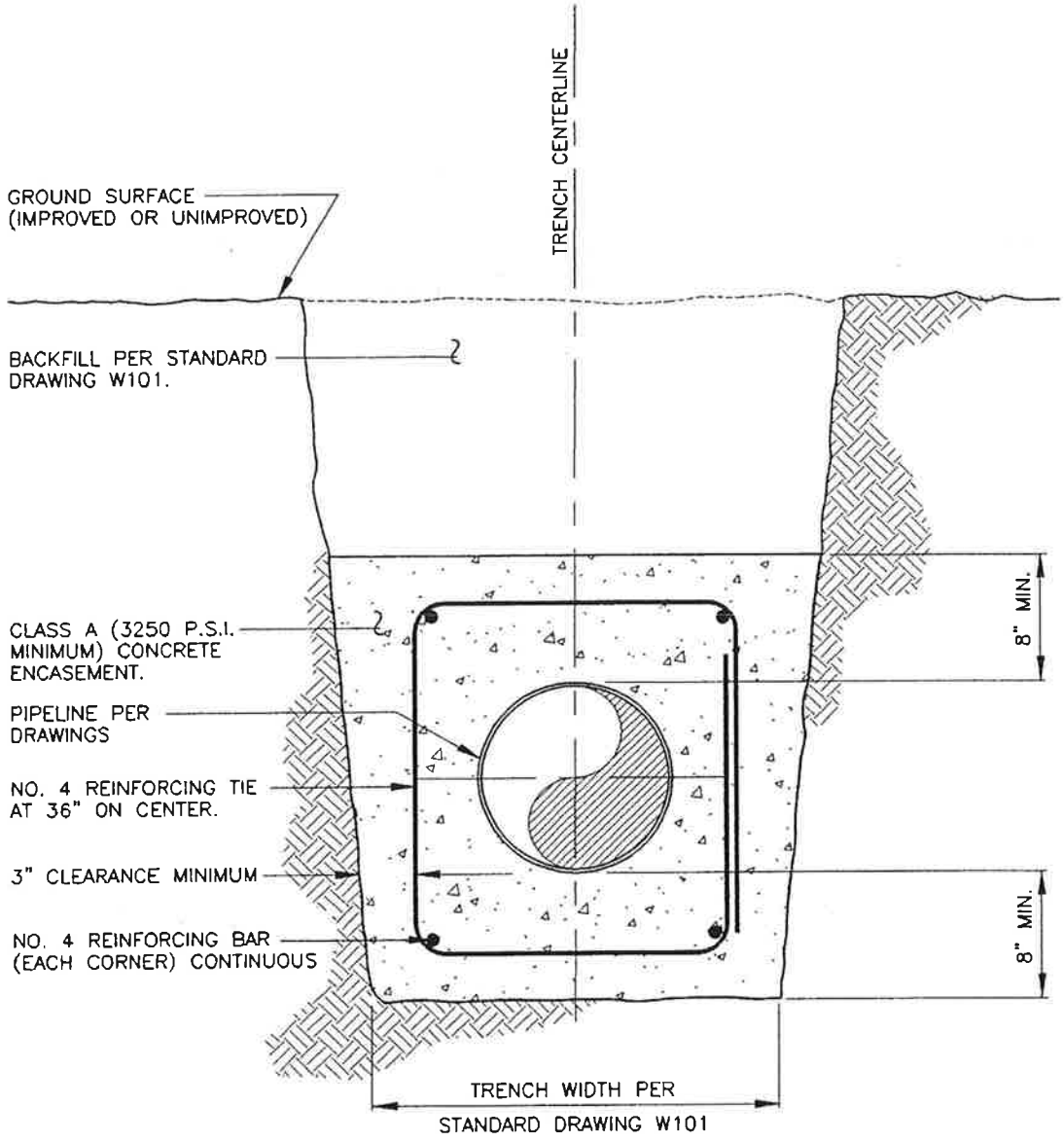
ASSISTANT GENERAL MANAGER/
DISTRICT ENGINEER

DATE: JANUARY 2005

RUBIDOUX COMMUNITY SERVICES DISTRICT

WELDED STEEL PIPE CUT-TO-FIT AND JOINT REPAIR DETAIL

STANDARD DRAWING | W1220



NOTES

1) PIPE ENCASEMENT SHALL BE PROVIDED WHERE SPECIFIED. PIPE ENCASEMENT SHALL BE PLACED ON UNDISTURBED OR COMPACTED EARTH AND AGAINST CLEAN PIPE.

2) ALL BARS SHALL BE DEFORMED AND LAPPED 20" MINIMUM. ALL BARS SHALL BE FULLY ENCASED WITH 3" MINIMUM CLEARANCE ALONG RUN, AT BEND, OR AT END.

3) IF ANY APPURTENANCES ARE REQUIRED WITHIN LIMITS OF PIPE ENCASEMENT, ENCASEMENT SHALL BE FORMED (LUMBER OR SANDBAGS) TO HOLD CONCRETE AWAY FROM SUCH APPURTENANCES TO PERMIT ACCESS TO SAID APPURTENANCES.

4) PIPE SHALL BE RESTRAINED AGAINST FLOTATION DURING PLACEMENT OF CONCRETE AND IT SHALL BE RELAID IF IT IS ALLOWED TO RISE ABOVE SPECIFIED GRADE.

APPROVED: KRIEGER & STEWART , ENGINEERING CONSULTANTS

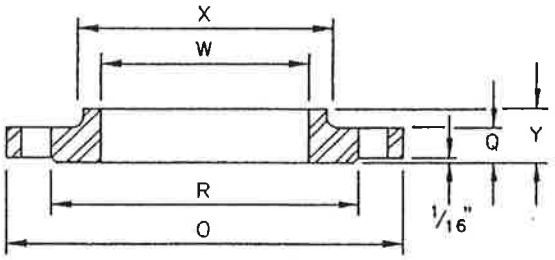
_____ R.C.E. _____

REVISION	BY	DATE

KRIEGER & STEWART
INCORPORATED

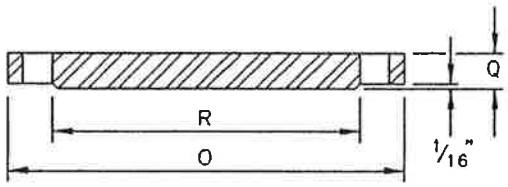
PIPE ENCASEMENT

STANDARD DRAWING W103



SLIP–ON FLANGES

DRILLING TEMPLATE											
NOMINAL PIPE SIZE	O.D. OF FLANGE O	THICK. OF FLANGE Q	DIA. OF RAISED FACE R	DIA. OF HUB AT BASE X	LENGTH THRU HUB Y	DIA. OF BORE W	No. OF HOLES	DIA. OF BOLTS	DIA. OF BOLT CIRCLE	LGTH. OF BOLTS 1/16" RAISED FACE	APPROX. WEIGHT IN POUNDS
4	9	15/16	6 3/16	5 5/16	1 5/16	4.57	8	5/8	7 1/2	3 1/2	13
5	10	15/16	7 5/16	6 7/16	1 7/16	5.66	8	3/4	8 1/2	3 3/4	15
6	11	1	8 1/2	7 9/16	1 9/16	6.72	8	3/4	9 1/2	4	17
8	13 1/2	1 1/8	10 5/8	9 11/16	1 3/4	8.72	8	3/4	11 3/4	4 1/4	28
10	16	1 3/16	12 3/4	12	1 15/16	10.88	12	7/8	14 1/4	4 3/4	40
12	19	1 1/4	15	14 3/8	2 3/16	12.88	12	7/8	17	4 3/4	61



BLIND FLANGES

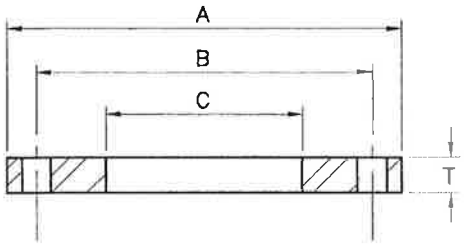
DRILLING TEMPLATE						
NOMINAL PIPE SIZE	O.D. OF FLANGE O	THICK. OF FLANGE Q	DIA. OF RAISED FACE R	No. OF HOLES	DIA. OF BOLTS	DIA. OF BOLT CIRCLE
4	9	15/16	6 3/16	8	5/8	7 1/2
5	10	15/16	7 5/16	8	3/4	8 1/2
6	11	1	8 1/2	8	3/4	9 1/2
8	13 1/2	1 1/8	10 5/8	8	3/4	11 3/4
10	16	1 3/16	12 3/4	12	7/8	14 1/4
12	19	1 1/4	15	12	7/8	17

REVISION	BY	DATE

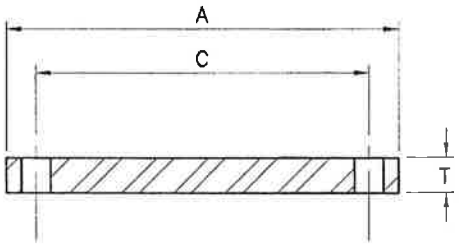
KRIEGER & STEWART
INCORPORATED

SLIP–ON FLANGES AND BLIND FLANGES
(ANSI B16.5 150 PSI)

STANDARD DRAWING W136B



RING FLANGE



BLIND FLANGE

NOMINAL PIPE SIZE (INCHES)	O.D. OF FLANGE (A) (INCHES)	NUMBER OF BOLTS	DIA. OF BOLT CIRCLE (C) (INCHES)	DIA. OF BOLTS X LENGTH (INCHES)	THICKNESS OF FLANGE (T) (INCHES)
4	9.00	8	7.50	0.625 x 3.250	1.125
6	11.00	8	9.50	0.750 x 4.000	1.313
8	13.50	8	11.75	0.750 x 4.000	1.500
10	16.00	12	14.25	0.875 x 4.875	1.563
12	19.00	12	17.00	0.875 x 4.875	1.750
14	21.00	12	18.75	1.000 x 5.250	1.875
16	23.50	16	21.25	1.000 x 5.250	2.000
18	25.00	16	22.75	1.125 x 5.625	2.125
20	27.50	20	25.00	1.125 x 6.125	2.375
24	32.00	20	29.50	1.250 x 6.750	2.625
26	34.25	24	31.75	1.250 x 6.750	2.750
28	36.50	28	34.00	1.250 x 6.750	2.750
30	38.75	28	36.00	1.250 x 7.250	2.875
32	41.75	28	38.50	1.500 x 8.000	3.000
34	43.75	32	40.50	1.500 x 8.000	3.000
36	46.00	32	42.75	1.500 x 8.000	3.125
38	48.75	32	45.25	1.500 x 8.000	3.125
40	50.75	36	47.25	1.500 x 8.000	3.250
42	53.00	36	49.50	1.500 x 8.750	3.375

REVISION	BY	DATE

KRIEGER & STEWART
INCORPORATED

RING AND BLIND FLANGES AWWA RING FLANGES (AWWA CLASS E)

STANDARD DRAWING W136C