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.

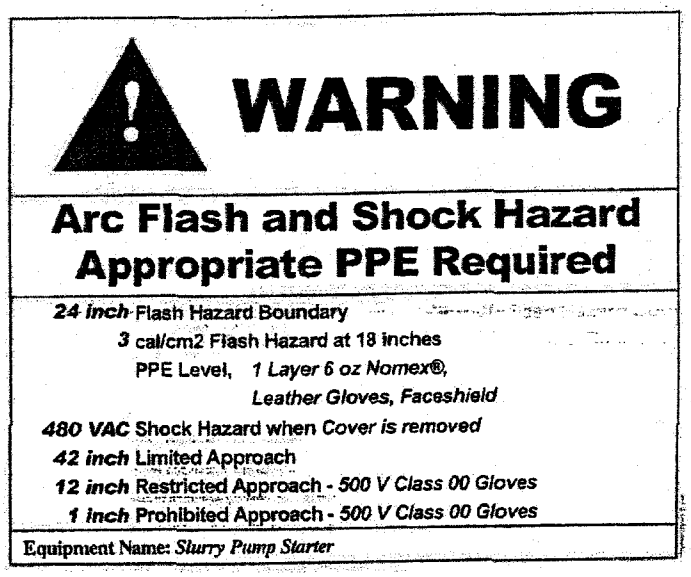
   d. Worst case PPE level and list required PPE.

   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, and Phase Unbalance (0 to 8 sec. - 1 sec. steps)
Watt Demand (2%) with (5-, 10-, 15-, 30-min. interval)	

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.

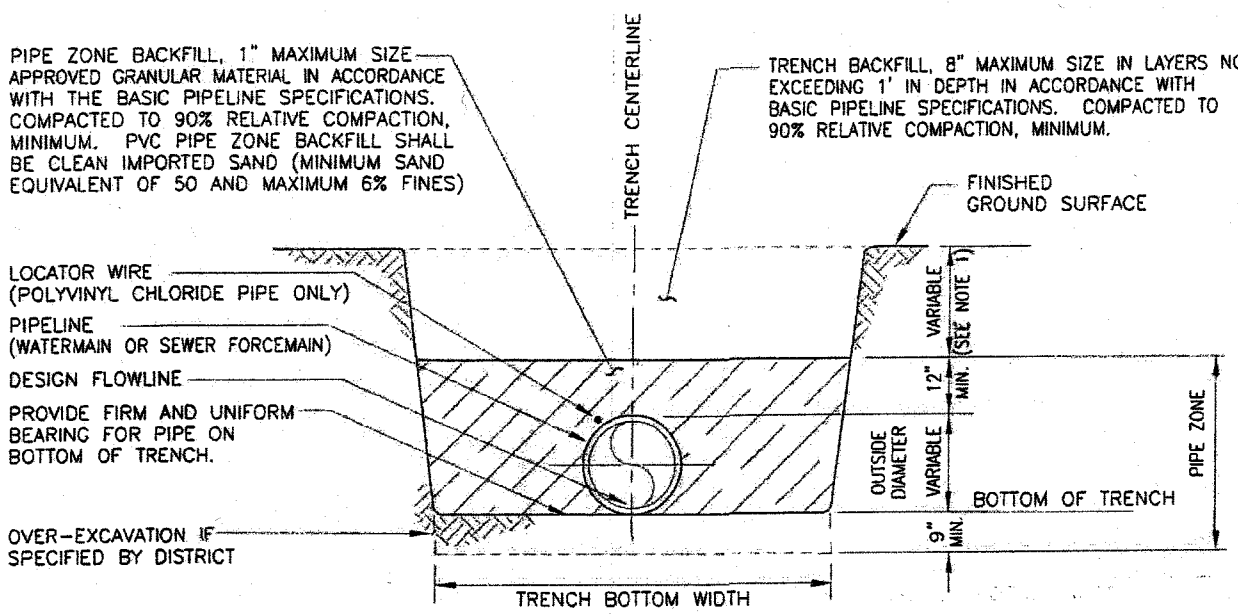
B. The meters shall be installed in easily accessible locations for ease of reading and maintenance. Meters shall be installed in accordance with manufacturer's recommended straight approach and straight downstream piping dimensions. Meters shall be firmly supported from the structure or from the floor 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



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.

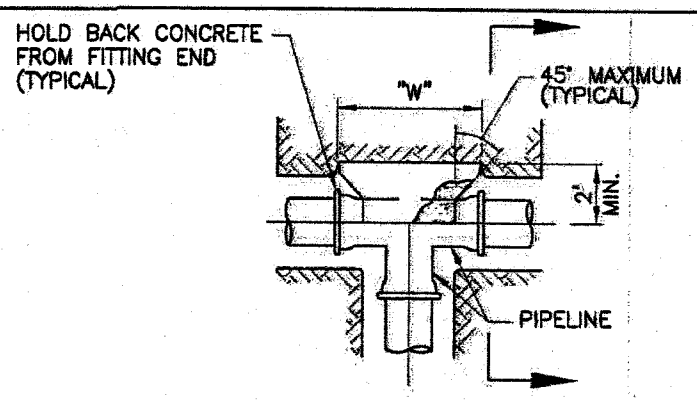
4) WHENEVER EXISTING CURBS ARE BEING USED FOR GRADE CONTROL, PIPELINES SHALL BE LAID ON PROJECTED CONTINUOUS SLOPES THROUGH LOCALIZED HILLS, HUMPS, AND MOUNDS SUCH AS STREET INTERSECTIONS AND CHANNEL BERMS. PIPELINE GRADES SHALL BE SELECTED TO MAINTAIN MINIMUM COVER WITH CONTINUOUS PIPELINE SLOPE. PIPELINE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

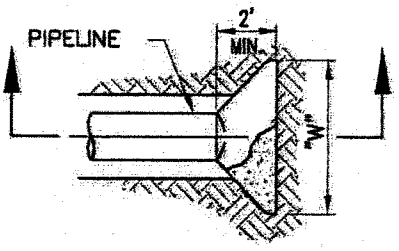
6) WHERE BOTTOM OF EXCAVATION IS IN ROCK WHICH CANNOT BE EXCAVATED TO PROVIDE UNIFORM BEARING FOR THE PIPE, TRENCH SHALL BE OVER-EXCAVATED 9" MINIMUM AND REFILLED WITH SELECT EXCAVATED MATERIAL OR IMPORTED BACKFILL MATERIAL COMPACTED TO 90% MINIMUM RELATIVE COMPACTION.

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



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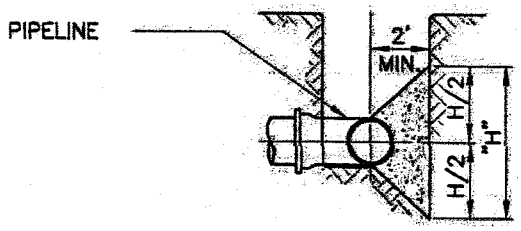
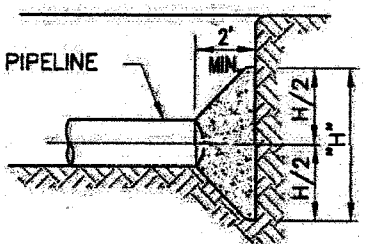


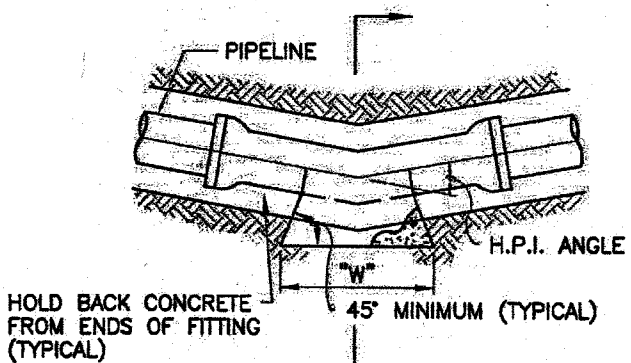
SECTION

TEE THRUST PROTECTION



SECTION

END THRUST PROTECTION



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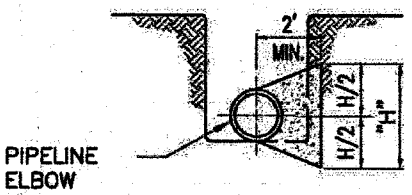


SECTION

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

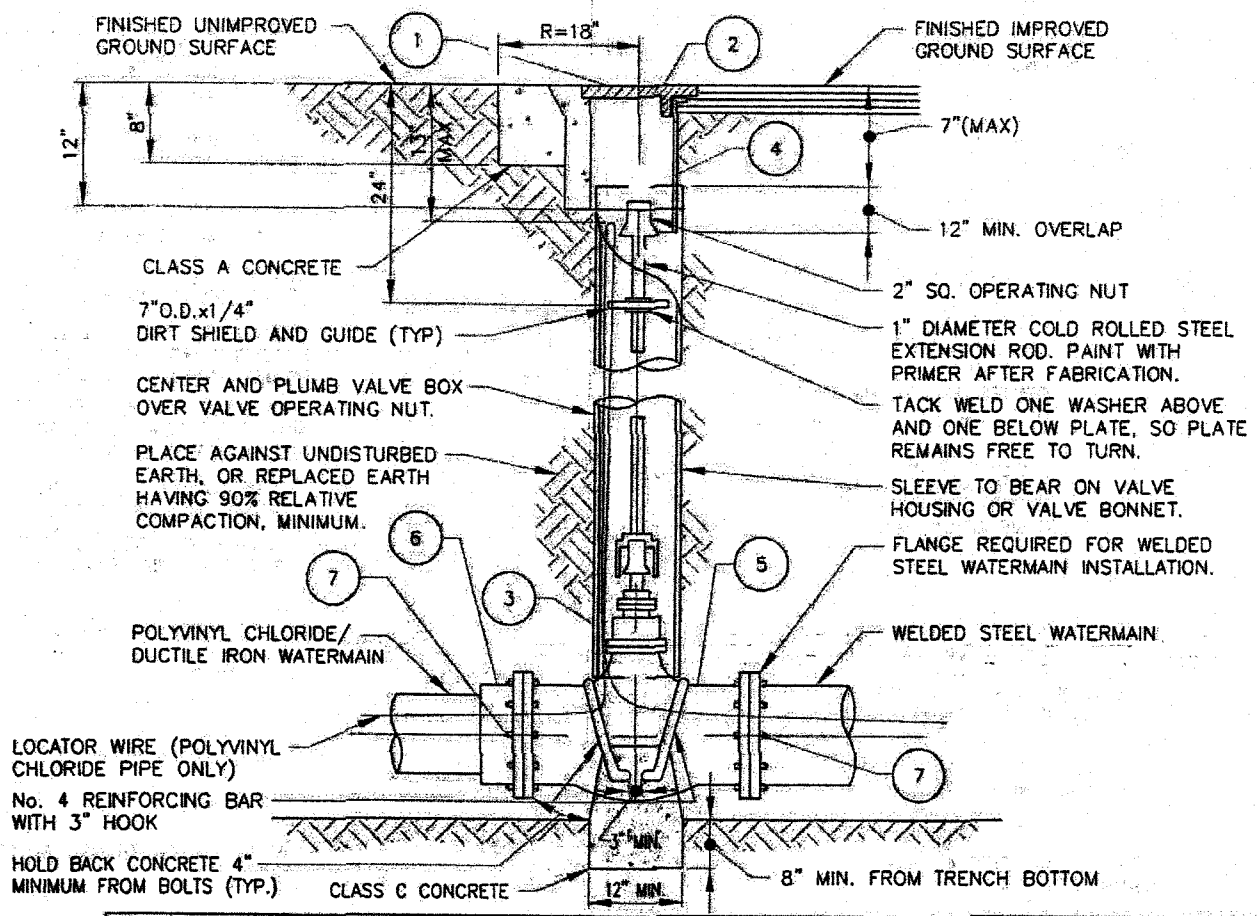
DATE: JANUARY 2005

RUBIDOUX COMMUNITY SERVICES DISTRICT

CONCRETE THRUST PROTECTION

STANDARD DRAWING

G40
SHEET 2 OF 2



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:

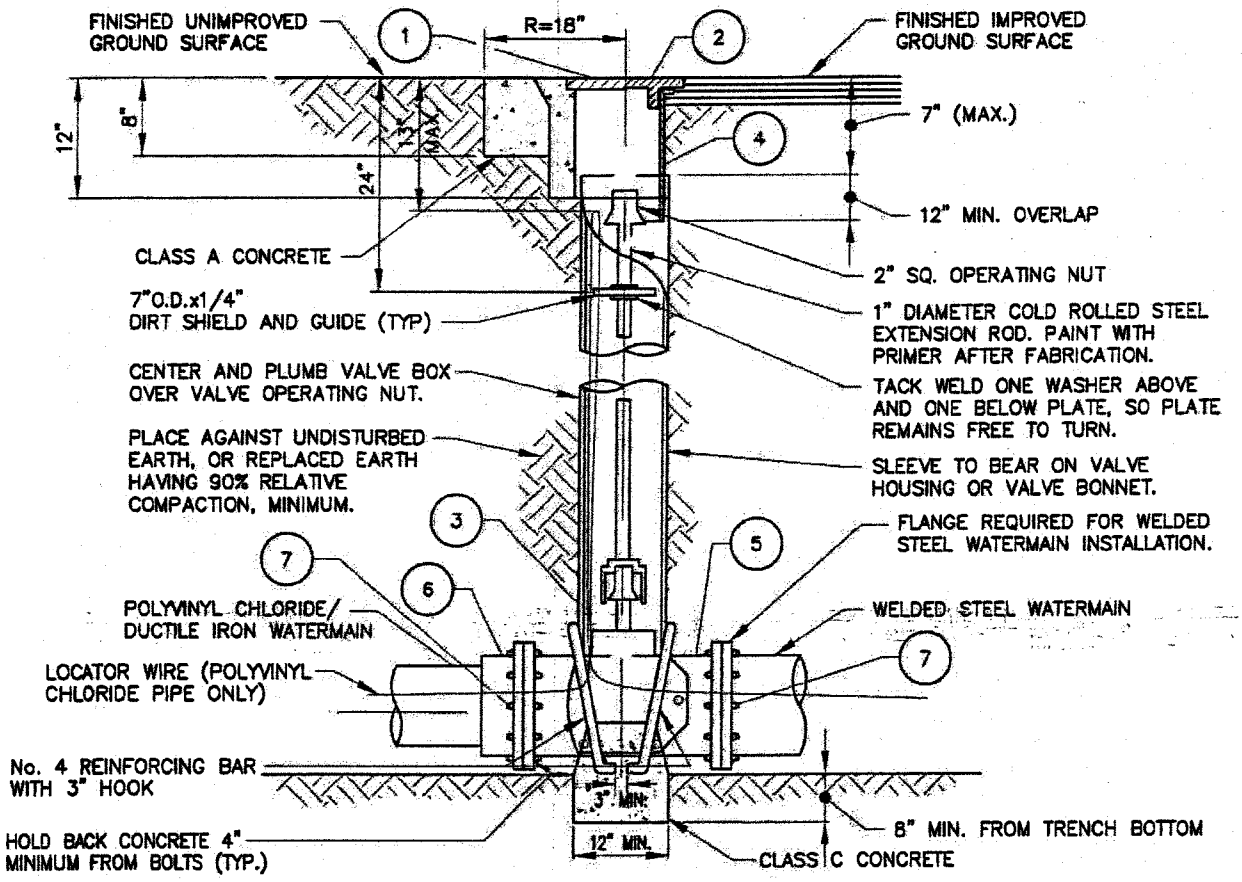
ASSISTANT GENERAL MANAGER/ DISTRICT ENGINEER

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:

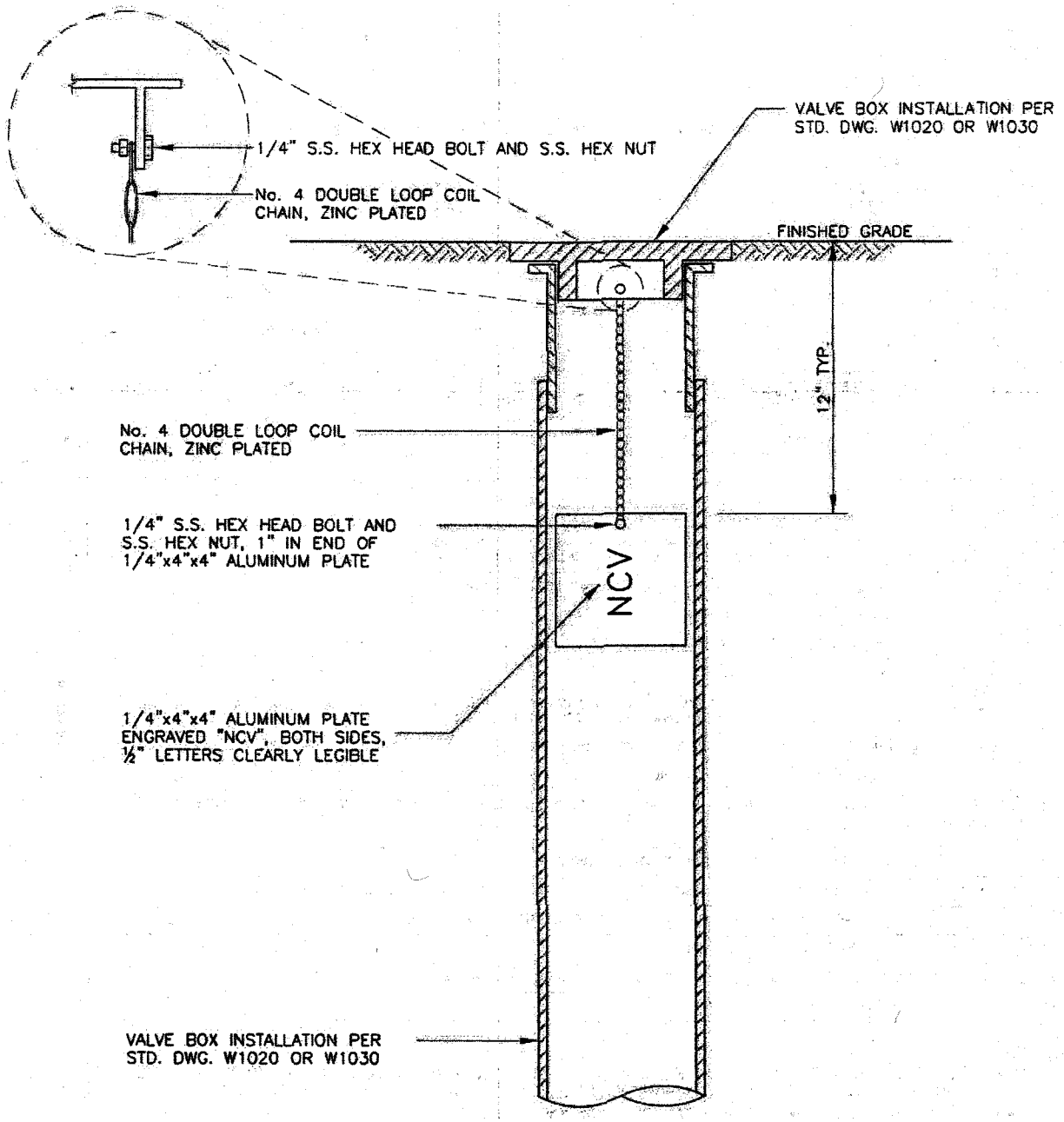
ASSISTANT GENERAL MANAGER/ DISTRICT ENGINEER

DATE: JANUARY 2005

RUBIDOUX COMMUNITY SERVICES DISTRICT

BUTTERFLY VALVE INSTALLATION

STANDARD DRAWING | W1030



APPROVED:

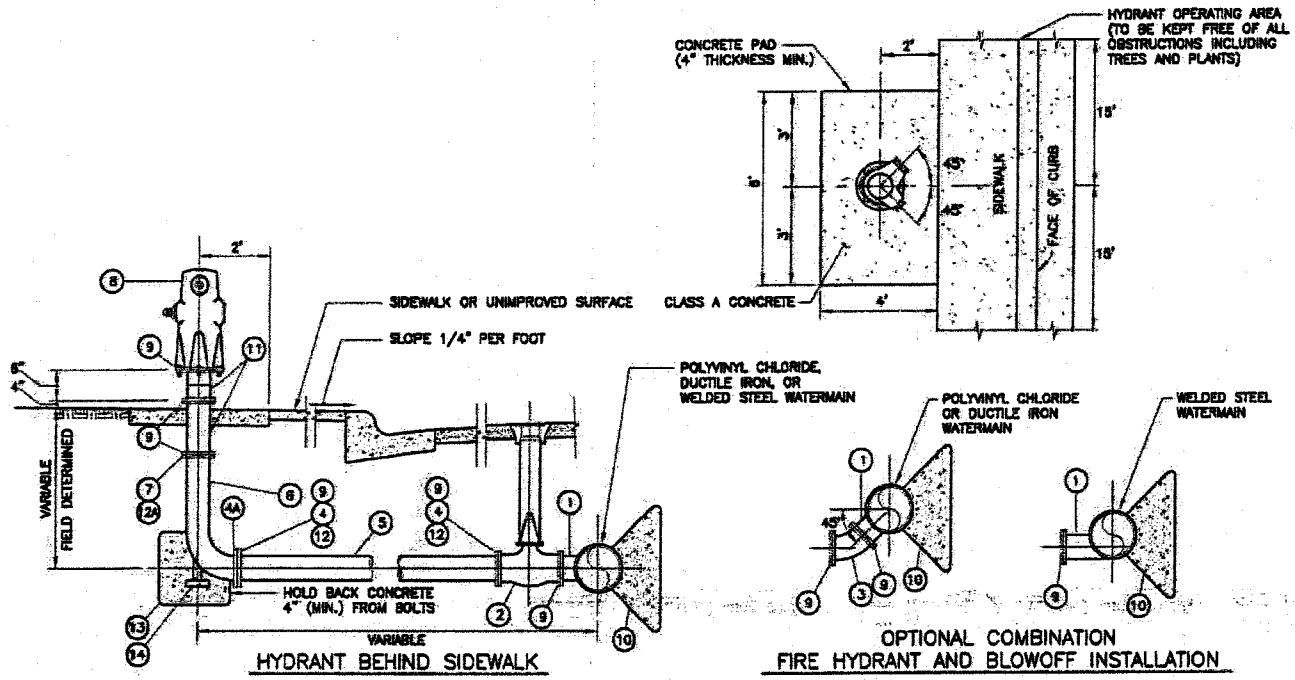
ASSISTANT GENERAL MANAGER/
DISTRICT ENGINEER

DATE: JANUARY 2005

RUBIDOUX COMMUNITY SERVICES DISTRICT

NORMALLY CLOSED VALVE BOX INSTALLATION

STANDARD DRAWING | W1040



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:

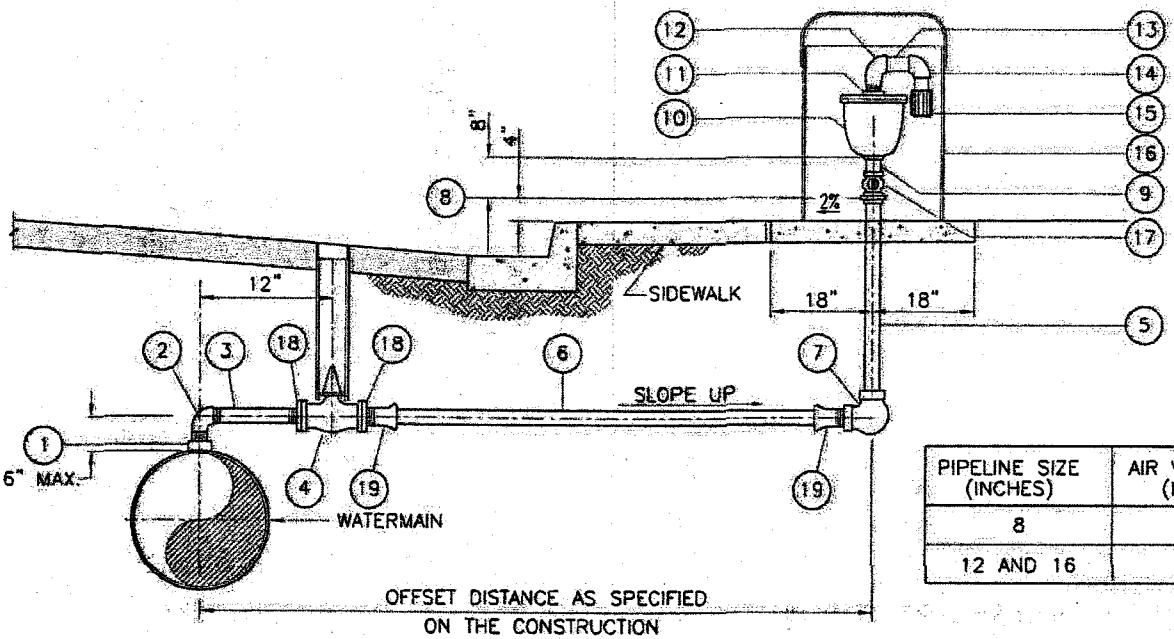
ASSISTANT GENERAL MANAGER/
DISTRICT ENGINEER

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.

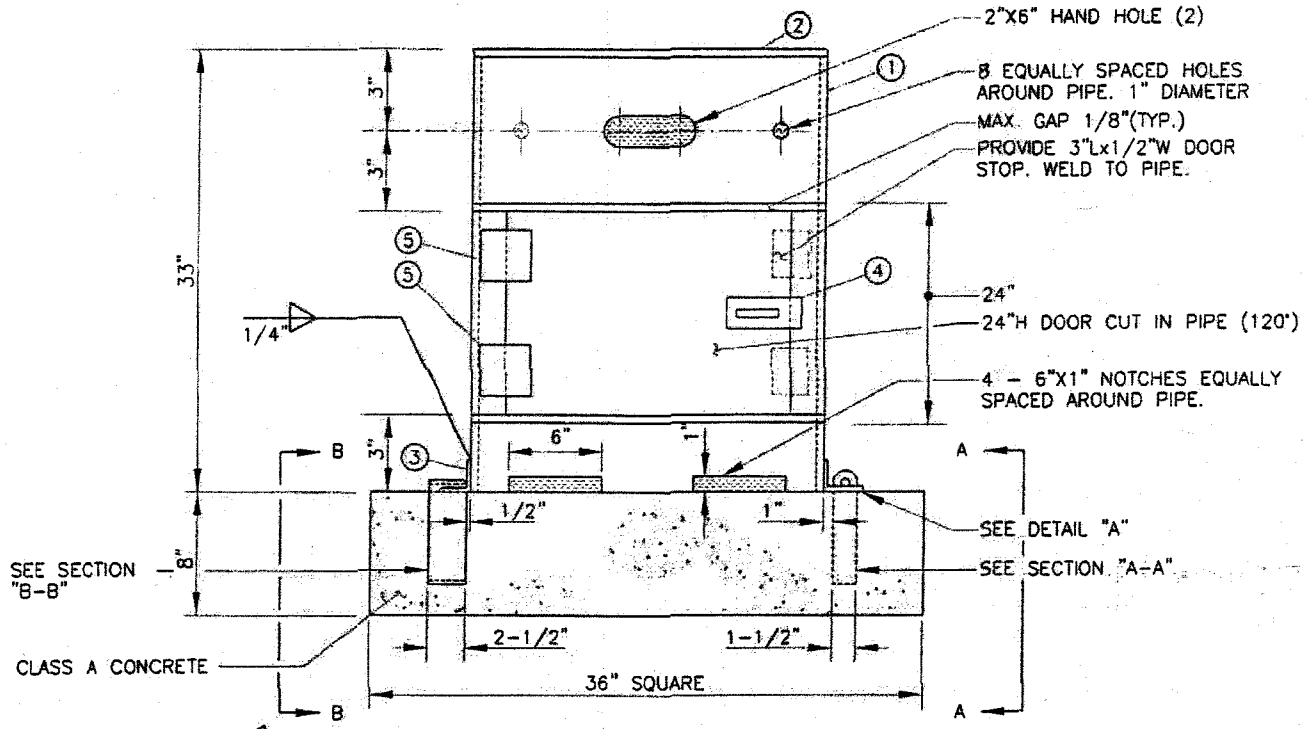
APPROVED:

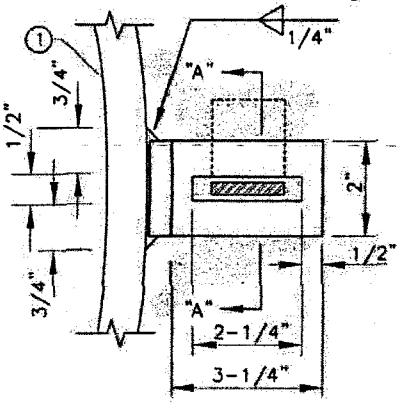
ASSISTANT GENERAL MANAGER/
DISTRICT ENGINEER

DATE: JANUARY 2005

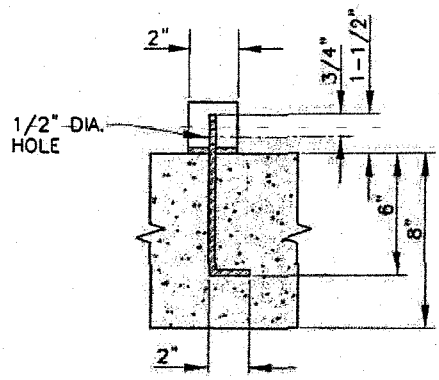
RUBIDOUX COMMUNITY SERVICES DISTRICT
1" OR 2"
AIR VALVE INSTALLATION

STANDARD DRAWING | W1070

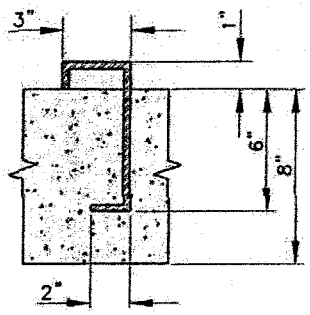




DETAIL "A"



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:

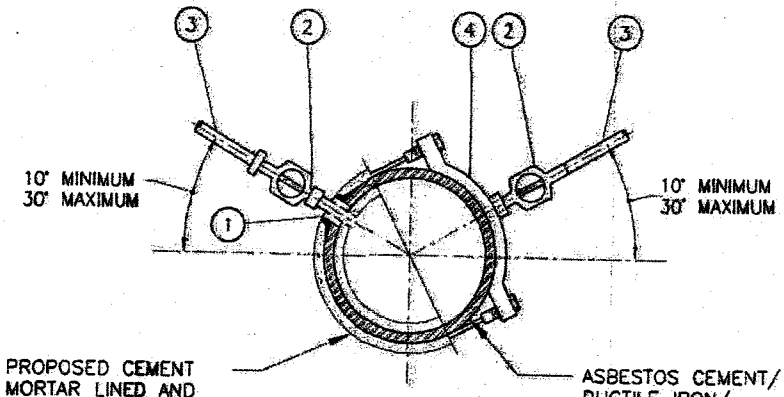
ASSISTANT GENERAL MANAGER/
DISTRICT ENGINEER

DATE: JANUARY 2005

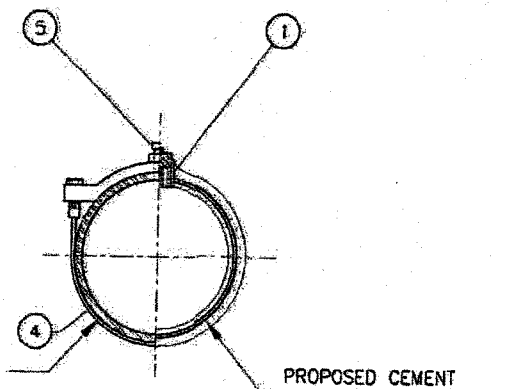
RUBIDOUX COMMUNITY SERVICES DISTRICT

1" AND 2" AIR VALVE COVER

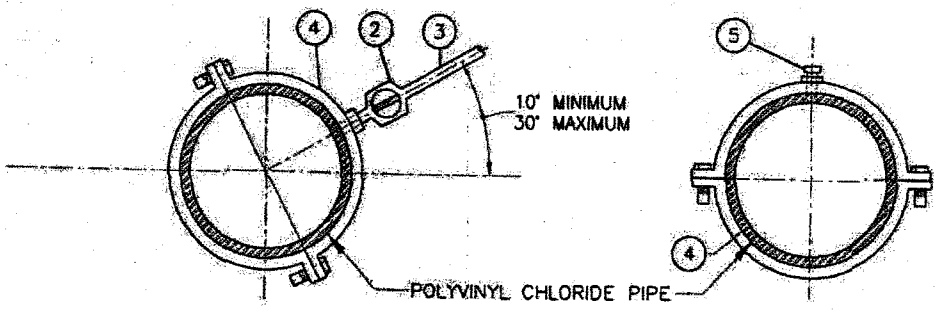
STANDARD DRAWING | W1080



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.

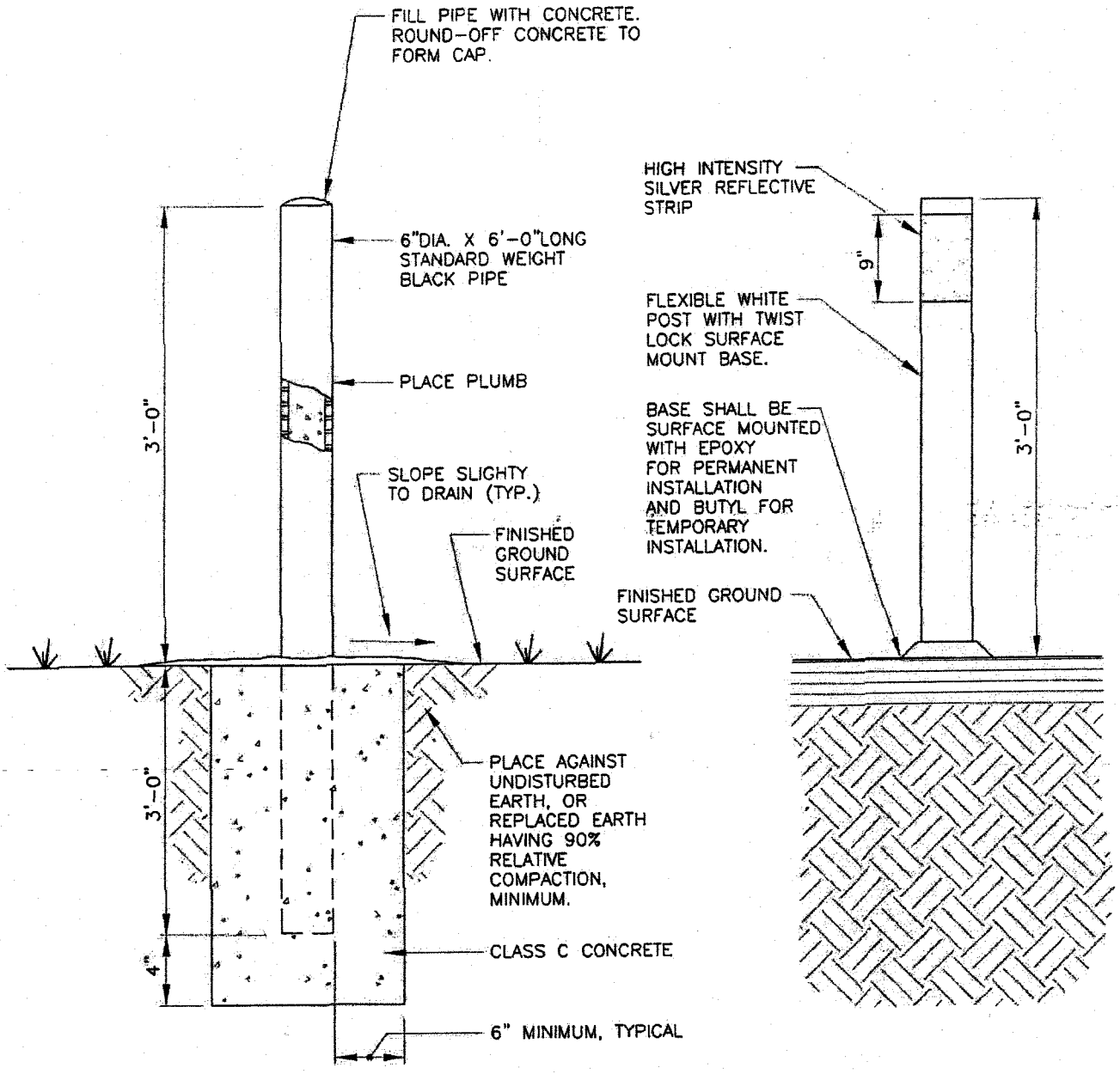
APPROVED:

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

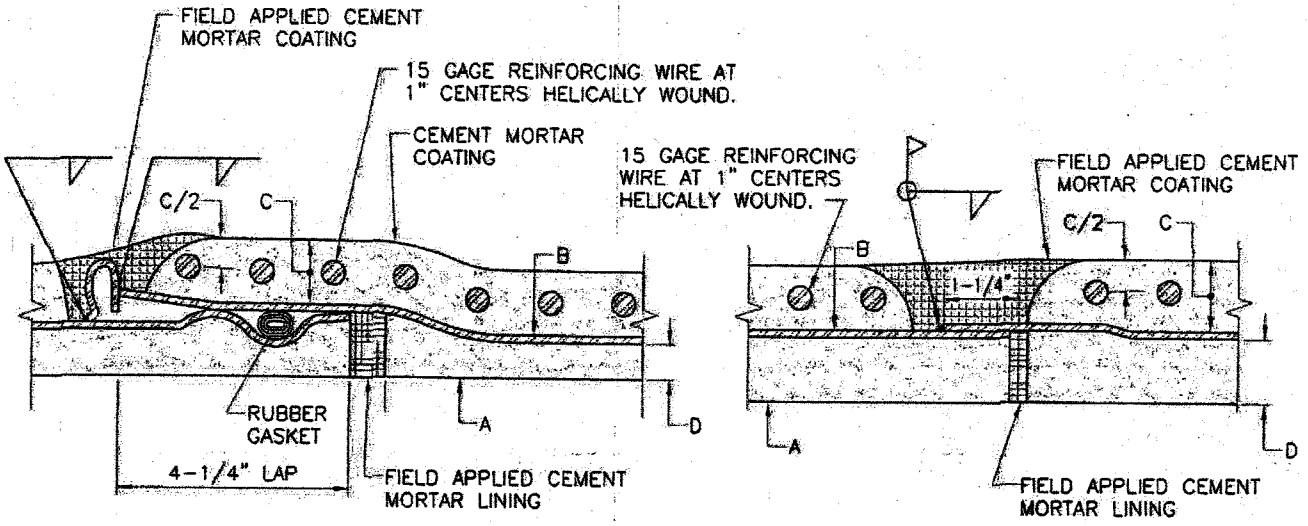
NOTES:

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

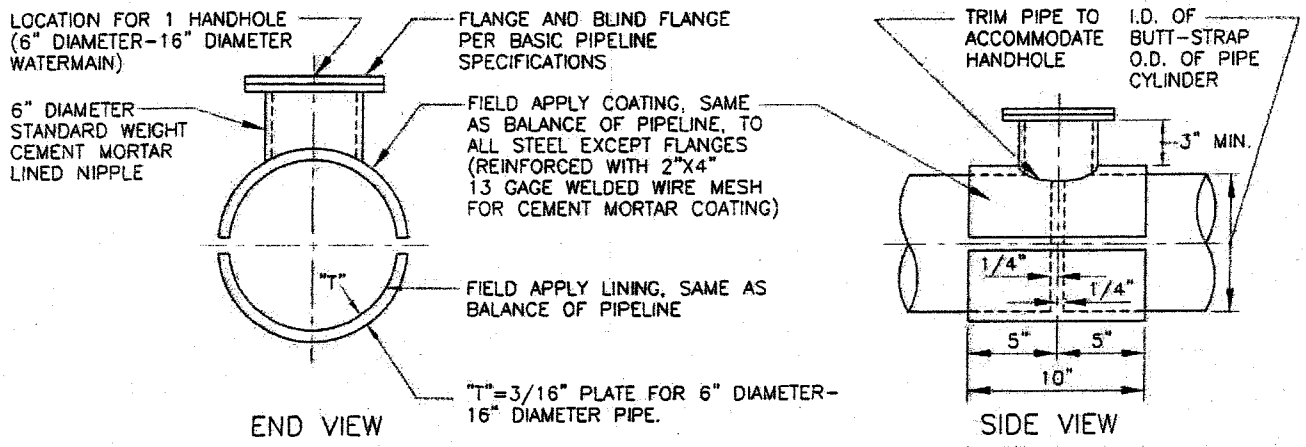
DATE: JANUARY 2005

RUBIDOUX COMMUNITY SERVICES DISTRICT

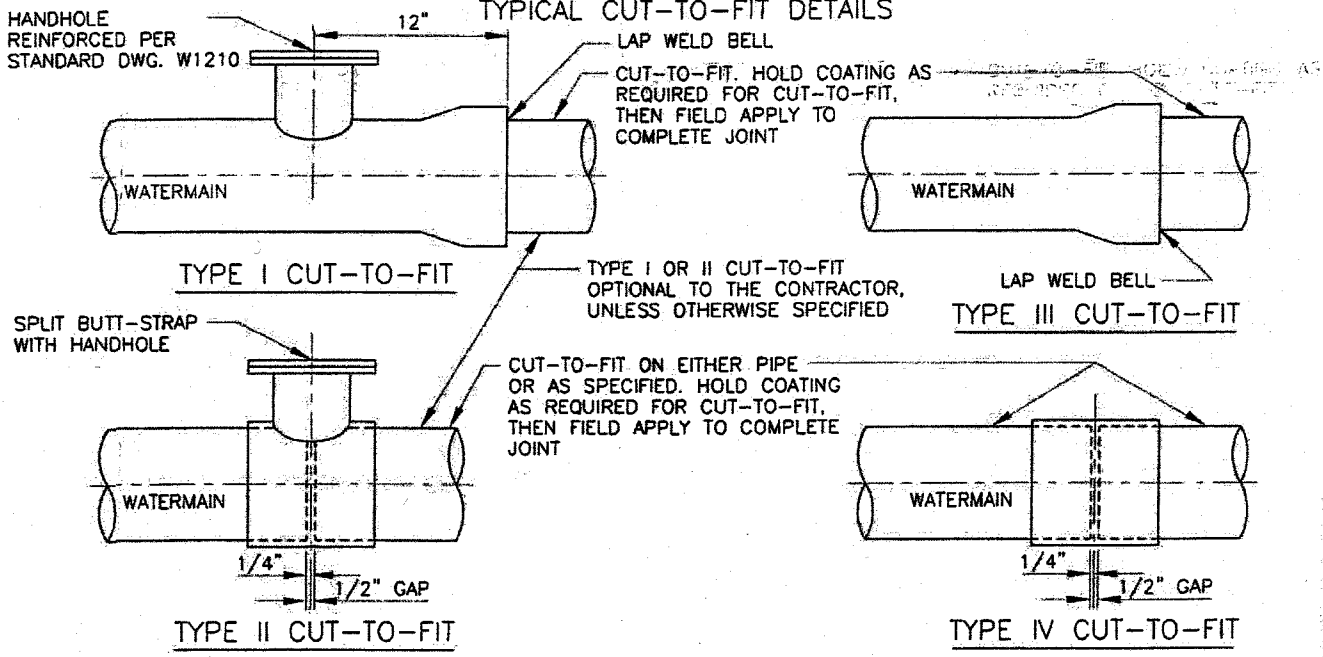
WELDED STEEL PIPE DETAILS

STANDARD DRAWING | W1200

TYPICAL BUTT-STRAP WITH HANDHOLE

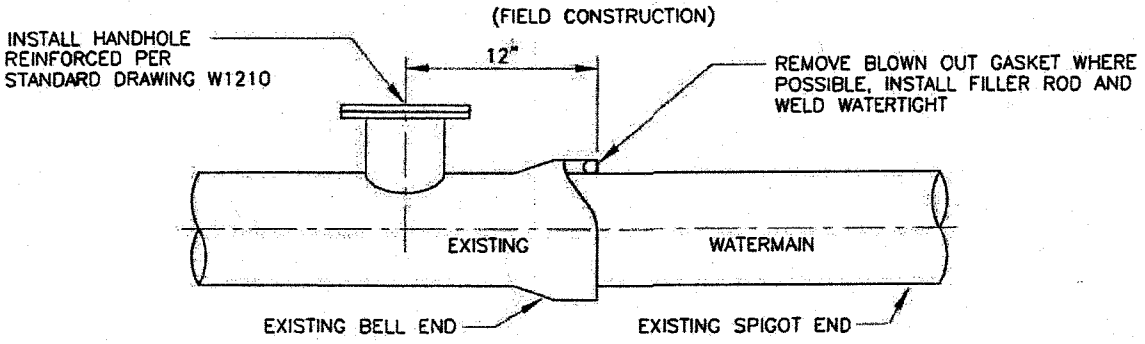


TYPICAL CUT-TO-FIT DETAILS



TYPICAL JOINT REPAIR DETAIL

(FIELD CONSTRUCTION)



APPROVED:

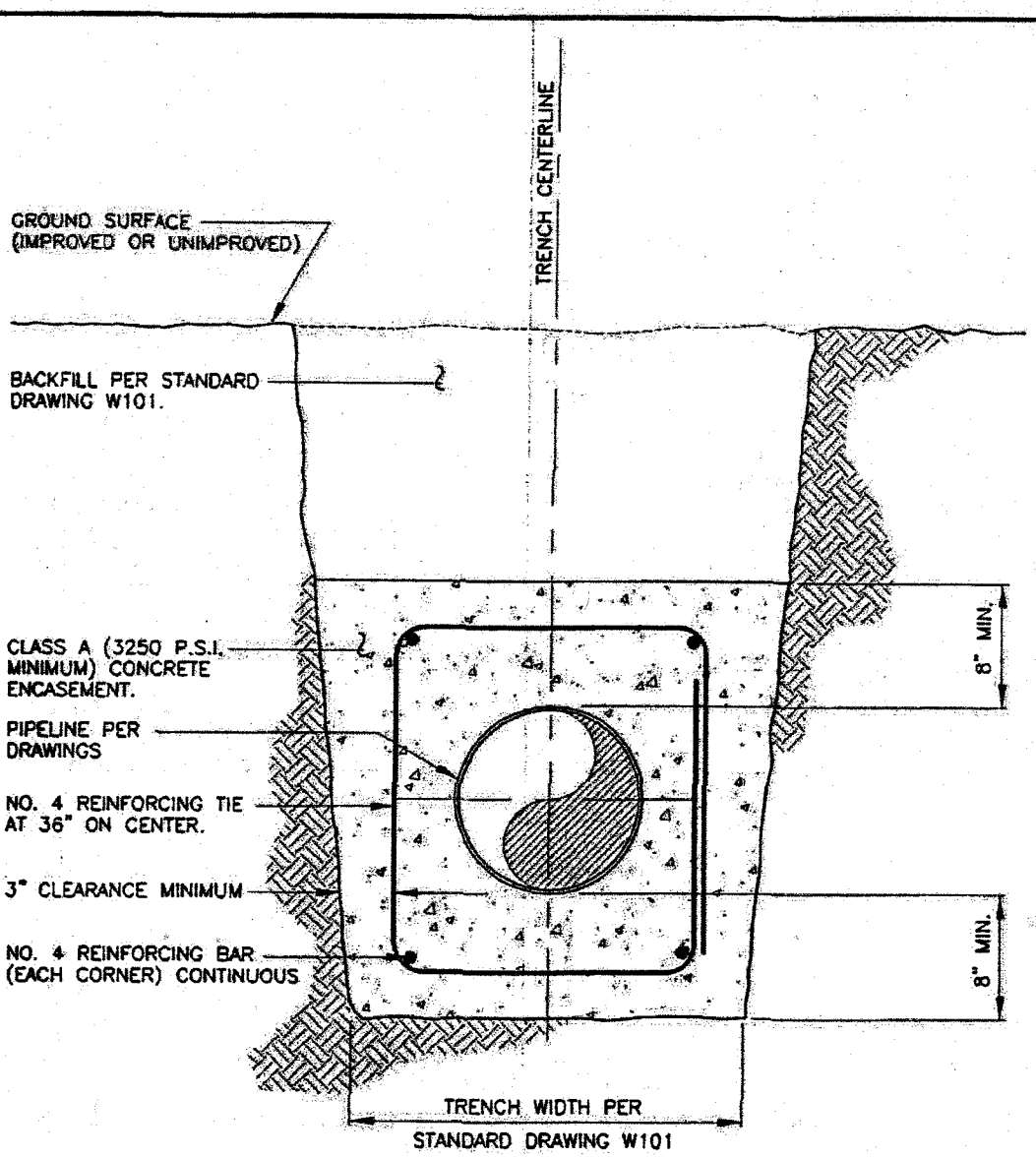
ASSISTANT GENERAL MANAGER/ DISTRICT ENGINEER

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

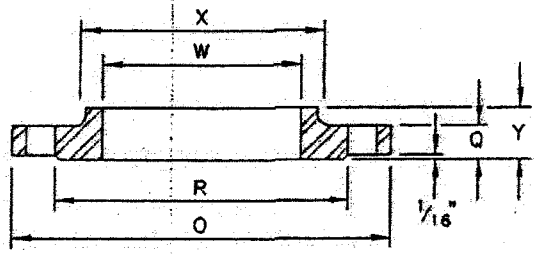
_____ R.C.E. _____

REVISION	BY	DATE

KRIEGER & STEWART
INCORPORATED

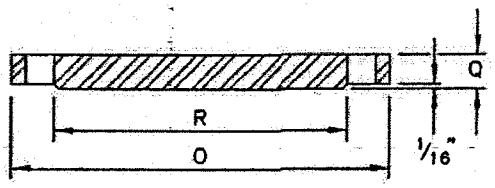
PIPE ENCASEMENT

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

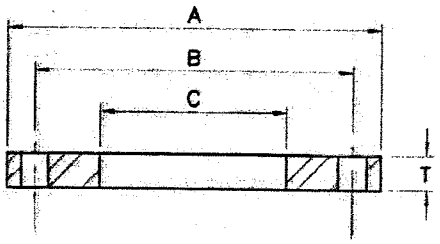
DRILLING TEMPLATE						
NOMINAL PIPE SIZE	O.D. OF FLANGE O	THICK. OF FLANGE Q	DIA. OF RAISED FACE R	No. OF HOLES	DIA. OF BOLTS	DIA. OF BOLT CIRCLE
4	9	15/16	6 3/16	8	5/8	7 1/2
5	10	15/16	7 5/16	8	3/4	8 1/2
6	11	1	8 1/2	8	3/4	9 1/2
8	13 1/2	1 1/8	10 5/8	8	3/4	11 3/4
10	16	1 3/16	12 3/4	12	7/8	14 1/4
12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

REVISION	BY	DATE

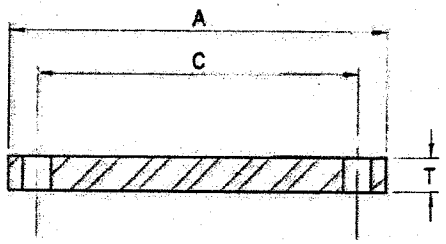
KRIEGER & STEWART
INCORPORATED

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