DICK PERREAULT

CITY OF AVONDALE

Property of
Flood Control District of MC Library
Please Return to
2801 W. Durango
Phoenix, AZ 85009

WASTEWATER TREATMENT PLANT

VOLUME II

PART B -- TECHNICAL SPECIFICATIONS (DIVISIONS 11 THROUGH 17)

ENGINEERING DIVISION
LIBRARY

MAY 1988

BROWN AND CALDWELL
Consulting Engineers

DIVISION 11

EQUIPMENT

Section	Title
11000	GENERAL REQUIREMENTS FOR EQUIPMENT
11010	EQUIPMENT CONTROL DEVICES
11015	NOISE REQUIREMENTS AND CONTROL
11020	VIBRATION AND CRITICAL SPEED LIMITATIONS
11021	EQUIPMENT MOUNTING AND VIBRATION ISOLATION SYSTEMS
11060	ELECTRIC MOTORS
11069	VARIABLE FREQUENCY DRIVES
11090	STANDBY GENERATOR EQUIPMENT
11100	SLUICE GATES
11105	SELF-CONTAINED SLIDE GATES
11121	ARTICULATED RAKE CLEANED BAR SCREENS
11145	GRIT SEPARATION AND DEWATERING EQUIPMENT
11148	GRIT REMOVAL UNIT
11190	SECONDARY CLARIFFIER TANK EQUIPMENT
11200	FLOATING SKIMMING EQUIPMENT
11232	SHEAR BOX DIFFUSERS
11232	FINE BUBBLE AIR DIFFUSERS
11271	JET AERATION SYSTEM
11301	VERTICAL CONSTANT SPEED MIXED FLOW CENTRIFUGAL PUMPS

FLOOD CONTROL DISTRICT
RECEIVED
JUN 20 '88
CH ENG | P & PM
DEP | HYDRO
ADMIN | LMGT
FINANCE | HLT
REMARKS:

Section	Title
11310	VERTICAL AXIAL FLOW PROPELLER PUMPS OPEN LINESHAFT-PRODUCT LUBRICATED
11318	VERTICAL TURBINE PUMPS OPEN LINESHAFT-PRODUCT LUBRICATED
11333	NONCLOG VERTICAL COLUMN WASTEWATER PUMPS
11346	SUBMERSIBLE PUMPS
11350	SUBMERSIBLE NONCLOG SLUDGE PUMPS
11355	RECESSED IMPELLER PUMPS, SEVERE DUTY
11385	ROTARY LOBE PUMP
11425	AIR COOLED NONLUBRICATED AIR COMPRESSORS
11435	AIR COOLED RECIPROCATING AIR COMPRESSOR
11450	BUILT-IN RESIDENTIAL EQUIPMENT
11454	REFRIGERATED AIR DRYER
11475	ROTARY POSITIVE DISPLACEMENT BLOWERS
11486	MULTISTAGE CENTRIFUGAL BLOWER
11495	REGENERATIVE BLOWER
11530	CIRCULAR DISSOLVED AIR FLOTATION THICKENER
11705	CHLORINATORS
11710	CHLORINE GAS EJECTORS
11720	SAFETY EQUIPMENT
11721	CHLORINE STORAGE AND HANDLING EQUIPMENT
11875	PRESSURE VESSELS AND TANKS

SECTION 11000

GENERAL REQUIREMENTS FOR EQUIPMENT

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies general requirements which are applicable to all mechanical equipment. The Contractor is responsible for ensuring that all mechanical equipment meets the requirements of this section in addition to the specific requirements of the individual equipment specification section.

B. EQUIPMENT LISTS:

Equipment lists, and as specified, are included for the convenience of the Construction Manager and Contractor and are not complete listings of all equipment, devices and material to be provided under this contract. The Contractor agrees to prepare his own material and equipment takeoff lists as necessary to meet the requirements of this project manual.

1.02 QUALITY ASSURANCE

A. ARRANGEMENT:

The arrangement of equipment as specified is based upon information available to the Owner at the time of design and is not intended to show exact dimensions peculiar to a specific manufacturer. The drawings are, in part, diagrammatic, and some features of the illustrated equipment may require revision to meet actual equipment installation requirements. Structural supports, foundations, connected piping, valves, and electrical conduit specified may have to be altered to accommodate the equipment provided. No additional payment will be made for such revisions and alterations.

B. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
AFBMA Std 9-78	Load Ratings and Fatigue Life for Ball Bearings
AFBMA Std 11-78	Load and Fatigue Life for Roller Bearings
ANSI B1.1-82	Unified Screw Threads
ANSI B1.20.1-83	Pipe Threads, General Purpose (Inch)
ANSI B16.1-75	Cast Iron Pipe Flanges and Flanged Fittings, Class 125
ANSI B18.2.1-81	Square and Hex Bolts and Screws, Including Askew Head Bolts, Hex Cap Screws, and Log Screws
ANSI B18.2.2-72	Square and Hex Nuts

C. UNIT RESPONSIBILITY:

Equipment systems made up of two or more components shall be provided as a unit by the responsible manufacturer. Unless otherwise specified, the Contractor shall obtain each system from the supplier of the driven equipment, which supplier shall provide all components of the system to enhance compatibility, ease of construction and efficient maintenance. Contractor is responsible to the Owner for performance of all systems as provided in paragraph 00710-2.04.

PART 2--PRODUCTS

2.01 FLANGES AND PIPE THREADS

Flanges on equipment and appurtenances provided under this section shall conform in dimensions and drilling to ANSI B16.1, Class 125. Pipe threads shall conform in dimension and limits of size to ANSI B1.1, coarse thread series, Class 2 fit.

Threaded flanges shall have a standard taper pipe thread conforming to ANSI B1.20.1. Unless otherwise specified, flanges shall be flat faced.

Flange assembly bolts shall be heavy pattern, hexagonal head, carbon steel machine bolts with heavy pattern, hot pressed, hexagonal nuts conforming to ANSI B18.2.1 and B18.2.2. Threads shall be Unified Screw Threads, Standard Coarse Thread Series, Class 2A and 2B, ANSI B1.1.

2.02 BEARINGS

Unless otherwise specified, equipment bearings shall be oil or grease lubricated, ball or roller type, designed to withstand the stresses of the service specified. Each bearing shall be rated in accordance with the latest revisions of AFBMA Methods of Evaluating Load Ratings of Ball and Roller Bearings. Unless otherwise specified, equipment bearings shall have a minimum L-10 rating life of 50,000 hours. The rating life shall be determined using the maximum equipment operating speed.

Grease lubricated bearings, except those specified to be factory sealed and lubricated, shall be fitted with easily accessible grease supply, flush, drain and relief fittings. Extension tubes shall be used when necessary. Grease supply fittings shall be standard hydraulic alemite type.

Oil lubricated bearings shall be equipped with either a pressure lubricating system or a separate oil reservoir type system. Each oil lubrication system shall be of sufficient size to safely absorb the heat energy normally generated in the bearing under a maximum ambient temperature of 60 degrees C and shall be equipped with a filler pipe and an external level indicator gage.

2.03 V-BELT ASSEMBLIES

V-belt assemblies shall be Dodge Dyna-V belts with matching Dyna-V sheaves and Dodge Taper-lock bushings, Wood's Ultra V-belts with matching Ultra-V sheaves and Wood's Sure-Grip bushings, or equal.

Sheaves and bushings shall be statically balanced. Additionally, sheaves and bushings which operate at a peripheral speed of more than 5500 feet per minute shall be dynamically balanced. Sheaves shall be separately mounted on their bushings by means of three pull-up grub or cap tightening screws. Bushings shall be key seated to the drive shaft.

Belts shall be selected for not less than 150 percent of rated driver horsepower and, where two sheaves sized are specified, shall be capable of operating with either set of sheaves. Belts shall be of the antistatic type where explosionproof equipment is specified.

2.04 SEALS

A. MECHANICAL:

Unless otherwise specified, rotating shafts shall be provided with mechanical seals and stuffing boxes tapped for flushing seal faces. Seals shall be factory installed. Seals shall be internal, single or double as specified, and unbalanced except balanced seals

shall be provided when shaft speed is greater than 3600 rpm for variable speed pumps, or when pressures are greater than shown in the following. Mechanical seals for variable speed pump applications shall be specifically designed to accommodate shaft deflection incurred under specified operating conditions.

Limits for Unbalanced Seals

Seal inside diameter, inches	Shaft speed, rpm	Sealing pressure, psig
1/2 to 2	Up to 1800	100
	1801 to 3600	50
Over 2 to 4	Up to 1800	50
	1801 to 3600	25

Single unbalanced seals shall be Crane 8-1, Durametallic RO, or equal. Single balanced seals shall be Chesterton 880, Crane 8B-1, or equal. Double seals shall be Chesterton 241, Durametallic RO/RD, or equal.

To maintain the necessary minimum or maximum pressure across the seal faces, spring pressure shall be uniformly distributed to the sealing faces by a coil spring or multiple springs. The rotating seal element shall be clamped to the shaft and provided with an O-ring seal. The stationary seal element shall be sealed with O-ring or gasket material.

Seal faces shall be either tungsten carbide, carbon, silicon carbide or ceramic. Elastomeric materials shall be Viton. Metal parts shall be type 316 stainless steel.

B. SHAFT PACKING:

Where shaft packing is specified, stuffing boxes shall be tapped to permit introduction of seal liquid and shall hold a minimum of five rows of packing. Unless otherwise specified, lantern rings shall be bronze, packing shall be die-molded packing rings of nonasbestos material suitable for the intended service and as recommended by the manufacturer, and glands shall be bronze, two piece split construction. Lantern rings shall be of two-piece construction and shall be provided with tapped holes to facilitate removal. Lantern rings shall be drilled and tapped 1/4 NC-20. Threaded lantern ring removal tools shall be provided with spare parts for each pump.

2.05 COUPLINGS

Unless otherwise specified in the particular equipment sections, equipment with a driver greater than 1/2 HP, and where the input shaft of a driven unit is directly connected to the output shaft

of the driver, shall have its two shafts connected by a flexible coupling which can accommodate angular misalignment, parallel misalignment and end float, and which cushions shock loads and dampens torsional vibrations. The flexible member shall consist of a tire with synthetic tension members bonded together in rubber. The flexible member shall be attached to flanges by means of clamping rings and cap screws, and the flanges shall be attached to the stub shaft by means of taperlock bushings which shall give the equivalent of a shrunk-on fit. There shall be no metal-to-metal contact between the driver and the driven unit. Each coupling shall be sized and provided as recommended by the coupling manufacturer for the specific application, considering horsepower, speed of rotation, and type of service.

Where torque or horsepower capacities of couplings of the foregoing type is exceeded, Thomas-Rex, Falk Steel Flex, or equal, couplings will be acceptable provided they are sized in accordance with the equipment manufacturer's recommendations and sizing data are submitted. They shall be installed in conformance to the coupling manufacturer's instructions.

2.06 GUARDS

Exposed moving parts shall be provided with guards which meet the requirements of OSHA. Guards shall be fabricated of 14-gage steel, 1/2-13-15 expanded metal screen to provide visual inspection of moving parts without removal of the guard. Guards shall be galvanized after fabrication and shall be designed to be readily removable to facilitate maintenance of moving parts. Reinforced holes shall be provided. Provisions shall be made to extend lube fittings through guards.

2.07 CAUTION SIGNS

Equipment with guarded moving parts which operates automatically or by remote control shall be identified by signs reading "CAUTION - AUTOMATIC EQUIPMENT MAY START AT ANY TIME". Signs shall be constructed of fiberglass material, minimum 1/8 inch thick, rigid, suitable for post mounting. Letters shall be white on a red background. The sign size and pattern shall be as shown on the drawings. Signs shall be installed near guarded moving parts.

2.08 PRESSURE TAPS, TEST PLUGS AND GAGES

Pressure taps shall be provided on the suction and discharge sides of pumps, blowers and compressors. Pressure and vacuum test plugs and gages shall be provided where specified. Test plugs and gages shall be as specified in Division 15.

2.09 NAMEPLATES

Nameplates shall be provided on each item of equipment and shall contain the specified equipment name or abbreviation and equipment number. Equipment nameplates shall be engraved or stamped stainless steel and fastened to the equipment in an accessible location with stainless steel screws or drive pins.

2.10 LUBRICANTS

The Contractor shall provide for each item of mechanical equipment a supply of the lubricant required for the commissioning period. Lubricants shall be of the type recommended by the equipment manufacturer and shall be products of the Owner's current lubricant supplier. The Contractor shall limit the various types of lubricants by consolidating them, with the equipment manufacturer's approval, into the least number of different types. Not less than 90 days before the date shown in his construction schedule for starting, testing and adjusting equipment, the Contractor shall provide the Owner with three copies of a list showing the required lubricants, after consolidation, for each item of mechanical equipment. The list shall show estimated quantity of lubricant needed for a full year's operation, assuming the equipment will be operating continuously.

2.11 ANCHOR BOLTS

Anchor bolts shall be designed for lateral forces for both pullout and shear in accordance with the provisions of Section 05501. Unless otherwise stated in the detailed specification, anchor bolt materials shall conform to the provisions of Section 05501.

PART 3--EXECUTION

Installation of equipment accessories included in this section shall be as recommended by the equipment manufacturer unless otherwise specified in the individual equipment specification section.

END OF SECTION

SECTION 11010

EQUIPMENT CONTROL DEVICES

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies electrical and instrumentation devices specified as part of equipment systems.

1.02 QUALITY ASSURANCE

A. GENERAL:

Control devices shall be listed by Underwriters Laboratories Inc., Factory Mutual, or Canadian Standards Associations for their intended purpose where such listing has been applied to similar products.

B. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
JIC EMP-1-67	Electrical Standards for Mass Production Equipment
NEMA ICS 2-83 Rev. 1984	Industrial Control Devices, Controllers and Assemblies
NFPA 70-84	National Electrical Code (NEC)

PART 2--PRODUCTS

2.01 POWER RATINGS

Devices shall be suitable for the control circuit voltage.

Where more than one piece of equipment (each having its own power source) have a common control power system, provision shall be made for transferring the control power system to an active source should the main source of control power fail.

2.02 PILOT DEVICES

Electrical pilot devices including switches, relays, and contacts shall be heavy-duty industrial quality devices. Contacts which provide alarm, malfunction or control to external systems shall be rated NEMA A600 (10 amps continuous at 600 volts AC), except that pressure switches and temperature switches shall be rated NEMA B600 (5 amps continuous at 600 volts AC). Range of switches shall be that recommended by the mechanical equipment manufacturer.

2.03 ALARM AND MALFUNCTION DETECTION

Devices which are used to directly signal alarm or malfunction conditions shall be externally manually reset. The devices shall have a minimum of one contact which shall open on malfunction or alarm condition, as scheduled. Other output relays and devices shall have a minimum of one normally open and one normally closed contact which may be a NEMA Form C contact. If the contact of the device is required for internal equipment control as well as to signal alarm or malfunction conditions, then the manufacturer may make the reset function a part of his equipment's master shutdown system. However, each source of shutdown shall be shown by local trouble lights or flags which are manually reset at the equipment control panel. Trouble output contacts shall open and remain open until manually reset when equipment is shut down due to a malfunction. Trouble contacts shall not indicate abnormal conditions when the equipment has been manually shut down. Alarm and malfunction signals shall be initiated by a contact opening.

2.04 CABLE

Rubber covered multiconductor cable shall not be used on stationary equipment for any voltage exceeding 250 volts AC, nor shall it be used for connections to any motor rated 1/4 horsepower or larger. For these purposes, JIC EMP-1-1967 E12.4.4 through E12.4.8 and E13.3 shall apply.

2.05 LIQUIDTIGHT CONDUIT

Flexible conduit shall be liquidtight flexible metal conduit, formed from spirally wound galvanized steel strip with successive convolutions securely interlocked, jacketed with liquidtight plastic cover. Minimum size shall be 1/2 inch. Fittings for liquidtight conduit shall have cadmium-plated malleable iron body and gland nut, brass grounding ferrule threaded to engage conduit spiral and O-ring seals around the conduit and box connection and isolated throat. Forty-five and 90-degree fittings shall be used where applicable. Maximum length of flexible conduit shall be 36 inches.

2.06 INDICATING LIGHTS

Indicating lights shall be oiltight transformer type with low voltage lamps and push-to-test features and shall be equipped with colored lenses in accordance with the following schedule:

Color	Typical function	Example
Red	Danger, abnormal condition, fault condition	Voltage applied; cycle in automatic; faults in air, water, lubricating or filtering systems; ground detector circuits.
Amber (yellow)	Attention	Motors running; machine in cycle; unit or head in forward position.
Green	Safe condition (security)	End of cycle; unit or head returned; motors stopped; motion stopped; contactors open.
White or clear	Normal condition	Normal pressure of air, water, lubrication.

2.07 GROUNDING

A separate ground conductor shall be run in each power conduit. The conductor shall be sized in accordance with NEC Table 250-95. The conductor shall be bonded to the inside of the device junction box.

Freestanding control panels shall be equipped with a 1/4-inch by 1-inch copper ground bus running the length of the panel, with the steel structure connected to the bus so as to effectively ground the entire structure. A compression fitting shall be provided at each end of the ground bus for accepting plant ground connections.

2.08 DEVICES WITH MOTOR STARTERS AND CONTACTORS

Equipment which is provided with control devices having motor starters or contactors shall also comply with the following.

A. DISCONNECT SWITCHES:

Equipment shall be provided with a disconnect switch. If the disconnect switch is not located within sight of the drive, it shall be provided with a padlock hasp. The disconnect shall be a horsepower rated disconnect switch or molded case circuit breaker, except that a manual motor starter may be used for drives less than 2 kVA. Horsepower rated disconnect switches for equipment 2 kVA or greater shall be provided with UL Class RK1 fuses. Circuit

breaker interrupting ratings shall be 10,000 symmetrical amperes for service at 240 volts or below and shall be 22,000 symmetrical amperes for service above 240 volts unless otherwise noted. When the disconnecting device is not a circuit breaker or fused disconnect, the circuit feeding the disconnecting device shall have adequate overcurrent and short circuit protection.

B. OVERLOAD PROTECTION:

Protection shall be provided for full motor running overload in ungrounded conductors for motors.

C. OVERLOAD RELAY CONTACTS:

Overload relay contacts shall not be connected in the line having provision for grounding. Grounding connections shall be provided in the unfused side of control circuits and shall be connected.

D. POWER:

Power will be supplied at one voltage as shown or specified. Additional voltage requirements, such as 120 volt control power, shall be derived from transformers provided internal to the control device as required. Each control power transformer shall be rated at least 150 percent of the calculated maximum load it serves.

2.09 PRODUCT DATA

The following shall be provided in accordance with paragraph 00710-4.02:

1. Sufficient data for materials and components to demonstrate compliance with the specifications.

2. Location of ancillary devices, conduit, junction boxes, safety and control devices, and conduit entries for feeding or controlling the equipment.

3. Electrical elementary diagrams, internal connection diagrams, and external interconnection diagrams, drawn in accordance with JIC and/or ICS standards. Connection diagrams shall be the conventional type with lines showing point-to-point wiring and must show terminals and devices as viewed by the electrician; wireless or wire schedule types are not acceptable.

4. Process flow diagrams and process and instrumentation diagrams (P&IDs) using ISA symbols for equipment which interfaces with the instrumentation system or has internal control loops.

5. Range and setting of indicators, instruments, timers, and devices.

PART 3--EXECUTION

3.01 INSTALLATION

Control devices, when installed, shall comply with the requirements of the NEC.

3.02 FIELD WIRING

Conduit, wiring, or mounting of devices not shown on the electrical or instrumentation drawings but required for a complete and operable system shall be provided under this section.

END OF SECTION

SECTION 11015

NOISE REQUIREMENTS AND CONTROL

PART 1--GENERAL

1.01 DESCRIPTION

This section includes the noise requirements and test regulations for all mechanical equipment. Unless otherwise specified, the maximum noise level for each piece of mechanical equipment shall be 85 dbA. Mechanical equipment shall consist of any and all equipment provided under the specification sections listed in Divisons 11, 14, and 15.

1.02 QUALITY ASSURANCE

A. FACTORY TESTS:

Where required in the individual equipment specification sections, or where determined to be necessary to the equipment manufacturer, the Contractor shall furnish, prior to shipment to the job site, a certified factory noise test report on the actual equipment to be provided or an unconditional guarantee that the equipment, when operating under design conditions, will not produce noise exceeding the permissible levels specified. Noise levels in excess of those specified shall be cause for rejection of the equipment. Standard noise data is not acceptable.

Noise measurements shall be accomplished preferably at the factory. In any event, these measurements shall be accomplished prior to shipment of any equipment to the job site. The measurements shall take place in a reverberant or semireverberant condition, with equipment sitting on a hard reflective surface. Alternative permitted conditions are those which duplicate the circumstances under which the equipment will operate on this project. Tests shall be made at 1/2, 3/4, and full load where applicable.

B. FIELD TESTS:

Where required by the individual mechanical equipment specification sections, the Contractor shall retain the services of an independent testing agency to perform, for each affected item of mechanical equipment, a field noise test to verify that the equipment, when operating under design conditions, will not produce noise exceeding the permissible level specified. Tests shall be made at 1/2, 3/4, and full load where applicable. All readings shall be taken with only that equipment operating or allowances shall be made for any background level within 5 dbA of the equipment being measured. All measurements shall be witnessed by the Engineer. The Engineer shall be notified at least 5 working days prior to any field noise test.

C. TESTING AGENCY:

Noise level measurements shall be taken or observed by an independent acoustical laboratory or consultant retained and paid for by the Contractor. Such independent acoustical laboratory or consultant shall be qualified by experience in the acoustical field to take such measurements and shall be responsible for conducting them in accordance with accepted procedures for the measurement of sound. Such person responsible for the tests shall certify the maximum noise levels emanating from the equipment, its operating conditions, the environment in which tested, a list of the acoustical instruments used, and the points at which the measurements were made. The description shall be sufficiently detailed to permit the test to be repeated, and it shall include a sketch of the item being measured which shows the points of measurement and the point of maximum encountered noise level on the measurement line. Three copies of certified test results shall be submitted to the Engineer prior to shipment.

Final acceptance of any equipment is dependent upon satisfactory noise level performance after installation.

PART 2--PRODUCTS

No products are included in this section.

PART 3--EXECUTION

3.01 PERFORMANCE REQUIREMENTS

Unless otherwise specified, the maximum permissible noise level for a complete piece of mechanical equipment located within or outside a structure shall not exceed 85 dbA at three feet. A complete piece of equipment includes the driver and driven equipment plus any intermediate couplings, gears, and auxiliaries. Field and factory testing for noise generation, where required by the individual specification sections, shall be at the Contractor's expense.

Maximum permissible noise (sound pressure) levels are in decibels as read on the "A" weighted network of a standard sound level meter (dbA); all measurements are made in relation to a reference pressure of .0002 microbar. Measurements of emitted noise levels shall be made on a sound level meter meeting at least the Type II requirements as set forth in ANSI SI.4-1961 Specification for General Purpose Sound Level Meters, or the latest revision thereof. The sound level meter shall be set on the "A" scale and to slow response. Unless so stated in the specific section relating to a particular piece of equipment, the point of measurement of sound level shall be made at the specified distance from any major surface along the entire perimeter and at mid-height of the piece of equipment or at the specified distance from an outer major surface encompassing the sound source including inlets or outlets.

3.02 INSTALLATION

In the event that the noise tests show levels in excess of the allowable limits, apropriate field noise reduction measures shall be undertaken to reduce the noise levels at the measurement location(s) to the allowable level. All field noise reduction measures shall be at the Contractor's expense and shall be approved by the Engineer prior to installation.

Methods to be employed may be in the form of sound reduction enclosures, acoustical equipment mountings, acoustical wall or ceiling panels, or acoustical insulation on the equipment. Any exposed acoustical materials shall be capable of being cleaned by hosing down with water. Any acoustical enclosures, walls, panels, or insulation provided to meet the requirements of these specifications shall allow adequate motor ventilation and shall not obstruct access to equipment for routine or preventive maintenance. Rated capacities, operation, and normal maintenance procedures of the equipment shall not be affected by the noise reduction measures.

END OF SECTION

SECTION 11020

VIBRATION AND CRITICAL SPEED LIMITATIONS

PART 1--GENERAL

1.01 SCOPE

This section specifies vibration and critical speed limitations for rotating mechanical equipment. Field testing and vibration measurements shall be taken when specified.

1.02 VIBRATION LIMITATIONS

A. GENERAL:

Vibration frequencies shall span the range from 5.0 to 5000 Hz. Where specified, measurements shall be obtained while the installed equipment is operating within the specified speed range.

B. CENTRIFUGAL:

1. MACHINES WITH SLEEVE BEARINGS: Unless otherwise specified, centrifugal machines with sleeve bearing shafts shall not exhibit unfiltered RMS readings for vibration displacement in excess of the following:

Shaft speed range, rpm	Displacement, peak to peak, mils
Up to 900	3.5
901-1800	3.0
1801-3000	2.5
3001-4500	2.0
Above 4500	1.6

Displacement measurements shall be taken radially on the shaft at two points at each bearing. Measuring points shall be 90 degrees apart.

2. MACHINES WITH ANTIFRICTION BEARINGS: Unless otherwise specified, centrifugal machines with antifriction bearing shafts shall not exhibit unfiltered RMS readings for vibration velocity in excess of 0.12 inch per second. Velocity measurements shall be taken on one point of each bearing housing.

C. POSITIVE DISPLACEMENT MACHINES:

Unless otherwise specified, positive displacement machines of the rotary, reciprocating and controlled volume types shall operate without any lateral or torsional vibration characteristics

that may accelerate wear of the equipment. The Contractor shall provide manufacturer's certification that the manufacturer has inspected the machine under operating conditions and found it to comply with the requirements of this paragraph.

1.03 CRITICAL SPEED REQUIREMENTS

Unless otherwise specified, rotating mechanical equipment shall not exhibit critical speeds within the specified range of operating speeds. Critical speeds for equipment with rigid rotor systems shall be at least 20 percent greater than maximum operating speed. Critical speeds for equipment with flexible shaft-rotor systems shall be at least 15 percent below minimum operating speed and 20 percent above maximum operating speed.

PART 2--PRODUCTS

2.01 PRODUCT DATA

The following information shall be provided in accordance with paragraph 00710-4.02:

1. Manufacturer's certified data showing location of critical speeds in relation to operating speeds.

END OF SECTION

SECTION 11021

EQUIPMENT MOUNTING AND VIBRATION ISOLATION SYSTEMS

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies general requirements for equipment mounting. Where specified, vibration isolation systems complying with the requirements of this section shall be provided.

1.02 QUALITY ASSURANCE

A. GENERAL:

Unless the equipment incorporates unit construction using an integral rigid frame or is specified otherwise, each item of mechanical equipment, along with its drive unit, shall be mounted on a rigid steel or steel and concrete base. Cast iron bases will be permitted only when the equipment is not furnished with a vibration isolation system. Where specified or noted on the drawings, the equipment, including the base, shall be mounted on or suspended from vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the supporting structure. Vibration isolation available internally in the equipment will not be considered equivalent and shall not be provided when vibration isolation as specified herein is required. Normally provided internal vibration isolators shall be replaced with rigid supports in such cases. In the event internal vibration isolation is specified in the individual mechanical equipment specification sections and is unavailable as part of the particular unit submitted, vibration isolation shall be provided in accordance with the requirements of this section. Vibration isolators shall be selected in accordance with unit weight distribution to produce reasonable uniform deflections at each support.

B. DESIGN REQUIREMENTS:

The Contractor shall be responsible for overall coordination between the equipment supplier and the manufacturer of the vibration isolation mountings as to equipment weight, weight distribution and vibration isolator configuration to ensure satisfactory performance under operating conditions. Vibration isolation mountings shall be as manufactured by Mason Industries, Inc., Korfund Dynamics Corporation, Consolidated Kinetics Corporation, or equal.

1.03 SUBMITTALS

Submittals required in accordance with Section 01300 only when a Contractor wishes to take exception to these specifications. A justification for each exception shall be submitted.

PART 2--PRODUCTS

2.01 BASES

A. CURB MOUNTED BASES:

Curb mounted equipment where vibration isolation is required, principally roof top heating, ventilating and air conditioning equipment, shall be mounted on vibration isolation bases that fit over the curb and under the isolated equipment. The extruded aluminum top and bottom members shall contain cadmium-plated springs having a 1-inch minimum deflection with 50 percent additional travel to solid. Spring diameters shall be no less than 0.8 times the spring height at rated load. Wind resistance shall be provided by means of resilient snubbers in the corners with a minimum clearance of 1/4 inch so as not to interfere with spring action except in high winds. The weather seal shall consist of continuous closed cell sponge materials both above and below the base and a waterproof flexible neoprene connection duct joining the outside perimeter of the aluminum members. Foam or other contact seals are unacceptable at the spring cavity closure. Caulking shall be kept to a minimum.

B. TYPE I BASES:

Type I bases shall be structural steel bases. The bases shall be rectangular in shape for all equipment other than centrifugal refrigeration machines and pump gases, which may be "T" or "L" shaped. Pump bases for split case pumps shall include supports for suction and discharge base ells. All perimeter members shall be beams with a minimum depth equal to 1/10th of the longest dimension of the base. Beam depth need not exceed 14 inches provided the deflection and misalignment is kept within acceptable limits as determined by the manufacturer. Grout holes shall be provided for the bases of all equipment where vibration isolation is not specified. Where vibration isolation is required, height saving brackets shall be employed in all mounting locations to provide a base clearance of 1 inch.

C. TYPE II BASES:

Type II bases shall be steel members used to cradle machines having legs or bases that do not require a complete supplementary base. All members shall be sufficiently rigid to prevent strains in

the equipment. Where vibration isolation is required, height saving brackets shall be employed in all mounting locations to provide a clearance of 1 inch below the base.

D. TYPE III BASES:

Type III bases shall be rectangular foundations consisting of concrete-filled structural steel beam or channel forms. Bases for split case pumps shall be of sufficient size to provide support for suction and discharge base ells. The base depth need not exceed 12 inches unless specifically recommended by the base manufacturer or required for mass or rigidity. In general, base depth shall be a minimum of 1/12th of the longest dimension of the base but not less than 6 inches. Forms shall include, as a minimum, concrete reinforcement consisting of 1/2-inch bars or angles welded in place on 6-inch centers each way in a layer 1-1/2 inches above the bottom or additional steel as required by structural conditions. Forms shall be furnished with drilled steel members with sleeves welded below the holes to receive equipment anchor bolts where the anchor bolts fill in concrete locations. Where vibration isolation is required, height saving brackets shall be employed in all mounting locations to maintain a 1-inch clearance below the base.

2.02 VIBRATION ISOLATION MOUNTINGS

A. TYPE A MOUNTINGS:

Type A mountings shall be double deflection neoprene mountings having a minimum static deflection of 0.35 inch. All metal surfaces shall be neoprene covered to avoid corrosion and shall have friction pads both top and bottom so that they need not be bolted to the floor. Bolt holes and anchor bolts shall be provided where required to resist lateral migration. Resilient washers and bushings shall be provided to prevent contact between the bolts and the equipment support bases. On equipment such as small vent sets, steel rails shall be used above the mountings to compensate for the overhang.

B. TYPE B MOUNTINGS:

Type B mountings shall be free-standing, spring-type isolators laterally stable without any housing and complete with 1/2-inch neoprene acoustical friction pads between the base and the support. Mountings shall have leveling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 times the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50 percent of the rated deflection. Mountings shall be hot-dip galvanized steel.

C. TYPE C MOUNTINGS:

Type C mountings shall be Type B mountings with a housing having vertical limit stops to prevent spring extension when weight is removed. Type C mountings shall be provided for equipment with operating weight different from the installed weight, such as chillers, boilers, etc., and equipment exposed to the wind, such as cooling towers. The housing shall serve as blocking during erection and shall be located between the supporting steel and roof or the grillage and dunnage as shown on the drawings. The installed and operating heights shall be the same. A minimum clearance of 1/2 inch shall be maintained around restraining bolts and between the housing and the spring to prevent interference with the spring action. Limit stops shall be out of contact during normal operations. Mountings shall be hot-dip galvanized steel.

D. TYPE D MOUNTINGS:

Type D mountings shall be steel hangers which contain a steel spring and a 0.3-inch deflection neoprene element in series. The neoprene element shall be molded with a rod isolation bushing which passes through the hanger box. Spring diameters and hanger box lower hole sizes shall be of sufficient size to permit the hanger rod to swing through a 30-degree arc before contacting the hole. Springs shall have a minimum additional travel to solid equal to 50 percent of the rated deflection.

E. TYPE E MOUNTINGS:

Type E mountings shall be double deflection, cork and rubber sandwich pads consisting of a high-density cork layer permanently bonded to top and bottom layers of corrugated oil-resistant synthetic rubber. The corrugated design shall allow deflection to increase with load and shall form a nonskid surface to resist lateral migration of the equipment. Bolt holes and anchor bolts shall be provided where required to resist migration. Resilient washers and bushings shall be provided to prevent contact between the bolts and the equipment support bases.

2.03 PRODUCT DATA

In accordance with paragraph 00710-3.05, the following information shall be provided to the Construction Manager:

1. Spring deflections and diameters, compressed spring heights and solid spring heights.

2. Manufacturer and manufacturer's type designation.

3. Manufacturer's catalog data.

PART 3--EXECUTION

Vibration isolation systems shall be installed in accordance with applicable requirements of the equipment isolation system manufacturers.

END OF SECTION

SECTION 11060

ELECTRIC MOTORS

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies alternating current induction motors, 250 horsepower or less, to be provided with the driven equipment. This section does not specify medium voltage (2300 volts and greater) motors and specialty motors such as submersible motors, hoist motors, valve operator motors or torque rated motors. Unless specified otherwise, electric motors shall be provided by the manufacturer of the driven equipment under the provisions of Section 11000. This section refers to motors by enclosure type as defined in NEMA MG 1, except as noted.

1.02 QUALITY ASSURANCE

A. GENERAL:

Motors shall be built in accordance with UL 674, UL 1004, NEMA Standard MG 1, and to the requirements specified.

B. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
AFBMA 9-78	Load Ratings and Fatigue Life for Ball Bearings
AFBMA 11-78	Load Ratings and Fatigue Life for Roller Bearings
ANSI/IEEE 112-1984	Polyphase Induction Motors and Generators
NEMA ICS 2-78	Standards for Industrial Control Devices, Controllers and Assemblies
NEMA ICS 6-78	Enclosures for Industrial Controls and Systems
NEMA MG 1-78	Motors and Generators

Reference (cont'd)	Title
UL 674-78	Motors and Generators, Electric, for Use in Hazardous Locations, Class I, Groups C and D, Class II, Groups E, F and G
UL 1004-84	Motors, Electric

1.03 SUBMITTALS

Motor data shall be submitted for each item of motor-driven equipment to be provided under this contract. Submittal data shall be furnished in accordance with Section 01300 and shall include a completed motor data form (Form 11060-A, Section 01999) and, for motors 100 horsepower and larger, a motor heating curve.

1.04 AMBIENT CONDITIONS

Unless specified otherwise, motors shall be suitable for continuous operation at an elevation of 930 feet above sea level. Motors to be installed outdoors, exposed to the weather, shall be suitable for continuous operation in a 50 degree C ambient temperature; motors to be installed indoors shall be suitable for continuous operation in a 50 degree C ambient temperature.

PART 2--PRODUCTS

2.01 NAMEPLATES

Motor nameplates shall be engraved or stamped stainless steel. Information shall include those items enumerated in NEMA Standard MG 1, paragraph 10.37, 10.38 or 20.60, as applicable.

Additionally, nameplates for motors 1/2 horsepower and larger shall indicate the AFBMA L-10 rated life for the motor bearings. Nameplates for high efficiency motors shall list the nominal efficiency. Nameplates for explosionproof motors shall also indicate UL frame temperature limit code.

Nameplates shall be permanently fastened to the motor frame and shall be positioned to be easily visible for inspection.

2.02 CONSTRUCTION

Unless specified otherwise, all motors provided under this specification shall have the following features of construction:

1. Cast iron frames.
2. Cast fan blades and shrouds.
3. Stainless steel hardware.
4. Nonhydroscopic leads.

2.03 MOTORS LESS THAN 1/2 HORSEPOWER

A. GENERAL:

Unless otherwise specified, motors less than 1/2 horsepower shall be squirrel cage, single phase, capacitor start, induction run type. Single phase motors shall have Class B insulation. Small fan motors may be split-phase or shaded pole type. Windings shall be copper.

B. RATING:

Unless specified otherwise, motors shall be rated for operation at 115 volts, single phase, 60 Hz, and shall be 1.15 service factor, continuous-time rated in conformance with NEMA Standard MG 1, paragraph 10.35. Dual voltage (115/230) rated motors are acceptable if all leads are brought out to the conduit box.

C. ENCLOSURES:

Unless otherwise specified, motors shall have totally enclosed fan cooled or totally enclosed nonventilated enclosures.

Explosionproof motors shall bear the UL label for Class I, Division 1, Group D hazardous locations. An overtemperature device in the enclosure shall be provided to detect and automatically de-energize the motor if the enclosure surface temperature exceeds 280 degrees C. The nameplate shall be marked with the UL frame temperature limit code T2A.

2.04 MOTORS 1/2 HORSEPOWER THROUGH 250 HORSEPOWER

A. GENERAL:

Unless otherwise specified, motors 1/2 horsepower through 250 horsepower shall be 3 phase, squirrel cage, full voltage start induction type. Unless otherwise specified, motors shall have a NEMA MG 1-1.16 design letter B or C torque characteristic as required by the driven equipment's starting torque requirements.

B. RATING:

Unless otherwise specified, motors shall be rated for operation at 460 volts, 3 phase, 60 Hz, and shall be continuous time rated in accordance with NEMA standard MG 1, paragraph 10.35. Dual voltage (230/460) rated motors are acceptable if all leads are brought out to the conduit box. Unless specified otherwise, motors shall have a service factor of 1.15 and shall not be required to exceed its nameplate rating.

Motors for variable frequency systems shall not be required to deliver more than 80 percent of the motor's service factor rating by any load imposed by the driven machine at any specified operating condition or any condition imposed by the driven machine's performance curve at maximum operating speed.

C. ENCLOSURE AND INSULATION:

1. GENERAL: Motors shall be classified as Type 1 (General Duty), Type 2 (Process), and Type 3 (Explosionproof). Enclosures and insulation systems shall be as specified in the following paragraphs. Temperature rise for all motor types shall not exceed that permitted by Note II, paragraph 12.42, NEMA MG 1. The insulation shall be nonhydroscopic.

2. TYPE 1 MOTORS (NONPROCESS): Unless specified otherwise, Type 1 motors shall have dripproof guarded enclosures with Class B insulation.

3. TYPE 2 MOTORS (PROCESS): Type 2 motors shall be totally enclosed, fan cooled with Class F insulation. Motors rated 10 horsepower and larger shall have Class F insulation with Class B temperature rise. All internal surfaces shall be coated with an epoxy paint. Aluminum frame motors will not be permitted. Steel frame motors will be permitted for motors with frames 184 and smaller.

4. TYPE 3 MOTORS (EXPLOSIONPROOF): NOT IN CONTRACT

D. MOTORS FOR VARIABLE FREQUENCY DRIVES:

Motors intended for use with variable frequency drives shall be compatible with the characteristics of the intended variable frequency generators. Motors shall be Type 2 or Type 3 as specified in the detailed specification and in paragraphs 11060-2.04 C.3 and 2.04 C.4, except insulation for all motors operating with variable frequency drives shall be Class F with Class B temperature rise. Variable frequency drive motors shall be energy-efficient motors as specified in paragraph 11060-2.04 E.

E. ENERGY-EFFICIENT MOTORS:

Where specified as energy efficient motors, Type 2 and Type 3 motors shall be designed to comply with the minimum nameplate efficiency in Schedule A. Motor efficiency shall be tested in accordance with IEEE-112, Test Method B with stray load loss adjustment as modified by NEMA MG 1-12.53(a) and (b). Motor nameplate efficiency shall conform with the nominal values

shown in NEMA MG 1, Table 12-4, and with the minimum acceptable efficiencies listed in Schedule A. Energy-efficient motors shall be Reliance Electric Duty Master XE, Baldor Super-E, or equal.

Schedule A, Minimum Nameplate Efficiency

	Speed, rpm		
Horsepower range	1200	1800	3600
1-2	82.5	84.0	82.5
3-5	89.5	88.5	86.5
7-25	90.2	90.2	89.5
30-60	92.4	93.0	92.4
75-200	94.1	95.0	94.1

F. VERTICAL MOTORS:

Unless otherwise specified, vertical motors shall be full voltage with a Type P base specifically designed for vertical installation. Universal position motors are not acceptable. Vertical motors shall have solid shafts unless specified otherwise. Vertical motors shall conform to either Type 2 or Type 3 requirements as specified under paragraphs 11060-2.03 C.3 and 2.03 C.4. Thrust bearing rating shall be compatible with the loads imposed by the driven equipment.

G. CONDUIT BOXES:

Conduit boxes shall be cast iron, split construction with threaded hubs. Conduit boxes shall be designed for rotation to permit installation in four positions at least 90 degrees apart. Motors shall be furnished with petroleum-resistant gaskets at the base of the conduit box and between the halves of the conduit box. Motors shall have a grounding lug located within the box for the ground connection.

H. BEARINGS:

Bearings may be oil or grease lubricated ball or angle contact roller bearings rated for a minimum L-10 life of 100,000 hours in accordance with AFBMA 9 or 11 at the ambient temperature specified herein. Motor designs employing cartridge type bearings will not be accepted. Bearings shall be fitted with lubricant fill and drain or relief fittings.

I. LIFTING EYES:

Motors weighing more than 50 pounds shall be fitted with at least one lifting eye.

J. CURRENT IMBALANCE:

Current imbalance shall not exceed the values tabulated below when the motor is operating at any load within its service factor rating and is supplied by a balanced voltage system:

Under 5 horsepower: 25 percent
5 horsepower and above: 10 percent

Imbalance criteria shall be based upon the lowest value measured.

K. SPECIAL FEATURES:

1. GENERAL: Where specified or required by this paragraph, special features, as specified below, shall be provided.

2. WINDING OVERTEMPERATURE PROTECTION: Stator winding overtemperature protection shall be provided on all motors rated 200 horsepower and larger. Motors rated less than 200 horsepower shall have stator winding overtemperature protection only if required by the specific equipment specification section or if recommended by the driven equipment manufacturer.

Explosionproof motors shall be protected as specified in this section, paragraphs 11060-2.03 C or 2.04 C.4.

Overtemperature protection for motors rated 100 horsepower and larger and other motors, where specified, shall be NEMA MG 1-12.53, Type 1, winding running and locked rotor overtemperature protection. Two detectors shall be provided per phase. Detectors shall be positive thermal protection (PTC) thermisters type, with leads brought out to a terminal strip in a NEMA 4 enclosure in Type 2 motors and a NEMA 7C or 9 enclosure for Type 3 motors.

3. HEATERS: Where specified, heaters shall be provided in motor enclosures to guard against condensation after shutdown. Headers shall be cartridge or flexible wraparound type. Heaters shall be rated 120 volts, single phase, 60 Hz. The heater rating in watts and volts shall be noted on the motor nameplate or on a second nameplate. Space heater terminals shall be brought to a separate terminal block or pigtails in the conduit box.

2.05 PRODUCT DATA

The following information shall be provided for each motor in accordance with paragraph 00710-4.02:

1. Motor outline, dimensions, and weight.

2. Manufacturer's general descriptive information relative to motor features.

3. Where a winding overtemperature device is required, provide a response curve for the temperature device.

4. Operating and maintenance information specified in Section 01730, items 1, 2, 3, 5, and 9. Provide item 6, Overhaul Instructions, for each motor 5 HP and over.

PART 3--EXECUTION

Winding insulation resistance and current imbalance testing shall be performed as specified in Section 16000.

END OF SECTION

SECTION 11069

VARIABLE FREQUENCY DRIVES

PART 1--GENERAL

1.01 GENERAL

A. SCOPE:

This section specifies the furnishing and testing of variable frequency drives (VFDs).

B. TYPE:

Variable frequency drives shall be 480 volt, 3 phase type with power factor correction.

C. EQUIPMENT LIST:

Item	Equipment number
Raw sewage pump 1 speed controller	SC 1111
Raw sewage pump 2 speed controller	SC 1112
Interceptor pump 1 speed controller	SC 10011
Interceptor pump 2 speed controller	SC 10012
Interceptor pump 3 speed controller	SC 10013

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section references the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
NEMA ICS 6-1978	Enclosures for Industrial Controls and Systems

B. UNIT RESPONSIBILITY:

The Contractor shall assign unit responsibility as specified in paragraph 11000-1.02 B to the pump manufacturers for the equipment specified in this section and the pumping equipment specified in Section 11333. VFDs shall be the product of a single manufacturer.

C. RELATED WORK SPECIFIED ELSEWHERE:

11060	Electric Motors
11080	Standby Engine Generators
16175	Miscellaneous Electrical Devices
11333	Non-Clog Vertical Column Wastewater Pumps

D. DESIGN REQUIREMENTS:

Drives shall meet the following general requirements:

1. Minimum VFD efficiency shall be 95 percent at 100 percent speed, and 87 percent at 60 percent speed.*

2. Rated input voltage 460V plus 10 percent to minus 5 percent.*

3. Service factor 1.0.

*Based on nominal 1,800 rpm motor with load horsepower varying as cube of speed.

Drive shall be provided with a main circuit breaker or input fused disconnect switch, mechanically interlocked with the drive cabinet door. Interlock shall be provided with defeater. Circuit breaker or fuse shall have a minimum short circuit interrupting capacity of 22,000 RMS symmetrical amps.

E. FACTORY TESTS:

Factory tests shall be conducted in accordance with the following requirements. Testing shall proceed in the order given below. The Contractor shall submit a description of the proposed testing procedure to the Construction Manager for his acceptance at least 10 weeks in advance of the proposed testing date. No tests shall be performed until the test procedure meets with the Construction Manager's approval. In addition, the Contractor shall furnish the Construction with at least 4 weeks advance written notice of the date and location of the witnessed performance tests. Similar requirements apply to the pumping system tests.

1. COMBINED DRIVE AND MOTOR TEST: Each variable frequency drive along with its associated actual AC motor to be provided shall be tested with the system logic and a dynamic load coupled to simulate field operation conditions and given complete factory tests at 25, 50, and 100 percent full load current. After operation tests are complete, the complete drive system shall be heat tested with "power on" in a heat room maintained at 50 degrees C for 50 hours.

Harmonic analysis shall be performed at unit full load using an harmonic analyzer (Hewlett Packard or equal). Results shall be corrected for a source impedance of 0.83 per unit Z, and a X/R ratio of 3.85. Tests shall prove that sufficient filtering has been provided to limit the harmonic distortion to a magnitude of 5 percent of fundamental.

2. PUMPING SYSTEM TEST: The complete pumping systems, composed of pumps, motors and variable frequency drives shall be factory tested as specified in Section 11333.

1.03 SUBMITTAL DATA

Four copies of the following data shall be submitted to the Construction Manager in accordance with Section 01300 and the schedule specified in Section 01010:

1. A completed "Motor Data Form" as specified in Section 11060.

2. Control schematic showing external wiring interfaces.

3. List of prior projects and references as required in paragraph 11069-2.01 A.2.

PART 2--PRODUCTS

2.01 GENERAL

A. ACCEPTABLE PRODUCTS:

1. MANUFACTURER: Drives shall be as manufactured by Robicon. Products of Toshiba or Eaton, modified as required to provide the specified features and to meet the specified design requirements, will be considered. Units shall be transistor type, Robicon Opti-Speed.

2. MANUFACTURERS EXPERIENCE: As a minimum qualification, the VFD manufacturer shall demonstrate at least 5 years experience in the production, testing, and installation of VFDs of the type

described in this section. Furthermore, manufacturer shall have three (3) working installations of the size and complexity of the VFD installation described in this section.

VFD manufacturer shall hvae full warranty service facilities within four (4) hours of traveling time from the installation site.

Under submittal informaiton manufacturer shall provide the followoing list of information:

1. Years of manufacturing experience.

2. List of three working installations with owner contact name and telephone number. Size of units.

3. Address and telephone number of nearest full service facility.

B. ENCLOSURES:

The enclosure for units rated 100 HP and greater shall be a dead front, freestanding assembly with cabinet base and maximum dimensions 102 inches high and 28 inches deep. Working height shall be not greater than 74 inches (78 inches minus 4-inch pad) to be in compliance with NEC paragraph 380-8. Removable lifting angles shall be provided. Enclosure for units rated less than 100 HP shall be wall-mounted type.

The enclosure shall be NEMA 1 with gasketed doors and door openings. Rear panel cover shall not be used for mounting of internals.

Painted parts shall undergo phosphatizing, prepaint treatment for rust resistance and paint bond. Vertical sections and cover plates shall be painted with one coat of enamel; doors shall be painted ANSI 24, light grey. Insides shall be white. Paint shall be applied by electrostatic process and baked to a durable hard finish.

In addition to the manufacturer's identification, enclosure shall be provided with phenolic nameplates showing the driver designations as specified. Nameplates shall be black, with minimum 3/16-inch high white letters. Nominal size shall be 1 inch high by 2 inches long. If abbreviations are required because of space limitations, abbreviations shall be submitted to the Construction Manager.

C. PROTECTIVE DEVICES:

The variable frequency drive shall be provided with the following protective devices:

1. Power circuit design such that power circuit components can withstand the following fault conditions:

   a. Single phase fault or three phase short circuit on driver output terminals.

   b. Failure to commutate inverter silicon controlled rectifier (SCR).

   c. Opening of driver contactor during operation.

   d. Opening of driver input circuit breaker during operation.

   e. Ground fault on downstream side of main disconnect.

2. Inverse time overload protection.

3. Three phase AC reactor to prevent generation of intervals of zero voltage (notches).

4. Main circuit breaker or fused disconnect switch, externally operated with current limiting fuses on all phases. Isolation from phase-to-phase and phase-to-ground faults shall be provided. Isolation transformer or in-line reactors are acceptable solutions if primary disconnect means are also provided.

5. Harmonic filtering shall be provided to limit the magnitude of the harmonic to 5 percent of the fundamental.

2.02 CONVERTER

Converter shall be provided with current limiting fuses for internal fault protection and current limiting regulators for external fault protection.

2.03 INVERTER

A. GENERAL:

The output voltage of the inverter shall be adjustable and controlled by the value of output frequency to maintain a constant ratio of volts per hertz throughout the operating range. The inverter shall be capable of varying the speed of any standard NEMA B design, squirrel cage, induction motor, with a 1.15 service factor, without derating or requiring any motor modifications.

B. FEATURES:

The inverter shall be provided with the following features:

1. Control circuit; fused 120 VAC control transformer and control relays for system logic functions. For system logic, see electrical wiring diagram and control strategy referenced in paragraph 1.02 C.

2. Provision for 4 to 20 mA non-isolated input speed reference signal. VFD manufacturer shall provide a signal cujrrent isolator to ensure signal and galvanic isolation of the speed reference signal. Isolator shall be Moore Industries SCX or equal.

3. SPDT electrically isolated auxiliary status contacts for inverter and converter faults, motor disabled, and logic power fault, wired to terminals for use in annunciator and alarm systems. Auxiliary run contacts from the output contactor and the driver and VFD enable contacts shall also be provided as required by the electrical control diagrams. The VFD controls shall energize a 120-volt AC pump lubrication solenoid when the motor is not energized (the solenoid is a fail open unit).

4. Adjustable minimum/maximum frequency limits.

5. Independent timed linear acceleration and deceleration functions, adjustable from 6 to 20 seconds.

6. Terminal blocks for wires entering and leaving the controller.

7. Provisions to monitor a normally closed temperature switch in the motor and shut the unit down if those contacts open.

8. Each VFD shall include a timer that will delay restart of the unit on resumption of power after a power failure for an adjustable time of 5 to 50 seconds.

2.04 CONTROL DEVICES

A. GENERAL:

Pilot devices and instruments shall be flush mounted on a bracket or pin located within the drive unit near the circuit breaker and control transformer. Pilot devices shall be oiltight,

"push-to-test" type. Door-mounted indicating lights shall be removable without removing related wiring. The control units of a given type and size shall be made interchangeable. Control devices shall be as specified in Section 16175.

B. FEATURES:

The following control devices shall be front mounted on the driver enclosure for each motor:

1. Manual speed control potentiometer.

2. HAND-OFF-AUTO selector switch.

3. Motor speed indicating meter.

4. Green/red lights to indicate running and ready to run, respectively.

5. Converter control power white pilot light.

6. Elapsed time meter to totalize converter runing time. Display shall be six digits for hours and tenths nonresettable.

7. Ammeter calibrated in percent motor full load amps.

Frequency regulator shall be provided to operate within the following tolerances:

1. Frequency regulator span shall be 4 mA at minimum speed and 20 mA at maximum speed.

2. Frequency regulator accuracy shall be withiin 1.0 percent of span.

3. Frequency regulator deadband shall be within 0.5 percent of span.

4. Frequency regulator repeatability shall be within 0.5 percent of span.

5. Drive principal time constant shall be 3 seconds or less for drives less than or equal to 200 horsepower; 5 seconds or less for drives greater than 200 horsepower.

6. Frequency reference signal input resistance shall be 550 ohms, maximum.

C. ISOLATION CONTACTOR:

An isolation contactor, on the input side of the VFD unit, shall be included in the unit. Contactor shall be controlled by an external contact, maximum rating will be 5 amps at 120 VAC. Contactor shall drop out upon the opening of the external contact and cause the VFD unit to immediately disconnect the load (uncontrolled stop).

2.05 TEST DEVICES

The adjustable frequency driver shall be provided with the following test devices:

1. Lights to indicate a failure of converter or inverter, SCR, inverter diode, or transistor.

2. Lights to indicate presence of gate pulses on converter and inverter SCR or transistor.

3. Indication of the following fault conditions:

1	No-fault
2	Incorrect phase sequence
3	Blown power fuse
4	Control power supply failure
5	Undervoltage
6	Instantaneous overcurrent
7	Sustained overload
8	Transistor/SCR overtemperature
9	Output overvoltage

4. Meter with switch to test for the following control signals:

   a. Frequency command
   b. Voltage command
   c. Motor voltage feedback
   d. Inverter bus voltage
   e. Current command
   f. Current feedback
   g. Converter command
   h. Filtered inverter bus voltage

5. Test lead and jack for monitoring logic cards.

6. Circuitry for the following test modes:

   a. Manual operation of the inverter through each firing sequence to test power circuit and logic.

   b. Operation of the drive open circuit.

2.06 POWER FACTOR CORRECTION

The collective power factor of the VFD and the motor, when running at full load amps, shall not be less than 0.95. The VFD manufacturer shall provide power factor correction capacitors and resonance filters as required to meet this power factor requirement.

2.07 MOTORS

Motos shall be as specified in the equipment specifications and Section 11060. Motors shall be shipped to the VD manufacturer's testing facility for testing with the VFD.

2.08 SPARE PARTS

One set consisting of the following spare parts shall be provided:

1--each printed circuit board type
1--card extender
1--each relay type
1--inverter SCR assembly (+bus)
1--converter SCR assembly (-bus)
1--converter assembly
1--set each fuse size and type

2.09 PRODUCT DATA

The following information shall be provided 30 days before scheduled equipment delivery:

1. Operation and maintenance information as specified in Section 01730.
2. Certification of completion of load, heat and harmonic tests as specified in paragraph 1.02 E.
3. Manufacturer's product literature.
4. Manufacturer's certification that driver can withstand fault conditions specified in paragraph 1.02 D.

PART 3--EXECUTION

3.01 INSTALLATION SERVICES

The equipment will be installed by others under a separate contract. Installation shall be under the direction of factory trained personnel as specified in Section 11000-3.01. The installation shall be certified by the manufacturer on Form 11000-A specified in Section 01999.

3.02 FIELD INSPECTION AND TESTING

On-site inspection, testing, and certification of the completed installations shall be provided by a qualified field service engineer. A minimum of 5 days of on-site field service shall be provided.

3.03 TRAINING

A minimum of 8 hours on site shall be provided for training the Onwer's personnel in the proper operation of the equipment. Training shall be certified on Form 11000-B specified in Section 01999.

END OF SECTION

SECTION 11090

STANDBY GENERATOR EQUIPMENT

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies two engine-driven generation units, complete with engine starting, operating and safety shutdown controls, generation control equipment, cooling system equipment, silencing equipment, automatic transfer switch, and appurtenances.

B. TYPE:

The generation units shall be driven by LP gas engines, suitable for continuous (standby basis) operation under the conditions specified. The engines shall be naturally aspirated or turbocharged, multicylinder, 4 stroke cycle, electric motor started, and radiator cooled. The generators shall be 4-pole, revolving field, brushless, synchronous type.

C. EQUIPMENT LIST:

Item	Equipment number
Main plant engine generator	EG 9300
Interceptor pumping station engine generator	EG 10200

A. PERFORMANCE AND DESIGN REQUIREMENTS:

1. MAIN PLANT ENGINE/GENERATOR: The standby engine/generator provided under this section for the main plant site shall be 277/480 volt 3 phase and shall be capable of starting and running a 40-horsepower, Code G, silicone controlled rectifier variable frequency drive (VFD) operated centrifugal pump motor with a running load on line consisting of two additioanl similar 40-horsepower VFD operated pumps; one 20-horsepower Code G centrifugal pump; three 15-horsepower Code G centrifugal pump motors; two 5-horsepower submersible centrifugal pump motors; one 3-horsepower centrifugal pump motor; 20 kW of lighting loads without incurring a voltage reduction of greater than 20 percent. The same voltage reduction limitations shall apply for starting any of the other motors listed above with all other loads listed being on line. Additionally, the engine/generator shall not be required to deliver

more than 80 percent of its kW rating for the total running load of all of the items listed. The engine/generator shall be capable of starting and being on line at full load in 10 seconds under any temperature conditions specified in paragraph 11080-1.03.

2. INTERCEPTOR PUMPING STATION ENGINE/GENERATOR: The standby engine/generator set provided under this section for the Interceptor Pumping Station site shall be 277/480 volt, 3 phase and shall be capable of starting and running a 30-horsepower, Code G, silicone controlled rectifier variable frequency drive (VFD) operated centrifugal pump motor with a running load on line consisting of two additional similar 25-horsepower VFD operated pumps; 15 kW of miscellaneous loads; and 2 KW of lighting load without incurring a voltage reduction of greater than 20 percent. Additionally, the engine/generator shall not be required to deliver more than 80 percent of its kW rating for the total running load of all of the items listed. The engine/generator shall be capable of starting and being on line at full load in 10 seconds under any temperature conditions specified in paragraph 11080-1.03.

B. FACTORY TESTING:

1. FACTORY PROTOTYPE MODEL TESTS: To assure that the equipment has been designed and built to the highest reliability and quality standards, the manufacturer shall be responsible for design prototype tests as described herein: components of the system, such as the engine/generator set, transfer switch, and accessories shall not be subjected to prototype tests because the tests are potentially damaging. Rather, similar design prototypes and reliability preproduction models, which will not be sold, shall be used for these tests. Upon request, the following certified test records shall be made available.

a. Maximum power (kW).

b. Maximum starting (kva) at 30 percent instantaneous voltage dip.

c. Alternator temperature rise by embedded thermocouple and by resistance method per NEMA MG1-22.40 and 16.40.

d. Governor speed regulation under steady-state and transient conditions.

e. Voltage regulation and generator transient response.

f. Fuel consumption at no load, 1/4, 1/2, 3/4, and full load.

g. Harmonic analysis, voltage waveform deviation, and telephone influence factor.

h. Three-phase line-to-line short circuit test.

i. Alternator cooling air flow.

j. Torsional analysis testing to verify that the generator set is free of harmful torsional stresses.

k. Endurance testing.

2. FACTORY PRODUCTION MODEL TESTS: Before shipment of the equipment, the engine/generator sets shall be tested under the rated load and power factor for performance and proper functioning of control and interfacing circuits. Testing at unity power factor only (resistance banks only) is not acceptable, since kW output is affected by the higher generator efficiency at unity power factor, and the KVAR for motor starting and regulation loads varies with power factor. Tests shall include:

a. Single step load pick-up per NFPA 110-1985, 1 paragraph 5-13.2.6.

b. Transient and voltage dip responses and steady state voltage and speed (frequency) checks.

1.03 ENVIRONMENTAL CONDITIONS

The equipment to be furnished under this section will be operated indoors at an elevation of 950 feet above sea level. Ambient air temperature is expected to vary between 30 degrees F and 120 degrees F and relative humidity is expected to vary between 10 and 100 percent. The ambient air temperature does not include any heating affect waste heat from the engine may have on the room air temperature which shall be considered for engine cooling requirements.

1.04 SUBMITTALS

The following submittals shall be provided as specified in Section 01300:

1. Outline drawings (plans and sections) for the complete unit showing the location, size and other pertinent details of each electrical, piping and monitoring connection, and overall dimensions.

2. Data showing ratings and characteristics of major components of the engine/generator set/transfer switch sufficient to determine compliance with the specifications.

3. Control diagrams for the tngine and transfer switch.

PART 2--PRODUCTS

2.01 GENERATION EQUIPMENT

A. GENERAL:

Engine/generators shall have the voltage rating and be sized for starting and operating the loads described in paragraph 11080-1.02 A. Each engine/generator set shall be mounted on a heavy duty steel base to maintain proper alignment between components, and each set shall incorporate spring-type isolators.

B. ENGINE:

Engine shall be stationary, liquid-cooled, and operate on LP gas. Design shall be four-cycle, with turbocharger and intercooler where required by engine manufacturer. Engine shall be certified by the engine manufacturer as capable of developing the required horsepower at 1,800 rpm under all environmental conditions specified in paragraph 11080-1.03, driving a generator yielding a kW rating as specified in Section 11080-1.02 A. Engine shall be capable of driving the generator of this rating on a continuous standby basis for the duration of normal utility source interruptions per SAE J1349 conditions. Fuel supply system and valves shall not require adjustment while in service.

C. ENGINE EQUIPMENT:

Engine equipment shall include the following:

1. Electric starter(s) as required by the manufacturer.

2. Positive displacement, mechanical full pressure lubrication oil pump, full flow lubrication oil filters with replaceable elements and dipstick oil level indicator.

3. Carburetor solenoid valve and gas pressure regulator mounted on the engine. A remote fuel vaporizer with heat from the engine cooling system shall also be provided.

4. Engine speed mechanical governing system to automatically control generator frequency to 4 percent or less of rated frequency from no load to full load rated output.

5. Engine protection devices shall have sensing elements located on the engine to initiate the following preliminary alarms and engine shutdowns:

a. Low coolant temperature alarm
b. Low lubrication oil pressure alarm
c. High coolant temperature alarm
d. Low lubrication oil pressure shutdown
e. High coolant temperature shutdown
f. Overspeed shutduwn
g. Overcrank lockout

6. Provide low coolant level shutduwn, which shall activate high engine temperature lamp and shutdown.

7. Engine starter battery charging alternator, with solid-state voltage regulator.

8. Engine mounted thermostatically controlled heater(s) for each engine to aid in quick starting as specified in Paragraph 11080-1.02 A. Heater(s) shall be rated 120 volts single phase.

D. ENGINE COOLING SYSTEM:

Engine shall be radiator cooled by engine mounted radiator system including belt-driven pusher fan, coolant pump(s), and thermostat temperature control. Performance of components shall be as required by set manufacturer. After cooler, if provided, shall be cooled by a water-to-air heat exchanger mounted on the engine.

E. ENGINE EXHAUST SYSTEM:

1. Exhaust muffler(s) shall be provided for each engine of size(s) as recommended by the set manufacturer. Muffler(s) shall be of the residential type.

2. Flexible exhaust connection(s) shall be provided by the contractor as required for connection between engine exhaust manifold(s) and exhaust line, in compliance with applicable codes and regulations.

3. The Contractor shall provide an exhaust condensation trap with manual drain valve to trap and drain off exhaust condensation and to prevent condensation from entering the engine.

4. Provide all necessary flanges and special fittings for proper installation.

F. GENERATOR:

1. Generator shall be single-bearing, self-aligning, four-pole, synchronous type, revolving field, with amortisseur windings, with direct drive centrifugal blower for proper cooling

and minimum noise, with temperature compensated solid-state voltage regulator, with brushless rotating rectifier exciter system. No brushes will be allowed. Generator shall be directly connected to engine flywheel housing and driven through a flexible coupling to insure permanent alignment; gear driven generators are not acceptable under this specification. Insulation shall meet NEMA standards for Class F. The maximum temperature rise shall not exceed 100 degrees C at 40 degrees C ambient. Generator design shall prevent potentially damaging shaft currents.

2. The three-phase, broad range, reconnectible generator shall have 12 leads brought out to allow connection by user to obtain any of the available voltages for the unit.

3. Voltage regulator shall be solid-state design and shall function by controlling the exciter magnetic field between stator and rotor to provide no load to full load regulation of rated voltage within ± 2 percent during steady-state conditions. The engine-generator set and regulator must sustain at least 90 percent of no load voltage for ten (10) seconds with 250 percent of rated load at near zero power factor connected to its terminals.

The voltage regulator shall be insensitive to severe load induced waveshape distortion from SCR or thyrister circuits such as those used in battery charging (UPS) and motor speed control equipment. Wave shape distortion and notching induced by the pump VFD units specified for this project shall not exceed the values specified in Section 11069-1.02 C. The generators shall be capable of performing as specified with this level of distortion and notching.

A rheostat shall provide a minimum of ± 5 percent voltage adjustment from rated value.

4. The generator, exciter, and voltage regulator shall be designed and manufactured by the engine-generator set manufacturer so that the characteristics shall be matched to the torque curve of the prime mover. This design allows the prime mover to use its fullest power producing capacity (without exceeding it or over compensating) at speeds lower than rated, to provide the fastest possible system recovery from transient speed dips. A system that routinely selects a linear-type (straight line) constant volts/hertz characteristic, without regard for the engine power and torque characteristics, will not meet this specification. These characteristics shall be demonstrable as follows:

a. With engine/generator set operating at rated speed, voltage and load, reduce engine speed to half rated by manually overriding the engine speed governor control. Engine/generator set must recover to full speed with the rated load connected when the engine speed governor control is returned to its normal mode.

b. Calculations must demonstrate that the exciter and voltage regulator will permit utilization of at least 80 percent of maximum available prime mover torque at all engine speeds between 50 percent and rated speed, and with rated unity power factor load connected to its teminals.

5. Exciter shall be three-phase, full-wave, rectified, with heavy-duty silicon diodes mounted on the common rotor shaft and sized for maximum motor starting loads. Systems using three-wire solid-state control elements (such as transistors or SCRs) rotating on the rotor shall not be acceptable.

6. Generators shall be provided with UL listed 3-pole molded case output circuit breakers with thermal magnetic trip mounted on the engine/generator.

a. The Main Plant site generator shall have a 480-volt, 3-pole, 400-ampere rated output circuit breaker.

b. The interceptor pumping station site generator shall have a 480-volt, 3-pole 200-ampere rated output circuit breaker.

H. ENGINE/GENERATOR SET CONTROL:

Provide a lighted, unit mounted control module that is factory built, wired, tested, and shock-mounted by the generator manufacturer.

Engine/generator set control shall include the following for each unit:

1. Gauges and meters: oil pressure gauge, coolant temperature gauge, charge rate ammeter and running time meter.

2. Manual selector switch: RUN-STOP-REMOTE.

3. Remote, two-wire controls start/stop terminals.

4. Manual reset field circuit breaker.

5. Automatic engine shut down for the following fault conditions:

a. Overcrank
b. Overspeed
C. Low oil pressure
d. High engine temperature

6. Indicator lamps shall be provided to signal the following functions:

a. RUN--indicates start disconnect.

b. FAULT--indicates overcrank, overspeed, high coolant temperature, or low oil pressure.

7. A fault reset switch shall be provided to clear fault indications and allow restarting of the engine after shut down faults. The control design shall be such that the fault indication shall remain until reset. The fault indicator memory shall not be dependent on the presence of either AC or DC voltage and shall retain the fault status memory even through complete removal and replacement of the starting batteries. The fault reset function shall operate only when the RUN-STOP-REMOTE switch is in the STOP position.

8. Manual reset exciter field circuit breaker.

9. A locking screwdriver type potentiometer shall be provided to adjust the voltage ± 5 percent from rated value.

10. AC voltmeter, 90-degree scale, 2 1/2 inches (61.25 mm) flange, 2 percent switchboard meter.

11. AC ammeter, 90 degree scale, 2 1/2 inches (61.25 mm) flange, 2 percent switchbaord meter.

12. Frequency meter 45 to 65 hertz, 90 degree scale, 2 1/2 inches (61.25 mm) flange, ± 0.6 hertz panel meter.

13. Four position AC meters phase selector switch to read line current and voltage in each phase with off position.

I. AUXILIARY EQUIPMENT:

1. Starting Battery: Two (2) batteries shall be supplied for each engine and shall be mounted in a battery rack within the engine-generator set skidbase, inside the unit enclosure.

2. Battery Charger(s): A voltage regulated battery charger shall be provided for each engine-generator set. Chargers shall be equipped with float, taper, and equalize charge settings. The charger power shall be supplied from a 120-volt single phase source.

3. Vibration Isolators: Each engine/generator set shall be mounted on spring-type vibration isolators.

2.02 TRANSFER SWITCHES

A. GENERAL:

A transfer switch shall be provided with each engine/generator housed in a separate NEMA 1 enclosure with dimensions not exceeding 42 inches wide x 90 inches high x 24 inches deep for remote mounting as shown. Transfer switch manufacturer shall have been regularly engaged in the production of UL Standard 1008 listed transfer switches. The transfer switches shall be documented, and have been offered for sale on the open market for a minimum of 5 years. The manufacturer shall provide factory trained parts and service support through a factory authorized distributor that is regularly doing business within 200 miles of the area of the installation.

The manufacturer shall supply literature containing diagrams, parts lists and descriptions sufficient for the owners personnel or subcontract supplier to install, operate and perform normal maintenance on the equipment.

B. RATINGS:

All transfer switches shall be UL listed per Standard 1008. All transfer switches shall be suitable for use on emergency and legally required standby systems in accordance with ANSI-Cl and NFPA-99, rated for total system load. These loads shall include motors, electric discharge lamps, resistive loads, and tungsten lamps as described in Section 1 of UL Standard 1008. Transfer switches shall have a 22,000 ampere RMS withstand and closing current rating.

Transfer switches shall be 60 Hz with solid neutral. Transfer switch for the Main Plant site shall be suitable for 277/480 volt 3-phase service and shall be 400 ampere minimum. Transfer switch for the interceptor pumping station site shall be suitable for 277/480 volt 3 phase service and shall be 200 ampere minimum.

Transfer switches shall be rated to carry 100 percent of their rated current continuously when in an enclosure. Transfer switches which must be derated when installed in an enclosure (due to integral overcurrent devices or any other reasons) do not meet this specification. Transfer switches shall be rated for continuous operation in ambient temperatures of -40 degrees C (-40 degrees F) to 67 degrees C (142 degrees F).

C. CONSTRUCTION:

Transfer switches shall be over center operation, double-throw construction, positively electrically and mechanically interlockeda by a simple mechanical beam to prevent simultaneous closing (for break before make operation), and mechanically held in both normal and emergency positions.

Transfer switches shall be quick-break, quick-make operation so that the speed of opening and closing is not controlled by an operator during manual operation. Transfer switches shall provide a center "programmed transition" position for manual switching, which shall disconnect the load from both power sources. Transfer switches shall be approved for manual operation under full load by integral mounted, permanently attached, high dielectric, manual operating handles. Manual operating handles, which are normally stored and must be installed for manual operation do not meet this specification.

The electrical operating means shall be a direct-acting, constant force in both directions, bi-directional linear induction motor to provide minimum friction, straight-line switch action. Motor shall be attached directly to the switching mechanism without the use of grears, cams, or other complex mechanical linkage methods. Transfer switches using solenoid operators and relying upon gravity, weights, or momentum for closing in either position do not meet this specification. Transfer switches shall not contain any integral overcurrent devices in the main power circuit, including molded case circuit breakers or fuses. The transfer switch electrical actuator shall have an independent disconnect means to disable the electrical operation during manual switching.

Manual operating handles and controls (other than key-operated switches) shall be accessible to authorized personnel only by opening the key-locking cabinet door. Transfer switches with manual operating handles and non-key-operated control switches located on the outside of the cabinet do not meet this specification.

All transfer switches shall have transparent protective covers to protect operating personnel during manual operation, and to allow an operator to visually determine that the main contacts are "open" or "closed."

The main switch contacts shall be of the no maintenance type and high-pressure silver cadmiun oxide to resist burning and pitting for long life operation. All switches shall have arc chutes of heat absorbing material and metal leaves for positive extinguishing of arcs quickly and effectively; arc chutes shall have insulating covers to prevent interphase flashover.

Transfer switches shall have one single pole double throw, 480 volts auxiliary switch on both the normal and standby sides, operated by the transfer switch. These auxiliary switches shall be factory wired to an easy access terminal block and may be used to monitor transfer switch position for controlling indicator lamps or other peripheral equipment.

Complete aluminum/copper lugs, UL listed and CSA certified, shall be provided for both normal and standby load positions. Load connections shall be field changeable either from top to bottom, or bottom to top. Wiring space at normal, standby, and load lugs inside the transfer switch cabinet shall comply with 1984 NEC Table 373-6(b).

D. CONTROLS:

Control accessories shall be mounted in a separate smaller cabinet mounted on the inside of the main cabinet door. This is to allow for ease of service when the main cabinet lockable door is opened, but to prevent access by unauthorized personnel.

Control circuit disconnect plugs shall be provided to deenergize control circuits to avoid the hazards of electrical shock to personnel while making adjustments.

The electronic control, undervoltage and time delay modules shall be a printed circuit board for ease of service. The solid-state undervoltage sensors shall simultaneously monitor all phases of the normal and standby power sources to provide field adjustable range sensors for specific applications. Voltage pick-up settings shall be adjustable from a minimum of 85 percent to a maximum of 100 percent of nominal voltage. Voltage dropout settings shall be adjustable from a minimum of 74 percent to a maximum of 98 percent of the pick-up setting with a fixed dropout time delay of 0.5 second. Voltage sensors shall be of the temperature compensated type, for maximum deviation over the temperature range of -32 degrees C (-25 degrees F) to 79 degrees C (175 degrees F). Voltage sensors shall allow for adjustment to sense partial loss of voltage on any phase of the normal or standby power source, even where motor feedback voltages exist.

Controls shall signal the standby power system to start upon signal from normal source voltage sensors. Solid-state time delay start shall avoid nuisance engine/generator set start-ups on momentary voltage dips or interruptions.

The transfer switch shall transfer the load to the standby power system after the engine/generator set reaches proper voltage and frequency and has stabilized.

The transfer switch shall control the engine/generator set to allow the set to start and transfer the load within 10 seconds after a normal source power failure. It shall be the responsibility of the transfer switch supplier to meet this requirement.

The transfer switch shall retransfer the load to the normal source after normal source power is restored, allowing normal source to stabilize before retransfer.

The controls shall signal the engine/generator set(s) to stop after load retransfer to the normal source, but shall maintain the availability of the standby source in the event that the normal source fails shortly after retransfer. The controls shall allow the engine/generator set(s) to run unloaded for a cooldown period prior to shutdown.

The controls shall provide an automatic retransfer of the load from the standby source to the normal source if the standby source fails when the normal source is available.

The transfer switch operating power transfer and retransfer shall be obtained from the source to which the load is being transferred.

Controls shall provide built-in "control mode status" indicators, consisting of light emitting diodes to indicate a sequence of functions such as the following:

Source 1 OK
2-wire run
Source 2 OK
Timing for transfer
Transfer command
Timing for retransfer
Retransfer command
Timing for stop

The indicators shall allow the operator to detemine that the controls are properly sequencing and shall assist in determining the sequence of any malfunctions that might occur.

Main cabinet front door mounted controls and indicitor lamps shall consist of oil-tight, neon position indicator lamps (NORMAL--white; STANDBY--amber) and key-operated test and selector switches to provide the following functions:

1. Test Switch:

   a. TEST--simulated normal source power loss to control unit for testing engine/generator set capability, including transfer of load if so equipped. Control system shall provide for system test without load transfer when specified.

   b. NORMAL--Normal operating position and also restores the system to standby operation; if load was transferred, retransfers load from standby to normal source after test and time delays.

c. RETRANSFER--Spring-loaded momentary position of switch that overrides retransfer time delay to cause the immediate return to the normal source after a test or actual power outage.

Transfer switches shall have the "programmed transition" feature by use of the proper program timer. This feature shall incorporate a field adjustable time delay of 5 to 50 seconds. The time delay shall occur during switching in both directions, during which time the load is isolated from both normal and standby sources. This will allow residual voltage components of motors or other inductive loads (such as transformers) to decay before completing the switching cycle. The program timer shall be connected in a manner that will not cause the time delay in switching, where the time delay has already been established by the loss of voltage to the load during normal source power interruptions. Transfer methods that use the phase relationships between the two power sources to control initiation time are not acceptable.

E. ACCESSORY ITEMS:

Transfer switches shall be equipped with the following items:

1. Provide exerciser clock to set day of week (1 week dial minimum), time of day, and duration of time of engine-generator set(s) exercise. Provide a period with/without load selector switch.

2. Provide manual/automatic retransfer selector switch. After normal source is restored, this switch provides either manual or automatic retransfer after the retransfer time delay has expired in the automatic position, or manual retransfer at a time selected by operator.

2.03 PRODUCT DATA

The following data shall be provided:

1. Operation and maintenance information items 1 through 9 as specified in Section 01730.

PART 3--EXECUTION

3.01 INSTALLATION

Engine/generators shall be installed as shown and according to the manufacturer's recommendations.

3.02 FIELD TESTING

The complete installation shall be initially started and checked out for operational compliance by factory-trained representative(s) of the engine/generator set(s) manufacturer. The engine lubrication oil as recommended by the manufacturer for operation under environmental conditions specified, shall be provided by the engine/generator set(s) supplier.

Upon completion of initial start-up and system checkout, the supplier of the system shall perform a field test, with the Engineer notified in advance, to demonstrate load carrying capability and voltage and frequency stability.

A power failure shall be initiated by opening all switches or breakers supplying the normal power to the building or facility. Records shall be maintained throughout the tests of time of day, coolant temperature, cranking time until prime mover starts and runs, time required to come up to operating speed, voltage and frequency overshoot, time required to achieve steady-state condition with all switches transferred to the standby position, voltage, frequency, current, oil pressure, ambient air temperature, kilowatts, power factor, battery charger rate at 5-minute intervals for the first 15 minutes, and at 15-minute intervals thereafter. Continue this load test for 6 hours observing and recording load changes and the resultant effect on voltage and frequency. Return normal power, record the time delay on retransfer for each switch (set for 15 minutes minimum) and the time delay on prime mover cooldown period and shutdown.

Upon completion of the above test, allow the prime mover to cool for 5 minutes. Then apply full rated load (nameplate kW) consisting of building load supplemented by a load bank if required. Unity power factor is suitable for on-site testing, provided that rated load tests at power factor have been performed by the manufacturer prior to shipment. This full load pickup shall be in one step immediately upon reaching rated rpm.

END OF SECTION

SECTION 11100

SLUICE GATES

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies sluice gates of cast iron construction for isolating and draining wastewater channels, tanks and conduits. The Contractor shall assign unit responsibility as specified in paragraph 11000-1.02 C to the sluice gate manufacturer for the combined equipment consisting of sluice gate and operator.

B. TYPE:

Sluice gates shall be of cast iron construction with full metal wedges, flat frames, and wall thimbles.

C. EQUIPMENT LIST:

Item	Equipment number
Plant isolation gate	SG 1001
Bar screen isolation gate	SG 1211A
Bar screen isolation gate	SG 1211B
Bar screen isolation gate	SG 1212A
Bar screen isolation gate	SG 1212B
Channel inlet gate	SG 3051
Channel outlet gate	SG 3052
Channel bypass gate	SG 3053
Waste mixed liquor inlet gate	SG 3352
Clarifier drain gate	SG 5152
RSS sump inlet gate	SG 5153
Clarifier drain gate	SG 5252
RSS sump inlet gate	SG 5253
Chlorine contact channel drain gate	SG 6150
Chlorine contact channel isolation gate	SG 6151
Chlorine contact channel bypass gate	SG 6152

D. OPERATING REQUIREMENTS:

Equipment number	Gate size, inch[1]	Bottom seating[a]	Frame[a] type	Design head, feet Seating	Design head, feet Unseating	Operator type
SG 1001	48	FB	SC	12	14	I
SG 1211A	36x48	FB	SC	4	4	II
SG 1211B	36x48	FB	SC	4	4	II
SG 1212A	36x48	FB	SC	4	4	II
SG 1212B	36x48	FB	SC	4	4	II
SG 3051	24x48	FB	SC	5	5	I
SG 3052	24x48	FB	SC	5	5	I
SG 3053	24x24	S	C	5	5	I
SG 3352	6	S	C	7	7	II
SG 5152	6	FB	C	19	19	III
SG 5153	12	S	C	19	19	III
SG 5252	6	FB	C	19	19	III
SG 5253	12	S	C	19	19	III
SG 6150	8	FB	C	18	18	III
SG 6151	48x48	S	C	7	7	I
SG 6151	48x48	FB	C	7	7	I

[1]Dimensions shown are width and height of gate opening, respectively. If one dimension is shown, opening is circular having the specified diameter.

[a]Abbreviations:

FB = flush bottom
S = standard
SC = self-contained (yoke type)
C = conventional

E. COMPONENT SIZING:

Operating forces used for determining the strength of gate components comprising of yokes, frames, discs, stems, disc nut pockets, and other load bearing members shall be based on the sum of the guide friction force (computed using an opening breakway friction factor of 0.70) and the weight of disc and stem.

When the gate is in motion, the operating forces shall be based on the sum of the frictional force (using a guide friction factor of 0.35) and the weight of disc and stem.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. In case of a conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASTM A126-84	Gray Iron Casting for Valves, Flanges and Pipe Fittings
ASTM A276-84a	Stainless and Heat-Resisting Steel Bars and Shapes
ASTM B98-84	Copper-Silicon Alloy Rod, Bar and Shapes
ASTM B103-81	Phosphor Bronze Plate, Sheet, Strip and Roller Bar
ASTM B139-83	Phosphor Bronze Rod, Bar and Shapes
ASTM B584-85a	Copper Alloy Sand Castings for General Applications
AWWA C501-80	AWWA Standard for Sluice Gates

PART 2--PRODUCTS

2.01 ACCEPTABLE PRODUCTS

Cast iron sluice gates shall be Rodney Hunt, Waterman, or equal.

2.02 EQUIPMENT

A. SLUICE GATES:

1. GENERAL: Sluice gates shall meet the requirements of AWWA C501 except as otherwise specified. Sluice gates shall be of the heavy-duty type. Frames shall be flat back.

Sluice gates shall be provided, unless otherwise specified, with one-piece F-section cast iron wall thimbles. The vertical centerline shall be shown by permanent marks at the top and bottom of the machined face with the word "top" marked near the top center of the thimble opening.

Stems and stem guides shall be provided in accordance with AWWA C501, Sections 3.11 and 3.12. Unless otherwise specified, gates shall have single rising stems. Stems shall have 29-degree acme threads and be turned straight and true and honed to a smooth 63 micro-inch or better finish. Stem couplings, where required, shall be of the stem material. Stem guides shall be of the split, bronze bushed, adjustable type.

B. MATERIALS:

Component	Material
Gate, guide and frame	ASTM A126, Class B, cast iron
Seating faces	ASTM B103 or B139, bronze
Wall thimbles	ASTM A126, Class B, cast iron
Stems	ASTM A276, stainless steel, type 304
Wedges, thrust nut, stem couplings	ASTM B584, bronze, CA872
Fasteners and adjusting hardware	ASTM A276, stainless steel, type 304
Yoke	ASTM A126, Class B, cast iron
Flush bottom seal	Neoprene
Flush bottom retainer bar	ASTM A276, stainless steel, type 304

2.03 OPERATORS

A. GENERAL:

Operators specified include hand crank, handwheel and T-wrench. Operators shall meet AWWA C501 specifications, except as otherwise specified, and shall be designed to meet the operating requirements specified in paragraph 11100-1.01 D. Plastic stem covers shall be provided as specified in AWWA C501, Section 3.14.5.

On both crank and handwheel manual operators, gears and bearings shall be enclosed in a weatherproof cast iron housing, and pressure type fittings shall be provided for grease lubrication of the bearings and gears. A maximum effort of 40 pounds pull on the crank or handwheel shall operate the gate under the specified operating conditions.

B. TYPE I:

Operator shall be the manual, geared, crank type. The operator shall be either pedestal or bench mounted as specified. Pedestal type floor stands shall be the offset type or the standard type with wall mounting bracket. The crank shall be 15 inches long.

The geared floor or bench stand shall have a weatherproof, cast iron housing, with a bronze operating nut, mounted on a high strength cast iron pedestal baseplate. The operating nut shall be internally threaded with 29-degree acme threads corresponding to stem threading. Tapered roller bearings or ball bearings shall be located above and below the bronze operating nut to support the output thrust of the floor stand. The pinion shaft shall be mounted on tapered roller bearings to resist axial and radial thrusts. Mechanical seals shall be provided around the operating nut and the pinion shaft to prevent lubrication from leaving the unit and moisture from entering the sealed housing. The reduction gear case shall be precision machined and equipped with tapered roller or needle bearings and sealed about the reduction shafts.

Operators shall be self-locking at any position of stem travel. The input shaft shall be fitted with an AWWA nut.

C. TYPE II:

Operator shall be the manual handwheel type. The operator shall be either pedestal or bench mounted as specified. Pedestal type floor standards shall be the offset type or the standard type with wall mounting bracket. Pedestal or bench stands shall be cast iron. The head of the pedestal or bench stand operator shall have a solid bronze internally threaded operating nut. The operator shall be mounted on antifriction roller bearings. Handwheels shall be removable from the operator.

D. TYPE III:

Operator shall be the T-wrench type, including floor box, thrust bearings, and lift nut. Floor box shall be of fabricated steel, with galvanized steel hinged cover and embedded in the floor or mounted on a wall bracket as specified on the drawings. Floor box depth shall be such that the gate stem and operating nut does not protrude above the floor under any condition. Wall brackets shall be cast iron or fabricated steel. Thrust bearings shall be roller or ball bearing type, replaceable and protected by seals. Accessible pressure type grease fittings shall be provided for bearing lubrication. Operating nuts shall be AWWA standard 2-inch square head nuts. T-wrenches shall be 4 feet long, aluminum, with socket to match the operating nut.

2.04 COATING SYSTEM

Sluice gates shall be shop coated with coating system CTE as specified in Section 09900.

2.05 PRODUCT DATA

The following information shall be provided in accordance with paragraph 00710-4.02:

1. Product information, calculations, charts or graphs to verify that the product provided meets the requirements set forth in this specification.

2. Results of the shop seat clearance check and the leakage tests as specified in AWWA C501, Sections 4.2 and 6.3.

3. Results of the field leakage test specified in paragraph 11100-3.02.

PART 3--EXECUTION

3.01 GENERAL

Unless otherwise specified, sluice gates shall be installed in accordance with manufacturer's instructions.

3.02 TESTING

A field leakage test shall be performed by the Contractor after installation of the sluice gate. The manufacturer shall be notified of the test in sufficient time to enable him to have a representative present at that test. After all adjustments have been made and the mechanisms properly lubricated, each gate slide shall be run through one complete cycle as a final check on proper operation before starting the leakage test. Seating and unseating heads shall be measured from the top surface of the water to the center of the gate.

Under the design seating head, the leakage shall not exceed 0.1 gpm per foot of seating perimeter.

Under the design unseating head, the leakage shall not exceed 0.2 gpm per foot of seating perimeter.

END OF SECTION

SECTION 11105

SELF-CONTAINED SLIDE GATES

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies self-contained slide gates for use as weirs and for isolating and draining wastewater channels, tanks, and conduits.

B. TYPE:

Slide gates shall be aluminum, self-contained type, complete with frame, seals, and operator. Slides shall be downward opening with flat back frames and rising stems, as specified in paragraph 1.02 C. Slide gates shall be Rodney-Hunt, Waterman, or equal.

C. EQUIPMENT LIST:

Item	Equipment number
Waste mixed liquor sump inlet gate	SG 3351
Clarifier inlet gate	SG 5151
Clarifier inlet gate	SG 5251

1.02 QUALITY ASSURANCE

A. GENERAL:

Gates, lifts, stems, and accessories shall be of the size, type, and construction specified in paragraph 1.02 C. and shown on the drawings.

B. ENVIRONMENTAL CONDITIONS:

Gates will normally be submerged and shall be designed for continuous exposure to wastewater. Environmental conditions will be as specified in Section 01800.

C. OPERATING REQUIREMENTS:

Equipment number	Gate size opening, inches (1)	Design head, feet	
		Seating	Unseating
SG 3351	24x24	1	1
SG 5151	12x60	2.5	2.5
SG 5251	12x60	2.5	2.5

(1) Dimensions shown are width and height of gate opening to be blocked, respectively.

PART 2--PRODUCTS

2.01 MATERIALS OF CONSTRUCTION

Component	Material
Side guides, slide plate, slide reinforcing and retainer	Aluminum, ASTM B209 or ASTM B308, Alloy 6061-T6
Fasteners	Stainless steel, ASTM A320 and ASTM A194, Type 304
Seals	Neoprene
Stem	Stainless steel, ASTM A276 Type 304 or ASTM A583, Type 303
Handwheel	Cast iron

2.02 EQUIPMENT

A. SLIDE GATES:

Slides shall be minimum 3/8 inch thick. The slide shall be reinforced with structural shapes to limit deflection to 1/360 of the span of the gate under the design head.

Guide frames shall be flat back type mounted flush with wall opening, shall be for surface mounting on end walls, and shall be continuously welded in one piece to form an integral unit. Guide frames shall be provided with "J" bulb seals for added watertightness.

Stem diameters shall be adequate to safely withstand twice the force created by a 40-pound pull on the handwheel. The threaded portion of the stem shall have Acme-type cold-rolled threads with a maximum surface roughness of 32 microinches. The bottom of the stem

shall be bolted to the pocket on the gate slide. The stem shall be supported by stem guides spaced to provide an l/r ratio of 200 or less. Gate slide pocket shall be designed to safely carry the thrust developed during gate operation.

B. OPERATORS:

1. GENERAL: Operators shall be designed to operate gate with a maximum effort of 40 pounds applied at the handwheel, based on a guide friction factor of at least 0.70. Clear plastic stem covers shall be provided to enclose the rising stem above the operator.

2. SLIDE GATES: The operator shall be of the removable handwheel lift type with the lift base bolted to the gate frame. The lift shall be supplied with ball bearings placed above and below the flange of the lift nut. The lift shall be equipped with grease fittings for lubricating the bearings. The maximum radius of the handwheel shall be 15 inches and the handwheel shall have an arrow to indicate the direction of opening.

2.03 PRODUCT DATA

In accordance with paragraph 00710-4.02, the following information shall be provided to the Construction Manager:

1. Installation drawings
2. Materials of construction
3. Operator sizing information
4. Required concrete block nuts and anchor bolt information.

PART 3--EXECUTION

Contractor shall coat all surfaces of aluminum in contact with concrete with a heavy coat of bitumastic paint. Ferrous, nonmachined surfaces shall be field coated in accordance with Section 09900. Guide frames shall be anchored to concrete in accordance with the manufacturers' installation details. The Contractor shall set gate operators to ensure no interference with adjacent handrailing or other structural features.

END OF SECTION

SECTION 11121

ARTICULATED RAKE CLEANED BAR SCREEN

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies one heavy duty mechanically cleaned bar screen, complete with all accessories, in compliance with the following specifications.

B. TYPE:

The equipment furnished under this section shall be front cleaned by a single articulated rake arm. Mechanisms which utilize either multiple rakes, chains, cables, or hydraulic cylinders to lift debris from the channel will not be acceptable. Backcleaned screens or designs which have moving parts permanently below the channel water surface at maximum design flow are explicitly excluded under this specification.

C. EQUIPMENT LIST:

Equipment numbers are as follows:

Item	Equipment numbers
Mechanical bar screen	SCR1211
Reverse limit switch	ZS1211A
End of travel limit switch	ZS1211B
Torque limit switch	WSH1211

1.02 QUALITY ASSURANCE

A. GENERAL:

Equipment furnished under this section shall be suitable for operation in wastewater from a municipal collection system.

The wastewater may be expected to contain coarse waste solids, vegetable parts, small sections of lumber, rags, rocks, sand, silt, petroleum products, industrial solvents and animal fats and oils. The wastewater will have a pH which may range from 6 to 8.

B. DESIGN REQUIREMENTS:

The following shall apply to the bar screen furnished under this specification:

Peak capacity, mgd	Channel Width, ft	Channel Depth, ft	Maximum upstream water depth, ft	Maximum velocity through bars, fps	Maximum motor HP
10	3	4.14	2.5	3.0	1.5

The bar screen shall be designed for continuous duty under the conditions set forth above. The design shall also ensure that all maintenance to the mechanism can be accomplished at or above the operating floor level. The bar screen shall be designed such that the motor will always be above the maximum water surface specified.

The bar rack shall be cleaned by a cogwheel driven rake arm assembly which shall function in the following manner: The rake arm shall be held in front, upstream of and away from the bar rack as it traverses into the channel to begin raking motion. When the rake arm approaches the channel invert, it shall mesh with the bar rack and travel up the bar rack cleaning and collecting trapped material. The rake arm shall transport the material up out of the sewage flow, across a deadplate and discharge to a belt conveyor with the top of belt located five (5) feet above top of the channel. Dimensions and elevations shall be verified at the site prior to fabrication.

1.03 ENVIRONMENTAL CONDITIONS

The equipment to be furnished under this section will be installed outdoors at a municipal wastewater treatment plant near Avondale, Arizona. The equipment will be subjected to frequent hose down for cleaning purposes. The equipment shall suitable for continuous operation under the environmental conditions specified in Section 01800.

1.04 SUBMITTALS

The mechanism manufacturer shall submit 4 copies of the following information to the Construction Manager in accordance with Section 01300:

1. Required concrete blockouts and anchor bolt information.

2. Shop drawings and materials of construction.

3. Detailed installation instructions and drawings.

4. Electrical diagrams.

5. Motor data form in accordance with Section 11060 (Form 11060-A specified in Section 01999).

Items shall be submitted in one complete package in accordance with the schedule specified in Section 01010.

1.05 OPERATION AND MAINTENANCE DATA

The following information shall be provided:

1. Operation and maintenance information in accordance with Section 01730.

2. Maintenance manuals in accordance with Section 01730.

1.06 SPARE PARTS

Spare parts shall be provided as follows:

1--wiper blade
2--cogwheels
50--rollers and bushings for the pin rack
2--limit switches

PART 2--PRODUCTS

2.01 MATERIALS

Bars	ASTM A36 steel
Deadplate	ASTM A36 steel
Rake arm	ASTM A500B structural tubing
Fasteners and hinges	ASTM A320 type 304 or 316 stainless steel
Side frame and cross members	ASTM A36 steel
Pin rack	
Rollers	AISI C1018, Rockwell hardness 55-60
Bushings	AISI C1018, Rockwell hardness 58-63
Cogwheels	AISI 1045 flame hardened steel with tooth bearing surface Rockwell hardness 50 R.C.
Drive shaft	AISI C1045, hot finished steel
All other shafting	AISI C1045, cold finished steel
Wiper	ASTM A36 steel

2.02 EQUIPMENT

A. GENERAL:

The bar rack shall be inclined from vertical and shall withstand, without deflection, damage or distortion, the loads imposed by a 3-foot water differential between the upstream and downstream side of the bar rack at maximum water depth in the upstream channel.

The only flow obstructions in the channel shall be the bar rack and rake arm. All structural supports and fasteners shall be recessed into the channel walls so they do not interfere with flow.

B. BAR RACK AND DEADPLATE:

The bar rack shall consist of steel bars 3/8 inch thick by 2.5 inches wide, formed straight and true, and held firmly and accurately in place with 3/4-inch clear openings. The bar rack bars shall be individually welded to a steel plate at each end. The bar rack shall be firmly anchored to the channel floor and extend a minimum of 8 inches above the maximum water depth in the channel. The top of the bar rack shall be attached to a deadplate.

The deadplate shall be made of steel plate having a minimum thickness of 1/4 inch, shall extend from the top of the bar rack to the floor level. A 10-gauge fully shrouded apron shall be provided from the floor level to the discharge lip.

C. SIDE AND BASE FRAMES:

The side frame shall be recessed into the channel walls to provide an unobstructed path for the rack cleaning mechanism. There shall be a minimum 8-inch clearance between the bottom of the side frame and the maximum water surface elevation to assure that no section of the side frame is immersed in the wastewater. The side frame shall be constructed of 3/8-inch thick minimum steel plate suitably reinforced to support the required loads. The frame shall be securely fastened to the concrete channel.

The base frame shall be a structural or formed channel at least 8 inches high. It shall be anchored with not les than four (4) anchor bolts on each side of the channel.

D. RAKING SYSTEM

1. GENERAL: Articulated rake cleaned bar screen shall employ a cogwheel and pin rack to power the rake arm. The motor and drive unit shall be mounted on the cogwheel shaft and shall move up and down the pin rack with the rake arm.

The mechanism shall be so designed that the rake can climb over and be free of an object encountered that cannot be removed. After the object has been bypassed, the rake shall again mesh with and continue to clean the bar rack. Positive overload protection against an object which is too large to be bypassed shall be provided by mounting the drive on a spring restrained rotating support. If the load on the rake carriage mechanism increases beyond a predetermined value, the drive and linkage shall rotate, causing a limit switch to stop the drive. When the overload condition has been corrected and the limit switch manually reset, the drive may again be operated.

The rake mechanism supplied shall be designed to be reversed by manual operated electric control to allow the operator to reverse the rake assembly free of the object which has caused the overload for unobstructed removal of the object by other means.

2. RAKE ARM ASSEMBLY: The rake arm assembly shall include guide rollers, cogwheels, rake arm spring and drive components (including motor). The entire system shall move up and down a set of pin racks mounted on the side frame. The debris shall be removed from the bar rack by the rake arm. The rake arm shall consist of a structural member and a shaped perforated plate cleaning rake with teeth designed to mesh with the bar rack. The rake arm shall be supported by the main drive shaft which in turn shall be attached to 2 cogwheels which shall rotate on and be supported by the pin rack. The rake arm shall be held against the bar rack by a heavy-duty coil spring and shall be kept in proper alignment by guide rollers which shall travel in channel-type tracks attached to the side frame.

Cleaning rakes shall be of reinforced steel plate and shall have teeth suitably shaped to effectively clear the top and side of the bars. The rake shall be formed from 1/4-inch plate section to form a shelf a minimum of 10 inches in depth.

The structural member which connects the cleaning rake to the main drive shaft shall be designed to handle all anticipated loads utilizing a conservative factor of safety. The torque overload switch shall provide positive overload protection against an object encounterd which cannot be removed.

3. RAKE ARM DRIVE: The rake arm shall be driven by a cogwheel and pin rack. The system shall withstand all loads and stresses to which it is subjected during operation. The cogwheel shall be flame hardened steel with a tooth bearing surface having a minimum Rockwell hardness of 50. The cogwheels shall be firmly keyed to the rake arm drive shaft.

The pin rack pins shall be specially manufactured using case-hardened rollers and bushings. Rollers shall have a minimum Rockwell hardness of 55 to 60. Bushings shall have a minimum Rockwell hardness of 58 to 63.

4. DRIVE UNIT AND MOTOR: The drive unit shall be powered by an electric motor. The motor shall be closed coupled to a gear reducer. The gear reducer shall be of the helical-worm type with a cast iron housing and have a service factor rating of 1.25 based on design running load. Drive system shall provide a lineal rake arm velocity of 20 feet per minute. Gear reducer bearings shall be anti-friction with oil bath lubrication. The motor shall contain an integral spring loaded electro-mechanical disc brake released by energization of the operating coils simultaneously with starting the motor. Brake motors shall comply with either NEMA or DIN standards.

The drive motor shall be Type 2 and shall comply with Section 11060.

E. SHAFTING:

All shafting shall be straight, true and of sufficient section to transmit the power required. Keyways with fitted keys shall be provided at sprocket or cogwheel connections. All rotating shafts shall be within a housing or cover. No rotating shafts shall be exposed.

F. WIPER AND DISCHARGE CHUTE:

The rake shall be guided over the discharge point and the accumulated debris shall be removed by a scraper arm attached to the side frame and designed to pivot to allow efficient cleaning of the rake on each pass. This scraper shall be fabricated of steel plate, and mounted on two steel pivot arms provided with self lubricating oilite bronze sleeve bearings. Adjustable shock absorbers shall regulate the return of the wiper. The wiper shall be so designed that screenings cannot wrap around the rake or the wiper during the process of screenings removal.

G. CONTROLS:

The bar screen shall be activated in the automatic mode by a timer or by an existing high influent channel level switch. Controls other than those specified in paragraph 2.02 H. below will be provided by others. In addition, a local control station will be provided by others to operate the bar screen in the forward or reverse direction. This local station will be equipped with forward-off-reverse positions. The manufacturer's recommended control logic diagram shall be provided with the bar screen.

H. ELECTRICAL

1. GENERAL: All conduit shall be rigid or intermediate metal conduit or liquid-tight flexible metal conduit. All electrical devices shall have their connection points run to a junction box mounted on the unit for connection by others.

2. END OF TRAVEL LIMIT SWITCH: A rake travel limit switch shall be mounted on the equipment. The switch shall be NEMA 4 enclosure SPDT and shall be actuated at a predetermined rake storage position.

3. REVERSE LIMIT SWITCH: A NEMA 4 enclosure SPDT limit switch arranged to actuate on reverse travel shall be provided to prevent the rake from reversing past the wiper.

4. HIGH TORQUE LIMIT SWITCH: A NEMA 4 enclosure SPDT limit switch arranged to activate on high drive torque shall be provided to stop the drive and initiate an alarm on high torque.

PART 3--EXECUTION

3.01 INSTALLATION AND TESTING

The bar screen shall be factory assembled and tested before being shipped. Units shall be shipped assembled for field erection by the General Contractor, unless shipping limitations or special installation requirements dictate otherwise. If knocked down, equipment shall be shipped in the minimum practical number of pieces for field assembly and erection by the General Contractor.

The screen manufacturer shall provide 2 days of field service by a qualified service engineer to inspect and test the completed installation for lubrication, alignment, free operation, etc., and to instruct the Owner's personnel in the proper operation and maintenance of the equipment. The installation shall be certified by the manufacturer on Form 11000-A specified in Section 01999. Instruction of the Owner's personnel shall be certified on Form 11000-B specified in Section 01999.

END OF SECTION

SECTION 11145

GRIT SEPARATION AND DEWATERING EQUIPMENT

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section includes equipment for separating and dewatering pumped grit slurries.

B. TYPE:

Grit separators shall be the top overflow, bottom discharge cyclonic type. Grit dewaterers shall be the helical screw classifer type.

C. EQUIPMENT LIST:

Equipment numbers are as follows:

Item	Equipment number
Grit separator	SEP 1320
Grit dewaterer	SEP 1330

1.02 QUALITY ASSURANCE

A. PERFORMANCE:

The grit separators and dewaterers shall be designed to separate and dewater solids from a grit slurry generated from screened domestic wastewater containing up to ten (10) percent solids by volume. The grit slurry will be comprised of sand, sticks, gravel, petroleum products, industrial solvents, organic solids, detergents, paper products, and some slaughterhouse waste products. Grit separators shall be capable of removing no less than 99 percent of all grit particles in the inlet slurry having a diameter equal to or greater than that retained on a 150-mesh U.S. standard sieve and specific gravity of 2.65 or greater.

The grit dewatering unit shall be designed to dewater grit from the underflow of the grit separators. The unit shall be capable of dewatering the grit slurry to a moisture content of not more than 65 percent at rates up to 2,500 pounds of grit particles per hour. The unit shall be designed to capture particles having a diameter greater than that retained on a 150-mesh U.S. standard sieve when operating in the cyclone underflow mode and greater than 60-mesh when operating in the air lift pump mode.

B. OPERATING REQUIREMENTS:

1. GRIT SEPARATOR:

Inlet flow rate, gpm	305
Inlet pressure, psig	10
Underflow rate, gpm	16
Inlet port size, inches	4
Overflow port size, inches	6
Apex diameter, inches	2
Vortex finder diameter, inches	4

2. GRIT DEWATERER:

Classifier size, inches	12
Maximum motor horsepower	3/4
Motor type	TEFC
Maximum screw speed, rpm	12

1.03 ENVIRONMENTAL CONDITIONS

Grit separators and dewaterers shall be designed for continuous operation in a municipal wastewater treatment plant situated near Avondale, Arizona. Environmental conditions will be as specified in Section 01800 of these specifications.

1.04 SUBMITTALS AND DELIVERY

Submittals shall comply with Section 01300.

1.05 SPARE PARTS

The following spare parts shall be provided:

Grit separator:

One set of all liners
One vortex finder gasket
One retainer ring

Grit dewaterer:

One lower bearing assembly
One lock bushing
One set wearing shoes with bolts and nuts

PART 2--PRODUCTS

2.01 MATERIALS

A. SEPARATOR:

Component	Material
Cone housing	Aluminum
Cone lining	Natural rubber
Flanged inlet, overflow ports	Ductile iron, ANSI A21.10
Inlet head housing	Ductile iron, ASTM A395
Inlet head liner	Natural rubber
Vortex finder	Ni-hard cast iron
Apex housing	Aluminum
Apex liner	Natural rubber
Cylinder housing	Steel, A131 1015
Cylinder lining	Natural rubber
Retainer ring	Steel, A151 1015 to 1020

B. DEWATERER:

Component	Material
Tank assembly	Steel, A151 1015 to 1020
Lower bearing assembly	Cast iron
Pivot beam and motor support	Steel
Spiral screw assembly	Steel
Lifting device	Steel
Separator support	Galvanized steel
Spray assembly	Steel
Spiral guards	Expanded metal
Wearing shoes	Steel

2.02 EQUIPMENT

A. SEPARATORS:

1. INLET AND OVERFLOW: Inlet and overflow for each separator shall be provided with fittings suitable for use with grooved end pipe couplings. The inlet shall be provided with a 0- to 25-psig pressure gage, calibrated in 0.20-psi increments and complete with sealed diaphragm.

2. APEX: The apex housing shall be of the fixed type. Quick disconnecting devices shall be provided to allow the removal of the apex assembly without disconnecting any other piping.

B. DEWATERER:

1. SETTLING TANK: The settling tank shall be a full flare fabricated steel tank constructed of not less than 1/4-inch steel plate, hot-dip galvanized as a complete unit after fabrication. It shall be suitably reinforced, mounted on steel legs and be designed to provide a settling compartment where grit separation takes place and a discharge trough for the grit conveyor. The depth of liquid in the settling compartment shall be regulated by an adjustable overflow weir at the end of the settling tank. Adjustable weirs for water level regulations shall provide a minimum pool depth of 150 percent of the dewatering conveyor diameter. The overflow weir shall discharge into an overflow launder box which shall be equipped with grooved mechanical overflow and overflow drain connections. The design of the settling tank shall prevent the accumulation of scum on the tank's water surface by providing a full width overflow weir and a flow pattern which sweeps scum over the weir.

2. DEWATERING CONVEYOR: The grit shall be removed from the bottom of the settling compartment and discharged by means of a 50 percent pitch helical conveyor. The helix shall be made up from preformed heavy steel flight sections with a minimum thickness of 3/16-inch welded to the shaft, fitted with wearing shoes. The wearing shoes shall be replaceable and shall be mounted on the flights by means of countersunk stainless steel bolts and nuts.

The pipe shaft of the conveyor shall be designed with a maximum stress of 3,000 psi, and a fatigue life, at 98-percent reliability, of 20 years minimum.

3. CONVEYOR SUPPORTS AND BEARINGS: The lower end of the conveyor shall be supported by a bearing attached to a manually operated handwheel and screw-type lifting device designed to allow the entire assembly to be lifted above the maximum water level. The upper end of the conveyor shall be rigidly connected to, and supported by, the drive unit. The drive and motor assembly shall in turn be supported by a pivoted frame. The pivot shall be located at the same level as the conveyor shaft centerline to permit raising of the conveyor without disconnecting the drive unit. The lower bearings shall be oil lubricated with a cast iron housing. The bearing shall be designed to withstand all thrust loads due to operation of the conveyor. The housing shall be provided with stainless steel cap screws, fill and drain plugs. The bearing shall be encapsulated and provided with a permanent seal to prevent leakage of oil and entrance of grit or foreign particles into the bearing. The seal shall be of the self-compensating type consisting of two mating hardened steel alloy rings, each held in place by a rubber toric. The wearing surfaces of the rings shall be precision lapped to form an initial sealing band of approximately 1/32 inch wide. The seal assembly shall be so designed that as the seal rings wear down througn operation, the pressure from the rubber torics shall push the rings further against each other to form a broadened contact band.

The upper end of the conveyor shall be connected to a cycloidal motion speed reducer by a flanged, rigid coupling. The cycloidal speed reducer shall be designed so that all torque is transmitted by rollers, and shall be capable of withstanding shock loads of 500 percent of rated loading. The cyclodrive shall take radial and all thrust loads from the shaft, and at maximum load provide a minimum B-10 bearing life of 50,000 hours.

4. DRIVE UNIT: The dewaterer drive unit shall be a 1,750-rpm Type 2 motor driving the cycloidal speed reducer described in paragraph 2.02 B.3. by means of a V-belt drive. Gear type speed reducers are not acceptable. The motor shall comply with the requirements of Section 11060.

PART 3--EXECUTION

Contractor shall provide for on-site start-up service by a qualified factory-trained equipment manufacturer's representative. As a condition precedent to final acceptance of the work, the manufacturer's representative shall demonstrate to the Construction Manager that the equipment has been properly installed, aligned, and tested and meets all requirements for satisfactory performance under the conditions specified herein. The Contractor shall provide the Construction Manager with five (5) copies of the manufacturer's certification stating that the equipment has been properly installed, aligned, and tested and meets all requirements for satisfactory performance under the conditions specified herein. Forms 11000-A and 11000-B, specified in Section 01999, shall be completed and provided to the Construction Manager.

END OF SECTION

SECTION 11148

GRIT REMOVAL UNIT

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies furnishing one grit removal unit for installation by others within a circular concrete grit removal chamber. All appurtenant items as described herein shall also be furnished.

B. TYPE:

The grit removal equipment shall be of the circular vortex type.

C. EQUIPMENT IDENTIFICATION NUMBERS:

Item	Equipment number
Grit removal unit	MME1300

1.02 QUALITY ASSURANCE

A. GENERAL:

The grit removal device shall have a headloss of less than 1/4 inch, at maximum flow, and shall be capable of removing grit from screened wastewater and depositing it in the grit storage chamber.

All devices, lubrication and support equipment bearings shall be readily accessible from the access walkway at ground level.

The grit shall be directed downward onto the floor of the grit chamber, hydraulically washed by the propeller or paddles, and shall pass into the grit storage chamber through an opening between the two chambers.

The manufacturer shall guaranty performance as specified for the grit removal device, and shall carry out a test to prove that the equipment performs as specified. Full scale factory tests performed under actual design flow conditions or independent test

data for an equivalent unit operating under similar design flow conditions will be an acceptable substitute for field performance testing of grit removal. Model tests utilizing other than full scale equipment operating at the published design capacity are not an acceptable substitute for the specified tests.

B. OPERATING CONDITIONS:

The grit removal unit shall be capable of removing grit according to the sizes and quantities indicated below:

95 percent of grit greater than 50 mesh in size
85 percent of grit greater than 70 mesh in size
65 percent of grit greater than 100 mesh in size

The grit chamber shall handle all flows less than the hydraulic peak flow of 30 mgd without loss of grit removal efficiency.

Grit will be removed from the grit storage chamber by means of a recessed impeller torque flow pump provided under a separate contract.

The drive unit shall be designed for 24-hour per day continuous service.

1.03 ENVIRONMENTAL CONDITIONS

The equipment to be furnished under this section will be installed outdoors in the headworks of a municipal wastewater treatment plant near Avondale, Arizona, which serves a predominantly residential community. However, some minor quantities of commercial and industrial wastes may be present in the wastewater. The equipment shall be suitable for continuous operation under the environmental conditions specified in Section 01800.

1.04 SUBMITTALS

The mechanism manufacturer shall submit 4 copies of the following information to the Construction Manager in accordance with Section 01300:

1. Required concrete blockouts and anchor bolt information.

2. Shop drawings and materials of construction.

3. Detailed installation instructions and drawings.

4. Electrical diagrams.

5. Motor data form in accordance with Section 11060 (Form 11060-A specified in Section 01999).

6. Results of factory testing demonstrating compliance with the performance specified, or proposed field test procedure.

PART 2--PRODUCTS

2.01 MATERIALS

Component	Material
Gearmotor enclosure	Non corrosive aluminum
Gears	Hardened and heat treated alloy steel
Spur gear pinion	High strength normalized steel
Bull gear	Wear resisting meehanite
Gear case	Heavy cast iron

2.02 EQUIPMENT

A. GENERAL:

The manufacturer shall furnish all of the necessary appurtenant items to produce a fully functioning normally operating grit removal unit.

B. PROPELLER:

The grit removal unit shall have a variable pitch propeller or paddle for gently agitating the flow and maximizing the removal of organics. The propeller or paddle pitch and speed shall be factory set for optimum grit removal efficiency at an initial flow range of 0.6 to 8.75 mgd.

C. DRIVE:

The propeller shall be driven by a totally enclosed gearmotor with a service factor of 2.0 or better. Drive shall be via a drive tube driven by a spurgear supported by a turntable bearing. The gearmotor shall drive a large spur tooth bull gear enclosed in a grease packed gear case. The drive shall be protected from torque overload by means of a shear pin device.

Gear teeth shall be hobbed and crown-shaved or crown ground. Helical gearing shall be oil lubricated. The bull gear shall be mounted on a turntable bearing with a minimum fiameter of 20 1/2 inches. Pinion and bull gears shall have a service factor of 5.0 or better.

The bull gear box shall be specifically designed for this service. It shall have an opening for a minimum 10-1/2-inch-diameter drive torque tube to the propeller or paddle. The gearbox shall be

sealed with ground joints. The bottom opening shall have an air bell around the drive torque tube to prevent water from entering the gearbox in case of flooding.

The top of the gearbox shall have a bolted flanged connection for the air lift pipe. All bearings shall be rated for 50,000-hour life in accordance with Section 11000.

D. MOTOR:

The drive motor shall be a Type 2 motor suitable for outside installation, and shall comply with Section 11060. It shall have normal starting torque and low starting current. The motor shall be non-overloading under any normal operating conditions encountered and shall be 2 HP maximum.

E. CORROSION PROTECTION:

Corrosion protection shall be as specified in Section 09900.

F. ANCHOR BOLTS AND EMBEDDED ITEMS:

All required anchor bolts, templates, and embedded items shall be furnished in accordance with the schedule specified in Division 1, Section 01010.

2.03 PRODUCT DATA

In accordance with paragraph 00710-4.02, the following information shall be provided to the Construction Manager:

1. Operation and maintenance data in accordance with Section 01730.

2. Maintenance manuals in accordance with Section 01730.

PART 3--EXECUTION

3.01 FACTORY ASSEMBLY AND TESTING

The grit removal unit shall be factory assembled and tested before being shipped.

3.02 FIELD TEST

When required in accordance with the provisions of paragraph 1.02 A., a field test shall be conducted under the supervision of the manufacturer's representative in the presence of the Construction Manager. In any event, the manufacturer shall provide 2 days of field service by a qualified field service engineer to inspect and test the completed installation for proper alignment, lubrication, free operation, adjustment, etc., and to instruct the Owner's operating personnel in the proper operation and maintenance of the equipment. Forms 11000-A and 11000-B specified in Section 01999 shall be used to certify the installation and instruction, respectively.

END OF SECTION

SECTION 11190

SECONDARY CLARIFIER TANK EQUIPMENT

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies equipment for two secondary clarifiers as follows: sludge and scum collection equipment, flocculator skirts, scum baffles, scum troughs, drive equipment, a bridge and center operating platform for access to the drive equipment, and miscellaneous appurtenances as shown and specified. The equipment shall be suitable for use in the gravity separation of secondary solids from the mixed liquor.

B. TYPE:

Center column-fed circular secondary clarifier equipment shall be furnished under this section. It shall have an energy dissipating influent distribution tub and feed well and the sludge collection equipment shall be of the hydraulic suction, multiple-inlet, sludge removal type, suitable for use with circular sedimentation tanks. It shall be specifically designed for the conditions described and shown.

C. EQUIPMENT IDENTIFICATION NUMBERS:

Equipment numbers are as follows:

Item	Equipment number
Secondary clarifier 1	COL 5100
Secondary clarifier 2	COL 5200

1.02 QUALITY ASSURANCE

A. PERFORMANCE AND DESIGN REQUIREMENTS:

1. GENERAL: Mixed liquor from the oxidation channel will be distributed to the sedimentation tanks through draft tubes connecting the mixed liquor transfer channel with the sedimentation tank inlet columns.

Kinetic energy available at the outlet of the sedimentation tank's center column inlet ports shall be dissipated through the dual effects of adjustable baffle gates at the periphery of the tank's influent distribution tub and the feed well's deep flocculation skirt. The system shall be arranged to direct the flow entering the tank into a spiral flow pattern outboard of the distribution tub to achieve nearly zero kinetic energy when it passes under the flocculation skirt.

Sludge accumulations shall be removed from the floor of the tank through the combined operation of the continuously rotating sludge collection mechanism and the return secondary sludge (RSS) pumps. The hydraulic collector shall be equipped with two squeegee and scraper blades that sweep the entire length of the clarifier floor.

Scum from the surface of each tank shall be collected and deposited into scum collection hoppers by two skimming arms fitted with articulated blades. Adjustable limit switches shall be provided for operation of common circuits activating a spray system to be installed at the scum box.

The central influent pier shall be designed to support the drive mechanism, the sludge collection mechanism, utility piping, access bridge beams and walkway, and the center operating platform beams and deck. All drive gears shall be located above water level and all gearing shall be completely enclosed and oil lubricated. The drive cage, sludge collector arms, and associated supports shall be designed to safely carry all loads and stresses associated with the application of 150 percent of the rated running torque specified. Sludge collectors shall be designed for balanced torque load on the center column with no submerged bearings.

The access bridge and operating platform shall be designed for a live load of 100 pounds per square foot. Deflection under full live load and dead load shall not exceed 1/360 of the span. The effluent troughs and their supports shall be designed for stable, safe, distortion-free operation when full of water and the tank empty, and vice versa. The effluent troughs shall be designed for no more than 0.01-foot lateral deflection of the trough sidewalls with the tank full to the effluent weirs and the troughs empty. Vertical deflection with the trough empty and the tank full, or vice versa, shall be not more than 0.01 foot between supports. Crossing bracing between the interior walls and the troughs will not be allowed.

The drive mechanism shall be designed in accordance with AGMA 218.01, and AGMA 440.04 for 24-hour continuous duty, uniform loading, and 20-year design life based on the specified rated running torque and maximum collector tip speed.

The influent distribution tub shall be designed for stable, safe, distortion-free operation under any unbalanced load condition which could occur during draining or filling of the tank.

Except where indicated otherwise, all plate and structural members designed for submerged service shall have a minimum thickness of 1/4 inch.

2. DESIGN AND OPERATING REQUIREMENTS: Each tank shall be designed and operable for the following conditions:

Internal diameter, feet	75
Sidewater depth, feet	16
Freeboard, at max inlet flow, feet	3.0
Influent column ID, inches	36
Rated running torque, foot-lbs applied at output of drive unit	30,000
Secondary baffle (flocculator skirt)	
Diameter, feet	24
Depth below water surface, feet	8
Influent distribution tub	
Diameter, feet	8
Depth, feet	5
Diffusion gates, minimum number	6
Maximum inlet flow, mgd (peak flow with 100 percent RSS return)	10.5
Minimum inlet flow, mgd (minimum flow with 100 percent RSS return)	3.5
Maximum RSS flow, mgd	3.5
Minimum RSS flow, mgd	1.75
Maximum overflow, mgd	7
Minimum overflow, mgd	1.75
Influent head loss at max flow, inches	3
Mixed liquor suspended solids concentration range, mg/l	1,500 to 3,500
Head loss in sludge collector header at maximum RSS flow[a], feet	2.5
Maximum motor horsepower	1.0
Minimum velocity through sludge collection header at minimum RSS flow, fps	1.0

[a]Does not include entrance losses at the opening of the RSS conduit from the outlet manifold or losses through the RSS suction piping located beneath the concrete tank's floor slab.

B. STANDARDS:

1. STRUCTURAL STEEL AND WELDS: All structural steel used for equipment fabrication shall conform to the requirements of the Standard Specifications for Steel for Bridges and Buildings and ASTM A36. All welding shall conform to the latest standards of the American Welding Society. Welded connections which will be submerged during normal operation of the equipment shall be seal welded to facilitate coating and provide a continuous barrier against corrosion.

2. STRUCTURAL DESIGN: All steel structural components shall be so designed that the stresses developed under the specified conditions will not exceed the allowable stresses defined by the latest AISC standards and the aforementioned standards.

3. GEAR DESIGN: All drive unit components shall be designed in accordance with the following standards:

Reference	Title
AGMA 440.04-71	Single- and Double-Reduction Cylindrical-Worm and Helical Worm Speed Reducers
AGMA 218-01-82	Rating and Pitting Resistance and Bending Strength of Spur and Helical Involute Gear Teeth
AGMA 420.04-75	Enclosed Speed Reducers or Increasers Using Spur, Helical, Herringbone and Spiral Bevel Gears
AGMA 461.01-66	Worm Gear Motors

4. BEARING DESIGN: Bearing design shall be in accordance with:

AFBMA Std. 9-1978	Load Ratings and Fatigue Life for Ball Bearings

1.03 SUBMITTALS

In accordance with provisions of Section 01300, drawings and data giving full descriptions of the secondary sedimentation tank equipment shall be submitted to the Construction Manager for review. All of the material required for submittal shall be furnished in one complete package in accordance with the schedule specified in Section 01300. The submittal shall consist of the following data, drawings and descriptive materials:

1. Drawings showing the entire assembly, including descriptions of all gears, structural members and sludge collection members.

2. Ratings and detail descriptions of all gear reducers and drives.

3. Motor submittal data as specified in Section 11060 (Form 11060-A as specified in Section 01999.)

1.04 SPARE PARTS

Spare parts shall be provided as follows:

1 sets - all bearings and bearing seal rings for drive unit
2 sets - all gaskets
2 sets - neoprene seal rings for sludge withdrawal manifold
6 sets - shear pins if utilized in the equipment

1.05 ENVIRONMENTAL CONDITIONS

Equipment to be furnished under this section shall be suitable for installation in a wastewater treatment plant serving a predominately residential community. However, some minor quantities of commercial and industrial wastes may be present in the wastewater. All components shall be suitable for exposure to industrial solvents and petroleum products and shall be suitable for continuous operation under the environmental conditions specified in Section 01800.

PART 2--PRODUCTS

2.01 MATERIALS

Component	Material
Center column	ASTM A36
Steel plate	ASTM A36
Structural steel shapes	ASTM A36
Steel tube	ASTM A36
Main spur gear	
Ductile iron	ASTM A536, 80-55-06
Cast iron	ASTM A48, Class 60
Forged steel	AISI 4140, 4150 or 4340
Main bearings	SAE 52100, Rockwell C64
Flocculator skirt	Fabricated steel
Submerged fastening hardware including anchor bolts	Type 304 stainless steel
Wiper blades	Neoprene
Collector squeegee	Neoprene
Center scraper blades	Steel
Center Collector Squeegee	Brass

2.02 EQUIPMENT

A. INFLUENT STRUCTURE:

The tank influent structure shall consist of the center column and the influent distribution tub. The center column shall be a hollow steel cylinder with its base flanged for fixing to the concrete floor of the tank. Its top shall also be flanged and stiffened for supporting the sludge collection mechanism, the drive mechanism, and the access bridge and center operating platform beams. Ports shall be provided for discharging the mixed liquor from the center column into the influent distribution tub. The influent distribution tub shall be designed to provide even distribution of flow into the feed well and shall include six diffusion ports. Influent distribution tub and feed well flocculation skirt shall be fabricated from 3/16-inch minimum plate.

Each distribution tub diffuser port shall be fitted with a steel gate complete with a chain for adjustment. All gates shall direct the flow to move in the same tangential direction to provide for energy control of the inflow. The influent distribution tub shall be supported from the drive cage and shall rotate therewith. A seal shall be provided at the bottom of the tub between its rotary floor and the stationary center column to prevent, at this point, the passage of mixed liquor into the sedimentation tank.

The top of the inlet ports in the center column and the top of the gates in the distribution tub shall be above the tank's maximum water surface elevation. At least four shallow scum ports with removable adjustable weir gates shall also be provided in the feed well flocculation skirt extending above the maximum water surface elevation to allow scum removal. The gates shall be designed to be manually operated from the center operating platform of the bridge.

B. DRIVE CAGE:

Torque shall be transmitted from the drive unit to the rotating components of the mechanism by a drive cage. The drive cage shall encompass the center column and shall be fabricated of structural steel shapes of sufficient strength to transmit and/or carry design torque specified in paragraph 1.02 A.2. of this section. The entire drive cage assembly shall be seal welded as specified in paragraph 1.02 B.1.

C. SLUDGE COLLECTOR MECHANISM:

Each sludge collector shall consist of a rotating fabricated steel center outlet manifold, with two fabricated steel headers located parallel to the tank bottom. The steel headers shall be complete with a series of inlet orifices and a neoprene squeegee designed to sweep the entire tank bottom clean every 1/2 revolution. The center portion of the collection shall have steel raking blades

and adjustable spring brass squeegees to move the sludge towards the outside wall of the tank. This slowly revolving mechanism shall collect the sludge from the tank bottom and carry it through the headers to the outlet manifold and to the opening of the sludge withdrawal conduit. The complete sludge collection mechanism shall be capable of handling the return sludge as specified in the paragraph 1.02 A.2. of this section.

The fabricated steel center outlet manifold shall encompass the center column. The manifold shall be rigidly attached to the drive cage and be provided with a positive sealing system capable of preventing passage of liquid from the tank into the outlet manifold under a 10-foot hydraulic pressure differential. The inside bottom of the manifold shall be open and completely cover the opening into the sludge withdrawal conduit at all times.

Sludge collectors shall be designed to operate continuously or intermittently at a peripheral speed no more than 15 feet per minute. To provide for uniform sludge velocities throughout, steel headers, consisting of rectangular or circular shaped tapered tubes, shall vary in size from a maximum near the tank center to a minimum at the outer end. The headers shall be fabricated of 1/4-inch-thick steel plate or equivalent weight steel pipe. Standard or fabricated incremental pipe sizes will not be acceptable for use in the sludge withdrawal tubes. The collectors shall be supported from the drive cage by a steel truss designed to hold the headers in alignment in both the vertical and horizontal planes. The use of tie rods is not acceptable.

To provide a peaked top, the longitudinal cross-sectional axis of rectangular headers shall be mounted at an angle of 45 degrees with the tank bottom. The leading edge of each rectangular header shall extend forward and down 2 inches at an angle of 45 degrees to provide an equalizing vane as an integral part of the header and to direct the sludge into the orifice's area of influence. Circular pipe headers shall be furnished complete with suction nozzles and companion plow flights to direct the sludge to the orifice's area of influence. Inlet orifices shall vary in size from a minimum near the tank center to a maximum at the outer end and shall be accurately drilled in each header. A flange shall be provided at the inner end of each header for connecting to the fabricated steel center outlet manifold.

Except where specifically indicated otherwise, all plate and structural members designed for submerged service shall have a minimum thickness of 1/4 inch. Submerged components requiring welding shall be seal welded as specified in paragraph 1.02 B.1.

Inlet orifices shall be spaced at regular intervals and plows shall be provided as necessary to direct sludge toward orifices if space between orifices exceeds 30 inches. Should standard pipe

sizes be used as orifices, they may be spaced irregularly, with no interval exceeding 30 inches, to ensure that the proportional sludge withdrawal is achieved. The orifices shall vary in size from a minimum near the tank center to a maximum at the outer end and shall be accurately drilled in each header. The header and orifice design shall ensure hydraulic balance through the sludge collection mechanism at all tank flows. The orifices shall be designed to withdraw sludge volumes proportional to their respectively swept areas of the tank. Calculations shall be submitted to show the derivation of the changing orifice driving head along the length of the header, the tank area served by each orifice, and the respective orifice size, as well as the driving head across the orifice and velocity through the orifice at maximum and minimum RSS flows. Inlet orifice size, spacing, and driving head shall be so adjusted that sludge withdrawal is proportional to the relative area of the tank served. The minimum inlet orifice size shall be 1-1/2 inches in diameter.

D. DRIVE MECHANISM:

The drive assembly for each mechanism shall include a gear motor, primary worm gear reducer, pinion gear, turntable type main spur gear, drive base, breaking pin hub coupling, shutdown switch, drive and driven sprockets, and drive chain with guard. The gear motor for each drive shall be suitable for operation under all weather conditions and shall be provided with a sealed conduit box. The drive mechanism shall be equipped for adjustable speed operation over approximately a 4:1 speed range and shall be capable of driving the sludge and scum collectors with a tip speed of 3.5 to 15 fpm. Drive mechanism shall be designed for the wear life and rated torque specified in paragraph 1.02 of this section.

The gear motor shall drive a special, single reduction primary worm gear reducer through a roller chain drive. The special worm gear reducer shall be constructed of cast 40,000 psi high-duty iron and shall have a hardened and ground alloy steel worm, which operates in a cast 40,000 psi high-duty iron gear case. The gear motor shall be designed for continuous duty Class II applications or better. The driving and driven gears shall be designed in accordance with AGMA 420.05 for a service factor of 1.50. The drive shall operate the steel driver and driven sprockets. After completion of the specified field test, the converter driven shall be furnished with a sprocket set which shall provide the sludge collection header with a tip speed of 7 feet per minute.

Additional sprockets and chain links shall be provided for tip speeds of 3.5, 10 and 15 feet per minute. A galvanized chain guard suitable for all sprocket combinations shall be provided. Provision shall be made for manual adjustment of chain tension.

The main spur gear materials shall comply with the requirements of AGMA 240.01. For inspection and maintenance of the interior of the center column, each spur gear shall have an access opening of not less than 16 inches in diameter. A properly reinforced fabricated aluminum cover plate with lifting holes shall be provided for the cover plate. If the spur gear is steel, it shall be designed and rated in conformance with AGMA Quality 5 with a service factor of 1.5 or greater.

The entire sludge collector mechanism shall be suspended from the turntable which, in turn, shall be supported on a ball bearing assembly that uses large diameter hardened steel bearing balls. The bearing balls shall run in full contour raceways or in an oil bath on replaceable tempered carbon spring steel inserts placed in annular raceways in the gear and turntable base. The turntable shall be designed for AFBMA L10 life of at least 500,000 revolutions. A felt seal and dust shield shall also be included with each spur gear housing to protect the oil bath from contamination. The gear case shall be complete with an oil fill and drain line with plugs, as well as an oil level indicator pipe. The turntable shall be constructed of cast 40,000 psi high-duty iron and mounted on the center column top flange. Fabricated steel is not acceptable.

The drive mechanism for the sludge collector shall be provided with a visual load indicator showing the load on the mechanism. The overload alarm system shall consist of one limit switch located in a NEMA 4 housing, to be actuated when torque load on the mechanism reaches 120 percent of rated running torque. When 120 percent of the rated running torque is reached, the switch shall actuate an alarm in the treatment plant central control room and shall shut down the collector drive unit. The limit switch shall be SPDT, rated at 5 amps and 120 volts AC. The enclosure shall be provided with a 120-VAC strip heater. A shear pin located in a breaking pin hub mounted on the output shaft of the gear motor shall also be provided. The shear pin shall be selected to break when 140 percent of the rated running torque load is reached.

Motor shall be 1-HP maximum, 1800 rpm, totally enclosed, fan cooled, complying with Section 11060.

E. SKIMMERS AND SCUM TROUGH:

The mechanism shall be provided with two skimming arms located 180 degrees apart to collect and move surface scum from the annular space between the inlet skirt and the scum baffle adjacent to the inboard effluent launder to a heavy, fabricated steel scum trough. This trough shall be provided with a steel approach lip which shall extend from the effluent weir. Each skimming arm shall comprise a scum deflector plate, a support boom and a hinged aluminum blade with neoprene wiping edges. Provisions shall be incorporated into the design of the skimming arm to permit

adjustment of the skimming blade position with respect to its penetration into the liquid within the tank. The equipment manufacturer shall be responsible for setting the lip elevation of the scum trough in relation to the effluent weir. Each skimming mechanism shall be supported by structural steel members rigidly fixed to the rotating collector arms. Skimming arms shall be designed to prevent binding and undue deflection when in contact with the scum baffle or scum trough.

F. WALKWAY AND OPERATING PLATFORM:

A center operating platform, with a full bridge access walkway, shall be provided. Bridge support systems shall be continuous from the center column support structure to the tank wall, and shall be oriented 180 degrees apart. The access walkway shall be continuous from tank wall to operating platform to tank wall.

The access bridges shall be supported on the main spur gear housing which shall, in turn, be supported by the center column support structure. The operating platform shall be provided as part of the bridge to ensure uninhibited access to all parts of the drive unit. The platform shall completely encircle the drive unit and shall be at least 36 inches wide on either side of the drive unit.

The support system shall consist of structural steel members. Either beam or truss support sections may be used. The bridge shall be interlaced for rigidity, with supports designed to take thermal expansion, contraction, and differential settlements. Walkways and platform surfaces shall be aluminum grating and enclosed with aluminum handrails. Grating shall be aluminum and shall comply with Section 05530. Handrailing shall comply with Section 05520. Aluminum toeboards, 1/4-inch by 4-inch size, shall be provided surrounding the operating platform and access walkways, in accordance with Section 05520. Except as required for access to the effluent trough, handrailing shall be continuous along both sides of the equipment walkways and shall completely encircle the operating platform. Openings for access to the effluent trough shall be chained in accordance with the latest Occupational Safety and Health Administration standards. Portable access ladders shall conform to the drawing details. No single piece of grating shall weigh more than 20 pounds. Structural steel shall comply with Section 05100. Structural design criteria for the access bridges and operating platform shall be as specified in paragraph 1.02 A.1 of this section.

2.03 ANCHOR BOLTS AND EMBEDDED ITEMS

All anchor bolts, anchor bolt templates, anchor sleeves, and embedded items shall be furnished to the Contractor prior to delivery or shipment of any other equipment. Anchor bolts shall be as specified in Section 05501.

2.04 PAINTING AND FINISHES

A. GENERAL:

Except where specified, all materials shall be delivered to the job site unpainted for final painting by others.

B. SUBMERGED ITEMS:

The influent structure, sludge collector, and all other submerged ferrous items shall be delivered to the job site unpainted for onsite cleaning, priming, and painting by others. All other unpainted items shall be boxed or packaged and protected by the manufacturer to prevent damage and corrosion from weathering before installation.

2.05 PRODUCT DATA

The equipment manufacturer shall deliver four (4) copies of the following product data to the Construction Manager:

1. O&M information and maintenance manuals in accordance with Section 01730.
2. Calculations showing the related stresses developed in the sludge collection arms at the specified design torque in accordance with paragraph 00710-4.02.
3. Calculations sizing the orifices and headers for uniform sludge withdrawal throughout the entire floor of the tank in accordance with paragraph 00710-4.02.

PART 3--EXECUTION

3.01 INSTALLATION AND TESTING

A. INSTALLATION:

The equipment specified in this section will be installed by the Contractor under the supervision of a factory-trained manufacturer's field reprepsentative. The installation shall be certified by the manufacturer on Form 11000-A specified in Section 01999.

B. INITIAL OPERATION TESTING:

The secondary sedimentation tank shall be filled with water to its operating level and the mechanism operated continuously at its maximum speed for a period not less than twenty-four (24) hours. Following the maximum speed test, the mechanism shall be operated at 23, 47, and 67 percent speeds for continuous periods not less than 6 hours each. At no time during the operating tests shall the equipment fail on torque overload or exhibit indications of binding or

uneven operation. The manufacturer's representative shall record torque values as registered on the drive mechanism torque indicator and motor amerpage (all three phases) at 3-hour intervals, and all recordings are to be witnessed by the Construction Manager.

If the mechanism should fail on torque overload or, the mechanism should exhibit indications of binding or improper adjustment, the Contractor shall immediately halt the tests and remedy the problem. After completion of necessary repairs or adjustments, the tests shall be repeated. Failure to successfully complete the test in six attempts shall be considered sufficient cause for rejection.

C. TORQUE TESTS:

A dynamic torque test shall be performed on the clarifier mechanism to verify accurate torque indication, test the adequacy of the mechanism to safely withstand the specified design torque, and calibrate overload devices. Tests shall be at specified running torque, alarm shutdown torque, and shearpin torque loadings. The test shall accurately depict actual operation of the mechanism and shall not apply impact loading, jerky loading or abnormal conditions which may reduce the life of the equipment.

A torque test device shall be attached near the outer end of each collector arm. The device shall allow load to be gradually applied uniformly to each arm as the arm rotates. Readings of the load applied at the arm versus the torque indicator reading shall be taken at 100-pound increments until the specified torque is achieved. Design torque shall be applied over not less than one half revolution of the mechanism. Torque indicator error shall not exceed 7 percent of full scale at any torque reading.

The mechanism shall also exhibit no permanent deformation of any components. If deformation does occur or correct torque is not achieved, the defective parts shall be replaced by the manufacturer and the unit retested at no cost to the Owner.

The testing device used shall not be a sled, a system of hydraulic cylinders, or one using pulleys and cables. The test shall utilize a device which is pulled by the arms and applies load to the arms. Load application shall be done by crank, requiring only one operator per arm. The device shall be Eimco's "Torkometer" or equal.

Prior to initiating the test, the Contractor shall furnish the Construction Manager with sketches and calculations illustrating the test procedure and demonstrating how the specified torque will be applied to satisfy this requirement.

D. SLUDGE COLLECTOR SEAL TESTS:

As part of the installed test program, each secondary sedimentation tank sludge collector shall be given a sludge collector seal test. As part of this test, the Contractor shall fill the tank to a depth 10 feet above the RSS manifold seal and place stoppers in the collector orifices. The RSS piping shall be dewatered and observed for a period of 24 hours. If the seal leaks excessively during this period, the test shall be halted, necessary repairs made, and the test repeated. Excessive leakage shall be construed as more than 100 gallons over a 24-hour period. Failure to successfully complete the test in six attempts shall be considered test failure.

3.03 INSTRUCTIONAL PERSONNEL

The Contractor shall provide a factory-trained field engineer at the for one day site to instruct the Owner's operating personnel in the proper method of operation and the recommended lubrication and maintenance procedures. Time of visit shall be arranged with the Construction Manager. Instruction shall be certified on Form 11000-B specified in Section 01999.

END OF SECTION

SECTION 11200

FLOATING SKIMMING EQUIPMENT

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies a floating scum remover designed to remove oils and floating particulate matter from the surface of a regional wastewater treatment plant's chlorine contact channel.

The general requirements applicable to all mechanical equipment, as summarized in paragraph 11000-1.01 A., are applicable to the equipment specified in this section.

B. TYPE:

Surface skimmers shall be of the floating type with an adjustable weir setting.

1.02 QUALITY ASSURANCE

The floatng skimmer shall be constructed of stainless steel spunwound sealed with silver solder.

The hose connection as shown in the drawings shall be lightweight spiral reinforced flexible urethane with a plain end. The hose shall be clamped to float and discharge piping with quick release clamps. The Contractor shall furnish the connection from the discharge end of the hose to the connecting piping. This connection shall be clamped with stainless steel clamps.

The hose shall be provided to allow for a minimum of 3 feet of travel in normal operation. The Contractor shall furnish and install the necessary cable support system as shown on the drawings.

1.03 SUBMITTALS TO BE PROVIDED

The Contractor shall provide the following submittals in accordance with Section 01300:

1. Shop drawings.
2. Materials list.
3. Connections, locations, sizes, and detail fittings.

PART 2--PRODUCTS

2.01 MATERIALS

Component	Material
Floats and weir	430 stainless steel
Weir and support struts	304 stainless steel
Connecting hose	3-inch lightweight spiral reinforced flexible urethane
Baffle	PVC belt with polyester chord
Baffle end connectors	Non-corrosive plastic
Baffle floats	Closed cell foam
Baffle ballast	Lead weights

The floating skimmers shall have a minimum of three floats oriented at 120-degree angles with a 12-inch central adjustable weir. Center weir shall have a 3-inch orifice. Hose attachment coupling on the bottom of the center weir shall be 180 degrees. A minimum of 10 feet of 3-inch flexible hose shall be provided for each skimmer. The hose provided shall be compatible with the skimmer to assure a correct flotation through the entire range of operation. One mooring ring shall be provided on each float to enable the units to be secured in place as shown on the drawings. Each mooring ring shall be capable of carrying the total suspended weight of the entire floating skimmer including the floats, weir, hose, and appurtenances. These devices shall, be Megator 3-inch Alpha Stainless Steel Floating Skimmers manufactured by the Megator Corporation, Pittsburgh, Pennsylvania, or equal.

2.02 OPERATION AND MAINTENANCE INFORMATION

Items 3 and 7 in Section 01730 shall be provided to the Construction Manager in accordance with the requirements of Section 01730.

END OF SECTION

SECTION 11222

SHEAR BOX DIFFUSERS

PART 1 - GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies the shear box diffusers for supplying coarse bubble agitation air to wastewater flows in rectangular channels.

B. TYPE:

Shear box diffusers shall be of the one-piece square box type suitable for full encasement in concrete.

1.02 QUALITY ASSURANCE

A. GENERAL:

Shear box diffusers shall be designed and selected for continuous submergence in municipal wastewater containing grit, semisolid grease particles, rags, paper and plastic products and organic solids. The liquid is expected to be comprised of water, industrial solvents, chlorine and petroleum products. A filtered air supply will be delivered to the channel diffusers.

B. OPERATING REQUIREMENTS:

Air flow per diffuser, acfm	Pressure at diffuser inlet, psig	Backpressure on diffuser, psig	Orifice head loss, inches W.G.
4.8	2.0	1.7	8

Normal operating pressure at the diffuser will be as indicated. However, 100 psig air, will be supplied to the diffuser periodically for flushing.

PART 2 - PRODUCTS

2.01 MATERIALS

Component	Material
Diffuser box	Zinc coated steel
Inlet pipe connection and orifice	Brass

2.02 EQUIPMENT

A. GENERAL:

Shear box diffusers shall contain a threaded-on nozzle suitable for connection to the agitation air piping shown with an integral orifice designed to produce the head loss specified in paragraph 1.02 B of this section.

B. DIFFUSERS:

Cast in place shear box diffusers shall be a one piece box; 7 inches square, open at the top, closed at the bottom and fabricated with a wall collar designed to prevent wastewater seepage down the wall of the diffuser. It shall be suitable for installation in the bottom of a concrete channel with no bottom access. Shear box diffusers shall be furnished with a threaded side inlet connection containing an orifice designed to produce a coarse bubble pattern under the operating conditions specified. The orifice shall be accessible for replacement from inside the shear box diffuser.

2.03 PRODUCT DATA

In accordance with paragraph 00710-3.05, the Contractor shall provide the Construction Manager with product data and drawings confirming compliance with the requirements of this section.

END OF SECTION

SECTION 11232

FINE BUBBLE AIR DIFFUSERS

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies fine bubble air diffusers for aerating the sludge holding tank and the mixed liquor channel. Equipment shall include the diffusers, drop piping, air distribution headers, and supports required for a complete system.

B. TYPE:

Fine bubble air diffusers shall be the self-sealing flexible membrane type.

1.02 OPERATING REQUIREMENTS

A. SLUDGE HOLDING TANK:

The fine bubble aeration system for the sludge holding tank shall be designed to comply with the following operating requirements:

Parameter	Value
Design air flow, total, ICFM	1760
Standard oxygen required, pounds/hour	162
Minimum oxygen transfer efficiency at design conditions, percent[a]	15
Diffuser head loss, maximum, inches W.C.	13
Operating dissolved oxygen. milligrams/liter	2
Wastewater temperature	
Maximum, degrees F	95
Minimum, degrees F	65
Site elevation, feet above MSL	930
Alpha factor	0.7
Beta factor	0.95

[a]Standard oxygen transfer efficiency on clean, clear water at 68 degrees F, zero dissolved oxygen, barometric pressure of 14.7 psia, and a submergence of 9 feet.

B. MIXED LIQUOR CHANNEL

The fine bubble air diffusers for the mixed liquor channel shall be designed to comply with the following operating requirements:

Parameter	Value
Design air flow per diffuser, scfm	2.2
Diffuser head loss, maximum, inches W.C.	14

1.03 SPARE PARTS

The following spare parts shall be furnished:

10 - diffusers, complete units

PART 2--PRODUCTS

2.01 ACCEPTABLE PRODUCTS

Flexible membrane diffusers shall be manufactured by Wilfley Webber, Envirex, or Sanitaire.

2.02 MATERIALS OF CONSTRUCTION

COMPONENT	MATERIAL
Membrane	EPDM
All metallic diffuser components	Type 316 stainless steel
Membrane holder	30 percent fiber reinforced high density nylon, PVC, or glass filled polypropylene
Diffuser mounting saddle	PVC
Pipe supports and anchors	Type 304 stainless steel

2.03 CONSTRUCTION

A. SLUDGE HOLDING TANK AIR DISTRIBUTION PIPING:

The sludge holding tank is a concrete structure composed of two bays. Each bay is 26 feet wide x 50 feet long, with a side water depth of 10 feet. The fine bubble aeration system for the sludge holding tank, complete with diffusers, drop piping, air

distribution headers, and pipe supports shall be provided by a single manufacturer.

Piping for the fine bubble aeration system for the sludge holding tank shall be designed in accordance with the requirements of Section 15050 and shall include provisions for thermal expansion of the air piping. Header section lengths shall not exceed 20 feet. All connections between pipe sections, pipe and fittings, or fittings, shall be expansion type couplings allowing for thermal expansion over a range of 120 degrees F. Pipe supports shall be located as recommended by the diffuser manufacturer and as shown on the manufacturers shop drawings.

B. MIXED LIQUOR CHANNEL AERATION PIPING:

The mixed liquor channel is a concrete channel approximately 280 feet long. The channel is 6 feet wide and has a side water depth of 6.6 feet. The fine bubble aeration system for the mixed liquor channel, complete with diffusers, drop piping, air distribution headers, and pipe supports shall be provided by a single manufacturer. The drop piping shall connect to a quick disconnect coupling located at the top of the channel as shown on the drawings. Aeration headers shall be located as shown and shall have a maximum length of 9 feet 6 inches. Air piping shall comply with the requirements of Section 15050.

2.04 PRODUCT DATA

In accordance with the requirements of paragraph 00710-3.05, the following information will be provided to the Construction Manager:

1. Performance test results as specified in paragraph 11232-3.03.

2. Shop drawings showing number of diffusers required and the manufacturers recommended diffuser layout for the sludge holding tank.

3. Calculations demonstrating that the standard oxygen required in paragraph 11232-1.02.A. for the sludge holding tank can be provided with the manufacturers recommended diffuser layout at the specified air flow rate.

4. Shop drawings, dimensions and materials of construction for the in-place acid cleaning system if ceramic diffusers are provided.

PART 3--EXECUTION

3.01 INSTALLATION

Fine bubble diffusers for the sludge holding tank shall be installed in accordance with the manufacturers shop drawings and recommendations. Particular care shall be taken to ensure that all diffuser air connections are installed in a single horizontal plane within a tolerance of plus or minus 3/8 inch.

Fine bubble diffusers for the mixed liquor channel shall be installed as shown and in accordance with the manufacturers recommendations. Particular care shall be taken to ensure that all diffuser air connections are installed in a single horizontal plane within a tolerance of plus or minus 3/8 inch.

3.02 CLEANING AND LEAK TESTING

Aeration air piping shall be thoroughly cleaned in accordance with the requirements of Section 15050. The placement of diffuser units shall not begin until the aeration air piping has been cleaned and inspected.

After the piping, headers and diffuser units have been installed, clear water shall be introduced into the tank until the diffuser units have been covered by about 2 inches. Compressed air shall then be released through the diffuser units and any leaks observed in the piping system shall be repaired. This test shall be repeated until all leaks have been located and repaired.

3.03 PERFORMANCE TEST

Results of a full scale clean water oxygen transfer efficiency test shall be provided. Tests shall be conducted in a tank with a surface area not less than 400 square feet and in accordance with the ASCE July 1984, publication: Standard for the Measurement of Oxygen Transfer in Clean Water. Test shall include specific diffuser depth, density, and air rates required to meet the design requirements specified in paragraph 1.02.A. Test report shall be complete with data tables and oxygen transfer curves verifying conformance with the design requirements.

END OF SECTION

SECTION 11271

JET AERATION SYSTEM

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section includes specifications for a jet aeration type aeration system and accessories for use in an extended aeration process.

B. TYPE:

Jet aeration system shall consist of jet aeration nozzles, integral air and liquid manifolds with support brackets, pneumatic backflush system, interconnecting flanges, nuts, bolts, gaskets, and air downcomer. Liquid recirculation shall be provided by mixed flow centrifugal pumps. Low-pressure air shall be supplied by multi-stage centrifugal blowers.

C. EQUIPMENT LIST:

Equipment numbers are as follows:

Item	Equipment number	See specification section
Jet aeration manifold 1	MME 3131	11271
Jet aeration manifold 2	MME 3132	11271
Jet aeration manifold 3	MME 3133	11271

Also included in this section are aeration appurtenances.

D. DESCRIPTION OF SYSTEM:

The jet aeration system shall consist of integrally-mounted air and liquid distribution manifolds equipped with jet aerator assemblies oriented in a common direction. Low-pressure air will enter the air manifold through a flanged opening and will be uniformly distributed to each of the jet aerator assemblies. Recirculated mixed liquor will enter the liquid manifold through a flanged opening and be uniformly distributed to each jet aerator assembly. The low-pressure air and recirculated mixed liquor shall be combined in the jet assembly, where the air is dispersed into fine bubbles. The fine bubble mixture is then discharged as a high-energy jet across the bottom of the tanks.

The manifold shall be arranged so that all tank contents are circulated with sufficient velocity to suspend solids, maintain homogeneity and distribute oxygen throughout.

Normal operation is with two blowers and three jet aerator headers operating continuously. Time clock adjustment of blower operating time reduces air delivered during periods of reduced demand. Control of all other system components is manual start/-stop.

1.02 QUALITY ASSURANCE AND DESIGN REQUIREMENTS

A. GENERAL:

The jet aeration blowers will provide air supply for satisfying oxygen requirements in the oxidation channel, and shall be of the multi-stage centrifugal type. The blowers are specified under Section 11486.

The jet aeration pumps shall be located in dry wells adjacent to the oxidation channel. The pumps are specified under Section 11301.

The jet aeration system shall be equipped with a pneumatic backflush system or alternate system which will unplug nozzles without removing the unit or dewatering the channel.

The jet aeration system shall be capable of satisfying the following requirements at all conditions.

	Value
Standard oxygen requirements, pounds/hour	980
Operating dissolved oxygen, milligrams/liter	2.0

B. RESPONSIBILITY:

The jet aerator manifold manufacturer shall guaranty performance as specified for the complete jet aeration system, and shall carry out tests to prove that the system performs as specified. The jet aerator manufacturer shall submit certified test reports for the complete jet aeration system to show that it is capable of meeting the design requirements.

C. DESIGN REQUIREMENTS:

The jet aeration system shall be designed and operable for the following conditions:

Tank dimensions, width by length	140 x 218 feet
Liquid depth	16 feet
Basin elevation	930 MSL
Wastewater flow	3.5 mgd
BOD in, mg/l	200
BOD out, mg/l	10
NH^3 in, mg/l	35
NH_3 out, mg/l	2
Oxygen required/pound BOD removed, pounds	1.4
Oxygen required/pound NH_3 removed, pounds	4.6
Alpha factor	0.7
Beta factor	0.95
Wastewater temperature	
Maximum, degrees F	95
Minimum, degrees F	65

D. STANDARDS:

1. JET AERATOR MANIFOLDS: All manifold materials and supports shall be designed by a registered structural engineer regularly engaged in design of these materials. All materials shall be designed for the specific environment and conditions in paragraph 1.02 C and 1.03.

1.03 ENVIRONMENTAL CONDITIONS

Equipment furnished under this section shall be suitable for operation in wastewater from a municipal sewerage system. Some minor quantities of commercial and industrial wastes, however, may be present in the wastewater. The wastewater may be expected to contain fine waste solids, vegetable parts, small pieces of wood, rags, silt, petroleum products, industrial solvents, fats and oils. The wastewater will have a pH which may range from 6 to 8.

1.04 SUBMITTALS

In accordance with the provisions of Section 01300, drawings and data giving full details of the jet aeration system shall be submitted to the Construction Manager for review. All of the materials required for submittal, as listed in this paragraph shall be furnished in one complete package. The submittal shall consist of the following data, drawings, and descriptive material.

1. Design calculations to determine manifold support size and location, air and liquid requirements, nozzle locations and manifold layout in the aeration tank.

2. Detailed installation drawings, showing the size and location of all piping and structural connections.

3. Proposed testing procedure for performance in field conditions if different from that specified in paragraph 3.02.

4. Certified test reports of the complete aeration system.

PART 2--PRODUCTS

2.01 MATERIALS

Manifold piping and fittings	FRP (ASTM D2996-83)
Manifold supports	ASTM A36 steel
Air supply downcomer	FRP (ASTM-D2996-83) or 304 stainless steel
Nuts, bolts	304 stainless steel
Anchor bolts	304 stainless steel

2.02 EQUIPMENT

A. JET AERATORS

The jet aerators shall consist of an internal liquid nozzle, air annulus chamber, and a discharge nozzle which are fabricated from filament wound FRP. Jet aerators shall be machined and assembled to be concentric within a TIR tolerance of ± 0.015 inches. The liquid nozzle and discharge nozzles shall be aligned within a perpendicularity tolerance of ± 0.01 inches from true position. Each jet aerator shall be precision-molded type with heavy-duty construction, a minimum wall thickness of 0.35 inches. Internal design shall permit operation over an extended range of air and recirculated mixed liquid flow rates.

Each jet aerator assembly shall be fitted with contact-molded air feed manifold. These air feed manifolds shall attach to the air and liquid disribution manifolds. The jet aerators shall be spaced to accommodate proper oxygen transfer and to maintain good mixing throughout.

B. BACKFLUSH SYSTEM:

The jet aeration system shall be equipped with a backflush system which cleans the submerged components of any fouling debris, thereby maintaining high oxygen transfer rates and efficiencies. Backflush shall be performed manually.

The backflush line shall be installed on the liquid section of each jet manifold assembly with an outlet and control valve located above the basin water elevation. Fittings shall be provided to blow the backflush stream into the basin. All necessary supports shall be provided.

The self-cleaning mode shall be activated by turning off the pump, opening the valve, and continuing to feed air, allowing the unit's aerodynamic design to convert the submerged aeration unit into a pneumatic pump, drawing liquid in the reverse, through the jets and liquid manifolds entraining any fouling material and debris. Backflush stream will be blown down into the aeration tank.

C. SUPPORTS:

All necessary in-tank supports for the aeration system or the air and liquid piping shall be supplied as part of the system. The supports shall be manufactured of mild common steel, sand-blasted to a near white finish, and provided with an epoxy coating for corrosion resistance..

The supports shall consist of a contoured saddle welded to a supporting base. The base shall be anchored on anchor bolts and grouted in place. The saddle shall be provided with a rubber pad to avoid abrasion. A contoured clamp with an accompanying rubber pad shall hold the piping to the saddle using bolted connections between the clamp and saddle.

PART 3--EXECUTION

3.01 INSTALLATION AND TESTING

The Contractor shall install the equipment as shown, to the requirements of these specifications, and to the requirements of the manufacturer's shop drawings and specifications. Contractor shall provide for on-site start-up service by a qualified factory-trained equipment manufacturer's representative.

3.02 TESTING

The aeration system manufacturer shall guarantee that the aeration system shall transfer a minimum of 980 pounds of standard oxygen per hour in the aeration tank. The aeration system manufacturer shall perform the test in the presence of the Construction Manager according to the procedure described below.

The method used shall be the dynamic reaeration test performed in wastewater as follows:

1. The aeration tank shall be filled with the normal wastewater.

2. The temperature of the wastewater shall be as near to standard temperature as possible.

3. Within a very short period of time of filling the basin, the aeration system shall be turned on to oxidize any chemical oxygen demand that may be present to prevent interference with reaeration tests. (Preferably the aeration system should be turned on late one afternoon, and reaction tests should begin on the following morning.)

4. A minimum of two (2) sampling points shall be selected as per approval of the Construction Manager. The dissolved oxygen at the sampling points shall be measured by a D.O. electrode probe.

5. The catalyst cobalt chloride shall be added to wastewater such that the concentration of cobaltous ion does not exceed 0.5 mg/l. The catalyst shall be dissolved into the tank contents by running the aeration system.

6. The slurry of sodium sulfite shall be added to deoxygenate the wastewater in the basin. (For a liquid having D.O. of 10 ppm, it requires about 1 pound of dry sodium sulfite for 1,000 gallons of liquid per test.) Monitor the D.O. concentration until it is depleted.

7. The aeration system shall then be started at the design rate. As D.O. rises in the basin, sampling shall be started. A total of at least six (6) readings of D.O. shall be recorded between 10 and 70 percent saturation. The D.O. probe shall be calibrated against the Winkler method of D.O. determination before and after the test.

8. The reaeration test shall be carried out until full dynamic saturation of the wastewater occurs; for example, the dissolved oxygen level no longer increases.

9. A semi-log plot of the dissolved oxygen deficit, determined by the difference between saturation value and recorded D.O. versus time, shall be constructed. The saturation value of dissolved oxygen shall be experimentally determined by long-term aeration and corrected for absorption efficiency.

10. The slope of the line shall be calculated.

11. At the beginning, during, and near the end of each test run, electrical measurements shall be made of the power input. The calibration curve of the efficiency of the drive unit shall be utilized to covert kilowatt input to brake horsepower.

12. The water temperature during the test shall be recorded.

13. The measured KLa value from the deficit plot shall be converted to the design temperatrue by the following equation:

$$\frac{KLaT}{KLaT_1} = \frac{(1.024)^{T-20}}{(1.024)^{T_1-20}}$$

Where T = design wastewater temperature

T_1 = actual wastewater temperature during test

14. The pounds of oxygen dissolved by the aeration system in the wastewater at actual design conditions shall be calculated as follows:

$$AOR = \frac{KLaT \times C_{st} \times V \times 62.5 \times 60}{10^6}$$

Where KLaT = mass transfer coefficient in wastewater at design temperature, 1/minute

C_{st} = Saturation concentration of oxygen in wastewater at design conditions, mg/l experimentally determined by long-term aeration and corrected for absorption efficiency.

V = Volume of basin, cubic feet

15. Alpha and Beta determinations for the field conditions shall be made in accordance with "Standard Methods for Examination of Water and Wastewater" or equivalent testing procedure.

16. Standard oxygen requirements shall be calculated from AOR as follows:

$$SOR = \frac{AOR}{\text{Alpha}\left[\frac{(C_{sw} \times \text{Beta}) - C_1}{C_{ss}}\right] 1.024 \text{ EXP } (T_w - 20)}$$

Where:

SOR = Standard oxygen transfer at 20 degrees C, 760 mm Hg, zero dissolved oxygen, alpha = 1.0, beta = 1.0 (pounds/hour).

AOR = Actual oxygen transfer at field conditions, (pounds/hour).

Alpha= Ratio of oxygen transfer coefficient of the wastewater to that of tap water

Beta = Ratio of oxygen saturation of the wastewater to that of tap water

C_{sw} = Equilibrium saturation dissolved oxygen concentration in clean water at the wastewater temperature and basin elevation, (mg/l)

C_{ss} = Equilibrium saturation dissolved oxygen concentration in clean water at 20 degrees C, and 760 mm Hg, (mg/l)

C_1 = Operating dissolved oxygen concentration in basin, (mg/l)

T_w = Wastewater temperature, (degrees C)

17. The oxygenation capacity of the aeration system shall be determined by dividing SOR by the BHp consumed during the test as follows:

O.C. = SOR/BHp

18. The aeration equipment manufacturer shall supply all chemicals, D.O. probes, wattage meters, velocity meters, and other equipment required to complete the tests necessary to show that the equipment meets these specifications.

3.02

Evidence of compliance with mixing requirements shall be obtained by measuring mixed liquor suspended solids concentrations at four locations (as directed by Construction Manager) in each tank and at three depths for each location. Aeration system shall be considered in compliance with mixing requirements if mixed liquor suspended solids of any sample is no more than 10 percent above or below the average of all samples.

3.03 WARRANTY

In the event the oxygen transfer rate determined in paragraph 3.02 does not meet the Standard Oxygen Requirements or Operating Dissolved Oxygen specified in paragraph 1.02 A. when operated at the specified depth and air flow rate, the Contractor shall supply and install additional in-basin aeration equipment at no cost to the Owner.

END OF SECTION

SECTION 11301

VERTICAL CONSTANT SPEED MIXED FLOW
CENTRIFUGAL PUMPS

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies vertical constant speed, mixed flow, end suction, centrifugal pumps for pumping fluids containing sewage solids.

B. EQUIPMENT LIST:

Item	Equipment number
Aeration pump 1	P 3111
Aeration pump 2	P 3112
Aeration pump 3	P 3113

C. PERFORMANCE REQUIREMENTS:

The fluid to be pumped is anticipated to range between 65 degrees F and 95 degrees F and contain up to 5,000 mg/l of solids consisting of grit and organic material with small quantities of petroleum products and animal fats and greases. The pump shall perform in accordance with the following:

Condition A[1,3] (Guaranteed performance):

Capacity, gpm	6,000
Total head, feet	22
NPSHA, feet	32.7

Condition B[2,3] (Shut off head):

Capacity, gpm	0
Total head, feet	41

NOTES:

1. Condition A shall be taken as the rated, continuous-duty operating condition. Performnace at the rated condition shall be guaranteed in accordance with tolerances set forth in the Test Standards of the Hydraulic Institute, except that any increase in head or capcity or both which results in a power requirement greater than the pump motor's nameplate rating will be cause for rejection.

2. Condition B is presented to indicate operating conditions when the pump is operating against maximum anticipated system head, assuming a hypothetical head-capacity curve. Pumps with head-capacity curves steeper than that assumed will produce slightly greater flow at slightly greater head. The reverse will occur with pumps having a shallower head-capacity curve.

3. Total head in the above tabulation is the algebraic difference between the discharge head and suction head as defined in the standards of the Hydraulic Institute. Net positive suction head available (NSHA) in the above tabulation is referred to project elevation 930 and is calculated in accordance with Hydraulic Institute standards for the worst combination of fluid temperature and barometric pressure.

D. DESIGN REQUIREMENTS:

1. GENERAL: The pump shall be specifically designed to pump unscreened municipal wastewater and shall operate without clogging or fouling caused by material in the pumped fluid at any operating condition within the range of service specified. The pump shall be designed to operate without cavitation and the motor and pump combination shall operate without vibration over the specified range of conditions. The pump head capacity curve shall slope in one continuous curve with no point of reverse slope inflection.

The pump shall be close-coupled with the drive motor, with the motor mounted on a fabricated steel pedestal, which shall in turn be mounted on the pump casing.

All components shall be designed to safely withstand forces resulting from flow reversals, up to 125 percent of maximum speed, within the pump during shutdowns caused by power failure.

The complete pumping unit shall be designed to operate without overload on any component at any point along the pump's entire operating curve.

2. CHARACTERISTICS: Equipment furnished under this section shall conform to the following:

Pump	
Maximum sphere, inches diameter, capable of passing through the pump from inlet to discharge	4
Efficiency at Condition A, minimum, percent	79

Piping connection size, inches, minimum	
Inlet	16
Discharge	16
Motor	
Speed, rpm, maximum	880
Horsepower, maximum[2]	50
Type (reference: Section 11060)	Type 2 Energy efficient

NOTES:

1. Because the pumps are to operate at constant speed, the pump shall be selected so that the rated condition lies within 5 percent (based upon capacity) of the best efficiency point on the pump's head-capacity curve.

2. The motor shall be non-overloading within the selected criteria set forth in Section 11060. Pump selections which do not conform to this requirement wihtout requiring a motor with a nameplate rating greater than that listed are not acceptable.

E. VIBRATION AND CRITICAL SPEEDS:

The pump shall comply with the requirements of Section 11020.

1.02 QUALITY ASSURANCE

A. REFERENCE:

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
AFBMA 9-78	Load Ratings and Fatique Life for Ball Bearings
AFBMA 11-78	Load Ratings and Fatigue Life for Roller Bearings
ASTM A36	Structrual Steel
ASTM A48-84	Gray Iron Castings

Reference, cont'd	Title
ASTM A108-81	Steel Bars, Carbon, Cold Finished, Standard Quality
ASTM A276-85	Stainless and Heat-Resisting Steel Bars and Shapes
ASTM A278-85	Gray Iron Castings for Pressure Containing Parts for Temperatures up to 650 Degrees F
ASTM A322-87	Steel Bars, Alloy, Standard Grades
ASTM A576-86	Steel Bars, Carbon, Hot Wrought, Special Quality
ASTM A743-86	Corrosion-Resistant Iron-Chromium, Iron-Chromium-Nickel, and Nickel-Base Alloy Castings for General Application
Hydraulic Institute Standards	Standards of the Hydraulic Institute, 14th Edition
UBC	Uniform Building Code, 1985

B. FACTORY TESTS:

Factory tests will not be required. However, the manufacturer must be prepared to guarantee the performance specified under paragraph 11301 1.01 C, Condition A.

1.03 SUBMITTALS

The following information shall be submitted in accordance with Section 01300:

1. Predicted pump performance curves showing head, power, efficiency and NPSH required on the ordinate plotted against capacity on the abscissa. All values shall be in English units and shall conform to the units stated in paragraph 11301-1.02 C.

2. Motor submittal information as requried under Section 11060.

PART 2--PRODUCTS

2.01 ACCEPTABLE PRODUCTS

Pumps shall be Fairbanks Morse Model 5741C, Goulds Model MF, Worthington Model MN, or equal, modified to provide the specified features and to meet specified operating conditions.

2.02 MATERIALS

Materials of construction shall be as follows:

Component	Material
Casing, inlet elbow impeller, covers, nozzles, and backhead	Cast iron, ASTM A48 or ASTM A278 Class 30, with 2 to 3 percent nickel added.
Shaft	Steel, ASTm A108, Class C1144 or Grade 1045, ASTM 576, Grade 1045 or ASTM A322, Grade 4140.
Shaft sleeve and wearings rings	Stainless steel, ASTM 276, Type 410, or ASTM A743, Grade CA-15.
Frame	Cast iron, ASTM A48 or ASTM A278, Class 30.
Motor support pedestal	Steel, ASTM A36

2.03 EQUIPMENT FEATURES

A. CASING:

Flanges as specified in paragraph 11000-2.01 shall be provided on the suction and discharge. The discahrge nozzle shall have drain and minimum 1/2-inch tap for gage connection. A handhole with cover shall be provided.

B. INLET ELBOW:

The inlet elbow shall be drilled and tapped for a 1/2-inch gage connection. A handhole with cover and a valved drain connection at the lowest point shall be provided. Handhole contours shall match the contours of the inlet elbow.

C. BACKHEAD:

The backhead shall be self-centering and shall permit back pullout. All horizontal surfaces in the backhead shall be sloped to the drain connection specified under paragraph 11301-2.03 D.

D. FRAME:

An opening in the frame shall be provided to permit adjustment of the mechanical seal. The connection between the backhead and frame shall have self-centering and registering fits. The seal box shall be drilled and tapped for seal flushing. A tapped drain connection shall be provided to permit field conenction to an external drain.

E. IMPELLER:

The impeller shall be enclosed, single suction, 2-vane or 3-vane, and shall be keyed to the shaft.

F. SHAFT AND SLEEVE:

The shaft or impeller hub, where inside the seal area, shall be fitted with a replaceable sleeve, which shall be fixed to the shaft to prevent rotation and gasketed to prevent leakage. The shaft sleeve shall have a Brinell Hardness Number of 500.

G. WEARING RINGS:

Wearing rings shall be provided for the impeller and the casing and shall be attached by screwed fasteners. Casing ring hardness shall exceed impeller ring hardness by not less than 100 points on the Brinell scale. Impeller ring hardness shall be 350 Brinell, minimum.

H. MECHANICAL SEAL:

Mechanical seal shall be double as specified in paragraph 11000-2.04 A.

I. BEARINGS:

Bearing shall be grease lubricated and shall have a minimum L-10 rating life (AFBMA 9-78 or 11-78) of 50,000 hours as specified in paragraph 11000-2.02.

J. DRIVER PEDESTAL AND FLEXIBLE COUPLING:

Driver pedestals for close coupled pumps shall be of sufficient size, strength, and rigidity to support the driver and prevent excessive vibration. In addition, the support frame and pump anchor routing shall be designed in accordance with UBC for seismic loads. Each shall be made of fabricated steel and provide for convenient maintenance access to stuffing box, bearing frame, and coupling.

An expanded metal coupling guard shall be provided. This guard shall be positioned to protect against contact with coupling end of shaft and coupling but still allow access to bearing lubrication fittings and stuffing box connections.

The coupling shall be all metal, non-lubricated, anti-backlash type as specified in paragraph 11000-2.05.

K. BASE:

A rugged heavy duty fabricated steel base, with openings large enough to permit access to the suction elbow and cleanout, bolted directly to the volute shall be provided. The base shall be designed to support the assembled weight of the pump and shafting. Anchor bolting shall be designed to withstand the unbalanced force developed by the pump at 200 percent of shutoff head at the specified speed and in accordance with Section 05501.

L. MOTOR:

The motor shall conform to the requirements of Section 11060 and paragarph 11337-1.01 D. The motor shall be mounted on a support pedestal designed to provide maintenance access to the upper bearings for the intermediate shaft coupling.

2.04 SPARE PARTS

The following spare parts shall be provided if one pump is furnished under this section. If more than one pump is furnished, the following shall be provided for each pair of pumps.

3 sets--all gaskets
1 shaft sleeve
1 set--pump bearings
1 set--wearing rings

2.05 PRODUCT DATA

The following information shall be provided in accordance with paragraph 00710-4.02:

1. Guaranteed pump performance curves.

2. Operation and maintenance information specified in Section 01730, except items 2 and 10.

3. Certification that the pumping units will meet the vibration and critical speed limitations as specified in Section 11020.

4. Manufacturers installation certificate as specified in Section 01999.

5. Motor product data as specified in Section 11060.

PART 3--EXECUTION

3.01 INSTALLATION

Each pumping unit shall be aligned, connected, and installed in accordance with the manufacturer's recommendations.

3.02 TESTING

After completion of installation, each pumping unit shall be field tested to demonstrate compliance with the perfomrance requirements as specified.

END OF SECTION

SECTION 11310

VERTICAL AXIAL FLOW PROPELLER PUMPS OPEN LINESHAFT-PRODUCT LUBRICATED

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies vertical shaft, propeller pumps, with product lubricated open lineshafts for pumping fluids which may contain minor concentrations of mildly abrasive small-diameter solids. The pumping arrangement shall be complete with a drive unit support, surface discharge assembly and a motor.

The Contractor shall assign unit responsibility as specified in paragraph 11000-1.02 C to the pump manufacturer for the combined equipment as stated above and as further specified in this section.

B. EQUIPMENT LIST:

Equipment number	Item
P 6211	Effluent pump 1
P 6212	Effluent pump 2

C. OPERATING CONDITIONS:

Equipment number	P 6211, P 6212
Pumping Condition A[a]	
Capacity, gpm	3,100
Head	12.5
Bowl efficiency, min., percent	69
Pumping Condition B	
Capacity, gpm	3,200
Head, feet	11.0
Pumping Condition C	
Capacity, gpm	2,250
Head, feet	25.5
Speed, maximum, rpm	1,770
Motor, maximum, HP	15
Motor efficiency, min. percent	93

Discharge head size, column x discharge, inches	12
Available NPSH, minimum, feet	40

[a]Condition A shall be the rated condition as defined in the standards of the Hydraulic Institute and is exclusive of inlet, bowl, column, and discharge head losses. Other conditions present approximate values which will vary with individual pump characteristics and are furnished to describe the full range of operating requirements for the equipment furnished under this section.

D. THRUST:

All components of the specified equipment shall be designed and sized for equipment weight plus the maximum hydraulic downthrust at all points on the pumping curve. Additionally, pumps shall be provided with drivers having a momentary upthrust capacity equal to or exceeding 30 percent of the downthrust capacity equal to or exceeding 30 percent of the downthrust rating.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. In case of a conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASTM A48-83	Gray Iron Castings
ASTM A120-84	Pipe, Steel, Black and Hot-Dipped Zinc-Coated (galvanized), Welded and Seamless, for Ordinary Use
ASTM A276-86	Stainless and Heat-Resisting Steel Bars and Shapes
ASTM A320-85	Alloy Steel Bolting Materials for Low-Temperature Service
ASTM A424-80	Steel Sheet for Porcelain Enameling
ASTM B584-85	Copper Alloy Sand Castings for General Applications

Reference	Title
Hydraulic Institute Standards	Standards of the Hydraulic Institute, 14th Edition

B. FACTORY TEST:

Factory tests will not be required. However, the manufacturer must be prepared to guarantee the performance specified under paragraph 11318-1.01 C, Condition A.

1.03 SUBMITTALS

The following information shall be provided in accordance with Section 01300.

1. Performance curves developed for specified operating conditions showing relationship between flow, head, efficiency, and horsepower.

2. Construction details and materials of construction.

3. Motor data form 11060-A as required in Section 11060.

PART 2--PRODUCTS

2.01 ACCEPTABLE PRODUCTS

Pumping units shall be Fairbanks Morse, Peerless, Worthington, Johnston, or equal, modified to provide the specified features.

2.02 MATERIALS

Component	Material
Sucton case, bowl assembly, and discharge case	Cast iron, ASTM A48, Class 30, Class 30, or Meehanite or fabricated steel, ASTM A424, Types 1 and 2
Bowl wear rings and propeller	Bronze, ASTM B584, or cast iron, ASTM A48
Pump shaft	Stainless steel, ASTM A276, type 316 or 416
Lineshaft	Stainless steel, ASTM A276, type 316 or 416
Pump bearings	Bronze, ASTM B584
Lineshaft bearings	Neoprene

Component	Material
Pump discharge column	Steel, ASTM A120
Discharge head	Cast iron, ASTM A48, or fabricated steel
Stuffing box assembly	Cast iorn, ASTM A48
Strainer	Bronze, ASTM B584
Bolts, studs, and nuts	Stainless steel, ASTM A320, type 304

2.03 EQUIPMENT FEATURES

A. INLET BELL AND BOWL ASSEMBLY:

The inlet bell shall be designed to provide conservative entrance velocities and direct the flow to the impeller. The inner surfaces of the bell shall be smooth and free of sharp projections or cavities which might cause turbulence or cavitation. A streamlined housing, centered and held in the bell by means of rigid vanes shall be provided to properly direct the flow to the impeller.

The bowl shall be designed for a flanged, registered fit to the inlet bell and discharge column to provide proper bearing alignment. The interior surfaces shall be smooth and free of sharp projections, transitions and cavities which might incite turbulence and undesirable vibration. The contours of the bowl shall be designed to closely match the shape of the propeller's vanes.

B. PROPELLERS:

Propellers shall be statically and dynamically balanced to minimize vibration and wear and shall be free of sharp projections, cavities or abrupt transitions which could encourage or incite cavitation or excessive turbulence. Propellers shall be adjustable vertically be means of an adjustable coupling at the discharge head.

C. SHAFTS:

Shafts shall be sized to prevent excessive elongation and transmit the required torque without distortion in both the forward and reverse direction. Shafts shall have a first critical speed not less than 20 percent above maximum operating speed. The pumping units shall utilize a two-piece headshaft, solid intermediate lineshafts supplied in maximum 10-foot lengths, and a single pump shaft shall be provided extending from the suction case through a discharge case or upper bowl case containing an upper pump shaft bearing.

The lineshaft shall be supported through the column with bearing encapsulating spiders.

D. BEARINGS:

Suction case, bowl, and discharge case bearings shall be close tolerance, sleeve type. The suction case bearing shall be grease lubricated. Bowl and discharge case sleeve bearings shall be lubricated by the process fluid.

Lineshaft bearings shall be neoprene sleeve type, encapsulated in bronze or cast iron spiders. The bearings shall be located at each column pipe joint but in no case shall exceed more than 10-foot centers.

E. DISCHARGE COLUMN:

Discharge columns shall be fabricated with interchangeable pipe sections with flanged watertight ends incorporating registered fits. Column interior shall be free of offsets, burrs, discontinuities, or irregularities. The column shall be supplied in sections not exceeding 10 feet in length.

F. DISCHARGE HEAD AND DRIVE UNIT SUPPORT:

The discharge head shall be of the above-ground discharge type. The discharge elbow shall be mitered or cast to form a smooth 90-degree transition. The discharge head shall be fitted with a packing box cast integrally into the head or otherwise fitted to prevent leakage between the connection. As a unit, the discharge head shall provide a mounting base for the driver. Adequate space shall be provided to access and dismantle the shaft coupling without removing the motor.

Each pump head shall be provided with a subbase or base plate manufactured expressly for the discharge head provided.

G. PACKING BOX:

The lineshaft shall penetrate the discharge elbow through a high-pressure-type packing box. The container unit shall incorporate a lantern ring, a minimum six rows of packing, and a packing gland. A hard faced, replaceable lineshaft sleeve shall be provided on the lineshaft as it penetrates the packing box.

Provisions shall be made to drain the lubrication leakage back into the sump or other location as specified.

H. COUPLINGS:

A threaded coupling shall be provided to connect the two-piece headshaft between the motor and packing box assembly.

Lineshaft couplings shall be a perfect butt-fit. They shall be designed with a safety factor of 1-1/2 times the shaft safety factor and shall have a left-hand thread to tighten during pump operation.

I. MOTOR:

All pumps shall be driven by continuous-duty, energy-efficient, Type 2, vertical, hollow shaft, high thrust, electric motors as specified in Section 11060.

The motor top shaft shall be provided with a nonreverese ratchet device which prevents backspin of the pump.

J. CORROSION PROTECTION:

The interior of the discharge column and all exterior below-grade surfaces of the pump shall be protected with coal tar eopxy paint applied to a dry film thickness of 20 mils in accordance with Section 09900.

2.04 AUXILIARY DEVICES

An upper lineshaft bearing prelubrication unit shall be provided. Prior to pump start-up, the unit shall automatically inject water into the pump column for an adjustable period of time ranging from 15 to 300 seconds. The unit shall include 1/4-inch piping between the pressure source and a port in the discharge elbow, solenoid valve, shutoff valve, time delay relay, and a control panel for remote mounting.

2.05 SPARE PARTS

Spare parts shall be furnished for each pump as follows:

1--suction bell/manifold bearing assembly
1--bowl bearing set
1--lineshaft bearing assembly
1--packing gland follower
1--set wear rings

Spare parts shall be tagged and stored in accordance with provisions of paragraph 11000-2.12.

2.06 PRODUCT DATA

The following informaiton shall be provided in accordance with paragraph 00710-4.02:

1. Motor data as specified in paragraph 11060-2.05.

2. Guaranteed pump performance curves as identified in paragraph 11318-1.02 B.

3. Operation and maintenance information, as specified in Section 01730.

4. Manufacturer's certification that the pumping units will meet the vibration and critical speed limitations as specified in Section 11020.

5. Installation certification Form 11000-A as specified in paragraph 11318-3.01.

PART 3--EXECUTION

3.01 INSTALLATION

The pumps shall be aligned, connected, and installed at the locations specified and in accordance with the manufacturer's recommendations. The installation and initial operation of all components shall be certified on Form 11000-A as specified in Section 01999.

3.02 FIELD TESTING

After completion of installation, each pumping unit shall be field tested to demonstrate compliance with the performance requirements as specified.

Testing procedures shall duplicate as nearly as possible the conditions of operation and shall be selected to demonstrate that the equipment is operational and free from damage. Each control device, item of mechanical, electrical, and instrumentation equipment, and control circuits shall be considered in the testing procedures to demonstrate that the equipment has been properly serviced, aligned, connected, calibrated, and adjusted prior to operation.

END OF SECTION

SECTION 11318

VERTICAL TURBINE PUMPS
OPEN LINESHAFT-PRODUCT LUBRICATED

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies vertical shaft, turbine pumps, with product lubricated open lineshafts for pumping fluids which may contain minor concentrations of mildly abrasive small-diameter solids. The pumping arrangement shall be complete with a drive unit support, surface discharge assembly and a motor.

The Contractor shall assign unit responsibility as specified in paragraph 11000-1.02 C to the pump manufacturer for the combined equipment as stated above and as further specified in this section.

B. EQUIPMENT LIST:

Equipment number	Item
P6311	3W pump 1
P6312	3W pump 2

C. OPERATING CONDITIONS:

Equipment number	P6311, P6312
Pumping Condition A[a]	
Capacity, gpm	305
Head	174
Bowl efficiency, min., percent	85
Pumping Condition B	
Capacity, gpm	410
Head, feet	141
Pumping Condition C	
Capacity, gpm	0
Head, feet	183
Speed, maximum, rpm	1,770
Motor, maximum, HP	20
Motor efficiency, min. percent	93

Discharge head size, column x discharge, inches	6
Available NPSH, minimum, feet	40.2

[a]Condition A shall be the rated condition as defined in the standards of the Hydraulic Institute and is exclusive of inlet, bowl, column, and discharge head losses. Other conditions present approximate values which will vary with individual pump characteristics and are furnished to describe the full range of operating requirements for the equipment furnished under this section.

D. THRUST:

All components of the specified equipment shall be designed and sized for equipment weight plus the maximum hydraulic downthrust at all points on the pumping curve. Additionally, pumps shall be provided with drivers having a momentary upthrust capacity equal to or exceeding 30 percent of the downthrust capacity equal to or exceeding 30 percent of the downthrust rating.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. In case of a conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASTM A48-83	Gray Iron Castings
ASTM A120-84	Pipe, Steel, Black and Hot-Dipped Zinc-Coated (galvanized), Welded and Seamless, for Ordinary Use
ASTM A276-86	Stainless and Heat-Resisting Steel Bars and Shapes
ASTM A320-85	Alloy Steel Bolting Materials for Low-Temperature Service
ASTM A424-80	Steel Sheet for Porcelain Enameling
ASTM B584-85	Copper Alloy Sand Castings for General Applications

Reference	Title
Hydraulic Institute Standards	Standards of the Hydraulic Institute, 14th Edition

B. FACTORY TEST:

Factory tests will not be required. However, the manufacturer must be prepared to guarantee the performance specified under paragraph 11318-1.01 C, Condition A.

1.03 SUBMITTALS

The following information shall be provided in accordance with Section 01300.

1. Performance curves developed for specified operating conditions showing relationship between flow, head, efficiency, and horsepower.

2. Construction details and materials of construction.

3. Motor data form 11060-A as required in Section 11060.

PART 2--PRODUCTS

2.01 ACCEPTABLE PRODUCTS

Pumping units shall be Peerless OLS, Goulds VIT, Byron Jackson, or equal, modified to provide the specified features.

2.02 MATERIALS

Component	Material
Sucton case, bowl assembly, discharge case and impeller	Cast iron, ASTM A48, Class 30, Class 30, or Meehanite or fabricated steel, ASTM A424, Types 1 and 2
Bowl wear rings	Bronze, ASTM B584, or cast iron, ASTM A48
Pump shaft	Stainless steel, ASTM A276, type 316 or 416
Lineshaft	Stainless steel, ASTM A276, type 316 or 416
Pump bearings	Bronze, ASTM B584
Lineshaft bearings	Neoprene

Component	Material
Pump discharge column	Steel, ASTM A120
Discharge head	Cast iron, ASTM A48, or fabricated steel
Stuffing box assembly	Cast iorn, ASTM A48
Strainer	Bronze, ASTM B584
Bolts, studs, and nuts	Stainless steel, ASTM A320, type 304

2.03 EQUIPMENT FEATURES

A. STRAINER:

The suction inlet shall be provided with a basket or cone type strainer having a net inlet opening area of not less than four times the area of the suction pipe. The strainer or mesh openings shall be sized to prevent passage of particles larger than the solids handling capability of the impeller.

B. SUCTION CASE:

The suction case shall be designed to provide conservative entrance velocities and evenly distribute the flow to the impeller. The inner surface of the case shall be smooth and free from projections of cavities. The pump shaft lower bearing shall be housed in a streamlined casing, centered and held in place by means of rigid, cast vanes.

C. PUMP BOWL:

The pump bowl shall be flanged for registered fit. Flow passages through the bowl shall be polished or porcelain-lined. If required on multistage installation, the first-stage bowl may be designed to facilitate a low NPSH impeller arrangement.

D. IMPELLER:

The impeller shall be constructed free from projections, cavities, or abrupt transitions. The impeller surfaces shall be either polished or porcelain-lined.

Impellers shall be of the enclosed type, with the shroud designed to rotate against wearing rings installed in the bowl assembly. Impellers shall be secured to the pump shaft using tapered collets or keyways.

E. SHAFTS:

Shafts shall be sized to prevent excessive elongation and transmit the required torque without distortion in both the forward and reverse direction. Shafts shall have a first critical speed not less than 20 percent above maximum operating speed. The pumping units shall utilize a two-piece headshaft, solid intermediate lineshafts supplied in maximum 10-foot lengths, and a single pump shaft shall be provided extending from the suction case through a discharge case or upper bowl case containing an upper pump shaft bearing.

The lineshaft shall be supported through the column with bearing encapsulating spiders.

F. BEARINGS:

Suction case, bowl, and discharge case bearings shall be close tolerance, sleeve type. The suction case bearing shall be grease lubricated. Bowl and discharge case sleeve bearings shall be lubricated by the process fluid.

Lineshaft bearings shall be neoprene sleeve type, encapsulated in bronze or cast iron spiders. The bearings shall be located at each column pipe joint but in no case shall exceed more than 10-foot centers.

G. DISCHARGE COLUMN:

Discharge columns shall be fabricated with interchangeable pipe sections with flanged watertight ends incorporating registered fits. Column interior shall be free of offsets, burrs, discontinuities, or irregularities. The column shall be supplied in sections not exceeding 10 feet in length.

H. DISCHARGE HEAD AND DRIVE UNIT SUPPORT:

The discharge head shall be of the above-ground discharge type. The discharge elbow shall be mitered or cast to form a smooth 90-degree transition. The discharge head shall be fitted with a packing box cast integrally into the head or otherwise fitted to prevent leakage between the connection. As a unit, the discharge head shall provide a mounting base for the driver. Adequate space shall be provided to access and dismantle the shaft coupling without removing the motor.

Each pump head shall be provided with a subbase or base plate manufactured expressly for the discharge head provided.

I. PACKING BOX:

The lineshaft shall penetrate the discharge elbow through a high-pressure-type packing box. The container unit shall incorporate a lantern ring, a minimum six rows of packing, and a packing gland. A hard faced, replaceable lineshaft sleeve shall be provided on the lineshaft as it penetrates the packing box.

Provisions shall be made to drain the lubrication leakage back into the sump or other location as specified.

J. COUPLINGS:

A threaded coupling shall be provided to connect the two-piece headshaft between the motor and packing box assembly.

Lineshaft couplings shall be a perfect butt-fit. They shall be designed with a safety factor of 1-1/2 times the shaft safety factor and shall have a left-hand thread to tighten during pump operation.

K. MOTOR:

All pumps shall be driven by continuous-duty, energy-efficient, Type 2, vertical, hollow shaft, high thrust, electric motors as specified in Section 11060.

The motor top shaft shall be provided with a nonreverese ratchet device which prevents backspin of the pump.

L. CORROSION PROTECTION:

The interior of the discharge column and all exterior below-grade surfaces of the pump shall be protected with coal tar eopxy paint applied to a dry film thickness of 20 mils in accordance with Section 09900.

2.04 AUXILIARY DEVICES

An upper lineshaft bearing prelubrication unit shall be provided. Prior to pump start-up, the unit shall automatically inject water into the pump column for an adjustable period of time ranging from 15 to 300 seconds. The unit shall include 1/4-inch piping between the pressure source and a port in the discharge elbow, solenoid valve, shutoff valve, time delay relay, and a control panel for remote mounting.

2.05 SPARE PARTS

Spare parts shall be furnished for each pump as follows:

1--suction bell/manifold bearing assembly
1--bowl bearing set

1--lineshaft bearing assembly
1--packing gland follower
1--set wear rings

Spare parts shall be tagged and stored in accordance with provisions of paragraph 11000-2.12.

2.06 PRODUCT DATA

The following informaiton shall be provided in accordance with paragraph 00710-4.02:

1. Motor data as specified in paragraph 11060-2.05.

2. Guaranteed pump performance curves as identified in paragraph 11318-1.02 B.

3. Operation and maintenance information, as specified in Section 01730.

4. Manufacturer's certification that the pumping units will meet the vibration and critical speed limitations as specified in Section 11020.

5. Installation certification Form 11000-A as specified in paragraph 11318-3.01.

PART 3--EXECUTION

3.01 INSTALLATION

The pumps shall be aligned, connected, and installed at the locations specified and in accordance with the manufacturer's recommendations. The installation and initial operation of all components shall be certified on Form 11000-A as specified in Section 01999.

3.02 FIELD TESTING

After completion of installation, each pumping unit shall be field tested to demonstrate compliance with the performance requirements as specified.

Testing procedures shall duplicate as nearly as possible the conditions of operation and shall be selected to demonstrate that the equipment is operational and free from damage. Each control device, item of mechanical, electrical, and instrumentation equipment, and control circuits shall be considered in the testing procedures to demonstrate that the equipment has been properly serviced, aligned, connected, calibrated, and adjusted prior to operation.

END OF SECTION

SECTION 11333

NONCLOG VERTICAL COLUMN WASTEWATER PUMPS

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies nonclog, vertical column-type pumps for pumping unscreened municipal wastewater. Each pump shall consist of a bowl assembly with suction bell, discharge column assembly, discharge head, motor, variable frequency drive controller, and all appurtenances to provide a complete pumping system.

B. EQUIPMENT LIST:

Item	Equipment number
Raw sewage pump 1	P 1111
Raw sewage pump 2	P 1112
Interceptor pump 1	P 10011
Interceptor pump 2	P 10012
Interceptor pump 3	P 10013

C. OPERATING CONDITIONS:

	P1111 P1112	P10011 P10012 P10013
1. Condition, A(1)		
Capacity, gpm	6,100	2,500
Total head, feet	20.5	16.5
Speed, rpm	705	1,770
Bowl efficiency, percent, minimum	83	80
2. Condition B, (2)		
Capacity, gpm, minimum	7,100	2,500
Total head, feet	16.3	16.5
Speed, rpm	705	1,770
Efficiency, percent, minimum	82.5	80
3. Condition C, (3)		
Capacity, gpm	2,000	490
Total head, feet	15.7	16.5
Speed, rpm	520	1,050

4. Condition D, (4)

Capacity, mgd	0	0
Total head, feet	19.7	16.5
Speed, rpm	0	0

Notes: (1) Condition A shall be the rated condition with the pump operating at full speed. Pumps supplied under this specification shall be guaranteed for performance at this condition with the indicated operating characteristics. Performance tolerance under factory test at this condition shall be as follows:

At rated capacity:	Minus 0, plus 5 percent of rated head
At rated head:	Minus 0, plus 10 percent of rated capacity
Efficiency:	Minus 0

except that plus capacity and head tolerances shall not combine to result in motor power requirements which exceed the motor's nameplate rating as defined under Section 11060.

Total head, as listed in the table, includes discharge velocity head, but is exclusive of pump inlet, bowl, discharge column, and discharge head losses.

(2) Condition B represents an approximation of operating requirements when the pump is operating at full speed against minimum head.

(3) Condition C is the minimum sustained operating condition expected to be encountered in normal operation. Pumps supplied under this specification shall be guaranteed for continuous operation at Condition C.

(4) Condition D represents the expected minimum momentary operating condition for equipment furnished under this specification. Condition D may be expected to be encountered at start-up, shutdown, and for no more than 5 minutes in each 24-hour period.

The pumps will be operated at variable speed in response to the control system specified in Section 17125. When more than one pump is required to accommodate inflow, both pumps will operate at the same speed, responding to a common control signal. Rarely will any pump be required to operate at full speed. Thus, it is preferred that the rated condition, Condition A, lie to the right of the best efficiency point on the pump's head/capacity curve.

D. DESIGN REQUIREMENTS:

The pump shall conform to the following:

Description	P1111 P1112	P10011 P10012 P10013
Discharge diameter, inches	24	10
Maximum sphere passing capability, inches, diameter	5	3
Discharge head, type	Surface	Surface
Driver type	2	2

E. PERFORMANCE REQUIREMENTS:

The fluid to be pumped will be unscreened municipal wastewater containing organic and inorganic solids, rags, strings, small sticks, industrial solvents, petroleum products, industrial wastes, vegetable and animal fats and grit. Fluid temperature is expected to range from approximately 65 degrees F to 95 degrees F.

The pumps shall operate without clogging or fouling caused by material in the pumped fluid at any operating condition within the range of service specified. Pump shall be designed to operate at variable speed without cavitation or damaging vibration over the entire specified range of flow and head conditions. Pumping system vibration shall not exceed the acceptable field vibration limits given in the Standards of the Hydraulic Institute as further limited by the requirements of Section 11020. The pump head capacity curve shall slope in one continuous curve with no points of reverse slope inflection capable of causing hunting at any pump operational speed.

All components shall be designed to safely withstand forces resulting from flow reversals up to 125 percent of maximum speed, within the pump during shutdowns caused by power failure.

The complete pumping unit shall be designed to operate without overload on any component at any point along the pump's entire full-speed operating curve.

F. MASS ELASTIC SYSTEMS AND CRITICAL SPEEDS:

The pumping unit, consisting of pump, shafting, couplings, motor, and all attached appurtenances shall have no dangerous critical or resonant frequencies or multiples of resonant

frequencies within 20 percent above and 35 percent below the speed range required by the pump to meet the specified operating conditions. For the purposes of design, a dangerous critical speed shall be defined as one which produces a torsional stress exceeding 3,500 psi. The Contractor shall be responsible for the analysis of critical speeds and the complete mass elastic system, which shall be analyzed and certified by a registered professional engineer regularly engaged in this type of work. Analysis shall be based upon the techniques developed by Dunkerly and Holzer.

1.02 QUALITY ASSURANCE

A. REFERENCES;

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
Hydraulic Institute Standards	Standards of the Hydraulic Institute, 14th edition
ASTM A48-83	Gray Iron Castings
ASTM A120-83	Pipe, Steel, Black and Hot-Dipped Zinc Coated (Galvanized) Welded and Seamless for Ordinanry Uses
ASTM A276-85	Stainless and Heat-Resisting Steel Bars and Shapes
ASTM A283-84	Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes and Bars
ASTM A743-86	Castings, Iron Chromium, Iron-Chromium-Nickel, and Nickel Base Corrosion-Resistance for General Application
ASTM B505-85	Copper Base Alloy Continuous Castings
UBC - 1985	Uniform Building Code

B. UNIT RESPONSIBILITY:

The Contractor shall assign unit responsibility as specified in paragraph 11000-1.02 C to the pump manufacturer for the equipment specified in this section and the variable frequency drive controllers specified in Section 11069. Any components of each complete pumping unit not provided by the pump manufacturer shall be designed, fabricated, tested and installed by factory authorized representatives experienced in the design and manufacture of variable speed pumping equipment. Additionally, the Contractor shall cause the pump manufacturer and its suppliers to coordinate design of the pumping units with the manufacturers of the adjustable frequency drives and motors such that all equipment is compatible and capable of achieving the performance requirements specified herein. Nothing in this provision, however, shall be construed as relieving the Contractor of his overall responsibility for his portion of the work.

C. FACTORY ASSEMBLY AND TESTING:

1. ASSEMBLY: The pumps shall be factory assembled and tested before being shipped. Units shall be shipped assembled for erection by the Contractor, unless shipping limitations or special installation requirements dictate otherwise. If knocked down, equipment shall be shipped in the minimum practical number of pieces for field assembly by the Contractor.

2. PERFORMANCE TESTS: Each pump shall be subjected to a nonwitnessed test at full speed, using a calibrated motor. The test shall be sufficiently comprehensive to develop head capacity and efficiency for at least six points on the pump's head capacity curve, and shall confirm performance at the guaranteed performance condition (Condition A, paragraph 11333-1.01 C).

Tests shall be conducted in accordance with the test code of the standards of the Hydraulic Institute except that predicted performance from model tests will not be permitted.

The Contractor shall submit a sketch of the proposed test setup, along with a description of the proposed testing procedure to the Construction Manager for this acceptance at least 10 weeks in advance of the proposed testing date. No tests shall be performed until the test procedure meets with the Construction Manager's approval. In addition, the Contractor shall furnish the Construction Manager with at least 4 weeks advance written notice of the date and location of the performance tests.

Test results (both test logs and performance curves) shall be signed and certified correct under penalty of perjury by an officer of the manufacturing corporation.

Upon completion of testing, curves shall be produced showing pump performance (head, efficiency, and power required versus capacity) at full speed and predicted performance at speeds required to meet all other specified operating conditions. Test logs and curves shall be provided to the Construction Manager as product data. The pumps shall not be shipped until authorized, in writing, by the Construction Manager. Final acceptance of the equipment will depend on satisfactory operation after installation.

D. SHIPMENT AND STORAGE:

The equipment shall be protected during shipment and sotrage as specified in Section 01605.

1.03 ENVIRONMENTAL CONDITIONS

The equipment shall be suitable for continuous operation under the environmental conditions specified in Section 01800.

1.04 SUBMITTALS

The following submittals shall be provided as specified in Section 01300:

1. Head-capacity-efficiency-power curves showing predicted performance for each condition point specified under paragraph 11333-1.01 C.

2. Motor data from 11060-A as required in Section 11060.

3. Details and materials of construction.

4. Description of factory testing procedure and sketch of test setup as specified in paragraph 11333-1.02 C.

PART 2--PRODUCTS

2.01 ACCEPTABLE PRODUCTS

Pumps shall be Fairbanks Morse VTSH modified to provide the specified features and to meet specified operating conditions. The Owner is not aware of an equal product.

2.02 MATERIALS

Materials of construction shall be as follows:

Component	Material
Inpeller, diffuser bowl, and suction bell	Cast iron, ASTM A48, Class 40 with 2 to 3 percent nickel added

Component	Material
Pump shaft and impeller key	Stainless steel, ASTM A276, type 416
Shaft couplings, enclosing tubes, and enclosing tube adapter	Stainless steel, ASTM A276, type 416
Lower bowl bearing, upper bowl bearing	Commerical bronze backed rubber
Connector bearings packing box	Bronze, ASTM B505, AL932, cast iron, ASTM A48, Class 30, bronze, ASTM B505
Lantern ring, gland follower packing	Asbestos free, graphite impregnated, commercial grade
Lineshafts and drive shaft	Stainless steel, A151 582, type 416
Shaft sleeve	Stainless steel, ASTM A276, type 316, 500 BHN
Flanged column pipe and discharge head	Steel, ASTM A283, Grade D or ASTM A120
Bowl and impeller wearing rings	Stainless steel, ASTM A743, Grade CA-15 or CA-40
Capscrews, studs, nuts, washers, and bolts	Stainless steel, ASTM A276, type 316

2.03 EQUIPMENT

A. BOWL ASSEMBLY:

The pump bowl shall be free of blow holes and sand holes. The discharge bowl shall contain two symmetrically arranged diffusion vanes. The impeller shall be of the enclosed nonclog type, statically and dynamically balanced, containing a maximum of two vanes. An L-type wearing ring shall be fitted to the impeller entrance port, hardness of the wearing ring shall be not less than 300 on the Brinell scale. The impeller and bowl diffusion vanes shall be of hydrofoil design with well-rounded leading edges to prevent the accumulation of fibrous and stringy material. The impeller shall be secured to the shaft using a key and capscrew with alignment maintained by upper and lower sleeve bearings. The bowl bearings shall be water lubricated. The impeller and bowl waterways and the clearance between the periphery of the maximum diameter impeller and bowl diffuser vanes shall be capable of passing a sphere as specified in paragraph 11333-1.03 D.

The suction bell shall be free of bearing hubs and supporting ribs or vanes to allow unobstructed flow to the impeller and fitted with an L-type wearing ring. The suction bell wearing ring shall have a hardness which exceeds that of the impeller ring by not less than 100 points on the Brinell scale.

B. DISCHARGE COLUMN ASSEMBLY:

The discharge column shall be furnished in lengths of not over 10 feet and shall be connected by flanged joints registered to provide alignment after assembly. Column pipe shall contain a splitter vane to prevent stringy material from accumulating on the shaft enclosing tube. The vane shall run the entire length of the column aligned with bowl diffusion vane and discharge elbow splitter vane and be securely welded in place. Use of strut type bearing retainers is not acceptable.

C. SHAFTS:

The section of shaft passing through the packing box shall be fitted with a replaceable sleeve which shall be fixed to the shaft. Lineshafting shall be furnished in interchangeable sections of not over 10 feet in length and shall be coupled with threaded couplings. An enclosing tube shall be provided to house the lineshaft. The enclosing tube shall be furnished in interchangeable sections not to exceed 5 feet in length with ends machined to receive lineshaft connector bearings.

D. DISCHARGE HEAD:

A base shall be provided for mounting of the driver and suport of the complete pump and driver. The support shall be designed in accordance with UBC-1985 for seismic zone 2. Discharge elbows shall be of the two-cut miter surface or below ground type as indicated, incorporating a splitter vane to prevent the collection of stringy material. The discharge head shall have a drilled and tapped drain connection which shall be piped to drain to the station wet well through the support plate.

E. PACKING BOX AND GLAND:

The discharge head shall be fitted with a water lubricated packing box conforming to paragraph 11000-2.04 B. A threaded removal tool shall be supplied with the spare parts. The packing box and packing box cartridge shall be designed to allow water to enter the lineshaft enclosing tube to lubricate the lineshaft and bowl bearings. The packing box shall be drilled and tapped for a pipe connection to a separately mounted purge connection.

F. DRIVER AND SHAFT COUPLING:

The pump shall be driven by a continuous duty, high efficiency vertical solid shaft Type 2 motor conforming to Section 11060. Requirements for motors to be employed with variable frequency drives are specified in paragraph 11060-2.04 D. The motor bearings shall be designed to accept thrust loads imposed by the pump. The motor shall be fitted with a nonreverse clutch and shall have an enclosure conforming to the requirements set forth in paragraph 11060-2.04 C.

G. VARIABLE FREQUENCY DRIVE:

The variable frequency drive controller shall conform to the requirements of Section 11069.

H. PAINTING:

Equipment shall have a shop applied prime coat compatible with the field coats conforming to Section 09900.

2.04 SPARE PARTS

The pump manufacturer shall supply the following spare parts for each pump size. Spare parts shall be packed and boxed as specified in paragraph 11000-2.12.

2--lantern ring removal tools
1--set wearing rings
1--packing box assembly, complete
1--complete set of lineshaft bearings for one pump
1--shaft sleeve

2.05 PRODUCT DATA

The following information shall be provided as specified in paragraph 00710-4.02:

1. Operation and maintenance information as specified in Section 01730, including items 1 through 10.

2. Calculations of critical speeds and mass elastic system analysis for pumps as specified in paragraph 11333-1.01 F.

3. Certification of satisfactory factory asesmbly and testing of each unit as specified in paragraph 11333-1.02 C.

4. Manufacturer's certification that the pumping units and variable speed control equipment are fully compatible for the services specified.

5. Manufacturer's certification that the pumping units will meet the vibration and critical speed limitations as specified in Section 11020.

6. Motor data as specified in paragraph 11060-2.05.

7. Installation certification form 11000-A as specified in paragraph 11333-3.01.

8. Training certification form 11000-B as specified in paragraph 11333-3.03.

PART 3--EXECUTION

3.01 INSTALLATION

The pump manufacturer shall provide the complete pumping system and factory trained personnel to supervise installation and initial operation of all components. The pumps shall be aligned, connected and installed at the locations shown and in accordance with the manufacturer's recommendations. The installation shall be certified on Form 11000-A as specified in Section 01999.

3.02 TESTING

After the completion of installation, each pumping unit shall be field tested to ensure compliance with the performance requirements as specified.

3.03 TRAINING

A minimum of 4 hours of training shall be provided by the pump manufacturer's service engineer. Training shall be certified on Form 11000-B as specified in Section 01999.

END OF SECTION

SECTION 11346

SUBMERSIBLE PUMPS

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies submersible pumps.

B. TYPE:

The pumps shall be of the motor driven, nonclog, centrifugal type designed to be completely submerged in the fluid to be pumped. Pumps shall be Flygt, ABS, or equal. Pumps manufactured by Flygt shall be provided with NEVA-CLOG impellers on all models, where available.

Item	Equipment Number
Secondary clarifier 1 RSS pump 1	P 5111
Secondary clarifier 1 RSS pump 2	P 5112
Secondary clarifier 2 RSS pump 1	P 5211
Secondary clarifier 2 RSS pump 2	P 5212
Tank drain pump 1	P 5511
Tank drain pump 2	P 5512
Waste sludge pump 1	P 7221
Waste sludge pump 2	P 7222

1.02 QUALITY ASSURANCE

A. GENERAL:

Pump shall be capable of pumping wastewater with a maximum solids concentration of 50,000 mg/l. Pump shall be suitable for heavy-duty continuous service and shall be capable of running dry continuously in a totally dry condition.

B. OPERATING REQUIREMENTS:

Pumps shall have the following operating characteristics:

Equipment number	Capacity, gpm	Total head, feet	Pump speed, rpm	Motor, HP	Pump efficiency, percent	Maximum BHP	Discharge pipe diamemter, inches
P 5111	1,020	22.4	1,750	10	62	8.5	8
P 5112	1,020	22.4	1,750	10	62	8.5	8
P 5211	1,020	22.4	1,750	10	62	8.5	8
P 5212	1,020	22.4	1,750	10	62	8.5	8
P 5511	353	29	1,700	5	60	4.1	6
P 5512	353	29	1,700	5	60	4.1	6
P 7521	370	20	1,700	5	60	3.1	4
P 7522	370	20	1,700	5	60	3.1	4
P 9511	190	39	1,700	5	53	4.2	4
P 9512	190	39	1,700	5	53	4.2	4
P 9513	195	24	1,750	3	48	2.5	4
P 9514	195	24	1,750	3	48	2.5	4

The specified duty points for all pumps shall lie at or to the right of the pumps' best efficiency points.

1.03 ENVIRONMENTAL CONDITIONS

The pumps will be located in concrete sumps and open tanks. Maximum expected water depth over these pumps will be 20 feet. Pumps shall be suitable for continuous operation under the environmental conditions specified in Section 01800.

PART 2--PRODUCTS

2.01 CONSTRUCTION

Bearings shall be heavy duty, permanently grease lubricated ball type double shielded and factory sealed and designed for an L-10 rating life of at least 20,000 hours in accordance with Section 11000. Motor and all rotating parts shall be removable from the motor end of pumps. Pumps shall be fitted with dynamically balanced nonclog impellers designed to pass coarse solids and stringy material. Motors shall be 3-phase, 460V, sealed in corrosion-resistant heavy cast iron shells. Motor shall be air-cooled and shall be nonoverloading over the entire operating range of the pump. Motor shall be NEMA Design B with Class F insulation suitable for at least 10 starts per hour. All pumps 5 horsepower and over shall be provided with a normally closed thermal overload protection switch. The stator shall be dipped and baked at least three times in Class F varnish.

Cable entry shall be a mechanical, waterproof type designed to facilitate cable replacement and prevent damage to the motor should the cable leak. The use of glues, epoxies, or similar methods for cable sealing will not be acceptable. Cable shall be equipped with rubber fillers. The use of jute is expressly prohibited. All external bolts and nuts shall be of Type 304 stainless steel. A wear ring designed for abrasion resistance shall be installed at the inlet of the pump to provide protection against impeller wear.

The pumps shall be provided with a tandem double mechanical seal running in an oil reservoir, composed of two separate lapped face seals. The lower seal unit, between the pump and oil chamber, shall consist of one stationary and one positively driven, rotating tungsten-carbide ring, with each pair of rings held in contact by separate spring. The upper seal unit, between the oil sump and the motor housing, shall consist of one stationary tungsten carbide ring and one positively driven rotating carbon ring. Ceramic seals will not be acceptable. The seals shall require neither maintenance nor adjustment and shall be easily replaceable. Conventional double mechanical seals with a single or a double spring between the rotating faces, or that require constant differential pressure to effect sealing and are subject to opening and penetration by pumping forces will not be acceptable. The submersible pumps shall be capable of continuous submergence without loss of watertight integrity to a depth of 65 feet.

Pumps shall be automatically connected to the discharge piping when lowered into place on the discharge connections. Pumps shall be easily removable for inspection or service, requiring no bolts, nuts, or other fastening to be removed for this purpose, and no need for personnel to enter pump well. Pumps shall be fitted with stainless steel chain or cable of adequate strength and length to permit raising pumps for inspection and removal. Sealing of the pumping unit to the discharge connections shall be accomplished by a simple linear downward motion of the pump with the entire weight of the pumping unit guided to and pressing tightly against the discharge connections in metal-to-metal contact. No portion of the pump shall bear directly on the floor of the sump and no rotary motion of the pump shall be required for sealing. Sealing of the discharge interface by means of a diaphragm, o-ring, or similar method will not be acceptable.

The pump casing shall be provided with an integral sliding bracket. The discharge connections shall be bolted to the floor and shall serve as a lower bracket for the guide bars. Guide brackets and sliding brackets shall be suitable for use with standard weight galvanized pipe. Upper guide brackets, and a cable and chain holder shall be provided and shall be installed according to the manufacturer's recommendations on the concrete face of the sump access opening.

2.02 CORROSION PROTECTION

The pump impeller shall be coated with PVC epoxy primer. The pump exterior shall be coated with PVC epoxy primer followed by a chloric rubber finish coat. Coatings shall be shop applied by the manufacturer.

2.03 CONTROLS

A. GENERAL:

Controls and motor starters for all pumps shall be provided under Divisions 16 and 17.

2.04 PRODUCT DATA

In accordance with paragraph 00710-4.02, the Contractor shall provide the following product data to the Construction Manager:

1. Complete product information including materials of construction, drawings, dimensions, and descriptive materials.

2. Pump performance curve showing flow, head, efficiency and power input.

3. Operation and maintenance data, in accordance with Section 01730.

4. Maintenance manuals, in accordance with Section 01730.

2.06 SPARE PARTS

The following spare parts shall be provided for each pump:

2 sets--top and bottom seals
1 set--complete O-rings
1 set--complete bearings

PART 3 - EXECUTION

3.01 INSTALLATION AND TESTING

The pumps shall be installed in strict accordance with the manufacturer's recommendations and shall be tested for proper alignment, rotation, vibration, and the specified operating requirements. The manufacturer shall provide a formal test procedure and forms for recording all pertinent data required to assure a satisfactory installation.

3.02 FIELD SERVICE

The manufacturer shall provide 8 hours of on-site field service by a qualified service engineer to inspect and test the completed installations for lubrication, alignment, free operation, etcetera, and to instruct the Owner's personnel in the proper operation and maintenance of the equipment. Installation shall be certified on Form 11000-A specified in Section 01999. Instruction shall be certified on Form 11000-B specified in Section 01999.

3.03 WARRANTY

The pump manufacturer shall warrant the units being supplied to the Owner against defects in materials and workmanship for a period of 5 years or 10,000 hours under normal use, operation, and service. This warranty shall be delivered, in writing, to the Owner and shall include, as a minimum, 100 percent full payment coverage for parts and labor during the first 18 months or 3,000 hours of operation.

END OF SECTION

SECTION 11350

SUBMERSIBLE NONCLOG SLUDGE PUMPS

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies submersible nonclog sludge pumps.

B. TYPE:

The pumps shall be of the motor driven, nonclog, semi-vortex or vortex type designed to be completely submerged in the fluid to be pumped. Pumps shall be Ebara, or equal.

C. EQUIPMENT LIST:

Item	Equipment number
Waste mixed liquor pump 1	P 3311
Waste mixed liquor pump 2	P 3312
Waste mixed liquor pump 3	P 3313
Drying bed decant pump 1	P 7611
Drying bed decant pump 1	P 7612

1.02 QUALITY ASSURANCE

A. GENERAL:

Pump shall be capable of pumping wastewater with a maximum solids concentration of 5,000 mg/l. Pumps shall be suitable for heavy-duty continuous service and shall be capable of running dry continuously in a totally dry condition.

B. OPERATING REQUIREMENTS:

Pumps shall have the following operating characteristics:

Equipment number	Capacity, gpm	Total head, feet	Pump speed, rpm	Motor, HP	Pump efficiency, percent	Maximum BHP	Discharge pipe diameter, inches
P 3115	150	15	1,130	2	38	1.5	3
P 3116	150	15	1,130	2	38	1.5	3
P 3311	40	10	3,600	0.33	35	0.29	2
P 3312	40	10	3,600	0.33	35	0.29	2
P 3313	40	10	3,600	0.33	35	0.29	2
P 7611	145	33	3,600	3	45	2.6	3
P 7612	145	33	3,600	3	45	2.6	3

The specified duty points for all pumps shall lie at or to the right of the pumps' best efficiency points.

1.03 ENVIRONMENTAL CONDITIONS

The pumps will be located in concrete sumps. Maximum expected water depth over these pumps will be 20 feet. Pumps shall be suitable for continuous operation under the environmental conditions specified in Section 01800.

PART 2--PRODUCTS

2.01 CONSTRUCTION

The pumps shall be designed to pump sewage containing 1.5-inch-diameter solids without damage during operation. The pumps shall be designed so that the pump shaft horsepower (BHP) shall not exceed motor rated horsepower throughout the entire operating range of the pump performance curve.

All major parts of the pumping units including casing, impeller, motor frame, and discharge elbow shall be manufactured from gray cast iron. Internal and external surfaces coming into contact with the pumpage shall be protected with one coat of zinc-chromate primer and all external surfaces shall be protected by one coat of acrylic-alkyd resin enamel. All exposed bolts and nuts shall be Type 304 stainless steel. All 2-inch units shall be furnished with a discharge elbow and screwed type NPT companion flanges. All 3-inch units shall be furnished with 125-pound flat face ANSI flange. Impellers shall be of the semi-vortex, multi-vane design which shall be slip fit to the shaft and shall be key driven. Three-inch units shall be provided with impellers having back pump-out vanes.

The pumps shall be furnished with a dual mechanical shaft seal located completely out of the pumpage, running in a separate oil filled chamber. The seal chamber shall be equipped with a built-in

device to prevent over filling and an anti-vortexing vane to insure proper lubrication of both seal faces. Lower seal faces on 1/3-horsepower units shall be tungsten carbide running against phosphorous bronze. Lower seal faces on 1/2-horsepower and larger units shall be silicon carbide running against silicon carbide. The upper mechanical seal shall be carbon running against a stationary ceramic seat. Mechanical seal hardware shall be all stainless steel.

All motors shall comply with the requirements of Section 11060 and shall be rated for 20 starts per hour. Motor shaft shall be Type 420 stainless steel and shall be supported by two permanently lubricated ball bearings, with a B-10 life of 50,000 hours. All 120-volt motors shall be supplied with built-in thermal overload protection and shall be rated for continuous duty. No motors shall require thermal overload protection wired to external controls, or moisture detection to maintain the warranty required in paragraph 3.03.

Pump motor and detector cables shall be suitable for submersible pump applications. Cable entry shall be composed of a one-piece, vulcanized, three-way mechanical sealing connector with a thickly molded shoulder with increasing cable diameters to resist fatigue from bending forces. The cable entrance shall also incorporate a limited tightening plate with built-in strain relief. The cable entry shall prevent water from leaking into the motor due to capillary action, even if cable is cut or damaged.

The pumping units shall be equipped with quick discharge connectors. The construction will be such that the pumps will be automatically connected to the discharge piping when lowered into place on the discharge connection. The pumps shall be easily removable for inspection or service. There shall be no need for personnel to enter the pump well for any purpose. The pumping units shall be fitted with a machine chain of sufficient length and strength to permit the raising and lowering of the units. The chain shall be fastened at the top of the structure near the access opening.

A sliding guide bracket shall be an integral part of the pumping unit and the pump casing shall have a machined connection with a bracket to connect with the cast iron discharge connection, which shall be bolted to the floor of the sump and so designed as to receive the pump connection without the need of any bolts, nuts, or gaskets.

Sealing of the pumping unit to the discharge connection shall be accomplished by a single liner downward motion of the pump with the entire weight of the pumping unit guided to, and wedged tightly against, the discharge connection; no portion of the pump shall bear directly on the floor of the sump and no rotary motion of the pump shall be required for sealing.

Guide rails required by the manufacturer for raising and lowering the pumps shall be furnished and installed by the Contractor for each pump. Guide rails shall be of adequate length to extend from the lower guide holder on the pump discharge connection to a bracket mounted at the top of the sump.

2.02 CONTROLS

A. GENERAL:

Controls and motor starters for all pumps shall be provided under Divisions 16 and 17.

2.04 PRODUCT DATA

In accordance with paragraph 00710-4.02, the Contractor shall provide the following information to the Construction Manager:

1. Complete product information including materials of construction, drawings, dimensions, and descriptive materials.

2. Pump performance curve showing flow, head, efficiency and power input.

3. Operation and maintenance data, in accordance with Section 01730.

4. Maintenance manuals, in accordance with Section 01730.

2.06 SPARE PARTS

The following spare parts shall be provided for each pump:

2 sets--top and bottom seals
1 set--complete O-rings
1 set--complete bearings

PART 3--EXECUTION

3.01 INSTALLATION AND TESTING

The pump shall be installed in strict accordance with the manufacturer's recommendations and shall be tested for proper alignment, rotation, vibration, and the specified operating requirements. The manufacturer shall provide a formal test procedure and forms for recording all pertinent data required to assure a satisfactory installation.

3.02 FIELD SERVICE

The manufacturer shall provide 8 hours of on-site field service by a qualified service engineer to inspect and test the completed installations for lubrication, alignment, free operation, etc, and to instruct the Owner's personnel in the proper operation and maintenance of the equipment. Installation shall be certified on Form 11000-A specified in Section 01999. Instruction shall be certified on Form 11000-B specified in Section 01999.

3.03 WARRANTY

The pump manufacturer shall warrant the units being supplied to the Owner against defects in materials and workmanship for a period of 5 years or 10,000 hours under normal use, operation, and service. This warranty shall be delivered, in writing, to the Owner and shall include, as a minimum, 100 percent full payment coverage for parts and labor during the first 18 months, or 3,000 hours of operation.

END OF SECTION

SECTION 11355

RECESSED IMPELLER PUMPS, SEVERE DUTY

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies recessed impeller vortex pumps with frames and motors for pumping abrasive slurries.

B. EQUIPMENT LIST:

Item	Equipment number
Grit pump	P1310

C. OPERATING CONDITIONS:

The pump shall operate at the following conditions:

Pump speed, rpm	Capacity at rated head, gpm	Rated head, ft	Maximum motor horsepower
900	305	38.5	15

Pumps shall be provided with a 4-inch flanged suction and discharge connection. P1310 shall be non-overloading as defined in Section 11060 when operating unthrottled against 28 feet of head.

1.02 QUALITY ASSURANCE

A. GENERAL:

Pumps shall be capable of continuous operation, pumping abrasive slurries such as grit and sludge.

B. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASTM A48-83	Gray Iron Castings
ASTM A108-81	Steel Bars, Carbon, Cold-Finished, Standard Quality
ASTM A276-86	Stainless and Heat-Resisting Steel Bars and Shapes
ASTM A532-82	Abrasion-Resistant Cast Irons

1.03 SUBMITTAL

The following information shall be submitted in accordance with Section 01300:

1. Performance curves developed for the specific applications. Performance curves shall show speed, capacity, pressure, and horsepower for specified conditions.

2. Construction details with parts list and materials of construction.

3. Motor data form 11060-A required in Section 11060.

PART 2--PRODUCTS

2.01 ACCEPTABLE PRODUCTS

Pumps shall be Wemco Model C, Goulds Model 6100, or equal, modified as necessary to provide the specified features and to meet specified operating conditions.

2.02 MATERIALS

Component	Material
Casing and impeller	Ni-hard, or hardened high chrome iron, ASTM A532, with Brinell hardness of 600 min
Frame	Cast iron, ASTM A48, Class 25/35
Shaft	Steel, ASTM A108, Grade 1141 or 1045

Component	Material
Shaft sleeve	Stainless steel, ASTM A276, type 416 or 420, Brinell hardness or 450 min
Water lubricated seal (Reference 11000-2.04 B)	
Lantern ring	Teflon
Packing ring	Nonasbestos, Teflon w/GFO fiber
Split gland	Bronze or 316 stainless steel
O-ring	Buna-N

2.03 EQUIPMENT FEATURES

A. GENERAL:

Design of each pump shall be such that pumping action is provided by the vortex induced by rotation of the impeller with the impeller completely out of the flow path from the suction to the discharge.

B. CASING:

Casing shall be three-piece construction with separate rear liner and separate suction to allow front or back pull-out.

C. IMPELLER:

The impeller shall be vortex type with vanes and an integral rim forming a cup-type design.

D. SHAFT PACKING:

Shaft packing shall be as specified in paragraph 11355-2.02. The seal liquid shall be provided from an external source.

E. BEARINGS:

Bearings shall be oil lubricated (100,000 hours, L-10 rated life), at maximum efficiency, as specified in paragraph 11000-2.02.

F. DRIVE UNIT:

Each pump shall be V-belt driven by a Type 2, 1,750-rpm motor conforming to Section 11060. Maximum motor horsepower shall be as specified in paragraph 11355-1.01 C. Motor shall be provided on an adjustable base with adjustable pitch sheaves as specified in Section 11000.

G. BASE:

Pump and drive unit shall be mounted on a common, one-piece base provided with grout holes.

2.04 SPARE PARTS

The following spare parts shall be provided for each pump:

1--set of all gaskets
1--shaft sleeve
2--sets of packing
1--lantern ring

2.05 PRODUCT DATA

The following information shall be provided in accordance with paragraph 00710-4.02:

1. Information required under Sections 11020 and 11021 and motor data as specified in paragraph 11060-2.06.

2. Operation and maintenance information specified in Section 01730.

3. Electric motor manufacturer's standard overhaul instructions for motors 5 HP and larger.

4. Mill certificates confirming hardness of casings, suction pieces, impellers, wear plates and shaft sleeves.

5. Manufacturer's Installation Certification Form 11000-A as specified in Part 3.

PART 3--EXECUTION

Each pump shall be aligned, connected and installed in accordance with the manufacturer's instructions. The installation and initial operation of all components shall be certified on Form 11000-A as specified in Section 01999.

END OF SECTION

SECTION 11385

ROTARY LOBE PUMP

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies providing and testing positive displacement rotary lobe pumps for pumping thickened sludge. Each pump shall be complete with electric motor, and all specified appurtenances, mounted on a common baseplate.

B. TYPE:

Each pumping unit shall be of the positive displacement, rotary lobe type specifically designed for pumping wastewater process slurries containing organic solids and small inorganic particles.

C. EQUIPMENT LIST:

Item	Equipment number
Sludge pump 1	P 7111
Sludge pump 2	P 7112

1.02 QUALITY ASSURANCE

A. PERFORMANCE AND DESIGN REQUIREMENTS:

Equipment shall be specifically designed and selected for continuous duty pumping of thickened sludge derived from the treatment of municipal wastewater. As such, the pumps shall be suitable for exposure to primary scum containing plastics, small particles of wood, industrial solvents, greases, detergents, petroleum products and organic particles in concentrations as great as 12 percent. The pumped fluids are expected to range in temperature between 65 degrees F and 95 degrees F and the pH may range between 6.0 and 8.3.

The pump, and associated drive appurtenances, shall be mounted on a common Type I base as specified in Section 11021.

Flow, gpm	Max. total head, psig	Max. pump speed, rpm	Discharge port size, in.	Motor HP	Motor type
50	0.88	204	3	0.5	TEFC

1.03 ENVIRONMENTAL CONDITIONS

Pump will be mounted indoors on a concrete base. It is expected that the equipment furnished under this section will be subjected to intermittent hosedown for cleaning purposes. Pump shall be suitable for the environmental conditions specified in Section 01800.

1.04 SPARE PARTS

The following spare parts shall be provided:

1--set V-belts
1--shaft sleeve
1--rotor, coated as specified
2--sets of replacement packing
1--set gaskets

PART 2--PRODUCTS

2.01 MATERIALS OF CONSTRUCTION

Component	Material
Pump base and supports	Cast iron, cast steel or fabricated steel
Pump body and end cover	Ductile iron, ASTM A536
Shafts	Carbon steel, ASTM A293
Pump rotors	Ductile iron
Rotor coatings	Buna "N" synthetic rubber, Shore hardness 65-72

2.02 EQUIPMENT

A. ROTOR:

The rotors shall be of tri-lobe form coated with the material specified above. They shall be securely fastened to the shafts with friction ring retention devices so as to provide precise rotor timing. The rotors shall be easily removable.

B. SHAFTS:

The shafts shall be fitted with replaceable stellite-coated stainless steel sleeves where passing through the gland area. They shall be timed in their rotation by precision machined timing gears running in a separate oil bath. The bearings shall be separate from the pumping chamber.

C. CASING:

The pump casing and end cover shall be 140 to 190 Brinnell hardness. Flanged connections shall be provided at the suction and discharge ports for all pumps. The front cover of the pumping chamber shall be provided with a method of sealing which allows frequent removal without impairing sealing efficiency.

D. STUFFING BOX AND BEARINGS:

Each pump shall be provided with grease or oil lubricated thrust and radial bearings designed for all loads imposed by the specified service and rated for 50,000-hour life in accordance with Section 11000. The stuffing box shall be provided with a packed gland seal suitable for sewage sludge or scum. The gland seal shall be provided with lantern rings and connections for flushing with filtered plant effluent.

E. MOTOR AND DRIVE UNIT:

Each pump shall be driven by a Type 2 1,200 rpm (nominal) motor mounted on an adjustable baseplate that will permit belt tension adjustments and easy belt replacement. Motors shall be totally enclosed and shall comply with Section 11060. Motor HP shall be transmitted to the pump shaft by an arrangement of V-belts and sheaves, with a minimum of two belts. Belt guards shall be provided. V-belts, sheaves, and belt guards shall comply with Section 11000.

2.03 PRODUCT DATA

In accordance with paragraph 00710-3.05, the following information shall be provided to the Construction Manager:

1. Complete product information.

2. Materials of construction.

3. Pump peformance curves.

4. Motor data forms in accordance with Section 11060.

5. Operation and maintenance information and maintenance manuals in accordance with Section 01730.

In addition, the information provided shall include minimum and maximum stuffing box purge pressure required, minimum seal water flow required, and maximum sphere size which will be passed by the pumps.

PART 3--EXECUTION

3.01 FACTORY ASSEMBLY AND TESTING

The pump shall be factory assembled and tested for proper operation before being shipped.

3.02 INSTALLATION

Installation shall be in accordance with the manufacturer's recommendations.

3.03 FIELD SERVICE

The manufacturer shall provide 8 hours of on-site field service by a qualified service engineer to inspect and test the completed installation for lubrication, alignment, free operation, etc., and to instruct the Owner's personnel in the proper operation and maintenance of the equipment. Installation shall be certified on Form 11000-A specified in Section 01999. Instruction shall be certified on Form 11000-B specified in Section 01999.

END OF SECTION

SECTION 11425

AIR COOLED NONLUBRICATED AIR COMPRESSORS

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies duplex instrument air compressor systems. Each system shall consist of two compressors, a receiver, and associated appurtenances.

B. TYPE:

Instrument air compressors shall be the air cooled, oiless, two-cylinder type. Receivers shall be ASME pressure vessels.

C. EQUIPMENT LIST:

Item	Equipment number
Instrument air compressor 1	CP 9211
Instrument air compressor 2	CP 9212
Instrument air receiver	PVL 9220
Instrument air compressor 3	CP 10031
Instrument air compressor 4	CP 10032
Instrument air receiver	PVL 10040

1.02 QUALITY ASSURANCE

A. GENERAL:

Instrument air compressors and accessories shall be designed for continuous operation and shall deliver clean, oil-free air. Compressors shall meet the design requirements specified in this section and shall be equipped with an inlet filter/muffler.

B. UNIT RESPONSIBILITY:.

Duplex instrument air compressor systems specified under this section shall be furnished as a complete package by a single manufacturer.

C. OPERATING REQUIREMENTS:

Item	Value
Instrument air compressors (CP 9211, CP 9212, CP 10031, CP 10032)	
Discharge pressure, psig	100
Free air delivery, scfm	1.2
Motor horsepower, maximum	1/3
Instrument air receivers (PVL 9230, PVL 10040)	
Type	Horizontal
Shell length, inches	38
Diameter, inches	16
Volume, gallons	30
Design pressure, psig	125
Relief valve setting, psig	115

1.03 ENVIRONMENTAL CONDITIONS

Instrument air compressors and accessories will be located at an elevation of approximately 930 feet above sea level, in the work shop at a wastewater'treatment plant and at a wastewater pumping station near Avondale, Arizona. While sheltered from direct exposure to the elements, the equipment must be suitable for continuous duty operation under the environmental conditions specified in Section 01800.

PART 2--PRODUCTS

2.01 ACCEPTABLE PRODUCTS

The duplex instrument air compressor systems specified under this section shall be FL Pneumotive model number GH-410B-D30-AA, or equal.

2.02 EQUIPMENT

A. COMPRESSORS:

Compressors shall be the air cooled, oiless, two-cylinder type complete with inlet filter/muffler, discharge check valve, and 1/3-horsepower motor. Motor shall be 120 volt, single phase, and shall comply with the requirements of Section 11060. Compressors shall mount on top of the receivers.

B. RECEIVER:

Receivers shall be horizontal ASME pressure vessels equipped with a pressure relief valve as specified in paragraph 1.02 C. Receivers shall also be equipped with a manual drain valve.

C. CONTROLS:

Each instrument air system shall be furnished with the manufacturer's package controls. The package shall provide for automatic alternation of compressors. Pressure switches shall be provided for operation of the lead compressor between 80 and 100 psig and the follow compressor between 70 and 90 psig. Motors shall be equipped with magnetic contactors and internal thermal protection. A normally closed contact that opens on alarm condition shall be provided for an external alarm if the pressure should drop to 70 psig.

2.03 PRODUCT DATA

The following information shall be provided to the Construction Manager in accordance with paragraph 00710-4.02:

1. Mamufacturer's standard catalog information, including design details, performance information, and accessories.

2. Motor data as specified in Section 11060, including Motor Data Form 11060-A.

3. Operation and maintenance information in accordance with Section 01730.

PART 3--EXECUTION

3.01 INSTALLATION

The instrument air systems shall be installed as shown and in accordance with the manufacturer's recommendations.

END OF SECTION

SECTION 11435

AIR COOLED RECIPROCATING AIR COMPRESSOR

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section provides specifications for service air compressor and appurtenances.

B. TYPE:

Compressors shall be air cooled, two-stage, belt driven, base mounted, oil lubricated reciprocating type. Compressors shall be Ingersoll-Rand, LeRoi, Kellog-American or equal.

C. EQUIPMENT LIST:

Item	Equipment number
Service air compressor 1	CP 9111
Service air compressor 2	CP 9112

1.02 QUALITY ASSURANCE

A. PERFORMANCE AND DESIGN REQUIREMENTS:

Air cooled compressor and accessories shall be designed and selected for heavy duty automatic start/stop operation.

B. OPERATING REQUIREMENTS:

Compressor shall be designed to comply with the following at standard conditions:

Item	
1. Discharge pressure, psig	200
2. Minimum capacity at rated discharge pressure, acfm	19.5
3. Rotative speed, maximum, rpm	660

Item	
4. Installed motor horsepower, maximum	7.5
5. Compressor BHP at rated conditions, including belt drive losses	7.4

C. STANDARDS:

ASME Heat Exchanger Code

1.03 ENVIRONMENTAL CONDITIONS

Air cooled compressor and accessories will be located inside a ventilated equipment room. Compressor will be located at an elevation approximately 930 feet above sea level. Compressor shall be suitable for the environmental conditions specified in Section 01800.

1.04 SPARE PARTS

The following spare parts shall be furnished:

1 - complete set of crankshaft oil seals
1 - complete set of gaskets
1 - set of piston rings
1 - set of valve fingers, plates and springs
2 - sets of filter elements

PART 2--PRODUCTS

2.01 MATERIALS

Component	Material
Piston rings	Cast iron
Cylinders and counterweights	Cast iron, ASTM A48, Class 30B
Low pressure piston	Aluminum alloy, AISI S-132
High pressure piston and heads	Cast iron, ASTM A48, Class 25B
Crankshaft and connecting rods	Forged steel
Frame and intercooler manifolds	Cast iron, ASTM A48, Class 20A
Intercooler	Cooper
Baseplate	Fabricated steel
Gaskets	Asbestos
Valves	Type 304 and 316 stainless steel

2.02 EQUIPMENT

A. GENERAL:

Compressor shall be two-stage with deep ribbed construction for efficient heat dissipation. Valves shall be readily accessible. Connecting rods shall be of forged steel with crankpin bearings. The crankshaft shall be a balanced, single steel forging. Crankshaft bearings shall be Class M3 (50,000 hours) life, designed for the radial and thrust loads imposed by the operating conditions specified. Lubrication shall be splash or pressure type. The interstage cooler shall be finned and of multitube copper construction. The interstage coolers shall have a pressure relief valve. Compressors shall automatically unload during shutdown. An ASME relief valve, set at 110 percent of the compressor's rated discharge pressure and sized for not less than the unit's maximum capacity, shall be provided on each compressor discharge.

B. CONTROLS:

The crankcase shall be provided with a low oil level switch with contacts that open on low level, suitable for the 120V AC control circuit shown on the electrical drawings, which shall shut the compressor off on low oil level, and shall not reset until oil is added to the compressor. The oil level switch shall provide NEMA 4 protection.

C. DRIVE UNIT:

Each compressor shall be driven by a 1750 rpm, Type 2 motor in accordance with Section 11060.

D. BASE:

The compressor and drive shall be mounted on a Type I base in accordance with Section 11021.

E. INTAKE FILTER-SILENCER:

Compressor shall be equipped with a replaceable dry type inlet air filter and inlet silencer. The filter-silencer shall be provided with threaded or flanged connections and mounting brackets suitable for proper installation. Interior surfaces shall receive a rust-inhibitive coating. The filter-silencer shall be sized so that the back pressure produced will not adversely affect performance of the compressor to which it is connected. Minimum noise reduction by octave frequency bank shall be as follows:

Octave band, Hz	Attenuation, decibels
63	14
125	19
250	25
500	22
1000	21
2000	18
4000	17
8000	17

2.03 CORROSION PROTECTION

External surfaces of the compressor and appurtenances shall be shop primed and painted with the manufacturer's standard materials. Color shall be as specified in Section 09900.

2.04 PRODUCT DATA

In accordance with paragraph 00710-3.05, the following information shall be provided to the Construction Manager:

1. Performance data showing capacity, discharge pressure, rpm, and BHP at the specified operating conditions.

2. Bearing ratings at the specified operating conditions.

3. Full product information including dimensioned drawings, and other descriptive materials necessary to ascertain compliance with these specifications.

4. Motor data required under Section 11060 (Form 11060-A specified in Section 01999).

5. Operation and maintenance information and maintenance manuals in accordance with Section 01730.

PART 3--EXECUTION

3.01 INSTALLATION

The compressors shall be located as shown on the contract drawings. Installation shall conform to the manufacturer's recommendations. The compressor base shall be mounted to the equipment pad in strict accordance with the manufacturer's directions prior to operating the unit.

3.02 TESTING

Prior to final acceptance, the compressor and appurtenances shall be field tested to guarantee compliance with these specifications.

END OF SECTION

SECTION 11450

BUILT-IN RESIDENTIAL EQUIPMENT

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Kitchen equipment.

B. Complete installation including all rough-in under separate sections.

1.02 RELATED WORK

A. Section 06100 - Rough Carpentry

B. Section 06200 - Finish Carpentry

C. Section 06410 - Architectural Woodwork

D. Division 15 - Mechanical and Plumbing Connections

E. Division 16 - Electrical Connections

1.03 SUBMITTALS

A. Submit shop drawings and product information under provisions of Section 01300.

1.04 WARRANTY

A. Provide minimum two (2) year warranty unless manufacturer's standard warranties are for a longer period of time.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Brand names indicated for equipment are to establish a standard of quality only. Other manufacturers will be accepted upon meeting the criteria of substutions as indicated in the Instructions to Bidders and General Requirements.

B. Hotpoint.

C. Maytag.

D. General Electric.

E. Frigidaire.

F. Ice-N-More.

G. White-Westinghouse.

2.02 GARBAGE DISPOSER

A. Model 77, as manufactured by In-Sink-Erator, 1/2 h.p. split phase motor, and 5-year warranty.

2.03 RANGE/OVEN/MICROWAVE/EXHAUST HOOD

A. Model RH961GJ, as manufactured by Hotpoint, 30 inch slide-in range, colors as selected by Construction Manager.

2.04 REFRIGERATOR FREEZER

A. Model CTX18 CJ as manufactured by Hotpoint, color as selected by Construction Manager.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Contractor to provide all rough-in connections and final connections for all equipment.

B. Follow manufacturer's installation instructions for rough-in openings, and install all equipment true, level and plumb.

C. Clean after installation and leave all manufacturer's literature, warranty packages, etc., with appliances.

END OF SECTION

SECTION 11454

REFRIGERATED AIR DRYER

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies a refrigerated air dryer.

B. EQUIPMENT LIST:

Item	Equipment number
Instrument air dryer	MME 9230
Instrument air dryer	MME 10050

1.02 OPERATING REQUIREMENTS

Air dryers shall be rated in accordance with Recommended Standard NFPA/T3.27.2-1975 of the National Fluid Power Association for Class H (33 degree F to 39 degree F) pressure dew point. Rating conditions are 100 degrees F inlet temperature, 100-psig inlet pressure, 100-percent relative humidity, and 100-degree F ambient temperature. Maximum pressure drop across each air dryer is 3.5 psi. Actual operating conditions are as follows:

Item	
Rated capacity, scfm	3
Operating pressure, psig	100
Inlet air temperature, degrees F	120

1.03 ENVIRONMENTAL CONDITIONS

The equipment shall be suitable for continuous operation under the environmental conditions specified in Section 01800.

PART 2--PRODUCTS

2.01 EQUIPMENT

Air dryers shall be Ingersal-Rand, Model HG-10, or equal. The compressor for each air dryer shall be driven by a 115-volt, single-phase, 60-hertz motor. Motors shall be 1/5 horsepower, maximum, and shall comply with the requirements of Section 11060. Air dryers shall be equipped with the following accessories:

1. Refrigerant flow control valves.
2. Refrigerant compressor overload switch.
3. Refrigerant filter dryer.
4. High evaporator temperature light.
5. Air-cooled condenser.
6. Automatic drain valve.

2.02 PRODUCT DATA.

The following information shall be provided to the Construction Manager in accordance with paragraph 00710-4.02:

1. Manufacturer's standard catalog information, including standard rating tables and accessories.

2. Motor data as specified in Section 11060, including Motor Data Form 11060-A.

3. Operation and maintenance information as specified in Section 01730.

PART 3--EXECUTION

3.01 INSTALLATION

Air dryers shall be installed as shown and in accordance with the manufacturer's recommendations.

END OF SECTION

SECTION 11475

ROTARY POSITIVE DISPLACEMENT BLOWERS

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies rotary-lobe positive displacement blowers for the sludge holding tank aeration system.

B. TYPE:

Blowers shall be rotary lobe, positive displacement type, designed for compressed air service and shall have side inlet and side discharge connections.

C. EQUIPMENT LIST:

Item	Equipment number
Holding tank aeration blower 1	B 7211
Holding tank aeration blower 2	B 7212

1.02 QUALITY ASSURANCE

A. PERFORMANCE REQUIREMENTS:

The blowers shall be designed to provide air for agitation of the liquid contents in the sludge holding tank. Blowers shall be designed for constant speed operation. Inlet air shall be drawn into the blower through a high efficiency filter and a chamber-absorption critical grade silencer.

The blowers shall be specifically selected for the following field conditions:

Parameter	Value
Capacity, ICFM	880
Discharge pressure, psig, at field conditions	5.0
Maximum blower speed, rpm	1,470
Motor horsepower, maximum	30
Altitude, feet above mean sea level	930
Inlet temperature, degrees F	120

1.03 ENVIRONMENTAL CONDITIONS

The blower shall be installed outdoors and shall be suitable for continuous duty operation under the environmental conditions specified in Section 01800.

1.04 SUBMITTALS

In accordance with the provisions of Section 01300, drawings and data giving full descriptions of the rotary positive displacement blowers shall be submitted to the Construction Manager for review. The submittal shall include standard performance curves, drawings, motor data including Motor Data Form 11060-4 in accordance with Section 11060, materials of construction, and descriptive materials necessary to ascertain compliance with the requirements specified.

1.05 SPARE PARTS

One complete set of the following spae parts shall be provided for each blower:

1--main seal
1--drive seal
1 pair--grip rings
1--O-ring bearing cartridge
1--cover gasket

PART 2--PRODUCTS

2.01 COMPRESSORS

A. CONSTRUCTION

Blowers shall be the rotary lobe, positive displacement type. Blowers shall be rated for continuous duty and shall have mechanical seals. Rotors shall be constructed of high strength ductile iron and shall be dynamically balanced to assure vibration-free operation. Rotor housing and end plates shall be constructed of block-grained cast iron. Bearings and timing gears shall be lubricated by a self-contained splash system. Bearings shall be rated for 50,000-hour L-10 life in accordance with Section 11000. Blowers shall be V-belt driven with cast iron or ductile iron drive and companion sheaves. Both sheaves shall be key-seated and shall have hubs.

Each blower shall be provided with an inlet filter and a critical grade chamber-absorption inlet silencer as specified in paragraph 2.01 D. The discharge of each blower shall be provided with a spring loaded pressure relief valve. The valve shall be capable of discharging not less than the rated capacity of the

blower when the pressure exceeds 6 psig. The pressure relief setting of the valve shall be adjustable. Each blower shall also be provided with a discharge silencer as specified in paragraph 2.01 D.

B. MOTORS:

Each blower shall be driven by a Type 2, high-efficiency, horizontally mounted electric motor complying with Section 11060.

C. BASE AND ISOLATION PADS:

Each blower unit, including blower, belt drive and motor, shall be mounted on a fabricated steel base. Motor shall be mounted in line with the blower in an elevated position as required to achieve the necessary dimension between the rotating shafts.

D. INLET AND DISCHARGE SILENCERS AND NOISE CONTROL:

A chamber-absorption critical grade silencer shall be provided on the inlet and discharge of each blower as shown for noise and pulsation control. Silencers shall be Universal, Burgess-Manning, or equal. Noise requirements shall be as specified in Section 11030 and field testing shall be conducted to determine the adequacy of the installation.

2.02 OPERATION AND MAINTENANCE INFORMATION

Operation and maintenance data and maintenance manuals shall be provided in accordance with Section 01730.

PART 3--EXECUTION

3.01 INSTALLATION AND TESTING

The blowers shall be installed in strict accordance with the manufacturer's recommendations and shall be tested for proper alignment, vibration, and the operating requirements.

END OF SECTION

SECTION 11486

MULTISTAGE CENTRIFUGAL BLOWER

PART 1 - GENERAL

1.01 DESCRIPTION

A. SCOPE:

Motor driven, multistage centrifugal air blowers with appurtenances are specified in this section.

B. TYPE:

Blower shall be of the heavy duty, multistage, centrifugal type suitable for continuous duty under the specified conditions.

C. EQUIPMENT LIST:

Equipment numbers are as follows:

Item	Equipment number
Aeration blower 1	B 3121
Aeration blower 2	B 3122
Aeration blower 3	B 3123
Mixed liquor channel blower 1	B 3211
Mixed liquor channel blower 2	B 3212

1.02 QUALITY ASSURANCE

A. PERFORMANCE AND DESIGN REQUIREMENTS:

1. GENERAL: Blowers will provide air for aeration and agitation of the liquid contents in the oxidation and mixed liquor transfer channels. Blowers shall be suitable for continuous duty under the conditions specified.

Supply air for the blower will be drawn from the outdoors through an inlet filter provided with the unit as shown. Blowers will be installed outdoors at an elevation of approximately 930 feet above sea level. Ambient temperatures are expected to range between 30 degrees F and 120 degrees F. Other environmental conditions will be as specified in Section 01800.

2. OPERATING REQUIREMENTS: Operating requirements for the blowers shall be as follows at field conditions:

Parameter	B3121 B3122 B3123	B3211 B3212
Rated flow, icfm	2,366	500
Discharge pressure at field conditions, psig	6.7	3.2
Inlet temperature, degrees F		
At rated condition	120	120
Minimum	25	25
Relative humidity, percent	90	--
Altitude, feet above mean sea level	930	930
Conditions at which blower shall be free from surge		
Minimum flow, icfm	1,000	200
Minimum discharge pressure, psig	8.2	4.13
Motor horsepower (see paragraph 11486 2.02 B)	100	20

3. FACTORY TESTS: The blower shall be subjected to a factory test. The test shall be conducted at constant speed and shall extend from the surge point to not less than 120 percent of design volume at design pressure. The test shall be sufficiently comprehensive to produce guaranteed performance characteristics. The test data shall be employed to produce operating curves showing curves shall be certified correct by an officer of the manufacturer's corporation.

B. STANDARDS:

Factory tests shall be performed in accordance with the ASME Test Code for Centrifugal Compressors and Exhausters.

1.03 *SUBMITTALS*

In accordance with the provisions of Section 01300, drawings and data giving full descriptions of the multistage centrifugal blower shall be submitted to the Construction Manager for review. The submittal shall include standard performance curves, drawings, motor data in accordance with Section 11060, materials of construction and descriptive materials necessary to ascertain compliance with the requirements specified.

1.04 SPARE PARTS

One set of all gaskets, blower bearings and seals shall be furnished as replacement parts. In addition, two spare filter elements and one spare flexible coupling shall be furnished.

PART 2 - PRODUCTS

2.01 MATERIALS

Component	Material
Casing and bearing housing	Cast iron, ASTM A48, Class 25; or steel, ASTM 569
Impeller	Cast aluminum ANSI H35.1 Type 443; or fabricated aluminum 5052-H-34
Shaft	Carbon steel, SAE 1045
Tie rods	Steel
Base	Structural steel, ASTM A36

2.02 EQUIPMENT

A. MULTISTAGE BLOWER:

The casing shall be comprised of independently cast or fabricated single piece volute sections assembled in sufficient number with the inlet and discharge sections to provide the number of compression stages required to achieve the specified discharge pressure. The complete assembly shall be held together with high strength steel tie rods which shall connect body flanges on the inlet and discharge heads or shall be assembled in a welded construction, reinforced heavy gage sheet steel shell. Inlet and discharge connections shall be flanged and oriented for connection to the piping systems as shown. The interstage sealing diaphragm shall be cast or fabricated as a part of each casing section. Inlet air directing vanes shall be provided at the inlet to each stage to insure proper approach conditions, reduce turbulence and improve blower efficiency. Shaft seals shall be of the labyrinth, fibrous felt stuffing box, or carbon ring type, completely replaceable without disassembling the machine or disturbing the inlet and discharge piping.

Bearings shall be oil lubricated antifriction type, sized for 50,000-hour L-10 rating life, in accordance with Section 11000. Bearing lubrication shall be by constant-level oilers with transparent reservoirs. Bearings shall be mounted in outboard cast iron

or steel housings which shall be designed to effect a complete atmospheric separation between the bearing and the casing to isolate the bearing from heat generated by the machine. Bearings shall be replaceable without disconnecting any piping or disassembling the machine.

Impellers shall be keyed to the shaft and held in place by abutting spacers and lock washer assemblies. The entire rotating assembly shall be statically and dynamically balanced to limit vibration to 1.25 mils (peak-to-peak) when measured on the outboard bearing housing at design speed.

B. DRIVE UNIT:

Each blower shall be direct driven through a flexible coupling by a horizontally mounted Type 2 energy-efficient electric motor, complying with Section 11060. The motor shall be rated to deliver no more than the value listed in paragraph 11486 1.02 A.2., but in any case shall be selected to be non-overloading with the blower operating unthrottled at the listed minimum inlet temperature. Flexible couplings shall meet the requirements specified in Section 11000.

C. BASE AND ISOLATION PAD:

The blower and motor shall be connected through a flexible coupling and shall be mounted on a common Type I base with Type E vibration isolation mounting as specified in Section 11021.

D. INSTRUMENTS:

1. GENERAL: Each blower shall be provided with a local ammeter, furnished in a NEMA 4 enclosure which shall be post-mounted in the vicinity of the blower. Ammeter shall not be attached to the blower's casing.

2. AMMETERS: Ammeter shall be provided by the blower manufacturer and shall be calibrated in both amps and cfm.

2.03 PRODUCT DATA

Information to be provided to the Construction Manager in addition to that specified in paragraph 11486.1-1.03 shall include the following:

1. Results of factory tests including test logs.

2. Certified performance curves for each unit based upon test data for the specified conditions showing pressure, capacity, power, and surge points.

3. Operation and maintenance data and maintenance manuals in accordance with Section 01730.

PART 3--EXECUTION

3.01 INSTALLATION AND TESTING

The blower shall be installed in strict accordance with the manufacturer's recommendations and shall be tested for proper alignment, vibration, and the operating requirements.

END OF SECTION

SECTION 11495

REGENERATIVE BLOWER

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies the regenerative blower and appurtenances for providing agitation air for mixing the contents of wastewater channels.

B. TYPE:

Blower shall be the V-belt driven, high performance, single-stage regenerative type complete with motor, base, V-belt drive, silencers, filter, relief valve, and other accessories specified or required for proper operation.

C. EQUIPMENT LIST:

Item	Equipment number
Agitation air blower	B1500
Intake silencer	SIL1500A
Discharge silencer	SIL1500B

1.02 QUALITY ASSURANCE

A. GENERAL:

Blower will be located outdoors at a municipal wastewater treatment plant near Avondale, Arizona. Blower will be installed at an elevation of 930 feet above sea level. Blower shall be suitable for the environmental conditions specified in Section 01800.

Blower shall comply with the dynamic performance requirements specified in Section 11020. Belt guards, V-belts, bearings, and other general equipment features shall be in accordance with Section 11000, as modified herein. Equipment base shall comply with Section 11021, and shall include vibration isolators. Blower shall not require a rigid equipment mounting at the base/equipment pad interface for a stable, safe operating installation.

B. PERFORMANCE REQUIREMENTS:

Blower shall comply with the following requirements at standard conditions:

Parameter	Value
Rated capacity, scfm	495
Discharge pressure, psig	3.2
Blower speed, maximum, rpm	3,500
Blower BHP at rated capacity, maximum	20.1
Motor horsepower	25

C. FACTORY TESTS:

The blower shall be subjected to a factory test conducted in accordance with industry standards. Test shall be conducted at constant speed and shall extend from a discharge pressure of zero gage (free air) to 5 psig. Tests shall be sufficiently detailed to certify performance meets the specified requirements. As part of the testing program, vibration measurements shall be made and recorded to demonstrate compliance with the requirements specified in Section 11020.

1.03 SUBMITTALS

In accordance with the requirements of Section 01300, drawings and data giving a full description of the regenerative blower and all appurtenances shall be submitted to the Construction Manager for review. The submittal shall include standard performance curves, drawings, motor data in accordance with Section 11060, materials of construction, and descriptive materials necessary to ascertain compliance with the specified requirements.

1.04 SPARE PARTS

One set of all gaskets, blower bearings, V-belts, and seals shall be furnished as replacement parts. Ten spare filter elements shall be furnished.

PART 2--PRODUCTS

2.01 MATERIALS

Component	Material
Blower housing, impeller	Die cast aluminum

2.02 BLOWER CONSTRUCTION

Blower housings shall be finned for proper heat dissipation and secured with conservatively sized hex head capscrews. There shall be no contact between the shaft rotor and housing other than through the outboard mounted grease lubricated ball or roller bearings. Where the shaft passes through the casings, non-contact labyrinth seals shall be provided. Shafting shall be conservatively sized, suitable for 6,000 rpm operation, and shall safely transmit the full driver output without distortion. Blower inlet and outlet connections shall be 3-inch NPT.

2.03 BASE

Blower shall be provided with a suitable baseplate with integral vibration isolators complying with Section 11021. Baseplate shall be of welded construction and shall be sized to accommodate the combined blower, motor, and drive components as an integral unit. Bolting of the base to the equipment pad to secure the unit shall not be permitted.

2.04 RELIEF VALVE

The blower shall be provided with a pressure relief valve set to open at 5 psig and sized such that 120 percent of the rated capacity can be discharged without overloading the motor.

2.05 FILTER AND SILENCERS

Blower shall be provided with an inlet filter assembly and absorption-type silencers on the suction and discharge. Connection sizes shall be 3-inch NPT, and the total pressure drop through all three components shall not exceed 12 inches with the filter in a clean condition.

Silencer attenuation shall be as follows:

Octave band center frequency, hertz	Attenuation, db
63	2
125	6
250	11
500	20
1000	31
2000	31
4000	26

2.06 MOTOR

Blower shall be V-belt driven by a Type 2 energy efficient motor. Motor shall comply with Section 11060.

2.07 PRODUCT DATA

In accordance with paragraph 00710-3.05, the following information shall be provided to the Construction Manager:

1. Results of factory tests including test logs.
2. Certified performance curves based upon test data showing capacity, pressure, and power.
3. Certification that the blower meets the vibration limits specified.
4. The information required under Section 11020.
5. Operating and maintenance data and maintenance manuals in accordance with Section 01730.

PART 3--EXECUTION

3.01 INSTALLATION AND TESTING

The blower shall be installed in the location shown in strict accordance with the manufacturer's recommendations. The completed installation shall be completely field tested to prove compliance with the specified requirements.

3.02 FIELD SERVICE

The manufacturer shall provide one day (8 hours) of on-site assistance by a qualified field service engineer to inspect the completed installation for alignment, free operation, rotation, lubrication, etc. and to instruct the Owner's staff as to the proper methods of operating and maintaining the equipment. Forms 11000-A and 11000-B specified in Section 01999 shall be completed and delivered to the Construction Manager.

END OF SECTION

SECTION 11530

CIRCULAR DISSOLVED AIR FLOTATION THICKENER

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies dissolved air flotation equipment for thickening waste activated sludge solids.

B. TYPE:

The waste sludge thickener shall be the dissolved air flotation type, complete with steel tank, effluent launder, effluent weirs, sludge scrapper, float skimmer, pressurization system, and all other appurtenances required for a complete system. The pressurization system shall employ two single-stage pumps, a static air dissolving tank, and compressed air provided by the plant service air system.

C. EQUIPMENT LIST:

Item	Equipment number
Waste sludge thickener	DAF7100
Pressurization pump 1	P7111
Pressurization pump 2	P7112
Pressurization tank	PVL7120

1.02 QUALITY ASSURANCE

A. GENERAL:

The dissolved air flotation equipment furnished under this specification shall be designed specifically for the concentration of solids from an extended aeration activated sludge process treating municipal wastes. The influent stream will be mixed liquor containing biological solids in concentrations ranging from 1,000 to 5,000 mg/l, small bits of plastic, rubber goods, grease, petroleum products, animal fats and oils, industrial solvents, and ammonia. The waste's temperature may be expected to range between 65 degrees F and 95 degrees F.

Waste solids will be discharged to the thickener using three constant speed pumps, with a capacity of 40 gpm per pump. The pumps are operated manually by the treatment plant staff to control the sludge waste rate. Waste rates of approximately 40, 80, and 120 gpm may be expected. The pressurization pumps and the pressurization tank are located adjacent to the waste sludge thickener. One or two pressurization pumps will be operated, depending on the sludge waste rate. The pressurization system shall be suitable for operation on

either thickener overflow or plant effluent. If plant effluent is used, it will be provided to the suction intake of the pressurization pumps through the overflow collection box. Air for the pressurization system will be provided at 110 to 190 psig by the service air compressors which are specified in Section 11435 and are located in the operations building.

B. UNIT RESPONSIBILITY:

All equipment and appurtenances specified herein and shown in the contract drawings shall be supplied by a single manufacturer. it shall be the responsibility of the manufacturer to design and construct equipment which functionally and reliably performs in accordance with the criteria set forth herein, without vibration, deflection, or distortion.

Nothing contained wtihin these provisions shall be construed as relieving the Contractor of his responsibility for this portion of the work.

C. OPERATING REQUIREMENTS:

1. GENERAL: The equipment furnished under this section shall be designed to concentrate the solids in the liquid supplied to the thickener inlet to not less than 3.0 percent by weight without the use of coagulating chemicals. Solids captured in the float and sludge removed from the waste sludge thickener shall be not less than 90 percent of that supplied to the equipment.

2. DESIGN REQUIREMENTS: The dissolved air flotation thickener equipment shall be designed in accordance with the following criteria and the configuration shown:

Tank diameter, feet	16
Sidewater depth, feet	6.42
Pressurized flow maximum, gpm	220
Water temperature, degrees F	
Minimum	60
Maximum	95
Total dissolved solids in water, mg/l	900
WAS, flow maximum, gpm	120
Applied solids concentration, mg/l	
Minimum	1,000
Maximum	5,000
Air dissolution tank detention time, minutes	1-2
Pressurization tank pressure, maximum, psig	75
Minimum saturation efficiency, percent	85
Minimum air/solids ratio	0.03
Minimum float concentration, percent	3.0
Minimum solids capture efficiency, percent	90
Design torque, minimum, ft-lbs	
Continuous	3,100
Momentary peak	6,300
Float box volume, cubic feet, minimum	25

1.03 ENVIRONMENTAL CONDITIONS

The equipment supplied under this section shall be suitable for continuous duty operation under the environmental conditions specified in Section 01800.

1.04 SUBMITTALS

The following information shall be submitted to the Construction Manager in accordance with Section 01300:

1. Drawings showing the entire waste sludge thickener assembly, including descriptions of all gears, structural members, sludge collection members, float skimmer, and the entire pressurization system, including pumps, valves, pressurization tank, and control panel.

2. Detailed installation drawings for the waste sludge thickener and the associated pressurization system.

3. Motor submittal data as specified in Section 11060, including Motor Data Form 11060-A as specified in Section 01999.

1.05 SPARE PARTS

Spare parts shall be provided as follows:

one set--all bearings and bearing seals for waste sludge thickener drive unit and for each pressurization pump

one set--all gaskets for waste sludge thickener drive unit and for each pressurization pump

six sets--shear pins if utilized in this equipment

PART 2--PRODUCTS

2.01 ACCEPTABLE PRODUCTS

The equipment specified in this section shall be EIMCO, Walker Process, Envirex, or equal.

2.02 MATERIALS

Component	Material
Tank shell	Steel
Tank anchor channel	Steel
Walkway bridge	Steel with aluminum checkered decking or grating

Component	Material
Center shaft	Schedule 80 steel pipe
Influent pipe and diffuser	Schedule 40 steel pipe
Sludge collector arms	Steel with steel raking blades and brass squeegees
Float box	Steel, ASTM A36
Flotation compartment baffle	Steel, ASTM A36
Effluent weirs	Steel, ASTM A36
Submerged fastening hardware	Type 316 stainless steel
Air dissolution tank	Steel
Pressurization pump	
Casing	Cast iron, ASTM A400
Shaft sleeves	Stainless steel, Brinell 500
Shaft	Carbon steel
Impeller	Cast iron, ASTM A48
Impeller key	Type 316 stainless steel

2.03 EQUIPMENT

A. GENERAL:

The equipment furnished under this section shall be designed for installation on a circular reinforced concrete tank floor and shall be complete with all collector equipment, steel tank, drives, weirs, and walkways, as shown and required.

B. STRUCTURAL STEEL:

All structural steel shall be ASTM A36, minimum 3/16 inch thick unless otherwise specified. Handrailing and decking material shall be aluminum as specified in Division 5. All steelwork shall conform to all applicable provisions of AISC and AWS specifications.

C. TANK EQUIPMENT:

1. STEEL TANK SHELL: A 16-foot, 0-inch-diameter by 6-foot, 11-inch-deep by 3/16-inch steel tank shell shall be provided. The tank shall be designed to be welded to a 6-inch steel anchor channel imbedded in the tank floor. The tank shall include an effluent launder, a 10-inch flanged effluent nozzle, and a 4-inch flanged recycle nozzle.

2. WALKWAY BRIDGE: The bridge shall be 36 inches wide with a 30-inch minimum clear walkway and shall include aluminum checkered decking or grating, structural steel support members and aluminum pipe handrailing. The bridge and handrailing shall span the tank and be supported by the tank walls. The walkway shall be

designed to support, in addition to dead load, a live load of 100 pounds per square foot. Deflection under full live and dead loads shall not exceed 1/360 of span. The bridge shall have ample strength to safely withstand all operating load conditions and be designed to accommodate thermal expansion and contraction.

3. CENTER SHAFT: The rotating center shaft shall be a Schedule 80 steel pipe with the upper end connected to the drive mechanism through a flanged coupling. The shaft shall be furnished with connections for the rake arms and skimmers. At the lower end of the shaft, there shall be furnished a shaft guide support.

4. INFLUENT PIPE AND DIFFUSION WELL: The 8-inch-diameter steel influent pipe shall extend from a flexible coupling at the tank wall and shall terminate at the influent diffuser. The stationary diffusion well shall be placed at the tank center, and supported by steel tie rods extending to the tank shell. Flow shall discharge from the top of the diffusion well with a low velocity to facilitate float removal and collection.

5. BOTTOM SLUDGE COLLECTOR ARMS: The bottom sludge removal system shall include two bottom sludge collector arms. The arms shall have steel raking blades and adjustable brass squeegees. The blades shall properly move the sludge along the tank bottom to the center sludge hopper. A center sludge hopper scraper shall be properly attached to the center shaft for stirring and thickening action.

6. EFFLUENT WEIRS: Effluent weirs shall consist of 3/16-inch by 6-inch peripheral V-notch steel plate sections clamped to the tank wall. All bolts, nuts and washers for weir plates shall be Type 316 stainless steel. Provisions shall be made for a minimum 3-inch adjustment and leveling of the effluent weir downward from the maximum weir crest elevation shown.

7. FLOAT REMOVAL EQUIPMENT: The float removal equipment to be furnished with the mechanism shall sweep the outer surface of the flotation compartment, and consist of four rotating surface skimmers and a float box for collection and removal of floating matter from the flotation compartment.

Each skimmer blade shall consist of a vertical, adjustable pivoted float scraper with neoprene wipers attached to a skimmer support.

Each float skimmer shall maintain contact with the flotation baffle as it rotates. Upon approaching the flat section of the float box, the float will be trapped and scraped up the ramp and into the float box.

The steel float box shall be supported from the flotation baffle and shall consist of a trough, vertical steel sides, and a sloping ramp. The sloping ramp section shall be fabricated to form a section of a helix so that the skimmer blade remains in contact with the ramp at all times. The float box shall be a minimum of 6 feet long.

All floated solids delivered to the float box shall be conveyed by gravity through a 6-inch discharge pipe to the tank periphery.

8. FLOTATION COMPARTMENT BAFFLE: The flotation compartment baffle shall be 15 feet, 0 inches in diameter by 5 feet, 0 inches deep, including a 6-inch free-board. The baffle shall be fabricated of 3/16-inch steel plate and shall be provided with appropriate supports for attachment to the tank wall.

D. DRIVE UNIT:

The drive shall consist of a speed reducer rated for continuous duty, driven by a 1/4-horsepower nominal 5:1 mechanical variable speed drive. The drive shall be protected by a mechanical overload device with electrical contacts to stop the drive motor and sound an alarm.

All bearings shall run in an oil bath. Readily accessible lubricant fill and drain pipes with necessary fittings shall be provided.

The drive motor shall be TEFC and shall be designed for operation on 460 volt, 3 phase, 60 hertz current. The drive control shall be wired for 110 volt, single phase current.

E. PRESSURIZATION SYSTEM:

1. GENERAL: The equipment furnished with the pressurization system shall include two pressurization pumps, the pressurization tank, air control panel, back pressure control valve, recycle flow measurement device, and pressure gauges as shown on the contract drawings. Compressed air will be supplied by the plant's service air system.

2. PRESSURIZATION PUMP: Each pressurizing pump shall be a single-stage, end suction, open impeller pump arranged to deliver 110 gpm of liquid at a discharge pressure of 75 psig. The pump shall include a 10-horsepower TEFC motor directly connected through a flexible coupling to the pump. The motor shall comply with the requirements of Section 11060. A coupling guard and structural mounting base shall be included. Pump connections shall be Class 125 ASA flanged, 1-1/2-inch inlet and 1-inch outlet.

3. AIR FEEDING SYSTEM: The air feeding system shall consist of an air pressure regulator, air supply solenoid valve, rotameter, pressure gages, air control panel (suitable for post mounting), and appurtenances. The rotameter shall be of direct reading type ranged from 0 to 6.3 scfm. The solenoid valve shall be interlocked with the pressurization pump and shall be designed for operation on 120V AC single phase, 60 Hz electrical service. All pressure regulators, solenoid valves, rotameters, and pressure gages shall meet the requirements of Divisions 15 and 16 as specified.

4. PRESSURIZATION TANK: A vertically-mounted pressurization tank shall be provided for dissolving air into the pressurized flow. The tank shall be designed to provide a high degree of air saturation without requiring internal packing or internal re-aeration pumps. The tank shall be designed for 220 gpm and shall be 2 feet, 0 inches in diameter by 7 feet, 3 inches side height, have a clearance of 2 feet, 0 inches from the bottom of the tank to the tank pad, and shall be constructed on the basis of the ASME code for unfired pressure vessels for a working pressure of 100 psig. The tank shall be baffled such that the exit velocity of the liquid will be no greater than 0.75 feet per second to allow for free air to leave the liquid prior to its exiting the tank.

The pressurization tank shall be equipped with steel legs, a drain plug, access manhole for inspection, sight glass, pressure gauge, pop safety valve, and an air inlet connection. Liquid level in the pressurization tank shall be maintained by a mechanically operated float valve connected to an excess air bleed line.

5. BACK PRESSURE VALVE: A specially designed back pressure valve shall be provided to maintain the proper pressure in the pressurization tank. The valve shall release the pressurized flow inside the flotation unit to prevent loss of dissolved air in external piping and distribution systems.

The valve shall be fabricated from a 3-inch cast iron tee with a stainless steel disc and positioner to maintain back pressure control. The pressurized flow shall be released in a conical pattern to intimately mix it with the waste stream. The position of the back pressure control disc shall be controlled by a manual hand wheel. The stainless steel disc and pipe shall be properly beveled to insure proper air bubble formation. The handwheel shall be operated with no more than 35 inch pounds of torque.

F. PAINTING:

Equipment shall have a shop applied prime coat compatible with the field coats specified in Section 09900, except for pumps and gearmotors, which shall receive the manufacturer's standard coating.

2.04 PRODUCT DATA

The following information shall be provided as specified in paragraph 00710-4.02:

1. Operation and maintenance information as specified in paragraph 01730.

2. Calculations verifying a pressurization tank liquid exit velocity no greater than 0.75 feet per second as required in paragraph 2.03 C.4.

3. Performance test procedure.

4. Installation certification form 11000-A as specified in paragraph 11530-3.01.

5. Training certification form 11000-B as specified in paragraph 11530-3.03.

PART 3--EXECUTION

3.01 INSTALLATION AND TESTING

The equipment manufacturer shall provide factory trained personnel to supervise the installation and initial operation of the waste sludge thickener. The waste sludge thickener, pressurization system, and related appurtenances shall be aligned, connected and installed at the location shown and in accordance with the manufacturer's recommendations. The installation shall be certified on Form 11000-A as specified in Section 01999.

After completion of installation, the waste sludge thickener shall be field tested to ensure compliance with the performance requirements as specified in paragraph 1.02 C.2. The performance test procedure shall be provided to the Construction Manager as required in paragraph 2.04.

3.02 FIELD TESTING

A. GENERAL:

In addition to the installation and performance tests set forth in paragraph 3.01, the equipment furnished under this section shall be subject to the following field performance tests. Performance testing shall include both operating and torque load testing. Failure to complete the testing program, as outlined in the following paragraphs, shall be sufficient cause for the Construction Manager to require that the equipment be removed from the project.

B. *OPERATING TESTS:*

The waste sludge thickener tank shall be filled with potable water to its operating level and the mechanism operated continuously at its maximum speed for a period of not less than 48 hours. Following the maximum speed test, the mechanism shall be operated at 25, 50, and 75 percent speeds for continuous periods of not less than 6 hours. At no time during the operating tests shall the equipment fail on torque overload or exhibit indications of binding or uneven operation. The Contractor shall record torque values as registered on the drive mechanism torque indicator and motor amperage (all three phases) at 3-hour intervals.

After successful completion of the fully submerged operating test, the mechanism shall be operated at full speed with no more than 1.5 feet of water in the thickener tank for a period of not less than 6 hours. Data records, as described above, shall be taken by the Contractor.

If the mechanism should fail on torque overload or the mechanism should exhibit indications of bidding or improper adjustment, the Contractor shall immediately halt the tests and remedy the problem. After completion of necessary repairs or adjustments, the tests shall be repeated. Failure to successfully complete the test in six attempts shall be considered sufficient cause for rejection.

C. TORQUE TEST:

The Contractor shall load test the entire collector mechanism by anchoring collector arms individually. In successive tests, he shall demonstrate the bottom sludge collection mechanism's (including drive unit, center shaft, gears, and structures) capability to withstand not less than 140 percent of the specified continuous design torque. Prior to initiating the test, the Contractor shall furnish the Construction Manager with sketches and calculations illustrating the test procedure and demonstrating how the specified torque will be applied to satisfy this requirement.

3.03 INSTRUCTIONAL PERSONNEL

The Contractor shall provide a factory-trained field engineer at the site for 1 day to instruct the Owner's operating personnel in the proper method of operation and the recommended lubrication and maintenance procedures. Time of visit shall be arranged with the Construction Manager. Instruction shall be certified on Form 11000-B specified in Section 01999.

END OF SECTION

SECTION 11705

CHLORINATORS

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies equipment for the metering of gaseous chlorine.

B. TYPE:

The chlorinators shall be of the vacuum type, capable of accurately feeding chlorine gas to the ejectors associated with each unit. The chlorine gas feed rate will be automatically controlled by final effluent flow and all units shall have provisions for manual control. Chlorinators shall be Fischer & Porter, Wallace & Tiernan, Advance, or equal.

C. EQUIPMENT LIST:

Item	Equipment number
Chlorinator 1	CFR 6510
Chlorinator 2	CFR 6520
Vacuum regulator valve 1A	VRV 6515A
Vacuum regulator valve 1B	VRV 6515B
Vacuum regulator valve 2A	VRV 6525A
Vacuum regulator valve 2B	VRV 6525B

1.02 QUALITY ASSURANCE

A. PERFORMANCE AND DESIGN REQUIREMENTS:

1. GENERAL: The chlorinators are an integral part of the chlorination system for disinfection of finished water, and for other general plant uses. The chlorine gas shall be distributed to the various ejectors under vacuum.

The Contractor shall install, assemble, and test all equipment shown, including all necessary interconnecting piping, utility connections, controls, accessories and appurtenances to form a complete system that will function as specified.

Chlorinators shall operate in the feed-forward mode controlled by the flow of water to be chlorinated. A 4-20 mA flow signal shall be ratioed for automatic dosage adjustment. All additional dosage control and operational components and accessories required for the chlorination system specified shall be provided by the Contractor. The chlorinators shall be capable of manually controlling the dosage rate from 0 to 15 mg/l.

2. OPERATING REQUIREMENTS: The clorinators shall be designed to comply with the following:

	CFR6510	CFR6520
Rated capacity, lbs/day	2,000	2,000
Rotameter capacities, lbs/day	500	1,000
Minimum rotameter length, inches	5	5

B. STANDARDS:

All equipment provided under this section shall comply with the recommendations of the Chlorine Institute, Inc., and the Manufacturing Chemists Association.

1.03 ENVIRONMENTAL CONDITIONS

The chlorinators shall be cabinet mounted and housed within the chlorination room at a wastewater treatment plant near Avondale, Arizona. Chlorinators shall be suitable for the environmental conditions specified in Section 01800.

1.04 SUBMITTALS

Submittals shall comply with the requirements of Section 01300.

1.05 SPARE PARTS

The following spare parts for the chlorinators shall be furnished:

1 - complete set of all gaskets and O-rings.

1- complete cylinder connection assembly.

1 - set of replacement rotameters and other appurtenances required for capacity control.

Special tools required to remove, repair or service items specified in this section.

1.06 DELIVERY AND STORAGE

The Contractor shall be responsible for the chemical feeding equipment included in this section until the equipment has been finally accepted by the Owner.

The Contractor shall properly store, handle and protect all materials and equipment from injury or damage from any and all causes. Damaged material and equipment shall not be used in the work.

PART 2--PRODUCTS

2.01 MATERIALS

The materials used in the construction of the gas handling parts of the chlorinators shall be entirely compatible for corrosive chemical service. The chlorinators shall be mounted in cabinets constructed of material resistant to attack from wet chlorine gas.

2.02 EQUIPMENT

A. MOUNTING

The chlorinator vacuum regulator and automatic switchover valves shall be rail mounted adjacent to the ton containers. A gas heater and strainer shall be provided at the gas inlet to each vacuum regulator. A gas vent line shall be provided at the connection to the vacuum regulator, in case of equipment failure causing high pressure gas to reach the vacuum system. The automatic switchover system shall transfer feed to full containers, without the aid of electrical operators, when the on-line containers are empty. A visual indicator shall verify if the container is on-line, empty, or on standby.

B. GAS HANDLING COMPONENTS:

The internal gas handling components of the chlorinators shall be designed and arranged to facilitate adjustments, maintenance and repair. The vacuum regulator shall shut off the gas supply in the event vacuum is lost for any reason. Suitable backflow prevention and drain provisions shall be made to prevent ejector water from entering the gas handling components. Each unit shall be designed to prevent leakage of chlorine gas to the atmosphere under all conditions.

C. ELECTRICAL COMPONENTS:

Chlorinators shall be provided with electric valve operators which receive control signals and position the gas flow rate valve accordingly. The electric valve operators shall be adequately sealed to prevent any chlorine from entering the valve. The electric valve operator enclosure shall be NEMA 4X, and shall be provided with accessible adjustment components where required. The operator shall be wall mounted. Twenty amp, 120 volt, 60 hertz receptacles will be provided for the heaters on the vacuum regulator valves.

2.03 PRODUCT DATA

A. GENERAL:

Prior to initial operation of the system, the Contractor shall provide the following product data to the Construction Manager:

1. Operation and maintenance manuals and data in accordance with Section 01730.

2. Proposed on-site testing and start-up procedures.

3. Piping connections, locations, sizes and detail fittings.

4. Equipment schematic and control diagrams.

5. Detailed electrical wiring diagrams showing component designation and rating.

6. Manufacturer's guarantee.

B. TEST REPORTS:

The chlorinators shall be individually factory tested by the manufacturer prior to shipment. The manufacturer shall provide three certified copies of the factory test which indicates each unit passed the test and will perform as specified.

PART 3--EXECUTION

3.01 INSTALLATION

A. GENERAL:

The Contractor shall install and assemble each unit of equipment including all necessary interconnecting piping, utility connections, controls, accessories and appurtenances to form a complete and workable system that will function as specified. Unless otherwise shown or stated, each equipment unit shall be anchored to structural systems and shall resist all forces incidental to equipment operation.

Interconnecting piping between equipment units shall be field assembled and installed and shall comply with the requirements of Division 15.

B. SUPERVISION OF INSTALLATION:

All chlorination equipment shall be installed, aligned, inspected, and tested under the supervision of installation specialists, factory trained by the equipment manufacturers. Form 11000-A specified in Section 01999 shall be completed and provided to the Construction Manager.

3.02 TESTING AND START-UP

A. CLEANING:

All parts of equipment or piping which may come in contact with chlorine must be free of oil, grease and moisture before being put into service. Valves shall be dismantled, thoroughly cleaned with suitable solvents, and repacked if necessary. Any pipe dope inside the pipe shall be removed and oil or grease shall be removed with suitable solvent. The interior of all piping and valves shall be clean and thoroughly dry using nitrogen as specified in Section 15050.

B. INITIAL OPERATION:

Chlorine gas shall be admitted to the piping system only after the installation of all piping and equipment is completed and the system has been thoroughly checked. Pressure and leakage tests on piping shall be completed, and the piping shall be thoroughly dried before admitting any gas to the system.

Precaution shall be taken to slowly admit amounts of gaseous chlorine to the piping system until the entire system, including piping, connection valves and equipment is checked for leaks. Time shall be allowed for evacuation of nitrogen from the piping to insure that all piping is adequately tested. Leakage tests shall be performed using a swab soaked in ammonia solution.

In the event gas leaks are detected in the piping or the equipment, they shall not be repaired until all chlorine has been purged from the line. The system shall then be repurged with nitrogen and retested.

C. INSTRUCTIONAL AND OPERATIONAL:

After the chlorination system is operable and prior to acceptance, the equipment manufacturer shall provide a qualified engineer for a period of at least 2 working days to train the

operators and to develop operating techniques. Form 11000-B specified in Section 01999 shall be completed and delivered to the Construction Manager.

These requirements shall not relieve the Contractor of his responsibility for the work.

3.03 SYSTEM ACCEPTANCE

After the system is operable and prior to system acceptance, the equipment manufacturer shall provide a qualified engineer to demonstrate that the complete system performance requirements are met. Methods to determine performance shall be subject to review and approval by the Construction Manager.

Failure of the system to meet performance requirements shall cause the manufacturer to correct any deficiencies at no expense to the Owner. This provision, however, shall not relieve the Contractor of his overall responsibility for this portion of the work.

END OF SECTION

SECTION 11710

CHLORINE GAS EJECTORS

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section covers the vacuum ejectors for gas chlorination systems.

B. TYPE:

The ejectors shall be of the fixed orifice water flow venturi type. Ejectors shall be Fischer & Porter, Advance, Wallace & Tiernan, or equal.

C. EQUIPMENT LIST:

Item	Equipment Number
Chlorine ejector 1	EJ9210
Chlorine ejector 2	EJ9220

1.02 QUALITY ASSURANCE

A. PERFORMANCE AND DESIGN REQUIREMENTS:

1. GENERAL: Equipment furnished under this section shall be specifically designed to completely mix chlorine gas with water under pressure to produce a concentrated solution. The ejectors shall function to produce a vacuum by employing a venturi section which shall draw gas from the plant's chlorinators at the rates listed. The liquid employed for ejector operation will be No. 3 water.

2. OPERATING REQUIREMENTS: All ejectors shall be designed to comply with the following:

Capacity, pounds/day	1,000
Maximum initial rate, pounds/day	437
Minimum supply water pressure, psi	54
Maximum backpressure, psig	5
Water flow, gpm	25
Ejector size, inches	2

1.03 SUBMITTALS

Submittals shall comply with Section 01300, and shall include dimensioned drawings, materials of construction, and ejector performance curves.

PART 2--PRODUCTS

2.01 MATERIALS

All of the materials used for the wetted parts of the ejectors shall be suitable for exposure to chlorine solution.

2.02 CONSTRUCTION

Each ejector shall be provided with a compound pressure/vacuum gage on the gas connection and a water pressure gage on the inlet water piping. The gas pressure gage shall be provided with a silver diaphragm protector device to isolate the glycerin immersed bourdon tube pressure sensing mechanism from the corrosive chlorine gas. Each ejector shall include back check valve(s) and automatic overflow valve to prevent water from accidently backing into the chlorine gas line.

PART 3--EXECUTION

3.01 INSTALLATION

Each ejector shall be aligned, connected and installed at the locations shown and in strict accordance with the manufacturer's recommendations.

3.02 TESTING

After the completion of installation, each ejector shall be completely field tested to ensure compliance with the performance requirements as specified.

END OF SECTION

SECTION 11720

SAFETY EQUIPMENT

PART 1 - GENERAL

1.01 WORK INCLUDED

A. First Aid Cabinet.

1.02 RELATED WORK

A. Section 06100 - Rough Carpentry: Blocking.

B. Section 09260 - Gypsum Drywall.

1.03 SHOP DRAWINGS

A. Submit shop drawings in accordance with Section 01300.

B. Clearly indicate sizes, location, mounting method and installation instructions.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Fisher.

B. Johnson & Johnson.

2.02 SUBSTITUTIONS

A. All materials specified herein by brand name and as acceptable to establish a standard of quality only. Other manufacturers are acceptable and will be considered in accordance with provisions as outlined in Division 1, General Requirements.

2.03 FIRST AID CABINET

A. First Aid Cabinet, Fisher Model 10-020, includes everything needed to treat most common lab emergencies. Emergency Chart mounted on hinged door gives instructions at a glance. 6.4L x 27W x 42cmH (2-1/2 x 10-3/4 x 16-1/2 inch). Has three (30 shelves and holes in back panel for wall mounting. Meets OSHA requirements.

2.04 FIRST AID CABINET CONTENTS

A. 2 rolls adhesive tape, 1 inch x 2-1/2 yards
1 cotton, 1 oz.
1 absorbent gauze, 4-1/2 inch x 1 yard
1 aromatic spirits of ammonia
2 bottles P.V.P. iodine, 1-1/4 oz. each
6 paper drinking cups
1 forceps, sharp point
1 "First Aid at a Glance" card
1 scissors
2 gauze bandages, 1 inch x 10 yards
2 gauze bandages, 2 inch x 10 yards
1 bottle sterile boric acid solution, 4 oz.
25 gauze compresses, 3 x 3 inch
25 gauze compress pads, 2 x 2 inch
1 roll adhesive tape, 1/2 inch x 5 yards
10 Telfa adhesive pads, 1-1/2 x 2 inch
10 Telfa adhesive pads, 2 x 3 inch
1 4 inch nonadherent compress with 72 inch bandage
1 2 inch nonadherent compress with 36 inch bandage
1 adhesive bandage, plastic nonadherent pad, 2-1/4 x 3-1/4 inch
32 adhesive bandages, plastic, 1 x 3-1/2 inch
10 ammonia inhalants
4 tubes calloid burn ointment, 17g each
50 envelopes aspirin, 2/env.
1 8 inch x 10 inch nonadherent compress with 2 inch x 6 yard gauze bandage
1 triangular bandage, 40 inch
1 eye dressing set
1 U.S. Army type tourniquet
1 ice-pak compress

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install cabinet in Laboratory, as per manufacturer's printed instructions.

END OF SECTION

SECTION 11721

CHLORINE STORAGE AND HANDLING EQUIPMENT

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section covers the lifting bars, rollers trunnion assemblies, storage cradles, and weight scales for handling and weighing ton containers.

B. EQUIPMENT LIST:

Item	Equipment number
Load cell 1	WE 6513
Load cell 2	WE 6523
Weight indicator 1	WI 6514
Weight indicator 2	WI 6524

1.02 QUALITY ASSURANCE

A. PERFORMANCE AND DESIGN REQUIREMENTS:

1. GENERAL: The chlorine ton container roller trunnions shall be provided as shown. They shall enable the operator to easily position, rotate, and space the ton containers.

The chlorine cylinder lifting bar shall have a capacity of not less than 4,000 pounds and shall be designed to facilitate easy and rapid cylinder handling.

2. OPERATING REQUIREMENTS: The chlorine weighing scale shall be the load cell type designed for two ton containers and a capacity of 4 tons. It shall be provided with a weight indicator which shall have a 12-inch dial that reads from zero to 8,000 pounds with provision for tare weight and zero adjustment. Dial accuracy shall be better than 1/2 percent.

1.04 SUBMITTALS

Catalog information for each item furnished under this section shall be submitted to the Construction Manager in accordance with Section 01300. All data shall be furnished in one complete submittal.

PART 2--PRODUCTS

2.01 MATERIALS

A. TON CONTAINER TRUNNIONS:

Ton container roller trunnions shall be of corrosionproof design. The trunnion frame shall be steel to meet ASTM A7 standards. The wheels shall be cadmium-plated steel with bronze bushings. Roller pins shall be cadmium-plated steel with alemite fittings for lubrication.

B. WEIGHING SCALES:

Weighing scale frames shall be fabricated steel.

C. CONTAINER LIFTING BARS:

Container lifting bars shall be fabricated steel, hot-dipped and galvanized. Bolts and nuts shall be zinc-plated.

D. STORAGE CRADLES:

Roller trunnions, hardwood cradles, or fabricated steel cradles shall be provided for storage of full chlorine ton containers. Roller trunnions shall be as described in paragraph 2.01 A.

Hardwood cradles shall be of maple or oak laminated construction, dimensionally and structurally suitable for the storage of full chlorine ton containers. Hardwood cradles shall be as manufactured by Wallace and Tiernan, or equal.

Fabricated steel cradels shall be epoxy finished to prevent corrosion. Cradles shall be dsigned to prevent the tanks from rolling and shall be constructed with round corners to prevent tank damage. Fabricated steel cradles shall be Chlor-Scale Model 42SC, or equal.

2.02 EQUIPMENT

A. TON CONTAINER ROLLER TRUNNIONS:

The trunnion frames shall have holes in the ends to facilitate bolting to the load cell frame. Trunnions shall be Chlorine Specialties, Chlor-Scale Model 21L Roller Trunnions, Chlor-O-Quip Model 272, or equal. Sufficient trunnions shall be provided for the cylinders as shown on the drawings.

B. WEIGHING SCALES:

The chlorine ton container scale shall be designed to use the hydraulic load cell principle of operation to weigh two 1-ton containers. The scale frame shall be within the plan outline dimensions of the cylinder it supports. Scales shall be Chlor-Scale, Martin-Decker, or equal.

Flexible hose shall lead from the load cell beneath the frames to the scale dial at a remote wall-mounted location as shown on the drawings. Dial shall be damped to prevent damage from transient loads or shocks. Hoses shall be provided with quick disconnects to prevent loss of hydraulic fluid during dial calibration.

C. CONTAINER LIFTING BAR:

One container lifting bar shall be provided. It shall be designed to permit the lowest possible height for container unloading equipment. The bar shall be Chlorine Specialties, Inc., C-262, Chlor-O-Quip Model 273, or equal.

PART 3--EXECUTION

3.01 INSTALLATION

The ton container roller trunnions and weighing scales shall be aligned, connected and installed at the locations shown and in strict accordance with the manufacturer's recommendations.

3.02 TESTING

After the completion of installation, each weighing scale shall be completely field calibrated and tested to ensure compliance with the performance requirements as specified.

END OF SECTION

SECTION 11875

PRESSURE VESSELS AND TANKS

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section provides specifications for the compressed air receiver and the plant utility water system hydropneumatic tank.

B. TYPE:

Equipment furnished under this specification shall be of the welded steel type, cylindrical in shape, with semi-elliptical heads.

C. EQUIPMENT LIST:

Item	Equipment number
Hydropneumatic tank	PVL 6320
Service air receiver	PVL 9120

1.02 QUALITY ASSURANCE

A. PERFORMANCE AND DESIGN REQUIREMENTS:

1. GENERAL: The air receivers will store compressed air obtained from inside ventilated buildings at a water treatment plant. Oil-lubricated compressors will be used to supply the air. Moisture will be present in the air stream.

The hydropneumatic tanks will contain water from the plant Number 3 water system. This water will exhibit a temperature range from 40 degrees F to 80 degrees F and have a pH that varies between 7 and 8.5. The Number 3 water will be chlorinated up to a concentration of 1 mg/l.

2. OPERATING REQUIREMENTS: Operating and design requirements are as follows:

Item	PVL6320	PVL9120
Service (1)	3W	SA
Type	Horizontal	Vertical
Shell length, inches	131	84
Diameter, inches	96	30
Volume, gallons	4,990	240
Design pressure, psig	125	250
Relief valve size, inches	2	3/4
Relief valve setting, psig	80	200

NOTES:

(1) Service abbreviations as follows:

SA--service air

3W--No. 3 water (secondary effluent)

The hydropneumatic tank shall operate between nominal pressure limits of 55 and 70 psig. Water levels shall be as specified.

B. STANDARDS AND REFERENCES:

ASME Boiler and Pressure Vessel Code

1.03 ENVIRONMENTAL CONDITIONS

Pressure vessels and tanks provided under this specification shall be suitable for continuous service. PVL6320 will be installed outdoors. PVL9120 will be installed indoors. Environmental conditions are as specified in Section 01800.

1.04 SUBMITTALS

In addition to the requirements outlined in Section 01300, all tanks and pressure vessels manufactured under Division 2 in Section VIII of the ASME Boiler and Pressure Vessel Code shall have submittals as required by Article A-3 of that document.

PART 2--PRODUCTS

2.01 MATERIALS

Component	Material
Hydropneumatic tanks	Carbon steel
Air cooler and separator	Carbon steel body, brass tubes and baffles
Air receivers	Carbon steel
Mounting brackets	Steel

2.02 EQUIPMENT

A. GENERAL:

Pressure tanks supplied under this specification shall be fitted with pressure-type manholes and semi-elliptical pressure heads. All tanks shall be delivered with threaded or flanged bosses for inlet, outlet and gage connections as shown and shall have a 1-inch-minimum drain connection. The interior and exterior of all tanks shall be protected with a baked phenolic epoxy coating, factory applied after fabrication. The coating shall be applied in two coats and shall be completely free of pinholes and thin spots. The coating shall be white in color. Field coating of tank exteriors shall be in accordance with Section 09900.

Equipment delivered under this specification shall meet the requirements of Section VIII, Division 1 or Division 2 of the ASME Boiler Code. Each tank shall bear an ASME inspectors stamp, complete with design working pressure and date and place of manufacture. All pressure relief valves delivered under this specification shall bear the ASME stamp. Vertical tanks shall have a support skirt with a full flange suitable for anchor bolting.

B. HYDROPNEUMATIC TANK:

The hydropneumatic tank shall include two 11-inch-by-15-inch standard manholes located on the top half of the tank at each end. Connections for pressure relief valves, water level sensor gages, air and pressure switches, and all connections for water shall be as shown and as required to accommodate the specified equipment and instrumentation. The tank shall be equipped with ASME pressure relief valve, pressure gage, pressure switch, and connections for an 8-inch inlet and discharge and a 2-inch drain. The hydropneumatic tank shall be provided with integral factory welded ASME fabricated

steel pedestal supports for mounting to concrete. The contact angle of the pedestal support shall be 120 degrees minimum. The tank shall be provided with a full height protected ASME glass sight gage rated for 300 psig design pressure.

C. COMPRESSED AIR RECEIVERS:

The receiver shall have an 11-inch-by-15-inch manhole. The air receiver shall be vertically mounted, constructed according to ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, and shall bear the ASME stamp. The tank shall be equipped with connections for an ASME pressure relief valve, pressure gage, pressure switch and connections for a 1-1/2-inch inlet, 2-inch discharge, and 3/4-inch drain.

PART 3--EXECUTION

3.01 INSTALLATION

Each Pressure vessel shall be aligned, connected and installed at the location shown and in accordance with the manufacturer's shop drawings.

END OF SECTION

DIVISION 12

FURNISHINGS

Section	Title
12512	HORIZONTAL LOUVER BLINDS
12673	RECESSED FLOOR MATS

SECTION 12512

HORIZONTAL LOUVER BLINDS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Operating louver blind installed into window frames.

1.02 RELATED WORK

A. Section 04220 - Concrete Unit Masonry.

B. Section 08520 - Aluminum Windows.

1.03 DESCRIPTION

A. Provide horizontal metal slat louver blinds for all windows in all rooms of the building, including a tilter and cord lift assembly for each section.

1.04 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 01300.

B. Indicate at large scale installation of blind in window opening, method of attachment, clearances and operation.

C. Submit manufacturer's installation instructions under provisions of Section 01300.

D. Submit samples under provisions of Section 01300.

E. Provide two 12-inch blind slats in color and finish, and one (1) sample operational control and devices.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver blinds to site wrapped and crated in a manner to prevent damage to components or marring of surfaces.

B. Store in a clean, dry area, laid flat and blocked off-ground to prevent sagging, twisting or warping.

PART 2 - PRODUCTS

2.01 LOUVERED BLINDS

A. Louvered blinds, 1 inch wide by .011 inch thick, spring tempered, prefinished aluminum, supported by braid ladders (.050 inch diameter) at 15 rungs per foot of ladder, equally spaced at .788 inch intervals. Maximum 23 inches between ladders and maximum 7 inches between ladders and ends of slats.

B. Head shall be .025 inch thick "U"-shaped steel. Bottom rail shall be .031 inch thick steel. Both head and bottom rail shall have a plastic coating, cured at high temperature, formed after coating.

C. Lift cord braided of high strength synthetic fibers, sized as required.

D. Tilt road shall be a 5/16 inch transparent hexagonal wand which shall tilt blinds by means of a worm screw and gear.

E. Finish - Manufacturer's pretreatment and baked enamel finish. Color as selected by Construction Manager.

PART 3 - EXECUTION

3.01 PREPARATION

A. Ensure all painting, glazing and preparatory work is correctly done.

B. Notify Construction Manager in writing of any discrepancies which would affect proper installation and operation of blind system. Install after discrepancies are corrected.

3.02 INSTALLATION

A. Install louvered blinds in window openings in accordance with manufacturer's instructions.

B. Secure in place with flush countersunk mechanical fasteners.

C. Adjust parts for smooth operation.

END OF SECTION

SECTION 12673

RECESSED FLOOR MATS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Recessed mat frames.

B. Vinyl mats.

1.02 RELATED WORK

A. Section 03100 - Concrete Formwork.

B. Section 03300 - Cast-In-Place Concrete.

1.03 SHOP DRAWINGS

A. Submit shop drawings in accordance with Section 01300.

B. Clearly indicate sizes, locations, inserts required, depth of frames and installation instructions.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. All materials specified herein by brand name and as acceptable to establish a standard of quality only. Other manufacturers are acceptable, and will be considered in accord with the provisions as outlined in Division 1 - General Requirements.

B. American Floor Products.

C. Cactus Mat.

D. Durable Mat.

E. Eldorado.

F. Flexco.

G. R. C. Musson.

2.02 RECESSED MAT FRAMES

A. Cactus Kid Mat Recess Frames No. MF-3B for 3/8 inch deep recess made from aluminum 6063-T alloy, zinc chromated. Frames to be supplied knocked down. Units to be pre-cut and pre-fit with mitered corners, anchors

DIVISION 13

SPECIALTIES

Section	Title
13030	BREATHING APPARATUS
13230	REINFORCED THERMOSET PLASTIC SPECIALTIES
13234	RTP DUCTWORK

SECTION 13030

BREATHING APPARATUS

PART 1 - GENERAL

1.01 DESCRIPTION

This section specifies equipment for use in oxygen deficient atmospheres with a potential for severe toxicity.

1.02 QUALITY ASSURANCE

A. PERFORMANCE AND DESIGN REQUIREMENTS:

The air breathing apparatus shall be the self-contained, positive pressure type consisting of clear view face mask, interconnecting hoses, flow, and pressure regulating devices and two filled 30-minute air storage cylinders with adjustable carrying harness.

B. STANDARDS:

Equipment must be certified under the National Institute of Safety and Health (NIOSH) certification program and also be approved by the United States Bureau of Mines.

1.03 ENVIRONMENTAL CONDITIONS

The equipment must operate under conditions in which oxygen is deficient and there is a hazardous concentration of chlorine gas.

PART 2 - PRODUCTS

2.01 MATERIALS

The pad for the lower back shall include a larger vinyl-over-foam rubber pad. An aluminum frame shall be required to hold the air cylinders. Stainless steel cylinders shall be used. Shoulder straps shall be of vinyl-covered foam rubber. The face mask shall have a single-lens Clearvue facepiece, constructed of material especially suited for chlorine exposure.

2.02 EQUIPMENT

The following list of equipment shall be included under this specification for each set of breathing apparatus required:

No. of Items	Description of Items	Manufacturer
1	Pressure demand air masks (with single-lens Clearvue facepiece)	MSA (Model 471374), NIOSH - Bureau of Mines Approval TC 13F-30, or equal
1	Readily adjustable harness	
1	Belt-mounted demand regulator	
1	Audi-Larm audible signal device	
2	Steel cylinders (filled with air)	
1	Plastic carrying case	

PART 3 - EXECUTION

One set of breathing apparatus shall be provided. Breathing apparatus shall be located as directed by the plant operator.

END OF SECTION

SECTION 13230

REINFORCED THERMOSET PLASTIC SPECIALTIES

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies requirements for reinforced thermoset polyester resin laminated structures and equipment including items fabricated with epoxy resins but employing glass and other fiber filaments for structural reinforcement. Detailed requirements of specific reinforced thermoset plastic (RTP) items shall be as specified in other sections of this project manual.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section references the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASME Boiler and Pressure Vessel Code	Section X, Fiberglass-Reinforced Plastic Pressure Vessels
ASTM C581-68	Standard Method of Test for Chemical Resistance of Thermosetting Resins Used in Glass Fiber Reinforced Structures
ASTM D570-77	Standard Test for Absorption of Plastics
ASTM D638-77a	Standard Test for Tensile Properties of Plastics
ASTM D790-71	Standard Test for Flexural Properties of Plastics
ASTM D883-78a	Standard Definitions of Terms Relating to Plastics
ASTM D2583-75	Standard Test for Indentation of Plastic by Means of a Barcol Impressor

ASTM D3299-74	Standard Specification for Filament-Wound Glass-Fiber Reinforced Polyester Chemical-Resistant Tanks
ASTM E84-77a	Standard Method of Test for Surface Burning Characteristics of Building Materials
National Bureau of Standards Voluntary Standards PS 15-69	Custom Contact-Molded Reinforced-Polyester Chemical-Resistant Process Equipment
The Society of the Plastics Industry, Inc.	Recommended Practice for Shipping and Installation of Reinforced Plastic Pipe, Duct, and Tanks
NFPA No. 30 - 1977	Flammable and Combustible Liquids Code

B. TESTING LABORATORY:

The Owner shall provide the services of an independent testing laboratory for the purposes of monitoring the quality of the finished RTP products. The testing laboratory will be a member of the American Council of Independent Laboratories and shall be qualified to perform all necessary quality control tests as set forth herein.

C. TESTING:

1. SAMPLE SPECIMENS:

a. SAMPLING: Sample specimens shall be cut at locations selected by testing laboratory personnel from items fabricated for the project. Sample specimens shall be taken at a rate of one per 1000 square feet of surface area, with a minimum of five specimens per individual item. An individual RTP item shall be defined as an RTP product that is unique in fabrication and dimension from all other RTP products.

Sample specimens shall be identified by item sampled and sampling location. Cuttings required for nozzles, openings or connections shall be saved and submitted as sample specimens to be used for testing.

b. TESTS: Tests to be performed on each sample specimen may consist of the following from the National Bureau of Standards Voluntary Standard PS 15:

Glass Content: Subsection 4.3.1
Tensile Strength: Subsection 4.3.2
Flexural Strength: Subsection 4.3.3
Modulus of Elasticity (Tangent): Subsection 4.3.4
Hardness: Subsection 4.3.5

D. ALLOWABLE TOLERANCES:

1. TEST TOLERANCES: The average value of each of the tests performed on sample specimens for each individual RTP item shall satisfy the requirements set forth in Table A, Physical Requirements for Resins, Table B, Minimum Requirements for Laminate Fabrication..., ASTM D3299 and PS 15-69. Should an individual RTP item be found deficient in any of the tests, the testing laboratory shall select a second series of sample specimens as specified in paragraph 1.02 C.1.a and shall perform all tests on these specimen coupons. Failure of the second series of coupons to satisfy the physical requirements shall constitute cause for rejection of that individual RTP item.

2. PRODUCT TOLERANCES:

a. GENERAL: Any RTP specialty item which does not satisfy the tolerances specified in this section will be rejected.

b. TOLERANCES:

1) SECTION UNIFORMITY: Wall, flange and edge thicknesses shall be uniform to within plus or minus 1/32 of an inch in 12 inches.

2) COLOR: Items of a similar nature or subassemblies of a single unit shall be similar in color.

3) OUT-OF-ROUND AND PARALLEL: Unless otherwise specified, the out-of-round tolerance for cylindrical sections 12 inches in diameter and greater shall be one-half that listed in NBS PS-15 for ductwork. The out-of-round tolerance for cylindrical sections smaller than 12 inches in diameter shall be as listed in NBS PS-15.

Out-of-parallel tolerance for rectangular and square sections shall be as specified for out-of-round.

4) FLANGES: Flange faces shall be flat and true to a tolerance of plus or minus 1/32 inch for tanks, and 1 percent of the nominal diameter or 1/8 inch for ducts, whichever is less. Variation in manhole flange thicknesses shall be within plus or minus 1/16 inch. Variations in all other flanges shall be within plus or minus 1/32 inch. Tolerance in bolt hole locations and in bolt circle diameter shall be within plus or minus 1/16 inch.

5) SURFACES: Tolerances for defects on the surface of RTP items are specified in Table C of this section.

Table A, Physical Requirements for Resins

Resins[a]	Barcol hardness,[b] minimum average
Type A resins (nonfire-resistant)	
Atlac 382	30
Atlac 382 (4010A)[c]	35
Atlac 580	30
Derakane 411-45[c]	30
Derakane 470-36	40
Dion Cor-Res 6694	30
Dion Cor-Res 7000[c]	30
Hetron 197	40
Type A resins (fire-resistant)	
Atlac 711-05A+3% Sb_2O_3	30
Derakane 510N	30
Derakane 510A-40+5% Sb_2O_3	30
Hetron 92 FR	40
Hetron 197+5% Sb_2O_3	40
Hetron 800 FR	40
Type B resins (nonfire-resistant)	
Aropol 7240	40
Dion/SO 6631	40
Owens/Corning 701	30
Type B resins (fire-resistant)	
Dion Cor-Res 6693+5% Sb_2O_3	30

NOTE: For resins not listed here, Barcol hardness shall be at least 90 percent of the resin manufacturer's minimum specified hardness for the cured resin.

[a]For description of Types A and B resins, refer to paragraph 2.01 A.

[b]Determined with Barcol impressor, Model GYZJ 934-1, calibrated at two points in accordance with ASTM D2583.

[c]Resins which shall be used for filament-winding construction.

Table B. Minimum Requirements for Laminate Fabrication by Contact Molding, Matched Die Molding, and Filament Winding

Method of Laminate Fabrication	Property	Laminate thickness, inches			
		1/8, 3/16	1/4	5/16	3/8 and up
Contact molded, and matched die molded	Glass content, percent	25-30	30-34	34-38	38-42
Filament wound process	Glass content, percent	25-30	30-34	34-38	38-42
Filament wound process	Ultimate tensile strength,[a] psi	40,000	40,000	40,000	40,000
Filament wound process	Modulus of elasticity (tangent),[b] psi	$3x10^6$	$3x10^6$	$3x10^6$	$3x10^6$

[a]Minimum hoop tensile strength.

[b]Minimum hoop tensile modulus of elasticity.

Table C, Allowable Product Surface Tolerances

Defect	Surface Inspected: Process Side	Surface Inspected: Nonprocess Side
Cracks	None	None
Crazing (fine surface cracks)	None	Max length: 1/2 in.; max density: 5 per sq ft; min separation 2 in.
Blisters (rounded elevations of the laminate surface over bubbles)	None	Max dimension: 1/4 in. dia x 1/8 in. high; max density: 1 per sq ft; min separation 2 in. apart
Wrinkles and solid blisters	Max deviation: 10% of wall thickness, but not exceeding 1/8 in.	Max deviation: 10% of wall thickness, but not exceeding 1/8 in.
Pits (craters in the laminate surface)	Max dimension: 1/8 in. dia x 1/32 in. deep; max number: 10 per sq ft	Max dimension: 1/8 in. dia x 1/16 in. deep; max density: 10 per sq ft
Surface porosity (pinholes or pores in the laminate surface)	None	None
Chips	None	Max dimension of break: 1/4 in. and thickness no greater than 10% of wall thickness; max density: 1 per sq ft
Dry spot (nonwetted reinforcing)	None	Max dimension: 2 sq in. per sq ft
Entrapped air (bubbles or voids in the laminate)	Max dia: 1/16 in.; max density: 10 sq in. but none to a depth of 1/32 in.	Max dia and density: 1/8 in. and 4 per sq in. or 1/16 in. and 10 per sq in.
Exposed glass	None	None
Burned areas	None	None
Exposure of cut edges	None	None
Scratches	None	Max length: 1 in.; max depth: 0.010 in.
Foreign matter	None	None

1.03 PRODUCT SHIPPING, STORAGE AND HANDLING

The Contractor shall be responsible for proper packaging and protection of all materials to prevent damage during shipping, handling and storage. As material arrives on site, it will be inspected for compliance with "Recommended Practices for Shipping and Installation of Reinforced Plastic Pipe, Duct and Tanks," The Society of the Plastics Industry, Inc.

PART 2--PRODUCTS

2.01 MATERIALS

A. RESINS:

1. GENERAL: Resins used for RTP specialties exposed to view shall contain antimony compounds or other fire retardant agents and shall have a flame spread rating of 25 or less based on ASTM E84.

No thixotropic agent shall be added to resins used for a corrosion barrier. Up to 4 percent by weight of thixotropic agent may be added for viscosity control of resins not used for a corrosion barrier. The quantity of thixotropic agent added, however, shall not interfere with visual inspection of the laminate. Pigments, dyes and colorants shall not be used unless specified.

2. TYPE A RESIN: Type A resins shall provide sufficient chemical resistance under the corrosive environments listed in the detailed specifications for RTP structures and equipment. Where specified, Type A resins shall also meet flame spread requirements as given in paragraph 2.01 A.1. Type A resins shall be selected from the resins listed in Table A, paragraph 1.02.

3. TYPE B RESIN: Type B resins shall be suitable for weather-resistant, noncorrosive chemical service and, where specified, shall meet flame spread requirements as given in paragraph 2.01 A.1. Type B resins shall be selected from the resins listed in Table A, paragraph 1.02. Type A resins may be substituted for Type B resins.

B. REINFORCEMENT:

1. GENERAL: Glass reinforcement shall be Type C, chemical glass, or Type E, electrical glass, as specified.

2. SURFACING VEIL: Protective veils for interior and exterior surfaces shall be Type C glass surfacing mat with silane finish and styrene-soluble barrier. The thickness of the surfacing

veil shall be 10 to 20 mils for all applications except those involving exposure to chlorine or hypochlorite solutions, where a minimum 20 mils thickness shall be employed.

Surfacing veils for applications where the glass may be attacked by compounds in the process shall be a suitable spun-laced synthetic organic entangled fiber fabric, such as Nexus, not less than 20 mils in thickness, backed by chopped strand in a Type A resin.

3. CHOPPED STRAND MAT: Chopped strand mat shall be Type E glass with silane finish and a styrene-soluble binder.

4. CONTINUOUS ROVING: Continuous roving used in chopper guns for spray-up shall be Type E glass with chrome finish or silane coupling agent. Continuous roving used for filament winding shall be Type E glass with silane-type finish.

5. WOVEN ROVING: Woven roving shall be Type E glass with silane-type finish.

6. WOVEN CLOTH: Woven cloth shall be Type E glass with silane-type finish.

C. MISCELLANEOUS:

1. STAINLESS STEEL: Unless otherwise specified, stainless steel nuts, bolts, washers, hangers and miscellaneous fabricated parts shall be ANSI type 304.

2. GASKETS: Unless specified otherwise, gaskets shall be neoprene.

2.02 FABRICATION

Fabrication of RTP items shall be by the contact molding, filament winding, or pultrusion method.

A. CONTACT MOLDING:

Unless otherwise specified, contact molding fabrication shall be in conformance with NBS PS-15. Sequence of lay-up shall be as follows:

1. An interior surface corrosion barrier consisting of the laminate specified in paragraphs 2 and 3 shall be provided. Laminate thickness shall be 100 mils minimum. A separately cured unreinforced gel coat shall not be used.

2. The interior surface shall be resin rich, smooth and reinforced with a 10 to 20 mil Type C glass surfacing veil saturated with Type A resin.

3. The interior surface layer shall be covered with a minimum of 3 ounces per square foot of chopped strand mat and resin in two plies of 1-1/2-ounce mat saturated with Type A resin. Alternatively, the minimum 3 ounces per square foot may be applied as a minimum of two passes of chopped roving (minimum fiber length, 1/2 inch) and resin may be applied by the spray-up process. Each pass of chopped roving or ply of chopped strand mat shall be thoroughly rolled out individually.

4. Corrosion liner laminate consisting of the layers specified in paragraphs 2 and 3 shall be allowed to gel.

5. For laminates 3/16 inch nominal thickness, mat plies or spray-up shall be continued as required with adequate rollout between the application of each chopped pass or mat.

6. For laminates 1/4 inch nominal and thicker, mat (1-1/2 ounce per square foot) or spray-up and woven roving (24-1/2 ounce per square yard, 5 x 4 weave) shall be applied to the total required to achieve the desired nominal thickness. Two adjacent plies of woven roving will not be permitted. Each ply or pass shall be separately rolled out. Reinforcement for laminates having a nominal thickness of 1/4 inch shall include at least 1 ply of woven roving.

7. If interruption of laminate buildup is required for exotherm, such interruption shall be permitted only after every third ply of woven roving has been laid.

8. An exterior surface corrosion barrier of 100 mils minimum thickness shall be provided for buried RTP storage tanks and for RTP specialties exposed to corrosive exterior environments. Corrosion barrier shall consist of a two-pass mat, Type C glass veil and Type A resin as specified in paragraphs 2 and 3. Exterior surfaces of RTP specialties not exposed to corrosive environments shall be Type C glass veil and Type A resin, 15 mils minimum thickness.

9. The outer surface of the fabricated product shall be relatively smooth and shall have no glass fibers exposed.

10. A paraffin for full cure shall be incorporated in the final coat of resin.

11. All edges of reinforcement material shall be lapped 1 inch minimum for mat and 2 inches minimum for woven roving. Lapped edges of adjacent layers shall be staggered.

12. All cut edges on parts that will make up a secondary joint or be incorporated into a finished product shall first be sealed with at least two coats of lay-up resin.

B. FILAMENT WINDING:

Unless otherwise specified, filament winding fabrication shall be in conformance with ASTM D3299. Sequence of laminate construction shall be as follows:

1. An interior surface corrosion barrier consisting of the laminate specified in paragrapsh 2 and 3 shall be provided. Laminate thickness shall be 100 mils minimum. A separately cured unreinforced gel coat shall not be used.

2. Surfaces exposed to the fluids to be encountered shall be resin rich, smooth, and reinforced with a 10 to 20 mil thick Type C glass veil mat saturated with Type A resin.

3. The inner surfacing layer shall be followed with a minimum of 3 ounces per square foot or more of chopped strand mat and resin in a minimum of two plies saturated with Type A resin. Alternatively, the minimum 3 ounces per square foot may be applied as a minimum of two passes of chopped roving (minimum length, 1/2 inch) and resin may be applied by the spray-up process to produce an equivalent thickness (100 mils nominal). Glass content of this portion of the laminate shall be 25 to 30 percent by weight. For laminates 1/2 inch and thicker, the nominal 100 mil layer shall have a thickness of at least 90 mils after curing.

4. Subsequent reinforcing shall be resin-saturated, continuous roving, as may be required to satisfy all other requirements of this specification.

5. Additional chopped roving and resin may be sprayed up between winding cycles to provide improved resistance to interlaminar shear.

6. An exterior surface corrosion barrier of 100 mils minimum thickness shall be provided for underground RTP storage tanks and for RTP specialties exposed to corrosive exterior environments. Corrosion barrier shall consist of a two-pass mat, Type C glass veil and Type A resin as specified in paragraphs 2 and 3. Exterior surfaces of RTP specialties not exposed to corrosive exterior environments shall be Type C glass veil saturated with Type A resin, 15 mils minimum thickness.

7. No glass fibers shall be exposed on the outer surface.

8. A paraffin for full cure shall be incorporated in the final coat of resin.

9. Cut edges exposed to the chemical environment shall have a chemical resistant liner consisting of two mats and a veil. No cloth or woven roving shall be used for this purpose.

10. All cut edges on parts which will make up a secondary joint or be incorporated into a finished product shall first be sealed with at least two coats of lay-up resin.

2.03 PRODUCT DATA

The following information shall be provided to the Construction Manager in accordance with paragraph 00710-3.05:

1. Manufacturer and method of fabrication.

2. Materials selected for laminates to be furnished for project.

3. Manufacturer's shop drawings.

4. Installation procedures, including field jointing techniques.

PART 3--EXECUTION

3.01 GENERAL

RTP specialties shall be shipped, installed, joined and erected under the direction of factory-trained specialists. Where jointing is required, workmen employed for these efforts shall have been trained in proper jointing techniques by the RTP manufacturer's representative. Fabricated equipment shall have the warning, "Plastic Equipment Handle with Care" stenciled on two sides in letters a minimum of 2 inches high.

3.02 ASSEMBLY AND ERECTION PLANS

Prior to assembly and erection of RTP towers, tanks, stacks and similar structures, the Contractor shall provide assembly and erection plans prepared by the RTP manufacturer. The plans shall provide details on handling, field connections and final installation.

3.03 FIELD JOINTS

Field joints shall be either bell and spigot or butt-strap type. If bell and spigot, the provisions of this section and the detailed specification with respect to surface veils, laminate thickness and design shall apply to both the bell and spigot without regard to any consideration that they will ultimately be joined to each other. Bell and spigot joints shall be designed for air and watertightness. Upon completion of jointing, bell and spigot joints shall be wrapped with not less than two layers of surfacing veil impregnated with the specified corrosion barrier resin.

Butt-strap joints shall have a thickness not less than 1-1/2 times the longest cross-sectional dimension of the RTP specialty and shall develop at least 200 percent of the strength of the parent laminant. Notwithstanding this requirement, butt-strap joints shall be comprised of at least two layers of surfacing veil plus sufficient reinforcing glass impregnated in the specified barrier resin. Surface preparation, methods of curing, and ultaviolet light protection shall be as specified for the parent laminant.

3.04 DAMAGED OR DEFECTIVE AREAS

Damaged or defective areas which are otherwise acceptable shall be sealed with a minimum of two coats of the type resin used in the product.

END OF SECTION

SECTION 13234

RTP DUCTWORK

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies reinforced thermoset plastic (RTP) ductwork for foul air exhaust systems.

B. TYPE:

RTP ductwork furnished under this specification shall be custom fabricated laminated designed specifically for the applications shown under the conditions specified.

1.02 QUALITY ASSURANCE

A. GENERAL:

RTP ducting shall be fabricated to the dimensions and configurations shown. Adequate quantities of field joining kits containing premeasured volumes of resin and hardener, strips of glass mat, wrapper straps, mixing containers, mixing sticks and clip brushes shall be supplied by the RTP ducting manufacturer.

B. CORROSION RESISTANCE:

RTP ducting shall be designed for exposure to saturated air streams containing hydrogen sulfide, methane and other corrosive and flammable vapors and gases.

C. DESIGN REQUIREMENTS:

All RTP ductwork shall be designed in accordance with the following:

1. All ducts shall be designed for not less than 5 inches water column pressure and 10 inches water column vacuum.

2. A minimum structural safety factor of 5 shall be used in the design of ducting.

3. Maximum deflection of rectangular ducts under deadload and operating conditions shall not exceed 1 percent of the width of the longest side.

4. Type A resin shall be used for interior corrosion barriers. Type B resin shall be used for reinforcement laminates.

5. Resins used for exposed RTP ducting located within enclosed buildings or structures which may be routinely occupied by plant personnel shall have a maximum flame and smoke spread rating of 25 and 100, respectively, based on ASTM E84.

6. The requirements of Section 13230 shall apply.

7. Fire retardant paints shall not be used to meet the flame and smoke spread requirements.

8. Exterior braces shall be acceptable, but all exposed surfaces shall be covered with fiberglass.

D. STANDARDS:

The requirements of Section 13230 shall apply to the design, fabrication and installation of all ductwork furnished under this section.

1.03 SUBMITTALS

Submittals will not be required unless the Contractor wishes to take exception to the provisions of this specification.

1.04 INFORMATION TO BE PROVIDED

Refer to Section 13230, paragraph 1.03.

PART 2--PRODUCTS

2.01 MATERIALS

Materials shall be as set forth in Section 13230, paragraph 2.01.

2.02 PRODUCTS

A. ROUND OR ELLIPTICAL DUCTS:

1. GENERAL: Round ducts shall be fabricated by filament winding. Unless otherwise specified or shown, filament winding fabrication shall be as described in Section 13230, paragraph 2.02, B.

2. EXPOSED DUCTS: Exposed round ducts shall have minimum wall thicknesses as shown in Table 2, Reinforced-Polyester Round Duct Dimensions, NBS PS 15.

3. WRAPPED JOINTS: Branch and nozzle connections and butt joints shall be reinforced with an overlay of glass fiber and resin to at least the thickness of the heaviest section being joined. The reinforcement shall extend on each side of the joint a sufficient distance to make the joint as strong as the pieces joined. All mating edges shall be sealed and all voids filled with silica-filled resin putty to present smooth surfaces. Reinforcing and resin then shall be applied to the exterior surface. All accessible wrapped joints shall have their inside surfaces covered with at least two layers of resin-saturated chopped strand mat, followed by one layer of surfacing mat. Prior to making an overlay, the cured surfaces under the area of the overlay first must be roughened by sanding. The roughened area shall extend beyond the overlay, but this roughened area subsequently must be completely coated with new resin.

Duct flanges shall be as set forth in paragraph 2.02 C and shall be fabricated by contact-molded methods. Flanges shall be started with a 3-face ply of mat and reinforced with additional plies of mat to obtain the required flange thickness.

4. FITTINGS: Fittings such as elbows, laterals, tees, reducers, and transitions, shall be at least as strong as the adjoining duct sections. Wall thickness of fittings shall be at least that of duct of the same size. Standard elbows up to and including 24 inches shall be molded in one piece with a centerline radius of 1.5 times the duct diameter. Larger diameter elbows may be of mitered construction. Length of standard reducers shall be 2.5 times the difference in diameters. Minimum wall thickness shall be that required for the larger diameter.

B. DUCT FLANGES:

1. DIMENSIONS: Duct flange size and thickness, bolt circle diameter, bolt hole diameter, number of bolt holes, and shear length shall be as shown below:

Duct size, inches	Flange width, min(1) inches	Flange thick., min inches	Edge distance, inches	Bolt hole dia, inches	Bolt dia, inches	No. of bolt holes	Shear length, min (2) inches
6	2 3/16	1/4	1/2	7/16	5/16	8	1 1/2
8	2 3/16	1/4	1/2	7/16	5/16	8	1 1/2
10	2 3/16	3/8	1/2	7/16	5/16	12	1 1/2
12	2 3/16	3/8	1/2	7/16	5/16	12	1 1/2
14	2 3/16	3/8	1/2	7/16	5/16	12	1 1/2
16	2 3/8	1/2	3/4	1/2	3/8	16	1 1/2
18	2 3/8	1/2	3/4	1/2	3/8	16	1 1/2
20	2 3/8	1/2	3/4	1/2	3/8	20	1 1/2

Duct size, inches	Flange width, min(1) inches	Flange thick., min inches	Edge distance, inches	Bolt hole dia, inches	Bolt dia, inches	No. of bolt holes	Shear length, min (2) inches
24	2 3/8	1/2	3/4	1/2	3/8	20	2
30	2 3/8	1/2	3/4	1/2	3/8	28	2
36	2 3/8	1/2	3/4	1/2	3/8	32	2
42	2 3/4	5/8	7/8	5/8	7/16	36	3
48	2 3/4	5/8	7/8	5/8	7/16	44	3
54	2 3/4	5/8	7/8	5/8	7/16	44	3
60	2 3/4	5/8	1	3/4	1/2	52	3
72	3 3/16	3/4	1	3/4	1/2	60	4
84	3 3/16	3/4	1	3/4	1/2	72	4
96	3 3/16	3/4	1	3/4	1/2	80	6
108	3 3/16	3/4	1	3/4	1/2	88	6

All stainless steel surfaces shall be kept out of contact with the foul air stream to the maximum extent possible. All stainless steel exposed to the air stream shall be coated with coal tar epoxy.

(1) Widths shown are minimums from outside face of duct.

(2) Shear length is the length along the duct extending from the flange face to the point where the last flange reinforcement mat intersects the duct outer wall.

2. BOLTS: Bolts, nuts and washers shall be stainless steel, type 316. Type 316 stainless steel backing strips, drilled for the above bolting requirements, shall be employed for all connections at fans, demisting sections, and wherever shear or moment loads may be encountered on duct connections.

3. GASKETS: Gaskets shall be of neoprene or Buna-N.

D. SUPPORTS AND HANGERS:

RTP ductwork shall be supported at intervals no greater than 10-foot centers. Supports and hangers shall transmit all ductwork loads into the building structural frame through a system of intermediate beams and struts as necessary to accommodate requirements of these specifications. The Contractor shall submit his proposed plan for support of the RTP ductwork to the Construction Manager. Supports or hangers employing clip angles or similar devices for

attachment to the ductwork are prohibited, and all supports shall be designed to resist UBC Zone 2 seismic forces. All supports shall be fabricated from mild steel rods, bars and straps, hot-dip galvanized after fabrication. Where supports are clamped to RTP laminants, neoprene sponge protective pads shall be employed to protect the RTP.

E. DAMPERS:

Dampers shall have RTP or type 316 stainless steel blades, type 316 stainless steel shafts and hardware and permanently lubricated bearings of material impervious to attack by acids and caustics. Seals shall be provided at all shaft ductwork penetrations to prevent leakage. All dampers shall be of opposed blade design, with sealing strips on mating surfaces and around all edges. The design of the dampers shall be such as to guarantee no more than 1 cfm leakage per foot of sealing surface at 10 inches water column differential. Each damper shall be equipped with a locking, indicating quadrant.

F. TURNING VANES AND SPLITTERS:

Turning vanes and splitters shall be provided in rectangular ductwork at all miter bends, tees and similar fittings in accordance with ASHRAE recommendations. All vanes and splitters shall have sufficient section and stiffness to operate without flutter or vibration under the air flow conditions indicated.

Turning vanes shall be airfoil section with internal metal reinforcement and RTP laminate overlay or airfoil section, all type 316 stainless steel.

G. INSPECTION PLATES:

Removable inspection plates, not less than 6 inches square, shall be provided at all fan inlet and discharge connections, and upstream and downstream from all fittings. Inspection plates shall be gasketed and shall make an airtight seal with the parent duct.

H. EXPANSION JOINTS:

Expansion joints shall be provided to compensate for thermal expansion and contraction. Expansion joint shall be minimum 1/4 inch thick neoprene secure to ductwork with stainless steel worm drive clamps. Provide 3 inch clearance between ductwork ends; support ends of duct to avoid sagging.

PART 3--EXECUTION

3.01 GENERAL

The ductwork is to be installed as shown on the drawings. Underground ductwork shall be wrapped in a 8 mil vapor barrier and sealed watertight.

3.02 SEALING

All ductwork joints shall be sealed with tape or mastic to ensure leak-free operation.

END OF SECTION

SECTION 13579

ODOR CONTROL SYSTEM

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies the odor control reactor, chemical metering pumps, exhaust fan, air compressor, storage tanks, air receiver, water softener and appurtenances for the odor control system (OCS).

B. TYPE:

Odor control reactor, chemical metering pumps, exhaust fan, air compressor, air receiver and water softener shall function as a system and shall be the unit responsibility of the odor control reactor manufacturer in accordance with Section 11000.

C. EQUIPMENT LIST:

Item	Equipment number
Odor control reactor	T1800
Sodium hydroxide pump	P1810
Sodium hypochlorite pump	P1820
Sodium hypochlorite storage tank	T1821
Acid pump	P1830
OCS exhaust fan	F1840
OCS air compressor	CP1850
OCS air receiver	PVL1851
Duplex water softener	WS1860

1.02 QUALITY ASSURANCE

A. GENERAL:

The equipment furnished shall remove odors from the foul air entering the odor control reactor. The source of the foul air shall be from the ventilation of the headworks and the raw sewage channel in a wastewater treatment plant.

B. OPERATING REQUIREMENTS:

The odor control system must be a single system which is capable of continuous operation and does not require redundancy of equipment. The liquid distribution system shall be designed to be replaced without but momentary shutdown. Air from the odor control reactor shall be discharged to the atmosphere by means of an exhaust stack. The stack shall be provided with a plume eliminator.

The odor control system shall be capable of handling air flows as follows:

Flow rate	5,100 cfm
Gas temperature	100° F.
Inlet H_2S concentration	53 ppm

1.03 ENVIRONMENTAL CONDITIONS

The equipment is to be located outdoors at a wastewater treatment plant near Avondale, Arizona. Equipment shall be suitable for environmental conditions specified in Section 01800, and all components in the air stream shall be suitable for continuous exposure to moist, hydrogen sulfide laden air containing minor quantities of sulfuric acid.

1.04 SUBMITTALS

The Contractor shall submit the following information to the Construction Manager is accordance with Section 01300:

1. Shop drawings of units and specifications.

2. Detailed installation instructions and drawings.

3. List of spare parts that will be provided.

4. Chemical pump performance data.

5. Fan performance curves showing capacity pressure and horsepower.

1.05 OPERATION AND MAINTENANCE DATA

In accordance with Section 01730, the Contractor shall provide the following information:

1. Operating and maintenance data.
2. Maintenance manuals.

1.06 SPARE PARTS

A spare parts package shall be provided for replacement of all parts that can be reasonably expected to require replacement within the first year of operation. This spare parts package shall be described and detailed as to its specific contents.

PART 2--PRODUCTS

2.01 GENERAL

The main components of the odor control system are described individually in the following paragraphs.

A. ODOR CONTROL REACTOR:

The odor control reactor shall be manufactured of a filament wound fiberglass construction in accordance with ASTM D-3299 standard specifications and PS15-69 product standards.

The reaction chamber shall have a sufficient volume for the design contact time for odor removal. The interior of the tank shall be finished with a resin-enriched coating for corrosion resistance.

Lifting lugs, attachment lugs, drains, anchor plates, water tight access doors, and all required flanged and or threaded nozzle openings shall be provided for lifting, handling, and anchoring the reaction chamber, the attachment of access ladders and platforms, attachment of chemical supply and drains, access to interior parts of the chamber for inspection, cleaning, and repair, and attachment of inlet and outlet ducts.

The exterior of the reaction chamber and equipment housing shall be finished with a pigmented exterior coating.

The reaction chamber shall have the following configuration:

TOPSIDE ENTRY: The influent gas shall enter the reaction chamber tangentially near the top of the straight side of the reaction chamber. The influent gas shall exit the reaction chamber tangentially approximately 6 inches from the bottom of the straight side of the reaction chamber. The orientation of the inlet and outlet fittings are to be specified

by the purchaser, or the Engineer. The reaction chamber shall be 12 feet diameter, by 14 feet straight side height. The inlet duct shall be 24 inches. The exhaust duct shall be 36 inches. The manway shall be 24 inches. The drain shall be 1-1/2 inches threaded.

The reaction chamber shall have a slope bottom design to assure complete and rapid drainage of liquid from the reaction chamber. The pressure loss of air flow through the reaction chamber at design conditions shall not exceed 2 inches of water.

B. CHEMICAL SUPPLY AND DILUTION SYSTEM:

The reaction chemical to be diluted will be provided by the purchaser in a liquid form. It shall not be necessary for operators to dilute, or rehandle these corrosive and reactive chemicals. The feed and dilution system withdraws the chemical required by means of dip tubes into the chemical containing drums or tanks. Systems based on the dilution of powdered chemicals, or on the addition of proprietary chemicals to readily available non-proprietary chemicals are not acceptable. The chemical feed system shall contain all those parts necessary to achieve the required concentrations, at the required feed ratio, for satisfactory performance of the odor control system. Such proper operation shall be able to be monitored fully from the chemical dilution and feed control panel.

The sizing of pumps is based upon estimates of odor levels and estimates of chemical usage requirements for treatment of these odors. It is the aim that pump sizing shall be for approximately mid-range of pumping capacity. If upon start-up, it is determined that pump selection is incorrect, then the proper pump size will be installed.

The operation of the chemical feed and dilution system shall be automatically integrated with the features of the odor control system or may be manually and independently operated as well.

All parts of the chemical feed and dilution system shall be readily accessible for repair and maintenance, and shall be mounted on an open fiberglass panel for easy access.

All materials of construction of the chemical feed and dilution system shall be selected for long-time satisfactory performance with the types of chemicals and concentrations encountered. Therefore, all parts shall be plastic, of the correct types and formulations, or 316 stainless steel.

The chemical feed system shall be sized to provide the flow rate of the liquid required by the chemical distribution system. This dilute chemical flow rate is 0.75 gallons per minute.

The chemical feed system shall be a single-stage, two-chemical configuration to provide metering and controlled dilution for two chemicals feeding a single dilute chemical stream. The sodium hydroxide pump shall be automatically controlled by maintenance of pH to set point in the effluent. The sodium hypochlorite pump will be automatically controlled by maintenance of the H_2S level below a set point in the exhaust gas system. The acid pump shall be manually controlled.

Clean soft water from a water softener of reasonably uniform pressure and of a minimum pressure of 40 psi will be supplied to the system. A solenoid valve controlled by the electrical control system shall activate the flow for the system. A water pressure regulator shall be provided to assure uniform flow. A flow meter shall be provided to allow for adjustment and monitoring of flow of the chemical feed system. An oil-scaled pressure gauge shall be provided to observe line pressure in the chemical feed system. Metering pumps shall be provided to meter the chemical to be fed into the dilute chemical line. A cartridge-type replaceable filter for the dilute chemical feed shall be provided. Values to draw samples, or to drain the dilute chemical line shall be provided.

Chemical metering pumps shall be positive displacement, diaphragm-type pumps. Output volume shall be adjustable while pumps are in operation from zero to maximum capacity. Adjustment shall be by means of readily accessible dial knobs, one for changing stroke and one for changing frequency. Both knobs are to be located opposite the liquid handling end. On-off switch shall be integral with frequency control, "off" position to be below the lowest frequency control. Chemical metering pumps shall be capable of injecting chemicals against the existing line water pressure.

The pump drive shall be totally enclosed with no exposed moving parts. Solid state electronic pulser shall be fully encapsulated. Electronics shall be housed in a chemical resistant enclosure at the rear of the pump for maximum protection against chemical spillage.

Chemical metering pump housing shall be of chemically resistant glass fiber reinforced thermoplastic. All exposed fasteners shall be stainless steel. Chemical metering valves

shall be ball type, with ceramic balls seating on combination valve seat and seal ring. Valve seat and seal ring shall be renewable by replacing only the combination set-seal ring. Pump head shall be of PVC material. Fittings and connections at pump head shall be PVC.

Polyethylene tubing shall be provided complete with compressing connections. An injection/anti-siphon check valve with 1/2 inch NPT male connection shall be provided for the injection point. The injection valve shall incorporate a dilating orifice.

Control of the automatic metering pumps shall be selectable between internal and external pulsing by means of a 3-position center-off switch.

The chemical feed system shall be designed for automatic metering and variation of chemical flow. The reactors drain liquid shall be continuously monitored and the chemical injection rate on one chemical automatically adjusted to maintain the pH residual at the set point. Output signals from the sensor probe shall be transmitted to the analyzer over standard signal wire. The probe unit shall be automatically temperature compensated and shall have a minimum sensitivity of 0.01 pH. The analyzer shall be compatible with the sensor signal transmission and shall be mounted in the electric control panel. The analyzer shall contain a suitable meter or digital display for indication of the process variable, set point, or controller output. The unit shall contain a 2-mode controller (proportional or integral) with analog for control of the chemical injection system. An auto-manual switch shall be provided with suitable switches to increase or decrease control set point, to allow display of the process variables, set point or controller output, and for setting control action. The unit shall be provided with high and low alarm relays for deviation from set point. Contacts shall be provided for remote alarm transmission.

With a varying inlet H_2S concentration, the odor control system shall maintain a constant predetermined exhaust H_2S concentration without requiring an overfeed of process chemicals or monitoring by plant personnel.

C. CHEMICAL DISTRIBUTION SYSTEM:

The reaction chamber shall be equipped with a distribution device to atomize the dilute chemical solution so as to cause intimate contact between the chemical solution and the odor

laden air or gases being reacted to achieve reaction of the odor molecules and odor removal as required by the design. These nozzles shall create a fine mist of droplets in the range of 5 to 20 microns in diameter, and with a median droplet of less than 10 microns.

All pats of the chemical distributor shall be constructed of titanium and shall be easily removed and disassembled for cleaning and repair or replacement. The compressed air line connection shall be 3/4 inch NPT, and the dilute chemical connection shall be 3/8 inch NPT.

All parts of the chemical distributor shall be accessible and removable from the outside of the reaction chamber with only brief interruption of operation of the odor control system. There shall be no need for opening manways for access to the nozzle.

The odor control system supplier shall provide test results by a qualified independent laboratory indicating that the median droplet size falls below 10 microns, and that 90 percent or greater of the number of droplets formed fall below 20 microns.

The atomizer shall not require greater than 15 hp of compressed air for atomization. This compressed air shall not be greater than 60 scfm, at 80 psig at the nozzle.

D. COMPRESSED AIR FEED SYSTEM:

The compressed air fed system shall be supplied by an air compressor to fulfill the compressed air requirements, at a minimum pressure of 80 psi at the atomizer. The air feed control system shall be comprised of a solenoid valve controlled by the electrical panel, an air pressure regulator, an air filter, and an air pressure switch which will shut down the air flow under specified conditions.

The air compressor shall be a preassembled, single-stage, oil injected, rotary screw compressor in a sound attenuated steel cabinet enclosure. The air compressor shall be sized to the compressed air requirements of the odor control system. The air compressor shall be 15 hp and deliver 60 cfm at rated pressure. The compressor performance shall be stated at a 100-psig working pressure.

The air compressor shall include air intake filter, replaceable oil filter, and air-cooled oil cooler. The air/oil reservoir shall be ASME coded and include oil level site glass,

pressure relief valve, minimum pressure/check valve, pressure relieving oil filter plug, and replaceable oil separator. The control cubicle shall include full voltage starter, timer for automatic on-off, transformer and electronic control circuit.

The instrument panel shall include start-stop push buttons, discharge air pressure pump, discharge air/oil temperature gauge, load indicator lights with test button, hour meter, load/unload toggle switch and push button for oil separator differential pressure.

The noise shall not exceed 85 dbh at one meter as tested by the air compressor manufacturer.

A vertical air receiver sized to the requirements of the air flow will be supplied, and will include a manual drain valve.

Acceptable manufacturers are Atlas-Copco, Sullair, Joy, Ingersoll-Rand, or equal.

E. ELECTRICAL CONTROL PANEL:

The electrical control panel shall be a NEMA 4X panel and shall contain switches, status lights for all operating units to indicate control of electrical equipment required for the odor control system furnished.

The electrical control panel shall be provided for coordinated and independent operation of the components of water supply, chemical metering pumps, controls and exhaust fan. All units can be activated by a single button. Indicator lights shall indicate the unit functions. Similarly, each individual portion of the system shall be initiated by its own electrical control, with indicator lights indicating individual unit functions. Extra contacts shall be included for transmission of a 4-20 ma signal to an external alarm.

The electrical control shall provide controls for an automatic rinse of the chemical line, whereby activation of the stop button will result in a timed sequence for shutting down chemical, water, compressed air and exhaust fan.

F. EXHAUST FAN:

The process exhaust fan shall be a vane-axial fan type with operation characteristics of 14,350 cfm at 2.5 inches of water pressure drop. The fan shall run at 1,353 rpm, and require 9.4 brake hp, and shall be supplied with a 10 hp motor.

All structural parts in the airstream shall be fiberglass and resin. The resin is selected for resistance to attack of a large variety of acids, alkalies and other chemical agents. The fan housing shall have additional resistance provided by an inner veil with a resin enriched coating. Fan wheels are made of continuous glass lay-up using a combination of fabric-woven roving and man and shall be hardened for longer wear. The bearing supports are integral with the housing and motor support flanges. The bearing bases are reinforced with cross-strutting, all of glass and resin construction. Fan shafts are stainless steel, and bearing covers are designed to be sealed and yet allow for access to the bearings. Grease lines are extended, and the motor is located outside the airstream.

Belt driven fans shall have adjustable V-belts with motors mounted on heavy duty adjustable base plates. Bearing, belts, and pulley shall be on the negative pressure side of the fan and shall be protected from the main air or gas stream.

Motors shall be externally mounted and shall be totally enclosed. Motors shall be 460/230 volt, 3-phase, 60 cycle, unless otherwise specified. Motors shall be TEFC with Milland chemical rating. Motors shall be provided with fiberglass, or epoxy coated steel covers.

G. EXHAUST STACK:

The exhaust stack shall have a diameter of 36 inches and a height from the base of 18 feet. It shall be made of filament wound fiberglass construction and shall be manufactured of materials which are inert in the presence of the chemical solutions to be in the reaction chamber and exhaust gases and according to ASTM-D3299.

The exhaust stack shall be of a rigid construction. It is to be provided with lugs for guy wire connections or other bracing supports, where required. Bracing and mounting of the exhaust stack is a function of the installing contractor.

On the suction side of the fan, an adjustable opening shall be made to admit outside air, to decrease the presence of the vapor plume on some days of the year. The sizing of the exhaust fan shall account for the added air flow rate. The opening or openings shall be adjustable by a damper, or variation of size openings of some convenient design, but which is easily adjustable, and remains in a fixed position, when set.

H. WATER SOFTENER:

The water softener shall be a duplex ion-exchange water softener sized to meet the requirements of water flow and water hardness. The regeneration of the water softener by means of salt brine shall be activated by a timer. One unit shall be on stream at all times, while the other unit is regenerating, so that there is an uninterrupted flow of soft water. Resin tanks shall be of fiberglass. The water softener shall be provided prepiped. An acceptable water softener is Culligan HB-45.

J. SODIUM HYPOCHLORITE STORAGE TANK:

The tank shall be a flat bottom fiberglass storage tank of the resins suitable for the chemical stored and fabricated according to industry standards. The tank shall contain a top mounted fill tube, overflow tube, bottom side mounted fitting for the connection of piping to the chemical dilution panel, and top mounted manway. The tank shall be painted white with white gel coat, and a minimum of a 6-inch unpainted section shall be left, the height of the tank for visual observance of liquid level. The tank shall contain a top mounted low and/or high liquid level indicator of a float type, and impervious to the chemicals in the storage tank.

K. ACCESSORIES:

A ladder with safety cage and landing platform shall be provided for access to the liquid distribution system. The ladder shall be fastened to the reaction chamber and shall comply with all applicable OSHA standards. The ladder shall be epoxy coated steel.

PART 3--EXECUTION

The odor control system manufacturer shall provide field engineering start-up assistance to start-up, test, and arrive at proper operating conditions. In addition, training is to be provided to relevant operators on all shifts, and to selected maintenance personnel. A manufacturer's trained field service engineer shall be present at the job site for 2 working days (16 hours) to perform the above tasks. The installation shall be certified on Form 11000-A specified in Section 01999. The training shall be certified on Form 11000-B specified in Section 01999. Three copies of manuals on the installation, operation, and maintenance of the odor control system shall be provided by the manufacturer.

END OF SECTION

DIVISION 14

CONVEYING SYSTEMS

Section	Title
14311	MONORAIL HOIST
14315	PORTABLE HOIST
14548	SCREENINGS DEWATERING CONVEYOR

SECTION 14311

MONORAIL HOIST

PART 1 - GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies a monorail hoist including motorized hoist, motorized trolley, controls, and accessories as specified.

B. EQUIPMENT LIST:

Item	Equipment number
Monorail hoist	H 6530

C. SERVICE CONDITIONS:

The chlorine ton container hoist (H 6530) will be used for lifting and moving chlorine ton containers within the chlorine room and for loading and unloading containers from delivery trucks. Load-unload operations will be infrequent but will require intensive use of the hoist over a period of 1 to 2 hours.

D. OPERATING REQUIREMENTS:

Equipment shall be of the type and capacity specified below:

Equip. no.	Location	Item	
H9210	Chlorine room	Type	Monorail
		Hoist type	Motorized wire rope
		Trolley type	Motorized
		Capacity, tons	3
		Minimum lift, feet	16
		Operating floor elevation	931.25
		Bottom of monorail elevation	943.75
		Hook elevation in highest position, not lower than:	954.25
		Approximate hoist speed, fpm	14
		Approximate trolley speed, fpm	50
		Hoist horsepower	3
		Trolley horsepower	1/2

1.02 QUALITY ASSURANCE

Equipment furnished under this section shall comply with the requirements of OSHA. Hoisting equipment shall comply with the standards of the Hoist Manufacturers Institute.

1.03 ENVIRONMENTAL CONDITIONS

The chlorine ton container hoist will be operated both indoors and outdoors. The equipment shall be suitable for the environmental conditions specified in Section 01800.

1.04 SUBMITTALS

Submittals shall comply with the requirements of Sections 00710 and 01300.

PART 2 - PRODUCTS

2.01 EQUIPMENT

A. MOTORIZED TROLLEY:

Trolley wheels shall be hardened steel, mounted on permanently lubricated antifriction bearings. Motorized trolley shall be provided with an electric brake rated at 50 percent of full load motor torque. Drive mechanism shall be designed to move trolley in either direction under load at the speed specified in paragraph 1.01 D. Motorized trolley shall be equipped for cushioned starting.

B. ELECTRIC HOIST:

Hoist shall be designed and manufactured in accordance with the standards of the Hoist Manufacturers Institute (HMI). Hoist shall be motorized and designed for Class H3 HMI service. Electric hoist shall be wire rope type, two-part double reeved with a machine grooved winding drum.

Hoist shall have the operating speed specified and shall be powered by a reversible high torque motor designed specifically for hoist service. Hoist shall contain two brakes designed for long life and positive stopping. One brake shall stop the motor rotation. A second "load brake" shall be applied automatically on lowering and require the motor to drive the load down. Both motor and mechanical load brake shall be capable of holding 125 percent of load independently of each other.

The hoist shall be provided with geared adjustable upper and lower overtravel limit switches to assure safe operation and positive stopping under all conditions. The limit switches shall

automatically disconnect the motor and engage the brake when the hook reaches either its upper or lower limit. Reversing the motor shall reset the switch. The gear transmission assembly shall be fully enclosed in an oil bath. Antifriction bearings shall be used throughout to support the high speed motor shaft. All component parts shall be readily accessible for maintenance.

The lifting tackle shall consist of a safety type shrouded lower block and safety latch hook, necessary sheaves, and flexible steel wire rope. Rope sheaves shall be of steel construction and shall turn on ball bearings. The wire rope shall be extra flexible plow steel rope made especially for hoist service. The load hook shall be forged steel and shall be supported on a ball thrust bearing for 360-degree swivel.

C. MONORAIL TRACK:

Crane beams for the monorail shall be standard I-beam sections. Beam connections and spacing are shown on the structural drawings. The beams shall be designed to limit deflection under load to 1/450 of span. The beams shall be designed and constructed such that the hoist operates smoothly over the entire length of travel when fully loaded. End stops designed to cushion the stopping shall be installed at the limits of travel of the end trucks on each beam.

D. ELECTRICAL EQUIPMENT AND CONTROLS:

1. GENERAL: All electrical and control equipment shall comply with the requirements of Sections 11090 and 16000.

2. POWER SUPPLY: Power supply for hoisting equipment will be 460V, 3 phase, 60 Hz. Control power transformers shall be provided as necessary by the manufacturer. Control power shall be 24 volts.

3. MOTORS: Motors shall comply with Section 11060 and shall be 1800 rpm maximum.

4. ELECTRIFICATION: Electrification for monorail shall be the cable reel type. Cable reel shall be located in the approximate location shown on the drawings. Cable reel shall be furnished with outlet guide rollers for cable. Cable reel shall enable trolley to operate the full range of monorail length without cable sag below 9 feet above floor level. Cable shall be UL-listed Type SO and shall have four wires suitable for 3 phase, 460 volt service. Reel for hoist shall have swivel type base with a minimum 335-degree travel and cast stop lug to limit rotation. Reel and outlet roller guide shafts shall have oil-less type bearings. Motive power shall be from a steel clock-spring that shall be housed in a dust-tight, grease-filled compartment. Brushes shall be removable, set in a floating tension assembly that will provide uniform pressure,

arcless current collection and maintain perfect alignment. Reel shall have a junction box with an easily removable cover for access to solderless type electric terminals. A looped, flexible rubber cable as specified for reel shall be used to supply current to the brushes from the fixed mounting. A heavy-duty, stainless steel mesh cable grip shall be provided for the connection to the hoist.

5. CONTROLS: Hoist and trolley controls shall be the magnetic type. Pushbutton control for the hoist and trolley shall be provided at a single pendant pushbutton control station with spring loaded (deadman) pushbuttons to control hoist and trolley functions.

Electrical control cable from hoist to pendant controls shall be securely tied to a strain cable at 3-foot maximum intervals and shall have only the minimum slack necessary to allow the strain cable to independently support the pendant load. The pendant shall incorporate an emergency stop-start switch and be marked to clearly show each control function. Control cable shall be of the proper length to allow "walk-along" operation from the finished floor.

PART 3 - EXECUTION

3.01 USE BY CONTRACTOR

Any crane or hoist used by the Contractor shall be repaired, repainted and otherwise refurbished to like-new condition prior to its acceptance. The Contractor assumes all responsibility for operation and maintenance until the crane has been accepted.

3.02 TESTING

All hoisting equipment shall be operated through a complete lift and lowering cycle and through a complete travel of the bridge and trolley to determine that the equipment performs smoothly and safely. All tests shall be carried out with the hoisting equipment loaded at 100 percent of rated capacity. The Contractor shall provide the test weight loads. Any defects shall be corrected by the Contractor without any expense to the Owner.

END OF SECTION

SECTION 14315

PORTABLE HOIST

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies a portable hoist for lifting submersible pumps out of sumps.

B. TYPE:

The hoists shall be of the portable, hook-suspension type, for mounting in a platform socket located at each point of application.

PART 2--PRODUCTS

2.02 EQUIPMENT

A. HOIST:

The hoist shall be capable of lifting submersible pumps out of sumps. Raising and lowering of the load shall be accomplished by means of a double-geared hand winch, equipped with a disk brake for load control. To lower a load shall require the winch handle to be turned in reverse. The winch shall be designed to operate with a maximum effort of 40 pounds (lbs) applied to the crank.

The boom shall pivot 240 degrees side to side on low friction swivel points. The mast height shall be approximately 61 inches. The boom reach shall be 24 inches minimum. The hoist shall weigh no more than 60 lbs. The cable length shall be a minimum of 25 feet. The hoist shall have a minimum lifting capacity of 650 lbs.

B. PLATFORM SOCKETS:

Platform sockets shall be provided at the locations shown and shall be specifically designed to support the hoist and the maximum applied load as specified in paragraph 2.01 A. of this section.

3.01

PART 3--EXECUTION

The Contractor shall install the hoist platform sockets at the locations shown in accordance with the manufacturer's details. The hoist shall then be tested for proper operation.

END OF SECTION

SECTION 14548

SCREENINGS DEWATERING CONVEYOR

PART 1 - GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies the screenings dewatering screw for dewatering coarse screened solids removed by the mechanical bar screen.

B. TYPE:

The equipment shall be of the centerless screw type designed to press water from the screenings as they are conveyed through the barrel, and discharge the dewatered solids to a hopper. Dewatering screw shall be Statiflow Screw Press Model SP150, or equal.

C. EQUIPMENT LIST:

Item	Equipment number
Screenings dewatering screw	CNV 1220

1.02 QUALITY ASSURANCE

A. GENERAL:

The dewatering screw shall be capable of dewatering coarse solids removed from raw municipal wastewater by mechanical bar screens. Materials which will be routinely conveyed to the machine will include rags, stringy material, pieces of wood, metal objects, coarse waste solids, garbage, paper, rocks and glass. The manufacturer warrants that the equipment furnished under this specification is specifically designed for dewatering coarse solids containing the above objects, and that positive overload protection is provided with the equipment which will prevent damage to rotative equipment elements should the machine become jammed or encounter an object too large to be conveyed.

B. OPERATING REQUIREMENTS:

The equipment furnished under this specification shall be selected to provide the following operating characteristics:

Barrel diameter, inches	6
Screw RPM	14
Capacity, $ft^3/hr.$	2.5
Dewatered solids concentration, minimum, percent by weight	30
Motor horsepower, minimum	3/4

1.03 ENVIRONMENTAL CONDITIONS

The screenings dewatering conveyor will be located outdoors at a municipal wastewater treatment plant near Avondale, Arizona. The equipment shall be suitable for continuous operation under the environmental conditions specified in Section 01800.

1.04 SUBMITTALS

Submittals shall comply with Section 01300.

PART 2 - PRODUCTS

2.01 MATERIALS

Component	Material
Wetted parts	304 stainless steel
Nonwetted parts	Fabricated steel, epoxy coated

2.02 EQUIPMENT

A. BARREL:

Barrel shall be 6 inch diameter, Schedule 10, 304 stainless steel. Barrel shall be provided with a wedge wire screen with drain pan on the underside of the screw for liquid drainage and support of the screw. Both screen and drain pan shall be removable for cleaning and access to the screw. Barrel shall be provided with a removable cover to provide access to the internal parts. Barrel shall be equipped with a suitable entrance opening to receive solids from the inlet hopper, and support members to allow bolting the unit to the concrete floor. Barrel shall be provided with a 3-inch-diameter reject water drain pipe suitable for connection to drain piping as shown.

B. INLET HOPPER:

The inlet hopper shall be constructed of 304 stainless steel and shall be a minimum of 2 feet square at the top. Any flaring of the inlet hopper shall be at steep angles to minimize material adherence to the walls of the hopper.

C. SCREW:

Screw shall be of the single-flight centerless design having a maximum pitch equal to its outer diameter. Design torque shall exceed that which overloads the motor by a conservative factor of safety.

D. DRIVE UNIT:

Screw shall be direct driven by a 460 volt, 3 phase, 60 Hz explosionproof electric motor through a heavy duty right angle worm gear reduction unit. Motor shall have positive overload protection to prevent excessive torque from bending or damaging equipment parts. Gear reduction unit shall be designed with a conservative factor of safety for operating torque in excess of that which initiates the overload protection. Gear reduction unit shall be oil lubricated.

E. BEARINGS:

The dewatering screw shall be provided with a spherical roller thrust bearing designed to take loads from the screw. The thrust bearing shall be provided with lip seals on both sides and shall be grease packed.

2.03 OPERATION AND MAINTENANCE DATA

In accordance with Section 01730, the following information shall be provided:

1. Operating and maintenance data.
2. Maintenance manuals.

PART 3 - EXECUTION

The equipment shall be located and installed as shown on the drawings and in strict accordance with the recommendations of the manufacturer. Following installation, the equipment shall be completely field tested to assure compliance with the performance criteria specified.

END OF SECTION

DIVISION 15

MECHANICAL

Section	Title
15050	PIPING SYSTEMS
15056	REINFORCED CONCRETE PIPE
15057	CONCRETE CYLINDER PIPE
15059	VITRIFIED CLAY PIPE
15060	CEMENT MORTAR LINED AND COATED STEEL PIPE
15061	STEEL PIPE
15062	DUCTILE IRON PIPE
15064	PLASTIC PIPE
15065	STAINLESS STEEL PIPING
15066	COPPER PIPING
15075	JOINT GASKETS
15085	PIPING CONNECTIONS
15090	EXPANSION JOINTS ANDD FLEXIBLE METAL HOSE
15095	PIPING APPURTENANCES
15101	GATE VALVES
15103	BUTTERFLY VALVES
15110	ECCENTRIC PLUG VALVES
15118	SPRING-LOADED SWING CHECK VALVES
15119	DOUBLE DISC CHECK VALVES
15124	REDUCED PRESSURE PRINCIPLE BACKFLOW PREVENTERS

Section	Title
15147	SOLENOID VALVES
15150	SPECIALTY VALVES
15180	CONTROL VALVE SCHEDULE
15185	VALVE AND GATE OPERATORS AND OPERATOR APPURTENANCES
15250	INSULATION FOR EXPOSED PIPING AND EQUIPMENT
15400	PLUMBING
15450	PLUMBING FIXTURES
15460	EMERGENCY EYEWASH AND SHOWER AND EYEWASH UNITS
15663	ROOFTOP AIR CONDITIONING UNITS
15776	AIR TO AIR HEAT PUMP
15803	EVAPORATIVE COOLERS
15809	HVAC SYSTEMS BALANCING
15842	ROOF EXHAUST FANS
15849	FUME HOOD EXHAUST AND SUPPLY FANS
15850	FUME HOOD EXHAUST DUCTWORK
15855	SHEET METAL DUCTWORK
15856	FLEXIBLE DUCTWORK
15858	DUCTWORK THERMAL INSULATION
15861	ACOUSTICAL LINING FOR DUCTS
15863	DAMPERS
15867	MECHANICAL LOUVERS
15872	CEILING GRILLES

Section	Title
15881	DISPOSABLE FILTERS
15990	CATHODIC PROTECTION SYSTEM

SECTION 15050

PIPING SYSTEMS

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies systems of process piping and general requirements for piping systems. Detailed specifications for the components listed on the Piping System Specification Sheets are found in other sections of Division 15. This section shall be used in conjunction with those sections.

B. DEFINITIONS:

Pressure terms used in Section 15050 and elsewhere in Division 15 are defined as follows:

1. Maximum: The greatest continuous pressure at which the piping system operates.

2. Test: The hydrostatic pressure used to determine system acceptance.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
AASHTO M36/M36M-83	Metallic (Zinc or Aluminum) Coated Corrugated Steel Culverts and Underdrains
ANSI A13.1-81	Scheme for the Identification of Piping Systems
ANSI B1.20.1-83	Pipe Threads, General Purpose (Inch)
ANSI B16.1-75	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800
ANSI B16.11-80	Forged Steel Fittings, Socket Welding and Threaded
ANSI B16.12-83	Cast Iron Threaded Drainage Fittings

Reference (cont'd)	Title
ANSI B16.22-80	Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ANSI B16.26-83	Cast Copper Alloy Fittings for Flared Copper Tubes
ANSI B16.3-77	Malleable Iron Threaded Fittings Class 150 and 300
ANSI B16.5-81	Pipe Flanges and Flanged Fittings
ANSI B16.9-78	Factory-Made Wrought Steel Buttwelding Fittings
ANSI B31.1-83	Power Piping
ANSI B31.3-84	Chemical Plant and Petroleum Refinery Piping
ASME (1983)	Boiler and Pressure Vessel Code
ASTM A47-84	Malleable Iron Castings
ASTM A53-84	Pipe, Steel, Black and Hot Dipped, Zinc-Coated Welded and Seamless
ASTM A74-82	Cast Iron Soil Pipe and Fittings
ASTM A105/A105M-85	Forgings, Carbon Steel, for Piping Components
ASTM A106-85	Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A120-84	Pipe, Steel, Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless, for Ordinary Uses
ASTM A197-79	Cupola Malleable Iron
ASTM A234/A234M-85	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ASTM A312-85	Seamless and Welded Austenitic Stainless Steel Pipe
ASTM A403/A403M-85	Wrought Austenitic Stainless Steel Piping Fittings
ASTM A536-84	Ductile Iron Castings

Reference (cont'd)	Title
ASTM A570/A570M-85	Hot-Rolled Carbon Steel Sheet and Strip, Structural Quality
ASTM B88-83	Seamless Copper Water Tube
ASTM C76-84	Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C296-83	Asbestos-Cement Pressure Pipe
ASTM C564-70	Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM D1248-84	Polyethylene Plastics Molding and Extrusion Materials
ASTM D1784-81	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D1785-83	Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241-84	Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR)
ASTM D2513-85	Thermoplastic Gas Pressure Pipe, Tubing, and Fittings
ASTM D2665-85	Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D3261-82	Butt Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM F441-84	Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
AWWA C105-82	Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids
AWWA C110-82	Ductile-Iron and Gray-Iron Fittings, 3 Inch Through 48 Inch, for Water and Other Liquids
AWWA C111-80	Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings
AWWA C115-83	Flanged Ductile-Iron and Gray-Iron Pipe with Threaded Flanges

Reference (cont'd)	Title
AWWA C151-81	Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids
AWWA C200-80	Steel Water Pipe 6 Inches and Larger
AWWA C203-78	Coal-Tar Protective Coatings and Linings for Steel Water Pipelines--Enamel and Tape--Hot-Applied
AWWA C205-80	Cement-Mortar Protective Lining and Coating for Steel Water Pipe--4 In. and Larger--Shop Applied
AWWA C206-82	Field Welding of Steel Water Pipe
AWWA C207-78	Steel Pipe Flanges for Waterworks Services--Sizes 4 In. through 144 In.
AWWA C208-83	Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C209-84	Cold-Applied Tape Coating for Special Sections, Connections, and Fittings for Steel Water Pipelines
AWWA C210-84	Coal-Tar Epoxy Coating System for the Interior and Exterior of Steel Water Pipe
AWWA C214-83	Tape Coating Systems for the Exterior of Steel Water Pipelines
AWWA C301-84	Prestressed Concrete Pressure Pipe, Steel Cylinder Type, for Water and Other Liquids
AWWA C303-78	Reinforced Concrete Pressure Pipe--Steel Cylinder Type, Pretensioned, for Water and Other Liquids
AWWA C600-82	Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA C601-81	Disinfecting Water Mains
AWWA C900-81	Polyvinyl Chloride (PVC) Pressure Pipe, 4 Inches Through 12 Inches, for Water

Reference (cont'd)	Title
AWWA M11-85	Steel Pipe--A Guide for Design and Installation
CISPI 301-75	Specification Data for Hubless Cast Iron Sanitary System with No-Hub Pipe and Fittings
FEDSPEC L-C-530B(1)-72	Coating, Pipe, Thermoplastic Resin or Thermosetting Epoxy
MIL-P-22245A	Pipe and Pipe Fittings, Glass Fiber Reinforced Plastic
MIL-STD-810C (1975)	Environmental Test Methods
UPC (1985)	Uniform Plumbing Code

PART 2--PRODUCTS

2.01 PIPING MATERIALS

Unless otherwise specified, piping materials listed on the Piping System Specification Sheets, including pipe, gaskets, fittings, joint assemblies, linings and coatings, shall conform to detailed specifications for each type of pipe and piping appurtenance specified in other sections of Division 15.

2.02 PIPING IDENTIFICATION

A. PLASTIC CODING MARKERS:

Plastic markers for coding pipe shall conform to ANSI A13.1 and shall be as manufactured by W. H. Brady Company, Seton Name Plate Corporation, or equal. Markers shall be the mechanically attached type that are easily removable; they shall not be the adhesive applied type. Markers shall consist of pressure sensitive legends applied to plastic backing which is strapped or otherwise mechanically attached to the pipe. Legend and backing shall be resistant to petroleum based oils and grease and shall meet criteria for humidity, solar radiation, rain, salt, fog and leakage fungus, as specified by MIL-STD-810C. Markers shall withstand a continuous operating temperature range of -40 degrees F to 180 degrees F. Plastic coding markers shall not be the individual letter type but shall be manufactured and applied in one continuous length of plastic.

Markers bearing the legends on the background colors specified in the PIPESPEC shall be provided in the following letter heights:

Outside pipe diameter,[a] inches	Letter height, inches
Less than 1-1/2	1/2
1-1/2 through 3	1-1/8
Greater than 3	2-1/4

[a]Outside pipe diameter shall include insulation and jacketing.

In addition, pipe markers shall include uni- and bidirectional arrows in the same sizes as the legend. Legends and arrows shall be white on blue or red backgrounds and black on yellow or green backgrounds.

B. PLASTIC TRACER TAPE:

Tracer tape shall be 6 inches wide, yellow and made of inert plastic material suitable for direct burial. Tape shall be capable of stretching to twice its original length.

The message printed on the tape shall read "CAUTION CAUTION CAUTION _____ PIPE BURIED BELOW" with bold letters approximately 2 inches high. The blank shall be filled with the particular system fluid such as chlorine, oxygen or sulfur dioxide.

C. MAGNETIC TRACER TAPE:

Polyethylene magnetic tracer tape shall be acid and alkali-resistant, 3 inches wide, 0.005 inch thick, and have 1,500 psi strength and 350 percent elongation value. The tape shall be colored the same as the background colors as specified in the PIPESPEC and shall be inscribed with the word "CAUTION--PIPE BURIED BELOW" and the name of the piping system.

2.03 VALVES

Valves of the same size and service shall be provided by a single valve manufacturer. Actual length of valves shall be within 1/16 inch (plus or minus) of the manufacturer's specified length. Flanges shall meet the requirement of ANSI B16.5. Push-on and mechanical joints shall meet the requirements of ANSI A21.11. Valve operators are specified in Section 15185.

2.04 PRODUCT DATA

Product data on piping materials shall be provided in accordance with paragraph 00710-4.02 where specified.

Piping layout drawings shall be transmitted to the Construction Manager a minimum of 2 weeks prior to construction. Drawings shall be original layouts by the Contractor; photocopies of contract drawings are not acceptable.

PART 3--EXECUTION

3.01 INSTALLATION

A. LOCATION:

Piping shall be provided as specified except for adjustments to avoid architectural and structural features and shall be coordinated with electrical construction.

B. PIPING SIZES:

Where the size of piping is not specified, the Contractor shall provide piping of the sizes required by UPC. Unless specified otherwise, small piping (less than 1 inch in diameter) required for services not described by UPC shall be 1/2 inch.

C. PIPE SUPPORT, ANCHORAGE AND SEISMIC BRACING:

Piping shall be supported by anchor brackets, guides, saddles or hangers. Acceptable types of supports, guides, saddles, hangers and structure attachments for general pipe support, expansion/contraction and for seismic bracing, as well as anchorage details, are shown on the drawings. Minimum spacing shall be as specified for supports and for seismic bracing. Where a specific type of support or anchorage is indicated on the layout drawings, then only that type shall be used there. Piping shall be vertically supported by anchor brackets, guides, saddles or hangers and shall be seismically braced where indicated to resist lateral load. Supports shall be provided on each run at each change of direction. Pipe supports shall be hot-dip or mechanically galvanized. Unless otherwise specified, existing pipes and supports shall not be used to support new piping.

D. ANCHORAGE FOR BURIED PIPING:

All plugs, caps, tees and bends in buried pressure piping systems shall be anchored by means of reaction backing or restrained joints as specified.

E. BEDDING AND BACKFILL:

Bedding and backfill for buried piping shall be as specified.

3.02 PIPING IDENTIFICATION

A. PIPE CODING:

After application of the specified coating and insulation systems, exposed piping, interior and exterior, and piping in ceiling spaces, pipe trenches, pipe chases and valve boxes shall

be identified with plastic markers as specified in paragraph 15050-2.02 A. Legend markers and directional arrows shall be located at each side of walls, floors and ceilings, at one side of each piece of equipment, at piping intersections, and at approximately 50-foot centers.

B. PLASTIC TRACER TAPE:

A single line of tape as specified in paragraph 15050-2.02 B shall be provided 2.5 feet above the centerline of buried pipe. For pipelines buried 8 feet or greater below finished grade, contractor shall provide a second line of tape 12 inches below finished grade, above and parallel to each buried pipe. Tape shall be spread flat with message side up before backfilling.

C. MAGNETIC TRACER TAPE:

Polyethylene magnetic tracer tape shall be buried 12 to 18 inches below ground and shall be above and parallel to buried nonferrous, plastic and reinforced thermoset plastic pipelines. For pipelines buried 8 feet or greater below final grade, the Contractor shall provide a second line of tape 2.5 feet above and parallel to the buried pipe.

3.03 VALVE IDENTIFICATION

Stainless steel tags bearing the specified valve number stamped in 1/4-inch high letters shall be installed on valve flanges in a position visible from floor level. Flangeless valves 8 inches in diameter and larger shall have tags attached to the valve body by self-tapping corrosion resistant metal screws. Flangeless valves 6 inches in diameter and smaller shall have tags attached to the valve stem by stainless steel wire. Wire shall be 0.063 inch minimum.

3.04 TESTING

A. GENERAL:

Upon completion of piping, but prior to application of insulation on exposed piping, the Contractor shall test the piping systems. Pressures, media and test durations shall be as specified in the PIPESPEC. Equipment which may be damaged by the specified test conditions shall be isolated. Testing shall be performed using calibrated test gages and calibrated volumetric measuring equipment to determine leakage rates. Each test gage shall be selected so that the specified test pressure falls within the upper half of the gage's range. The Contractor shall notify the Construction Manager 1 hour prior to each test.

Unless otherwise specified, testing, as specified herein, shall include existing piping systems which connect with new pipe systems. Existing pipe shall be tested to the nearest existing valve. Any piping which fails the test shall be repaired. Repair of existing piping will be considered and paid for as extra work.

Where testing existing chlorine and sulfur dioxide systems to the nearest isolation valve, Contractor shall provide a tee in the line adjacent to the valve. The branch outlet on the tee shall be valved and used for cleaning, pressure testing, draining, and drying the line. Prior to placing the line in service, the valve on the branch outlet shall be plugged or sealed with a blind flange or threaded plug. Contractor shall be responsible for all damage to the existing system as a result of this work.

B. GAS, AIR AND VAPOR SYSTEMS:

The Contractor shall test steam lines hydrostatically in accordance with the ASME procedure for testing pressure piping.

Testing medium and procedures for chlorine and sulfur dioxide systems are specified in paragraph 15050-3.04 D.

Unless otherwise specified, the testing medium for other gas, air and vapor systems shall be as follows:

Pipeline size	Specified test pressure	Testing medium
2 inch and smaller	75 psi or less	Air or water
2 inch and smaller	Greater than 75 psi	Water
Greater than 2 inch	3 psi or less	Air or water
Greater than 2 inch	Greater than 3 psi	Water

The allowable leakage rate for hazardous gas systems, insulated systems, and systems tested with water shall be zero at the specified test pressure throughout the specified test period. Hazardous gas systems shall include sulfur dioxide, chlorine, propane, sludge gas and natural gas systems.

The allowable leakage rate for other systems tested with air shall be based on a maximum pressure drop of 5 percent of the specified test pressure for the duration of the period. Prior to starting a test interval using air, the air shall be at ambient temperature and specified test pressure.

C. LIQUID SYSTEMS:

Leakage shall be zero at the specified test pressure throughout the specified duration for the following systems: exposed piping, buried insulated piping, and buried or exposed piping carrying liquid chemicals. Testing procedures for chlorine and sulfur dioxide systems are specified in paragraph 15050-3.04 D. Unless otherwise specified, leakage from other buried liquid piping systems shall be less than 0.02 gallon per hour per inch diameter per 100 feet of buried piping.

D. CHLORINE AND SULFUR DIOXIDE SYSTEMS:

1. GENERAL: Chlorine and sulfur dioxide systems comprise chlorine and sulfur dioxide, in gaseous and liquid phase, under positive and negative pressure. After cleaning, as specified in paragraph 15050-3.05 E, the system shall be pressure tested. Pressure gages, relief valves, automatic control valves, and other components which may be damaged or exceeded by test pressures shall be removed and openings shall be blocked off prior to testing. The Contractor shall not attempt to repair leaks until all pressure has dissipated from the system. The system shall be repaired and retested as necessary until a successful test (zero leakage) is achieved.

For evaporator-supplied systems, Contractor shall disconnect the vent from the discharge side of the pressure relief valve of each evaporator, plug the resultant opening, inspect and secure all joints, close all valves which discharge to atmosphere, and open all in-line valves. Contractor shall open the valve in the bypass line around the pressure reducing valve on the downstream side of each evaporator to provide a through path around this valve. System piping shall then be tested to 150 psig. After testing, Contractor shall replace all equipment previously removed and close all in-line valves. Contractor shall reconnect the vent line to the downstream side of the pressure relief valve of each evaporator and close the valve in the bypass line around the pressure reducing valve on the downstream side of each evaporator.

Steel pipelines shall be hydrostatically tested. However, if drying after hydrostatic testing is impractical or cannot be accomplished, the Contractor may test steel lines with nitrogen gas or dry air providing he takes the necessary safety precautions to safeguard personnel and minimize the risk incurred when performing such a test at high pressures. All PVC pipelines shall be hydrostatically tested. Testing PVC lines with nitrogen or air is not permitted.

2. HYDROSTATIC TESTING: Steel piping lines and PVC solution lines hydrostatically tested shall be tested to 150 psig. PVC vacuum lines shall be hydrostatically tested to 50 psig. After testing, all moisture absorbing gaskets and valve packing shall be replaced.

3. DRYING: Chlorine and sulfur dioxide piping systems shall be dried prior to placing in service. Even if water has not been purposely introduced into the system for hydrostatic testing or cleaning, drying is still required because moisture may enter the system from the atmosphere or other sources.

For steel pipe, drying shall be accomplished by passing steam through the lines from the high end of the system until the lines are thoroughly heated. While steaming, the Contractor shall allow

condensate and foreign matter to drain out. The steam supply shall then be disconnected and all pockets and low spots in the line drained. While the line is still warm, dry oil-free air having a dew point of -40 degrees F, or below, shall be blown through the line until the exiting air dew point is the same as the supply air. Valves shall be fixed in the half-open position during drying. Valves removed temporarily from the system during drying operations must be free of moisture before being recoupled to the system piping.

Drying of PVC pipe applies solely to vacuum lines and consists of draining and removing all water and moisture from the system. After draining the line, the Contractor shall first pig the pipe to remove excess water. The Contractor shall then air dry the system in accordance with the requirements for steel pipe. PVC pipe shall not be steamed.

4. NITROGEN OR AIR PRESSURE TESTING: The Contractor may use nitrogen gas or oil-free dry air to test steel lines. Testing consists of gradually introducing nitrogen gas or dry air up to 50 psig and maintaining this pressure while testing the line for leaks with soapy water. When the system is free from leaks at this pressure, the test pressure shall then be increased in increments of 50 psig up to a maximum of 150 psig. At each stepped increase in pressure, the Contractor shall check for leaks and take corrective action as necessary. When the system is free from leaks at the final test pressure, the system shall then be depressurized, the test source disconnected, and the system capped to prevent the entrance of water.

For testing with nitrogen gas, the Contractor shall use cylinders of dry high purity nitrogen gas, nitrogen handling cylinder mounted pressure regulator 0 to 300 psig, and necessary fittings and adapters to complete connection between the source and system header. Pressure regulator shall be self-relieving type which vents to the atmosphere and include a throttling valve.

For testing with air, the Contractor shall provide oil-free air with a relative humidity of zero. All fittings, adapters, and accessories, pressure regulator and throttling valve shall be suitable for pressure testing with air and rated for 300 psig service.

5. SERVICE GAS TESTING: After the chlorine or sulfur dioxide system has been dried and pressure tested, the service gas shall be gradually introduced and the entire system tested for leaks. Time shall be allowed for the complete replacement of air from the piping with service gas.

The Contractor shall use a liquid ammonia solution or chlorine gas detector to detect for chlorine leaks. The Contractor shall spray the solution at the pipe connections and shall not squirt the

liquid on the pipe or fittings. In the event leaks are detected in the piping or the equipment, they shall not be repaired until all gas has been purged from the line. The reaction of the two substances produces a dense white cloud. Upon completion of repairs, the Contractor shall repeat the cleaning and drying process described in paragraphs 15050-3.04 D and 3.05 E.

The Contractor shall use a commercial electromechanical volt-ammetric sensor for detecting sulfur dioxide leaks. Gas detectors manufactured by Interscan Corporation and Enterra are recommended.

E. DRAINS:

Drain systems, other than pumped drain systems, shall be tested in accordance with UPC.

3.05 CLEANING AND FLUSHING

A. GENERAL:

Piping systems shall be cleaned following completion of testing and prior to connection to operating, control, regulating or instrumentation equipment. The Contractor may, at his option, clean and test sections of buried or exposed piping systems. Use of this procedure, however, will not waive the requirement for a full pressure test of the completed system. Unless specified otherwise, piping 24 inches in diameter and smaller shall first be cleaned by pulling a tightly fitting cleaning ball or swab through the system. Piping larger than 24 inches in diameter may be cleaned manually or with a cleaning ball or swab.

B. TEMPORARY SCREENS:

Upon completion of the cleaning, the Contractor shall connect the piping systems to related process equipment. Temporary screens in accordance with the following table shall be inserted in pipelines at the suction of pumps and compressors:

Equipment suction or piping size, inches	Maximum screen opening, inches
0 - 1	1/16
1-1/4 - 3	1/4
3-1/2 - 6	1/2
Over 6	1

Temporary screens shall be provided with locator tabs which remain visible from the outside when the screens are in place.

The Contractor shall maintain the screens during testing, initial start-up, and initial operating phases of the commissioning process. In special cases, screens may be removed as required for

performance tests. The Contractor shall remove the temporary screens and make the final piping connections after the screens have remained clean for at least 24 consecutive hours of operation. Systems handling solids are exempted.

C. GAS AND AIR SYSTEMS:

Unless otherwise specified, gas and air system piping 6 inches in diameter and smaller shall be blown out, using air or the testing medium specified. Piping larger than 6 inches shall be cleaned by having a swab or "pig" drawn through the separate reaches of pipe. After connection to the equipment, it shall then be blown out using the equipment. Upon completion of cleaning, the piping shall be drained and dried with an air stream. Sludge gas, natural gas and propane systems shall be purged with nitrogen and a nitrogen pad maintained at 10 psi until put in service. Chlorine and sulfur dioxide systems shall be cleaned in accordance with paragraph 15050-3.05 E.

D. LIQUID SYSTEMS:

After completion of cleaning, liquid systems, unless otherwise specified, shall be flushed with clean water. With temporary screens in place, the liquid shall be circulated through the piping system using connected equipment for a minimum period of 15 minutes and until no debris is collected on the screens. Liquid chlorine and sulfur dioxide lines shall be cleaned in accordance with paragraph 15050-3.05 E.

E. CHLORINE AND SULFUR DIOXIDE SYSTEMS:

1. GENERAL: All portions of the system shall be cleaned free of oil and grease.

2. STEEL PIPE: All pipe threads shall be washed clean and free from cutting oil. The inside of all pipe sections and fittings shall be cleaned of any pipe dope, oil and grease by drawing a cloth wetted with solvent through each assembly. Valves shall be dismantled, thoroughly cleaned with solvents, and repacked, if necessary. Contractor shall cap or plug all open ends at the end of each work day.

Contractor shall use carbon tetrachloride or trichloroethelene. The Contractor shall at all times exercise caution to minimize solvent exposure and shall be responsible for its proper handling and disposal. Solvents containing hydrocarbons or alcohols are unacceptable.

3. PVC PIPE: All solution lines shall be cleaned using water only. Vacuum lines shall be cleaned with a detergent and water and thoroughly rinsed to remove all vestiges of detergent. All lines shall be further purged of water by passing a cleaning ball or swab through the lines as specified in paragraph 15050-3.05 A.

F. STEAM SYSTEMS:

Before the steam system is put into service, cleaning shall be performed to remove such contaminants as mill scale, weld scale, corrosion products, oil, grease, dust and dirt. Cleaning shall include a water flush performed at a velocity not less than 2 feet per second, steam blowdown, and an alkaline flush boilout of the boiler.

After flushing as indicated above, the boiler shall be treated with a caustic compound such as sodium triphosphate, soda ash, sodium tripolyphosphate, or caustic soda. The cleaning process shall be in accordance with steam system cleaning schemes developed by Dowell, the Mogul Division of Dexter Corp., Bentz Entec, or equal.

After cleaning and flushing, and prior to continuous operation of the steam system, adequate corrosion protection shall be provided by maintaining the system full of steam or potable water. If continuous operation does not occur within 60 days after cleaning and flushing, the steam or potable water shall be treated with an acceptable corrosion inhibiting chemical to assure adequate corrosion protection of the steam system.

G. HYDRAULIC AND LUBE OIL SYSTEMS:

NOT IN CONTRACT.

H. POTABLE WATER SYSTEMS:

Potable water piping systems shall be flushed and disinfected in accordance with AWWA C601.

I. INTERCEPTOR FORCE MAIN:

Before the interceptor force main (located between the interceptor pumping station and manhole 12) is put into service, the pipe shall be cleaned free of all foreign materials such as mill scale, construction debris, etcetera, leaving the internal periphery of the pipe smooth and as free of irregularities as internal conditions of the pipe allow.

Cleaning shall be performed by using a hydraulically-propelled polyurethane pipeline cleaner as manufactured by Girand Polly Pig or equal. The cleaning pig is to have a dished base and a parabolic nose and a crosscross outer coating of polyurethane rubber which is abrasive resistant.

3.06 PIPING SPECIFICATION SHEETS (PIPESPEC)

Piping and valves for groupings of similar plant processes or types of service lines are specified on individual piping specification sheets (PIPESPECS). Piping services are grouped according to the chemical and physical properties of the fluid conveyed and/or by the temperature or pressure requirements.

Each grouping of services (PIPESPEC) is identified by a piping system number. Piping services specified in the PIPESPECS and on drawings are alphabetically arranged by designated service abbreviations as shown in Table A. Table A also indicates the system number, fluid category, and pipe marker background color of each service.

Table A, Piping Services

Symbol	Service	System	Fluid category	Pipe marker background color
A	Aeration Air	1	Air	Blue
AA	Agitation Air	1	Air	Blue
AFE	Air Flotation Effluent	13	Wastewater	Green
CD	Chemical Drain	25	Drain/Vent	Yellow
CLS	Chlorine Solution	19	Chemical	Yellow
CLV	Chlorine Vacuum	21	Chemical	Yellow
CSO	Caustic Soda	19	Chemical	Yellow
D	Drain	24	Drain/Vent	Green
DC	Decant	15	Sludge	Green
DW	Distilled Water	6	Water	Green
EE	Engine Exhaust	18	Gas	Yellow
FA	Foul Air	22	Foul Air	Yellow
FC	Ferric Chloride	19	Chemical	Yellow
GR	Grit	17	Grit Slurry	Green
HW	Potable Hot Water	7	Water	Yellow
IA	Instrument Air	2	Air	Blue
JWR	Jacket Water Return	28	Water	Yellow
JWS	Jacket Water Supply	28	Water	Yellow
LPG	Liquified Petroleum Gas	18	Petroleum	Yellow
MA	Muriatic Acid	19	Chemical	Yellow
ML	Mixed Liquor	14	Sludge	Green
OF	Overflow	13	Wastewater	Green
PD	Pumped Drainage	12	Wastewater	Green
RS	Raw Sewage	12	Wastewater	Green
RSS	Return Secondary Sludge	14	Sludge	Green
RWP	Rainwater Pipe	24	Drain/Vent	Green
SA	Service Air	2	Air	Blue
SD	Sanitary Drain	24	Drain/Vent	Green
SE	Secondary Effluent	13	Wastewater	Green

Table A, Piping Services, Continued

Symbol	Service	System	Fluid category	Pipe marker background color
SSC	Secondary Scum	16	Sludge/Scum	Green
STD	Storm Drain	24	Drain/Vent	Green
TD	Tank Drain	12	Wastewater	Green
THS	Thickened Sludge	16	Sludge	Green
V	Vent	24	Drain/Vent	Yellow
VA	Vacuum	23	Vacuum	Blue
VC	Chemical Vent	25	Drain/Vent	Yellow
WML	Waste Mixed Liquor	14	Sludge	Green
1W	Potable Water (city water)	7	Water	Red
2W	Nonpotable City Water	11	Water	Red
2WS	Softened Nonpotable City Water	10	Water	Green
3W	No. 3 Water (Secondary Effluent)	11	Water	Red

System numbers 3, 4, 5, 8, 9, 20, 26, and 27 not included.

3.06 PIPING SPECIFICATION SHEET--PIPESPEC

Piping Symbol/Service: A--Aeration Air System--1
AA--Agitation Air

Test Requirements:
- Medium: Air; ref. spec paragraph 15050-3.04 B.
- Pressure: 20 psig
- Duration: 120 minutes

Gasket Requirements:
- Flange: Neoprene, C.I.
- Push-on/Mech Cpl: EPDM

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(2" and smaller)

Pipe: Steel; ASTM A120, galvanized. Ref. spec Section 15061.
Conn; taper threaded, ANSI B1.20.1.
Ftgs; malleable iron, ASTM A197, ANSI B16.3, Class 150, galvanized.

Valves: Ball; Jamesbury Fig. 351, Apollo Series 70-100, Lunkenheimer 708 HST, or equal.
Globe; Crane 7 or 17, Lunkenheimer 123 or 214, or equal.
Lift check; Jenkins 117A, Lunkenheimer 231, or equal.

(2-1/2" thru 8")

Pipe: Steel; ASTM A120 or ASTM A53, ERW, Grade B, black, no lining. Ref. spec Section 15061.
Conn; butt weld, grooved mechanical pipe coupling or flanged.
Ftgs; malleable iron, ASTM A47; ductile iron, ASTM A536; or steel, ASTM A234; ANSI B16.9; ends and wall thickness to match pipe.

Valves: Butterfly; ref. spec Section 15103.
Double-disc check; Mission Duo-chek II, G or K 12 HMP; Gulf Valve Model MB, 12-5091SF; or equal. Ref. spec Section 15119.

(10" thru 24")

Pipe: Steel; same as 8" or AWWA C200, 7 gage, no lining. Ref. spec Section 15061.

Piping System:	1 (continued)
	Conn; same as 8".
	Ftgs; steel, ASTM A234; or fabricated steel, AWWA C208, ends to match pipe.
Valves:	Butterfly; ref. spec Section 15103.
	Double-disc check; Mission Duo-chek II, G 12 HMP; Gulf Valve Model MB, 12-5091SF; or equal. Ref. spec Section 15119.
(26" and larger)	
Pipe:	See Remarks
Valves:	See Remarks

Buried and Encased Pipe and Valves:
(See drawings for pipe size and valve type. Omit coating on encased pipe.)

(8" and smaller)	
Pipe:	Steel; same as exposed with polyethylene tape coating. Field application of coating to all couplings. Ref. spec Section 15061.
	Conn; butt weld, sleeve type or flanged with coating.
	Ftgs; same as exposed with coating.
(2" and smaller)	
Valves:	Ball; same as exposed with extension stem and valve box. Coating per spec Section 09900.
(2-1/2" thru 8")	
Valves:	Butterfly; same as exposed with extension stem and valve box. Coating per spec Section 09900.
(10" and larger)	
Pipe:	Steel; same as exposed with coating.
	Conn; butt weld, sleeve type or flanged with coating.
	Ftgs; same as exposed with coating.
Valves:	Butterfly; same as exposed with extension stem and valve box. Coating per spec Section 09900.

Remarks:

1. Aeration air pipe shall be lined and coated with fusion-bonded epoxy, as specified in Section 15061, paragraph 2.07. Agitation air piping shall have no lining.

2. Alternative piping materials for aeration air (A) piping for exposed pipes, in lieu of fusion-bonded epoxy-lined and coated steel, include the following.

(2" and smaller)

Pipe:	Stainless Steel; ASTM A312, Grade TP304 Sch. 40S. Conn; socket welded, ANSI B16.11; or taper threaded, ANSI B2.1, see remarks. Ftgs; stainless steel, ASTM A403, WP304, thickness to match pipe.
Valves:	Ball; Jamesbury 11-1100TT, Apollo Series 70-100, Lunkenheimer 708 HST, or equal. Globe; Crane 7 or 17, Lunkenheimer 123 or 214, or equal. Lift check; Jenkins 117A, Lunkenheimer 231, or equal.

(2-1/2" and larger)

Pipe:	Stainless Steel; ASTM A312, Grade TP304, Sch. 10S. Conn; Butt welded, MSS SP-43, flanged at valves. Ftgs; stainless steel, ASTM A403, WP304, thickness to match pipe.
Valves:	Butterfly; ref. spec Section 15103. Double-disc check; Mission Duo-chek II, G or K 12 HMP; Gulf Valve Model MB, 12-5091SF; or equal. Ref. spec Section 15119.

3. Aeration air piping shall be provided with the fine bubble diffusers as a package by the diffusr manufacturer where specified.

3.06 PIPING SPECIFICATION SHEET--PIPESPEC

Piping Symbol/Service: IA--Instrument Air System--2
SA--Service Air

Test Requirements:
- Medium: Ref. spec paragraph 15050-3.04 B.
- Pressure: 200 psig
- Duration: 120 minutes

Gasket Requirements:
- Flange: Neoprene, C.I.
- Push-on/Mech Cpl: N/A

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(1/2" and smaller)
Pipe: Copper tube; ASTM B88, Type L, drawn. Ref. spec Section 15066.
Conn; brass compression type.
Ftgs; brass compression type, Swagelok, Gyrolok, or equal.

(3/4" thru 2")
Pipe: Copper tube; ASTM B88, Type L, drawn.
Conn; solder type with threaded adapters for valves.
Ftgs; wrought copper or bronze, ANSI B16.22.

(2" and smaller)
Valves: Ball; Jamesbury Fig. 351, Apollo Series 70-100, Lunkenheimer 708HST, or equal.
Globe; Crane 7 or 17, Lunkenheimer 123 or 214, or equal.
Lift check; Lunkenheimer 233, Jenkins 655A, or equal.

(2-1/2" thru 6")
Pipe: Steel; ASTM A53, ERW, Grade B, black, no lining. Ref. spec Section 15061.
Conn; butt weld, flanged for valves.
Ftgs; steel, ASTM A234, ANSI B16.9; ends and wall thickness to match pipe.

Valves: Ball; Jamesbury 5150-31-2200TT, Apollo Series 88-100, Lunkenheimer 713LT, or equal.
Check; Pennsylvania Airchek, Hoerbiger, or equal.

Piping System: 2 (continued)

Buried and Encased Pipe and Valves:
(See drawings for pipe size and valve type. Omit coatings on encased pipe.)

(2" and smaller)

Pipe:	Copper tube; ASTM B88, Type K, annealed or drawn. Conn; solder type. Ftgs; wrought copper or bronze, ANSI B16.22.
Valves:	Ball; same as exposed with extension stem and valve box.

(2-1/2" thru 6")

Pipe:	Steel; same as exposed with polyethylene tape coating. Field application of coating to all couplings. Ref. spec Section 15061. Conn; same as exposed with coating. Ftgs; same as exposed with coating.
Valves:	Ball; same as exposed with extension stem and valve box. Coating per spec Section 09900.

Remarks:

1. Copper piping shall be isolated from dissimilar metals using dielectric protection as specified in Section 15066.

2. Lateral connections shall be made in the top half of the main line. Provide drip legs with valves at low points in the piping system.

3.06 PIPING SPECIFICATION SHEET--PIPESPEC

Piping Symbol/Service:	DW--Distilled Water SA--Service Air	System--6

Test Requirements:

Medium:	Distilled water; ref. spec paragraph 15050-3.04 C.
Pressure:	100 psig
Duration:	60 minutes

Gasket Requirements:

Flange:	N/A
Push-on/Mech Cpl:	N/A

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(2" and smaller)

Pipe:	PVC: ASTM D1784, Class 12454-B, NSF. certified, ASTM D1785, Sch. 80. Ref. spec Section 15064. Conn; plain end; solvent weld. Ftgs; PVC, Sch. 80, socket type.
Valves:	Ball; PVC, true union, socket type, Chemtrol Tru Block TU Series, Asahi/America Duo Bloc TU Series, GSR TU Series, or equal, with Teflon seats and Viton O-rings. Diaphragm; PVC body, Teflon diaphragm, Chemtrol Series PD, Posacon 677, Asahi/America, or equal.

Buried and Encased Pipe and Valves:
(See drawings for pipe size and valve type)

(2" and smaller)

Pipe:	N/A
Valves:	N/A

3.06 PIPING SPECIFICATION SHEET--PIPESPEC

Piping Symbol/Service	HW--Potable Hot Water lW--Potable Water	System--7

Test Requirements:

Medium:	Water; ref. spec paragraph 15050-3.04 C.
Pressure:	150 psig
Duration:	60 minutes

Gasket Requirements:

Flange:	Neoprene, C.I.
Push-on/Mech Cpl:	EPDM

Exposed Pipe and Valves:
(See drawings for pipe size and valve type. See Remarks for insulation requirements.)

(3" and smaller)
Pipe: Copper tube; ASTM B88, Type L, drawn. Ref. spec Section 15066.
Conn; solder type with threaded or flanged adapters for valves.
Ftgs; wrought copper or bronze, ANSI B16.22.

(2" and smaller)
Valves: Ball; Jamesbury Fig. 351, Apollo Series 70-100, Lunkenheimer 708 HST, or equal.
Globe; Crane 7 or 17, Lunkenheimer 123 or 214, or equal.
Swing check; Jenkins 352, Crane 141, or equal.

(4" and larger)
Pipe: Steel; ASTM A120 or ASTM A53, seamless, Grade B, black, with cement mortar lining. Ref. spec Section 15061.
Conn; butt weld, grooved mechanical pipe coupling or flanged.
Ftgs; malleable iron, ASTM A47; ductile iron, ASTM A536; or steel, ASTM A234 ANSI B16.9; ends, lining and wall thickness to match pipe.

(2-1/2" and larger)
Valves: Butterfly; ref. spec Section 15103. Substitute Type B on 2-1/2-inch lines.
Swing check; spring loaded per spec Section 15118.

Piping System: 7 (continued)

Buried and Encased Pipe and Valves:
(See drawings for pipe size and valve type. Omit coating on encased pipe. See Remarks for insulation requirements.)

(3" and smaller)

Pipe:	Copper tube; ASTM B88, Type K, annealed or drawn. Conn; solder type, with threaded or flanged adapters for valves. Ftgs; wrought copper or bronze, ANSI B16.2.
Valves:	Gate; ref. spec Section 15101, with extension stem and valve box. Coating per spec Section 09900.

(4" and larger)

Pipe:	Ductile iron; AWWA C151 and AWWA C111, with cement mortar lining and standard coating. Ref. spec Section 15062. Conn; mechanical or push-on rubber gasket joint. Flanged adapters for valves. Ftgs; ductile or gray iron per spec Section 15062; coating, lining and ends to match pipe.
Valves:	Butterfly; same as exposed with extension stem and valve box. Coating per spec Section 09900.

Remarks:

1. Exposed piping for potable hot water (HW) shall be insulated in accordance with Section 15250.

2. Manual air vents shall be provided at the high points and drains provided at the low points of each reach of pipeline as specified in paragraph 15095-3.01 C.

3.06 PIPING SPECIFICATION SHEET--PIPESPEC

Piping Symbol/Service: 2WS--No. 2 Water Soft System--10

Test Requirements:
- Medium: Water; ref. spec paragraph 15050-3.04 C.
- Pressure: 125 psig
- Duration: 120 minutes

Gasket Requirements:
- Flange: Neoprene, C.I.
- Push-on/Mech Cpl: Nitrile or Neoprene

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(2" and smaller)

Pipe: Steel; ASTM A120, galvanized. Ref. spec Section 15061.
Conn; taper threaded, ANSI B1.20.1.
Ftgs; malleable iron, ASTM A197, ANSI B16.3, Class 150, galvanized.

Valves: Ball; Jamesbury Fig. 351, Apollo Series 70-100, Lunkenheimer 708 HST, or equal.
Globe; Crane 7 or 17, Lunkenheimer 123 or 214, or equal.
Swing check; Jenkins 352, Crane 141, or equal.

Buried and Encased Pipe and Valves:
(See drawings for pipe size and valve type. Omit coating on encased pipe.)

(3" and smaller)

Pipe: PVC; ASTM D1784, Class 12454-B, ASTM D1785, Sch. 80. Ref. spec Section 15064.
Provide magnetic tracer tape.
tracer tape.
Conn; plain end; solvent weld with threaded or flanged adapters for valves.
Ftgs; PVC, Sch. 80, socket weld.

Valves: Gate; ref. spec Section 15101, with extension stem and valve box. Coating per spec Section 09900.

Remarks:

1. Manual air vents shall be provided at the high points and drains provided at the low points of each reach of pipeline as specified in paragraph 15095-3.01 C.

3.06 PIPING SPECIFICATION SHEET--PIPESPEC

Piping Symbol/Service: 2W--Nonpotable City Water System--11
3W--No. 3 Water

Test Requirements:
- Medium: Water; ref. spec paragraph 15050-3.04 C.
- Pressure: 200 psig
- Duration: 120 minutes

Gasket Requirements:
- Flange: Neoprene, C.I.
- Push-on/Mech Cpl: Nitrile or Neoprene

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(2" and smaller)

Pipe: Steel; ASTM A120, galvanized. Ref. spec Section 15061.
Conn; taper threaded, ANSI B1.20.1.
Ftgs; malleable iron, ASTM A197, ANSI B16.3, Class 150, galvanized.

Valves: Ball; Jamesbury Fig. 351, Apollo Series 70-100, Lunkenheimer 708 HST, or equal.
Globe; Crane 7 or 17, Lunkenheimer 123 or 214, or equal.
Swing check; Crane 141, Jenkins 352, or equal.

(2-1/2" thru 8")

Pipe: Steel; ASTM A120 or ASTM A53, ERW, Grade B, black, no lining. Ref. spec Section 15061.
Conn; butt weld, grooved mech pipe coupling or flanged.
Ftgs; malleable iron, ASTM A47; ductile iron, ASTM A536; or steel, ASTM A234, ANSI B16.9; ends and wall thickness to match pipe.

(2-1/2" thru 8")

Valves: Butterfly; ref. spec Section 15103. Substitute Type B on 2-1/2-inch lines.
Swing check; spring loaded per spec Section 15118.

Piping System: 11 (continued)

Buried and Encased Pipe and Valves:
(See drawings for pipe size and valve type. Omit coating on encased pipe.)

(3" and smaller)

Pipe:	Steel; same as exposed with polyethylene tape coating. Field application of coating to all couplings. Ref. spec Section 15061. Conn; taper threaded, ANSI B1.20.1 with coating. Flanged adapters for 2-1/2", 3" valves. Ftgs; malleable iron, ASTM A197, ANSI B16.3, Class 150, galvanized with coating.
Valves:	Gate; ref. spec Section 15101, with extension stem and valve box. Coating per spec Section 09900.

(4" thru 12")

Pipe:	Ductile iron; AWWA C151 and AWWA C111, standard lining and coating. Ref. spec Section 15062. Conn; mechanical or push-on rubber gasket joint. Flanged adapters for valves. Ftgs; ductile or gray iron per spec Section 15062; lining and ends to match pipe.
Valves:	Butterfly; same as exposed with extension stem and valve box. Coating per spec Section 09900.

Remarks:

1. Manual air vents shall be provided at the high points and drains provided at the low points of each reach of pipeline as specified in paragraph 15095-3.01 C.

2. 3W spray water piping located within the secondary clarifiers shall be CPVC, Schedule 80, in accordance with Section 15064.

3.06 PIPING SPECIFICATION SHEET--PIPESPEC

Piping Symbol/Service:	PD--Pumped Drainage RS--Raw Sewage TD--Tank Drain	System--12

Test Requirements:

Medium:	Water; ref. spec paragraph 15050-3.04 C.
Pressure:	125 psig
Duration:	120 minutes

Gasket Requirements:

Flange:	Neoprene, C.I.
Push-on/Mech Cpl:	Nitrile or Neoprene--(oil resistant)

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(2" and smaller)

Pipe:	Steel; ASTM A120, galvanized. Ref. spec Section 15061. Conn; taper threaded, ANSI B1.20.1. Ftgs; malleable iron, ASTM A197, ANSI B16.3, Class 150, galvanized.
Valves:	Eccentric plug; per spec Section 15110. Install valve with seat upstream. Swing check; Crane 141, Jenkins 352, or equal.

(2-1/2" thru 8")

Pipe:	Steel; ASTM A120 or ASTM A53, ERW, Grade B, black, no lining. Ref. spec Section 15061. Conn; butt weld, grooved mech pipe coupling or flanged. Ftgs; malleable iron, ASTM A47; ductile iron, ASTM A536; or steel, ASTM A234, ANSI B16.9; ends and wall thickness to match pipe.
Valves:	Eccentric plug; per spec Section 15110. Install valve with seat upstream. Swing check; spring loaded per spec Section 15118.

(10" thru 24")

Pipe:	Steel; same as 8 inch or AWWA C200, 3/16 inch thick, with lining. Ref. spec Section 15061. Conn; butt weld or flanged. See Remarks.

Piping System: 12 (continued)

Ftgs; steel, ASTM A234, or fabricated steel, AWWA C208; lining and ends to match pipe.

Valves: Eccentric plug; ref. spec Section 15110.
Swing check; spring loaded per spec Section 15118.

(26" and larger)
Pipe: See Remarks
Valves: See Remarks

Buried and Encased Pipe and Valves:
(See drawings for pipe size and valve type. Omit coating on encased pipe.)

(3" and smaller)
Pipe: PVC; ASTM D1784, Class 12454-B, ASTM D1785, Sch. 80. Ref. spec Section 15064. Provide magnetic tracer tape.
Conn; plain end; solvent weld with threaded or flanged adapters for valves.
Ftgs; PVC, Sch. 80, socket weld.

Valves: Eccentric plug; same as exposed with extension stem and valve box. Coating per spec Section 09900.

(4" thru 12")
Pipe: Ductile iron; AWWA C151 and AWWA C111, standard lining and coating. Ref. spec Section 15062.
Conn; mechanical or push-on rubber gasket joint. Flanged adapters for valves.
Ftgs; ductile or gray iron, AWWA C110; coating, lining and ends to match pipe.

Valves: Eccentric plug; same as exposed with extension stem and valve box. Coating per spec Section 09900.

(14" and larger)
Pipe: Ductile iron; same as 12 inch for pipe and ftgs or
Concrete cylinder; ref. spec Section 15057.
Conn; bell and spigot with O-ring rubber gasket joint. Flanged adapters for valves.
Ftgs; fabricated steel, mortar lined and coated. Ref. spec Section 15057.

Piping System: 12 (continued)

Valves: Eccentric plug; same as exposed with extension stem and valve box. Coating per spec Section 09900.

Remarks:

1. For buried piping 4 inches and larger located beneath structures, flexible restrained joints shall be used.

2. Testing for tank drains shall be in accordance with the Uniform Plumbing Code or the governing local code as applicable.

3. Pipe material for buried RS lines 36 inches and larger shall be:

   Reinforced concrete; RCP-LHP, Class C-25. Ref. spec Section 15056.
   Conn; Ref. spec Section 15056.
   Ftgs; fabricated steel; ASTM C200/C208, mortar lined and coated, 3/8-inch minimum steel wall, ends to match pipe. Thrust restrained for 25-foot pressure. Ref. spec Section 15060.

4. RS piping shall be plastic lined.

5. Test pressures for RS piping shall be 25 feet.

6. 15 inch vitrified clay pipe shall be used upstream of the interceptor pumping station as shown on the plans, and shall comply with the requirements of Section 15059.

3.06 PIPING SPECIFICATION SHEET--PIPESPEC

Piping Symbol/Service:	AFE--Air Flotation Effluent OF--Overflow SE--Secondary Effluent	System--13

Test Requirements:

Medium:	Water; ref. spec paragraph 15050-3.04 C.
Pressure:	125 psig
Duration:	120 minutes

Gasket Requirements:

Flange:	Neoprene, C.I.
Push-on/Mech Cpl:	Nitrile or Neoprene--(oil resistant)

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(2" and smaller)

Pipe:	Steel; ASTM A120, galvanized. Ref. spec Section 15061. Conn; taper threaded, ANSI B1.20.1. Ftgs; malleable iron, ASTM A197, ANSI B16.3, Class 150, galvanized.
Valves:	Ball; Jamesbury Fig. 351, Apollo Series 70-100, Lunkenheimer 708 HST, or equal. Globe; Crane 7 or 17, Lunkenheimer 123 or 214, or equal. Swing check; Crane 141, Jenkins 352, or equal.

(2-1/2" thru 8")

Pipe:	Steel; ASTM A120 or ASTM A53, ERW, Grade B, black, no lining. Ref. spec Section 15061. Conn; butt weld, grooved mech pipe coupling or flanged. Ftgs; malleable iron, ASTM A47; ductile iron, ASTM A536; or steel, ASTM A234 ANSI B16.9; ends, and wall thickness to match pipe.
Valves:	Butterfly; ref. spec Section 15103. Substitute Type B on 2-1/2-inch lines. Swing check; spring loaded per spec Section 15118.

Piping System: 13 (continued)

(10" thru 24")

Pipe: Steel; same as 8" or AWWA C200, 3/16 inch thick, with lining. Ref. spec Section 15061.
Conn; butt weld or flanged. See Remarks.
Ftgs; steel, ASTM A234, or fabricated steel, AWWA C208; lining and ends to match pipe.

Valves: Butterfly; ref. spec Section 15103.
Swing check; spring loaded per spec Section 15118.

(26" and larger)

Pipe: See Remarks
Valves: See Remarks

Buried and Encased Pipe and Valves:
(See drawings for pipe size and valve type. Omit coating on encased pipe.)

(3" and smaller)

Pipe: PVC; ASTM D1784, Class 12454-B, ASTM D1785, Sch. 80. Ref. spec Section 15064. Provide magnetic tracer tape.
Conn; plain end; solvent weld with threaded or flanged adapters for valves.
Ftgs; PVC, Sch. 80, socket weld.

Valves: Gate; ref. spec Section 15101, with extension stem and valve box. Coating per spec Section 09900.

(4" thru 12")

Pipe: Ductile iron; AWWA C151 and AWWA C111, standard lining and coating. Ref. spec Section 15062.
Conn; mechanical or push-on rubber gasket joint. Flanged adapters for valves.
Ftgs; ductile or gray iron per spec Section 15062; coating, lining and ends to match pipe.

Valves: Butterfly; same as exposed with extension stem and valve box. Coating per spec Section 09900.

Piping System: 13 (continued)

(14" and larger)

Pipe: Ductile iron; same as 12 inch for pipe and ftgs or
Concrete cylinder; ref. spec Section 15057.
Conn; bell and spigot with O-ring rubber gasket joint. Flanged adapters for valves.
Ftgs; fabricated steel, mortar lined and coated. Ref. spec Section 15057.

Valves: Butterfly; same as exposed with extension stem and valve box. Coating per spec Section 09900.

Remarks:

1. Pipe material for buried SE lines 36 inches and larger shall be:

   Reinforced concrete; RCP-LHP, Class C-25. Ref. spec Section 15056.
   Conn; Ref. spec Section 15056.
   Ftgs; fabricated steel; ASTM C200/C208, mortar lined pipe. Thrust restrained for 25-foot test pressure. Ref. spec Section 15060.

2. Test pressures for SE and OF piping shall be 25 feet.

3. Concrete cylinder pipe shall be back welded at joints when test pressures exceed 25 feet, and beneath structures when not encased in concrete.

4. Alternate piping material for buried lines 14" through 36" shall include:

   Ductile iron; See 4" through 12" pipe. Use flexible restrained joints for piping beneath structures not encased in concrete.

3.06 PIPING SPECIFICATION SHEET--PIPESPEC

Piping Symbol/Service:	ML--Mixed Liquor RSS--Return Secondary Sludge WML--Waste Mixed Liquor	System--14

Test Requirements:

Medium:	Water; ref. spec paragraph 15050-3.04 C.
Pressure:	125 psig
Duration:	120 minutes

Gasket Requirements:

Flange:	Neoprene, C.I.
Push-on/Mech Cpl:	Nitrile or Neoprene--oil resistant

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(2" and smaller)

Pipe:	Steel; ASTM A120, galvanized. Ref. spec Section 15061. Conn; taper threaded, ANSI B1.20.1. Ftgs; malleable iron, ASTM A197, ANSI B16.3, Class 150, galvanized.
Valves:	Eccentric plug; per spec Section 15110. Install valve with seat upstream. Swing check; Crane 141, Jenkins 352, or equal.

(2-1/2" thru 8")

Pipe:	Steel; ASTM A120 or ASTM A53, ERW, Grade B, black, no lining. Ref. spec Section 15061. Conn; butt weld, grooved mechanical pipe coupling or flanged. Ftgs; malleable iron, ASTM A47; ductile iron, ASTM A536; or steel, ASTM A234, ANSI B16.9; ends and wall thickness to match pipe.

(2-1/2" thru 12")

Valves:	Eccentric plug; per spec Section 15110. Install valve with seat upstream. Swing check; spring loaded per spec Section 15118.

Piping System: 14 (continued)

(10" thru 24")
Pipe: Steel; same as 8" or AWWA C200, 3/16 inch thick, with lining. Ref. spec Section 15061.
Conn; butt weld or flanged. See Remarks.
Ftgs; steel, ASTM A234, or fabricated steel, AWWA C208; lining and ends to match pipe.

(14" thru 24")
Valves: Butterfly; ref. spec Section 15103.
Swing check; spring loaded per spec Section 15118.

(26" and larger)
Pipe: See Remarks
Valves: See Remarks

Buried and Encased Pipe and Valves:
(See drawings for pipe size and valve type. Omit coating on encased pipe.)

(3" and smaller)
Pipe: PVC; ASTM D1784, Class 12454-B, ASTM D1785, Sch. 80. Ref. spec Section 15064.
Provide magnetic tracer tape.
Conn; plain end; solvent weld with threaded or flanged adapters for valves.
Ftgs; PVC, Sch. 80, socket weld.

Valves: Eccentric plug; same as exposed with extension stem and valve box. Coating per spec Section 09900.

(4" thru 12")
Pipe: Ductile iron; AWWA C151 and AWWA C111, standard lining and coating. Ref. spec Section 15062.
Conn; mechanical or push-on rubber gasket joint. Flanged adapters for valves.
Ftgs; ductile or gray iron per spec Section 15062; coating, lining and ends to match pipe.

Valves: Eccentric plug; same as exposed with extension stem and valve box. Coating per spec Section 09900.

Piping System: 14 (continued)

(14" and larger)

Pipe: Ductile iron; same as 12 inch for pipe and ftgs or
Concrete cylinder; ref. spec Section 15057.
Conn; bell and spigot with O-ring rubber gasket joint. Flanged adapters for valves.

Ftgs; fabricated steel, mortar lined and coated. Ref. spec Section 15057.

Valves: Butterfly; same as exposed with extension stem and valve box. Coating per spec Section 09900.

Remarks:

1. Manual air vents shall be provided at the high points of pump discharge headers for the mixed liquor, return secondary sludge, and waste mixed liquor pumps as specified in paragraph 15095-3.01 C.

2. Alternate piping materials for buried and encased pipe 14" through 36" include:

   Pipe: Ductile iorn; Class 51, AWWA C151 and AWWA C111, standard lining and coating. Ref. spec Section 15062.
   Conn; mechanical or push-on rubber gasket joint. Flanged adapters for vlaves.
   Ftgs; ductile or gray iron; AWWA C110; coating, lining and ends to match pipe.

   or Cement Mortar-lined and coated steel
   Ref. spec Sections 15060 and 15061. Use restrained sleeve-type flexible pipe couplings, or equal system, beneath structures when not encased in concrete.

3. Ductile iron piping located beneath structures which is not encased in concrete shall be provided with flexible restrained joints. Concrete cylinder piping located beneath structures which is not encased in concrete shall be provided with back-welded joints.

4. Mixed liquor piping within the oxidation channel shall be provided by the jet-aeration equipment manufacturer.

3.06 PIPING SPECIFICATION SHEET--PIPESPEC

Piping Symbol/Service: DC--Decant System--15

Test Requirements:
- Medium: Water; ref. spec paragraph 15050-3.04 C.
- Pressure: 100 psig
- Duration: 120 minutes

Gasket Requirements:
- Flange: Neoprene, C.I.
- Push-on/Mech Cpl: Nitrile or Neoprene--(oil resistant)

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(2" and smaller)

Pipe: Steel; ASTM A120, galvanized. Ref. spec Section 15061.
Conn; taper threaded, ANSI B1.20.1.
Ftgs; malleable iron, ASTM A197, ANSI B16.3, Class 150, galvanized.

Valves: Eccentric plug; per spec Section 15110. Install valve with seat upstream.
Swing check; Crane 141, Jenkins 352, or equal.

(2-1/2" thru 8")

Pipe: Steel; ASTM A120 or ASTM A53, ERW, Grade B, black, no lining. Ref. spec Section 15061.
Conn; butt weld, grooved mech pipe coupling or flanged.
Ftgs; malleable iron, ASTM A47; ductile iron, ASTM A536; or steel, ASTM A234, ANSI B16.9; ends and wall thickness to match pipe.

Valves: Eccentric plug; per spec Section 15110. Install valve with seat upstream.
Swing check; spring loaded per spec Section 15118.

(10" and larger)

Pipe: Steel; same as 8" or AWWA C200, 3/16 inch thick, with lining. Ref. spec Section 15061.
Conn; butt weld or flanged. See Remarks.
Ftgs; steel, ASTM A234, or fabricated steel, AWWA C208; lining and ends to match pipe.

Piping System: 15 (continued)

Valves: Eccentric plug; ref. spec Section 15110. Swing check; spring loaded per spec Section 15118.

Buried and Encased Pipe and Valves:
(See drawings for pipe size and valve type. Omit coating on encased pipe.)

(3" and smaller)
Pipe: PVC; ASTM D1784, Class 12454-B, ASTM D1785, Sch. 80. Ref. spec Section 15064. Provide magnetic tracer tape.
Conn; plain end; solvent weld with threaded or flanged adapters for valves.
Ftgs; PVC, Sch. 80, socket weld.

Valves: Eccentric plug; same as exposed with extension stem and valve box. Coating per spec Section 09900.

(4" thru 12")
Pipe: Ductile iron; Class 51, AWWA C151 and AWWA C111, standard lining and coating. Ref. spec Section 15062.
Conn; mechanical or push-on rubber gasket joint. Flanged adapters for valves.
Ftgs; ductile or gray iron; AWWA C110; coating, lining and ends to match pipe.

Valves: Eccentric plug; same as exposed with extension stem and valve box. Coating per spec Section 09900.

Remarks:

1. Alternate piping materials for buried DC and SN lines 4" through 8" not located beneath structures include those specified for buried piping 4" through 8" under System 16.

2. Ductile iron piping located beneath structures which is not encased in concrete shall be provided with flexible restrained joints.

3.06 PIPING SPECIFICATION SHEET--PIPESPEC

Piping Symbol/Service:	SSC--Secondary Scum THS--Thickened Sludge	System--16

Test Requirements:

Medium:	Water; ref. spec paragraph 15050-3.04 C.
Pressure:	200 psig
Duration:	120 minutes

Gasket Requirements:

Flange:	Neoprene
Push-on/Mech Cpl:	Nitrile or Neoprene--(oil resistant)

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(3" and smaller) Pipe:	Steel; ASTM A120, galvanized. Ref. spec Section 15061. Conn; taper threaded, ANSI B1.20.1. Flanged adapters for 2-1/2", 3" valves. Ftgs; malleable iron, ASTM A197, ANSI B16.3, Class 150, galvanized.
Valves:	Eccentric plug; per spec Section 15110. Install valve with seat upstream.
(2" and smaller)	Swing check; Crane 141, Jenkins 352, or equal.
(4" thru 12") Pipe:	Steel; ASTM A53, ERW, Grade B, black, with glass lining Ferrock MEH-32, Ervite SG-14, or equal. Ref. spec Section 15061. Conn; grooved mechanical pipe coupling or flanged. Ftgs; malleable iron, ASTM A47, ductile iron, ASTM A536, or segmented welded steel; ends, wall thickness and lining to match pipe.
Valves:	Eccentric plug; per spec Section 15110. Install valve with seat upstream.
(2-1/2" thru 12")	Swing check; spring loaded per spec Section 15118.

Piping System: 16 (continued)

Buried and Encased Pipe and Valves:
(See drawings for pipe size and valve type. Omit coating on encased pipe.)

(3" and smaller)

Pipe:	PVC; ASTM A1784, Class 12454-B, ASTM D1785, Sch. 80. Ref. spec Section 15064. Provide magnetic tracer tape. Conn; plain end; solvent weld with threaded or flanged adapters for valves. Ftgs; PVC, Sch. 80, socket weld.
Valves:	Eccentric plug; same as exposed with extension stem and valve box. Coating per spec Section 09900.

(4" thru 12")

Pipe:	Ductile iron; AWWA C151, with glass lining, Ferrock MEH-32, Ervite SG-14, or equal, and standard coating. Ref. spec Section 15062. Conn; mechanical joint. Flanged adapters for valves. Ftgs; ductile or gray iron; AWWA C110; coating, ends and lining to match pipe.
Valves:	Eccentric plug; same as exposed with extension stem and valve box. Coating per spec Section 09900.

Remarks:

1. Buried piping located beneath structures shall be concrete encased or shall be ductile iron as specified for buried piping 4" through 8" under System 15.

2. Glass lining shall not be provided for secondary scum (SSC) and thickened sludge (THS) piping.

3. Flush connections shall be provided at all dead ends in accordance the mechanical details.

4. Manual air vents shall be provided at the high points and drains provided at the low points of each reach of pipeline as specified in paragraph 15095-3.01 C.

3.06 PIPING SPECIFICATION SHEET--PIPESPEC

Piping Symbol/Service: GR--Grit System--17

Test Requirements:
- Medium: Water; ref. spec paragraph 15050-3.04 C.
- Pressure: 120 psig
- Duration: 120 minutes

Gasket Requirements:
- Flange: Neoprene, C.I.
- Push-on/Mech Cpl: Nitrile or Neoprene

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(2-1/2" and larger)

Pipe: Steel; ASTM A120 or ASTM A53, ERW, Grade B, black, Sch. 40, no lining. Ref. spec Section 15061.
Conn; mechanical pipe coupling; flanged for valves.
Ftgs; malleable iron, ASTM A47; ductile iron ASTM A536; or steel, ASTM A53, long tangent, seg. weld for wyes, crosses, and laterials; ends and wall thickness to match pipe.

Valves: Lubricated plug; cast iron, flanged, Teflon coated plug, Rockwell Fig. 143, Walworth Fig. 1797F, or equal, thru 5 inch; worm gear operator Rockwell Fig. 149, Walworth Fig. 1727F, or equal, 6 to 8 inch.
Swing or ball check; fully lined valve body; fully coated swing check flapper or ball check ball; lining and coating shall be neoprene or fluoronated ethylene propylene. Valve and Primer Co. APCO Series 100R, Peabody Dore Model 770, or equal.

Buried and Encased Pipe and Valves:
(See drawings for pipe size and valve type)

(3" and larger)

Pipe: Ductile iron; AWWA C151 and AWWA C111, Class 56, standard lining and coating. Ref. spec Section 15062.
Conn; mechanical or push-on rubber gasket joint.
Ftgs; ductile or gray iron, AWWA C110; coating, lining and ends to match pipe.

3.06 PIPING SPECIFICATION SHEET--PIPESPEC

Piping Symbol/Service: LPG--Liquified Petroleum Gas System--18
VP--Petroleum Vent

Test Requirements:
- Medium: Fuel oil; ref. spec paragraph 15050-3.04 B.
- Pressure: 150 psig
- Duration: 60 minutes

Gasket Requirements:
- Flange: Neoprene, C.I.
- Push-on/Mech Cpl: N/A

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(2" and smaller)

Pipe: Steel; ASTM A106, seamless, Grade B, black, pickled. Ref. spec Section 15061.
Conn; socket weld with threaded adapters for valves.
Ftgs; forged steel, ASTM A105, ANSI B16.11, pressure Class 3000, pickled.

Valves: Lubricated plug; cast iron, flanged, Teflon coated plug, Rockwell Fig. 143, Walworth Fig. 1797F, or equal.
Lift check; Jenkins 896, Lunkenheimer 898, or equal.

(2-1/2" thru 12")

Pipe: Steel; ASTM A53, seamless, Grade B, black, pickled. Ref. spec Section 15061.
Conn; butt weld, flanged for valves.
Ftgs; steel, ASTM A234, seamless, ANSI B16.9, pickled; ends and wall thickness shall match pipe.

Valves: Lubricated plug; cast iron, flanged, Teflon coated plug, Rockwell Fig. 143, Walworth Fig. 1797F, or equal, thru 5 inch; worm gear operator Rockwell Fig. 149, Walworth Fig. 1727F, or equal, 6 to 12 inches.
Swing check; cast iron, flanged, Jenkins 1025-B2, Walworth 5344F, or equal.

Piping System: 18 (continued)

Buried and Encased Pipe and Valves:
(See drawings for pipe size and valve type. Omit coating on encased pipe.)

(2" and smaller)

Pipe:	Steel; same as exposed with polyethylene tape coating. Field application of coating to all couplings. Ref. spec Section 15061. Provide plastic tracer tape. Conn; same as exposed. Ftgs; same as exposed with coating.
Valves:	Lubricated plug; same as exposed with extension stem and valve box.

(2-1/2" thru 12")

Pipe:	Steel; same as exposed with coating specified above. Provide plastic tracer tape. Conn; same as exposed. Ftgs; same as exposed with coating.
Valves:	Lubricated plug; same as exposed with extension stem and valve box.

3.06 PIPING SPECIFICATION SHEET--PIPESPEC

Piping Symbol/Service:	CLS--Chlorine Solution CSO--Caustic Soda FC--Ferric Chloride MA--Muriatic Acid SHC--Sodium Hypochlorite	System--19

Test Requirements:

Medium:	Water; ref. spec paragraph 15050-3.04 C.
Pressure:	150 psig
Duration:	120 minutes

Gasket Requirements:

Flange:	TFE bonded EPDM, full-face gaskets, ANSI B16.1, having concentric, convex molded rings.
Push-on/Mech Cpl:	N/A

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(All sizes)

Pipe:	PVC; ASTM D1784, Class 12454-B, NSF certified, ASTM D1785, Sch. 80. Pipe and fittings exposed to sunlight shall be painted. Ref. spec Section 15064. Conn; plain end, solvent weld, flanged for valves 3 inch and larger. Ftgs; PVC, Sch. 80, solvent weld.

(4" and less)

Valves:	Ball; Chemtrol TFU Bloc TU Series, Asahi/America Duo Bloc TU Series, GSR TU Series, or equal, with Teflon seats and Viton O-rings. Diaphragm; Chemtrol Series PD, Posacon 677, Asahi/America, or equal. Ball check; Chemtrol Series BC, Asahi/America, or equal.

(5" and larger)

Valves:	Diaphragm; Grinnell 2538-2-M, Hills-McCanna 0649-1-38, or equal. Swing or ball check; fully lined valve body; fully coated swing check flapper or ball check ball; lining and coating shall be Buna-N rubber or fluoronated ethylene propylene. Valve and Primer Co. APCO Series 100R, Peabody Dore Model 770, or equal.

Piping System: 19 (continued)

Buried and Encased Pipe and Valves:
(See drawings for pipe size and valve type)

(All sizes)
Pipe: PVC; same as exposed. Provide magnetic tracer tape.
Conn; same as exposed.
Ftgs; same as exposed.

(2" and less)
Valves: Ball; same as exposed with extension stem and valve box.

(2-1/2" and larger)
Valves: Diaphragm; same as exposed with extension stem and valve box.

Remarks:

1. Piping located beneath structures shall be concrete encased.

3.06 PIPING SPECIFICATION SHEET--PIPESPEC

Piping Symbol/Service: CLV--Chlorine Vacuum System--21

Test Requirements:

Medium:	Water; ref. spec paragraph 15050-3.04 D.
Pressure:	50 psig
Duration:	1440 minutes

Gasket Requirements:

Flange:	TFE bonded EPDM, full-face gaskets, ANSI B16.1, having concentric, convex molded rings.
Push-on/Mech Cpl:	N/A

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(All sizes)

Pipe:	PVC; ASTM D1784, Class 12454-B, NSF certified, ASTM D1785, Sch. 80. Piping and fittings exposed to sunlight shall be painted. Ref. spec Section 15064. Conn; plain end, solvent weld, flanged for valves 3 inches and larger. Ftgs; PVC, Sch. 80, solvent weld.
Valves:	Ball; Asahi/America Duo Bloc TU Series, Chemtrol Tru Bloc TU Series, GSR TU Series, or equal, with Teflon seats and Viton O-rings.

Buried and Encased Pipe and Valves:
(See drawings for pipe size and valve type)

(All sizes)

Pipe:	PVC; same as exposed. Provide magnetic tracer tape. Conn; same as exposed. Ftgs; same as exposed.
Valves:	Ball; same as exposed with extension stem and valve box.

Remarks:

1. Valves shall be provided with certification for use with chlorine by the Chlorine Institute, Inc. Contractor shall provide a copy of valve certification in accordance with paragraph 00710-4.02.

Piping System: 21 (continued)

Remarks, Continued

2. Valves shall be cleaned for chlorine service by the valve manufacturer prior to delivery to the job site.

3. Following test completion, piping, valves, and fittings shall be cleaned and dried as specified in paragraph 15050-3.04 D.

4. Where flexibility is required, the Contractor may substitute 5/8-inch by 1/2-inch polyethylene tubing.

3.06 PIPING SPECIFICATION SHEET--PIPESPEC

Piping Symbol/Service: FA--Foul Air System--22

Test Requirements:
- Medium: Air; ref. spec paragraph 15050-3.04 B.
- Pressure: 15 psig
- Duration: 60 minutes

Gasket Requirements:
- Flange: TFE
- Push-on/Mech Cpl: TFE

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(All sizes)
Pipe: Reinforced thermoset plastic (RTP); Ref. spec Section 13234.
Conn; RTP.
Ftgs; RTP.

(All sizes)
Valves: Butterfly; Ref. spec Section 15103.

Buried and Encased Pipe and Valves:
(See drawings for pipe size and valve type)

(All sizes)
Pipe: RTP; same as exposed, concrete encased.
Conn; same as exposed, encasement to match pipe.
Ftgs; same as exposed, encasement to match pipe.

3.06 PIPING SPECIFICATION SHEET--PIPESPEC

Piping Symbol/Service: VA--Vacuum System--23

Test Requirements:
- Medium: Water; ref. spec paragraph 15050-3.04 C.
- Pressure: 50 psig
- Duration: 1440 minutes

Gasket Requirements:
- Flange: Neoprene, C.I.
- Push-on/Mech Cpl: Neoprene

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(2" and smaller)

Pipe: Copper tube; ASTM B88, Type L, drawn. Ref. spec Section 15066.
Conn; solder type with threaded adapters for valves.
Ftgs; wrought copper or bronze, ANSI B16.22.

Valves: Ball; Jamesbury Fig. 351, Apollo Series 70-100, Lunkenheimer 708 HST, or equal.
Globe; Crane 7 or 17, Lunkenheimer 123 or 214, or equal.
Lift check; Jenkins 54, Lunkenheimer 1616, or equal.

(2-1/2" and larger)

Pipe: Steel; ASTM A53, seamless, Grade B, black, no lining. Ref. spec Section 15061.
Conn; butt weld, flanged for valves.
Ftgs; steel, ASTM A234, seamless, WPB, ANSI B16.9, Sch. 40; ends to match pipe.

Valves: Lubricated plug; cast iron with Teflon coated plug, Rockwell Fig. 305, Walworth Fig. 2710F, or equal.
Check; Pennsylvania Aircheck, Hoerbiger, or equal.

Buried and Encased Pipe and Valves:
(See drawings for pipe size and valve type. Omit coating on encased pipe.)

(2" and smaller)

Pipe: Copper tube; ASTM B88, Type K, annealed or drawn.

Piping System:	23 (continued)
	Conn; solder type, with threaded adapters for valves. Ftgs; wrought copper or bronze, ANSI B16.2.
Valves:	Ball; same as exposed, with extension stem and valve box. Coating per spec Section 09900.
(2-1/2" and larger) Pipe:	Steel; same as exposed with polyethylene tape coating. Field application of coating to all couplings. Ref. spec Section 15061. Conn; same as exposed, with coating. Ftgs; same as exposed with coating.
Valves:	Lubricated plug; same as exposed with extension stem and valve box. Coating per spec Section 09900.

3.06 PIPING SPECIFICATION SHEET--PIPESPEC

Piping Symbol/Service:	D--Drain RWP--Rainwater Pipe SD--Sanitary Drain STD--Storm Drain V--Vent	System--24

Test Requirements:

Medium:	In accordance with Section 318, Uniform Plumbing Code.
Pressure:	In accordance with Section 318, Uniform Plumbing Code.
Duration:	In accordance with Section 318, Uniform Plumbing Code.

Gasket Requirements:

Flange:	Neoprene, C.I.
Push-on/Mech Cpl:	Nitrile or neoprene

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(3" and smaller)

Pipe:	Steel; ASTM A120, galvanized. Ref. spec Section 15061. Conn; taper threaded, ANSI B1.20.1. Ftgs; cast iron, threaded drainage fittings, ASTM A126, ANSI B16.12, galvanized.
Valves:	None

(4" thru 12")

Pipe:	Cast iron soil pipe (CISP); ASTM A74. Conn; service hub and spigot compression type or hubless cast iron sanitary system per CISPI 301. Ftgs; CISP, ASTM A74, joint options to match pipe.
Valves:	None

(14" and larger)

Pipe:	Ductile iron; AWWA C151, with standard lining. Ref. spec Section 15062. Conn; flanged or AWWA C111 mechanical. Ftgs; ductile or gray iron, AWWA C110, ends to match pipe.
Valves:	None

Piping System: 24 (continued)

Buried and Encased Pipe and Valves
(See drawings for pipe size and valve type)

(8" and smaller)
Pipe: PVC; ASTM D1784, Class 12454-B, ASTM D2665, Sch. 40. Ref. spec Section 15064. Provide magnetic tracer tape.
Conn; plain end, solvent weld.
Ftgs; PVC, socket type, DWV, ASTM D2665.

Valves: None

(10" and 12")
Pipe: PVC; ASTM D3034, SDR 35. Provide magnetic tracer tape.
Conn; push-on with nitrile gasket.
Ftgs; PVC or IPS cast iron; ends to match pipe.

Valves: None

(14" and larger)
Pipe: Reinforced concrete pipe (RCP); ref. spec Section 15056.
Conn; ASTM C443, rubber gasket type.
Ftgs; concrete manhole as specified on the drawings.

Valves: None

Remarks:

1. Alternate piping materials for exposed vent and rainwater piping include the following:

   (All sizes)
   Pipe: CPVC; Sch. 80. Ref. spec Section 15064.
   Conn; plain end, solvent weld.
   Ftgs; CPVC, Sch. 80, socket type.

   Valves: None

2. In no case shall PVC pipe be installed beneath structures. See alternate pipe materials for installation beneath structures.

3. Alternate pipe materials for buried lines 12 inches and smaller located beneath structures include:

Piping System: 24 (continued)

Remarks, Continued

Pipe: CISP; same as exposed. concrete encased.
Conn; same as exposed.
Ftgs; same as exposed.

Concrete encasement shall extend to the underside of structures as shown on the structural details.

4. Alternate pipe materials for buried lines 12 inches and smaller located beneath structures include:

Pipe: Ductile iron; Class 53, AWWA C151 and AWWA C111, standard lining and coating. Ref. spec Section 15062.
Conn; flexible restrained joint.
Ftgs; ductile or gray iron, AWWA C110; coating; lining, and ends to match pipe.

5. Alternate pipe materials for exposed piping 3 inches and smaller shall be as specified for buried piping of the same size.

3.06 PIPING SPECIFICATION SHEET--PIPESPEC

Piping Symbol/Service: CD--Chemical Drain System--25
VC--Chemical Vent

Test Requirements:

Medium: In accordance with Section 318, Uniform Plumbing Code.

Pressure: In accordance with Section 318, Uniform Plumbing Code.

Duration: In accordance with Section 318, Uniform Plumbing Code.

Gasket Requirements:
Flange: N/A
Push-on/Mech Cpl: N/A

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(All sizes)
Pipe: PP; ASTM D2146, Sch. 40, flame retardant.
Ref. spec Section 15064.
Conn; ref. spec Section 15064.
Ftgs; PP, socket type coil fused DWV.
Ref. spec Section 15064.

Valves: None

Buried and Encased Pipe and Valves:
(See drawings for pipe size and valve type)

Pipe: PP; same as exposed. Provide magnetic tracer tape.
Conn; ref. spec Section 15064.
Ftgs; same as exposed.

Valves: None

Remarks:

1. Piping located beneath structures shall be concrete encased. Concrete encasement shall extend to the underside of structures as shown on the structural details.

3.06 PIPING SPECIFICATION SHEET--PIPESPEC

Piping Symbol/Service:	JWR--Jacket Water Return JWS--Jacket Water Supply	System--28

Test Requirements:

Medium:	Water; ref. spec paragraph 15050-3.04 C.
Pressure:	50 psig
Duration:	120 minutes

Gasket Requirements:

Flange:	Compressed gasketing consisting of organic fibers (Kevlar), fillers and styrene butadiene rubber (SBR) binder.
Push-on/Mech Cpl:	N/A

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(2" and smaller)

Pipe:	Copper tube; ASTM B88, Type L, drawn. Ref. spec Section 15066. Insulation per Section 15250. Conn; solder type with threaded adapters for valves. Insulation per Section 15250. Ftgs; wrought copper or bronze, ANSI B16.22. Insulation per Section 15250.
Valves:	Ball; Jamesbury Fig. 351, Apollo Series 70-100, Lunkenheimer 708 HST, or equal. Globe; Crane 7 or 17, Lunkenheimer 123 or 214, or equal. Swing check; Jenkins 352, Crane 141, or equal.

(2-1/2" and larger)

Pipe:	Steel; ASTM A120 or ASTM A53, seamless, Grade B, black, no lining. Ref. Section 15061. Insulation per Section 15250. Conn; butt weld, flanged for valves. Insulate per Section 15250. Ftgs; steel, ASTM A234, seamless, ANSI B16.9; ends and wall thickness to match pipe. Insulation per Section 15250.
Valves:	Butterfly; ref. Section 15103. Swing check; spring loaded per spec Section 15118.

Piping System: 28 (continued)

Remarks:

1. JWR and JWS piping shall be insulated in accordance with Section 15250.

3.06 PIPING SPECIFICATION SHEET--PIPESPEC

Piping Symbol/Service: 2WL--Landscape Irrigation System--29

Test Requirements:
- Medium: Water; ref. spec paragraph 15050-3.04 C.
- Pressure: 125 psig
- Duration: 120 minutes

Gasket Requirements:
- Flange: Neoprene, C.I.
- Flush-on/Mech Cpl: Nitrile or Neoprene

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(2" and smaller)

Pipe: PVC; ASTM D1784, Class 12454-B, NSF certified, ASTM D1785, Sch. 80. Pipe and fittings exposed to sunlight shall be painted. Ref. spec Section 15064.
Conn; plain end; solvent weld with threaded adapters for valves.
Ftgs; PVC, Sch. 80, socket type.

Valves: Ball; Jamesbury Fig. 351, Apollo Series 70-100, Lunkenheimer 708 HST, or equal.
Globe; Crane 7 or 17, Lunkenheimer 123 or 214, or equal.
Swing check; Jenkins 352, Crane 141, or equal.

(2-1/2" thru 8")

Pipe: Steel; ASTM A120 or ASTM A53, ERW, Grade B, black, no lining. Ref. spec Section 15061.
Conn; butt weld, grooved mech pipe coupling or flanged.
Ftgs; malleable iron, ASTM A47, ductile iron, ASTM A536; or steel, ASTM A234, ANSI B16.9; ends and wall thickness to match pipe.

Valves: Butterfly; ref. spec Section 15103. Substitute Type B on 2-1/2" lines.
Swing check; spring loaded per spec Section 15118.

(10" and larger)

Pipe: Steel; same as 8" or AWWA C200, 3/16" thick w/lining. Ref. spec Section 15061.

Piping System: 29 (continued)

Conn; butt weld or flanged. See Remarks.
Ftgs; steel, ASTM A234, or fabricated steel, AWWA C208; lining and ends to match pipe.

Valves: Butterfly; ref. spec Section 15103.
Swing check; spring loaded per spec Section 15118.

Buried and Encased Pipe and Valves:
(See drawings for pipe size and valve type. Omit coating on encased pipe.)

(6" and smaller)
Pipe: PVC; ASTM D1784, Class 12454-B, NSF certified, ASTM D2241, SDR 21. Ref. spec Section 15064.
Conn; plain end; solvent weld with threaded or flanged adapters for valves.
Ftgs; PVC, Sch. 80, socket type.

(All sizes)
Valves: Ref. spec Section 15053.

(8" thru 12")
Pipe: PVC; same as 6 inch.
Conn; push-on gasketed joint with flanged adapters for valves.
Ftgs; steel or ductile iron, IPS, push-on or mechanical joint with standard lining and coating. Ref. spec Sections 15061 and 15062.

END OF SECTION

SECTION 15056

REINFORCED CONCRETE PIPE

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies reinforced concrete pipe, gaskets, and PVC lining. This section includes specifications for manholes and appurtenances.

B. PIPE DESIGNATIONS:

Reinforced concrete pipe designations shall be as follows:

Designation	Definition
RCP	Reinforced Concrete Pipe
RCP-LHP	Reinforced Concrete Low Head Pressure Pipe

C. DEFINITIONS:

1. PIPE JOINT: The area approximately 12 inches each way from the centerline of the visible gap between pipe lengths.

2. PIPE LENGTH: The pipe between two joints; part of a pipe section.

3. PIPE SECTION: The reach of pipeline between two successive manholes.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASTM C76-84	Reinforced Concrete Culvert, Storm Drain and Sewer Pipe
ASTM C139-73 (1979)	Concrete Masonry Units for Construction of Catch Basins and Manholes

D. PLASTIC LINING:

Lining material shall be PVC, white, compounded of inert synthetic resins, pigments, and plasticizers to make permanently flexible sheets. The sheets shall be formed with T-rib extensions on one face for casting with the concrete pipe or structures. The lining shall withstand a 40-psig back pressure applied to the under surface of the lining without losing anchorage or without rupture. The lining shall be capable of repair at any time during the life of the structure or pipe. Joint strips and welding strips shall have the same corrosion resistance as the sheet lining material but shall not have locking extensions.

Plastic liner sheets, joints, corners, and welding strips shall have the following physical properties when tested at ±77 degrees F:

Property	Initial	After 112 days
Tensile strength	2200 psi min	2100 psi min
Elongation at breadth	200% min	200% min
Shore durometer, Type D	1 sec 50-60 10 sec 35-50	±5% with respect to initial test result
Weight change	---	±15%

Tensile speciments shall be prepared and tested in accordance with ASTM D412, using die B.

Liner plate locking extensions embedded in concrete shall withstand a test pull of at least 100 pounds per lineal inch applied perpendicular to the concrete surface for a period of 1 minute, without rupture of the locking extensions or withdrawal from embedment. This test shall be made at a temperature between 70 and 80 degrees F. Plastic liner sheets, including locking extensions, joint corners, and welding strips shall be free of cracks, cleavages, or other defects adverseley affecting the protective characteristics of the material.

Liner sheets shall be a nominal 0.065 inch in thickness. Locking extensions of the same material as that of the liner shall be integrally extruded with the sheet. Locking extensions shall be approximately 2.5 inches apart and shall be at least 0.375 inch high.

2.02 MANUFACTURE

A. PIPE:

1. GENERAL: Reinforcing steel for each length of pipe shall be held in place throughout the casting operation. Lift holes are not acceptable.

2. RCP: Pipe shall be manufactured in conformance with ASTM C76. Joints shall be rubber gasket conforming to ASTM C443, unless otherwise specified.

3. RCP-LHP: RCP-LHP shall be ASTM C361.

B. RUBBER GASKET JOINTS:

Joints shall use concrete bell and spigot.

C. TESTING AND INSPECTION:

1. GENERAL: The Construction Manager shall be notified of the place and time of testing 1 week prior to the commencement of testing.

2. CONCRETE COMPRESSION TESTS: Compression tests shall be as specified in ASTM C76, Section 11.4.1.

3. D-LOAD TESTS: Pipe shall be tested in accordance with ASTM C76, Section 11.3 and ASTM C497. Loads used for testing shall be the load to produce the 0.01-inch crack or the design test load, whichever is less.

One percent of the total number of pipes, with a minimum of three pipe lengths, of each class, size and wall type shall be tested.

4. HYDROSTATIC TESTS: Pipe specified to meet hydrostatic strength requirements shall be tested in accordance with ASTM C361, Section 10.4. Both pipe and joints shall be tested. The number and method of selection of pipe for testing, as well as the determination of acceptability for delivery to the job site, shall be in accordance with ASTM C361, Section 10.

D. LENGTH AND BEVELS:

Pipe shall be fabricated in nominal lengths of at least 8 feet except where shorter lengths are required to meet special conditions. Pipe ends may be beveled a maximum of 5 degrees to accommodate changes in alignment or curved alignments of the pipeline.

E. PLASTIC LINING:

Where specified, 360 degrees of the interior of reinforced concrete pipe and surfaces of appurtenant structures shall be lined. Joints between individual sheets or sections of the lining shall be continuously heat-welded using welding strips of similar type and equivalent thickness of material as the liner. Installation of the lining in concrete pipe and the field sealing and welding of joints shall be done in accordance with the lining manufacturer's instructions.

2.03 PRODUCT DATA

The following information shall be provided in accordance with paragraph 00710-4.02.

A. FABRICATION DRAWINGS:

Drawings shall illustrate details of wall thickness, pipe joint, joint gasket, and reinforcement. Reinforcement details shall include the type of cage, the location of the cages in the pipe wall, the size and spacing of circumferential and longitudinal reinforcing steel, and the cross-sectional area of reinforcing steel in each cage per lineal foot of pipe. The gasket details shall include the diameter of the cross section and the circumferential length.

B. LAYOUT DRAWINGS:

Layout drawings shall illustrate placement of each pipe length including fittings. Pipe lengths and joints shall be identified with a numbering system.

C. TEST RESULTS:

The Contractor shall provide results of the following tests as specified in the referenced paragraphs of this section:

	Test	Paragraph
1.	Concrete compression	2.02 C.2.
2.	D-load	2.02 C.3.
3.	Hydrostatic	2.02 C.4.
4.	Procedures for pipe acceptance	3.03 A., 3.03 B., 3.03 C.

D. CERTIFICATION:

The Contractor shall provide certified copies of laboratory reports from his gasket supplier indicating conformance with the specified requirements of Section 15075 and this specification for each shipment of gaskets.

E. PLASTIC LINING:

The Contractor shall provide the plastic lining manufacturer's installation and welding instructions.

PART 3--EXECUTION

3.01 PIPE LAYING

A. RCP:

Preparation of bedding and backfill shall be as specified in Section 02200 and the drawing details. Pipe shall be laid with uniform bearing under the full length of the barrel of the pipe.

The interior of the pipeline shall be cleaned as the work progresses.

The line and grade of any one pipe shall not deviate more than that specified in the following table. The allowable deviation is not cumulative.

Pipe length, feet	Maximum deviation per pipe length, feet
8	0.06
10	0.09
12	0.11
16	0.14

Assembled pipe joints shall be kept in compression until the the placement of the initial backfill is complete.

B. RCP-LHP:

Pipe laying shall conform to paragraph 15056-3.01 A of this specification and AWWA C600. Anchorage shall be provided at fittings and where specified. Details of thrust restraints and thrust blocks shall be in accordance with AWWA C600 and as specified.

C. JOINTING:

During jointing, neither mortar nor buttering compound is acceptable on either the exterior or interior of the joints. After jointing, joints over 3/4 inch shall be mortared.

3.02 STRUCTURES

Structures shall be as specified. Openings for future connections shall be sealed with a precast concrete plug made watertight with mastic compound or rubber gaskets. Concrete mortar shaping within any structure shall be as specified in Division 3.

3.03 PIPELINE ACCEPTANCE

A. RCP:

After backfilling and restoration of surfaces, pipelines shall be cleaned. Pipelines 21 inches or less in diameter shall be cleaned by the sewer ball method unless the pipeline can be shown to be clean by visual inspection.

B. RCP LEAKAGE TESTS:

1. GENERAL: Leakage tests shall be completed after pipelines have been cleaned of obstructions and inspected by the Construction Manager.

2. SECTION LEAKAGE TEST: Each section of pipeline shall be tested by closing the lower end of the pipe to be tested and the inlet pipe of the upper manhole with stoppers and then filling the pipe and manhole with water to a level 5 feet above the crown of the open pipe in the upper manhole or, if groundwater is present, 6 feet above the section's average adjacent groundwater level. The line shall be filled at least 1 hour prior to testing and shall be tested for 6 hours minimum, maintaining the specified head by measured additions of water. The sum of these additions shall be the measured leakage for the test period. The allowable leakage shall not exceed 0.05 gallon per hour per inch of diameter per 100 feet of pipe being tested. Testing of plastic-lined pipe shall be completed prior to welding the plastic joints.

3. JOINT LEAKAGE TEST: For pipes 48 inches in diameter and larger, the Contractor may test each individual pipe joint for leakage with portable bulkheads or other testing apparatus as an alternative to testing each section. Each joint shall be tested as an integral unit. The test pressure shall be equivalent to the head of water specified for the section leakage test. The allowable leakage shall be the same as that specified for the pipeline section leakage test. The Contractor shall record the test pressure, time under pressure, and actual leakage of each joint tested.

C. RCP-LHP LEAKAGE TESTS:

Pipelines shall be tested in accordance with AWWA C600 except that test pressures and allowable leakage shall be as specified in Section 15050.

3.04 PLASTIC LINING

A. FIELD JOINTS FOR CONCRETE PIPE LINING:

Pipe joints shall be prepared in the following manner before making the lining joint:

3.04 A.

The inside joint shall be filled and pointed with sealing compounds as recommended by the lining manufacturer. The sealant shall be flush with the interior surface of the pipe.

Where groundwater is encountered, the joint shall not be lined until pumping of the groundwater has been discontinued for at least 3 days and no leakage is evident at the joint.

No lining joint shall be made until the trench has been backfilled and dry.

END OF SECTION

SECTION 15057

CONCRETE CYLINDER PIPE

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies pretensioned and prestressed steel cylinder pipe, with externally wrapped rod or wire reinforcement, and cement mortar coating and lining.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASTM C150-85	Portland Cement
AWWA C208-83	Fabricated Steel Water Pipe Fittings
AWWA C301-84	Prestressed Concrete Pressure Pipe, Steel Cylinder Type, for Water and Other Liquids
AWWA C303-78	Reinforced Concrete Pressure Pipe--Steel Cylinder Type, Pretensioned, for Water and Other Liquids
AWWA C600-82	Installation of Ductile-Iron Water Mains and Their Appurtenances

PART 2--PRODUCTS

2.01 MATERIALS

A. GENERAL:

Concrete cylinder pipe shall be pretensioned concrete cylinder pipe provided in accordance with AWWA C303 or prestressed concrete cylinder pipe provided in accordance with AWWA C301. Unless otherwise specified, piping 60 inch diameter and smaller shall be per AWWA C303. Cylinder piping larger than 60 inch diameter shall be per AWWA C301.

B. CEMENT:

Cement shall be ASTM C150, Type II.

C. GASKETS:

Gaskets for joints shall conform to Section 15075.

2.02 MANUFACTURE

A. PRETENSIONED CONCRETE CYLINDER PIPE:

Design and manufacture of pretensioned concrete cylinder pipe shall be in accordance with AWWA C303 and its appendix for the specified pressure and loading. Unless otherwise specified, the design pressure, which is the sum of the working and transient pressures used in equations 1 and 2 of AWWA C303, Appendix A, shall be either 100 psi or the test pressure specified in Section 15050, whichever is greater. In additon, pipe shall be capable of withstanding a trench load of 20 feet with Type 2 bedding as indicated on the drawings. Greater trench or embankment loads and live loads in excess of the external dead load shall be used where specified.

B. PRESTRESSED CONCRETE CYLINDER PIPE:

Design and manufacture of prestressed concrete cylinder pipe shall be in accordance with AWWA C301 and its appendix for the specified pressure and loading. Unless otherwise specified, the design pressure shall be either 100 psi or the test pressure specified in Section 15050, whichever is greater. Pipe shall be able to resist external loads as specified for pretensioned concrete cylinder pipe.

C. CURING:

The pipe shall be steam cured in accordance with AWWA C302.

2.03 FITTINGS AND SPECIAL PIPE

Unless otherwise specified, fittings for concrete cyliner pipe shall be fabricated from steel plate or sheets and shall be cement mortar lined and coated. All fittings shall conform to AWWA C303 and the dimensional requirements of AWWA C208, and shall be equal to the strength of the pipe. Bell adapters shall be fabricated from steel plate and shall be accurately dimensioned for a rubber gasket joint.

Cement mortar coating shall be reinforced with 2 x 4 x 13 gage galvanized welded wire mesh of the self-furring type so that the mesh is completely surrounded by the cement mortar. Where cement

mortar lining is not centrifugally applied, it shall be reinforced with plain 2 x 4 x 13 gage welded wire mesh stud welded to the cylinder.

2.04 PRODUCT DATA

The following information shall be provided in accordance with paragraph 00710-4.02:

1. An affidavit of compliance with AWWA C301 or C303 as applicable.

2. Drawings showing cross section of the pipe wall and joints for each size, pressure rating, and loading.

3. Drawings showing details and dimensions of all fabricated fittings.

4. Details on anchoring bends and fittings.

5. Layout schedule.

PART 3--EXECUTION

3.01 PIPE LAYING

A. GENERAL:

Anchorage for joints from pipe to fittings and from fittings to structures shall be provided as indicated on the drawings. Unless otherwise specified, anchorage shall consist of concrete thrust blocks, providing bolts at springline, or by intermittent welding of the steel joint rings capable of withstanding the axial tension for the pressures involved.

Pretensioned concrete cylinder pipe is designed so that the structural qualities of the pipe together with the trenching and bedding methods specified will limit deflection of the pipe to no more than $D^2/4000$ inch, or 2 percent of outside pipe diameter, whichever is smaller. D is nominal inside diameter of the pipe in inches. Contractor shall be responsible for proper installation to meet specified trench excavation, bedding, or backfilling requirements and prevent deflections in excess of pipe design deflections.

B. RUBBER GASKET JOINTS:

Rubber gasket joints for concrete cylinder pipe shall be assembled in accordance with the manufacturer's instructions. After the joint has been made, the position of the rubber gasket

shall be verified. Joints in which gaskets are not properly positioned shall be fully separated, rejointed, and checked. Joints shall be mortared as follows.

1. INSIDE JOINT SPACE: For pipe 21 inch diameter and smaller, prior to assembling the joint, the inside shoulder of the bell shall be moistened and "buttered" with a stiff mortar consisting of one part portland cement to 1-1/2 parts sand. After the joint is assembled, excess mortar shall be removed to provide a smooth and continuous joint surface.

For pipe 24 inch diameter and larger, after the pipe zone bedding and backfill have been completed, the inside joint recess shall be moistened, then filled and pointed with a stiff cement mortar consisting of one part portland cement to 1-1/2 parts of sand. The finished joint shall be smooth and flush with the adjacent pipe surfaces. Interior joint pointing operations shall not be conducted within two joints of pipe laying operations.

2. OUTSIDE JOINT SPACE: The outside joint space shall be field coated using a cement mortar as follows.

After jointing mortar coated pipe, a cloth or band at least 8 inches in width shall be centered and secured over the exterior joint recess. The band shall be bound to the pipe by the use of steel box strapping or by an equivalent method and shall completely and snugly encase the outside joint except for an opening near the top where mortar grout is to be poured into the joint recess.

After the band is properly secured, the joint recess shall be moistened with water and then filled with mortar consisting of one part portland cement to two parts of sand mixed with water to the consistency of thick cream. The mortar grout shall completely fill the outside annular space between the ends of the pipe and around the complete circumference. After the recess has been filled, the opening shall be closed and the mortar allowed to set before bedding and backfilling at the joint.

C. WELDED JOINTS:

Where specified, welded joints or partially welded joints shall be welded by the shielded electric arc method in accordance with ASME Boiler Code (Class I) and API 1104. Welded joints shall be mortared as specified for rubber gasket joints.

3.02 TESTING

Hydrostatic testing shall be in accordance with Section 4 of AWWA C600 except that test pressures and allowable leakage shall be as listed in Section 15050.

END OF SECTION

SECTION 15059

VITRIFIED CLAY PIPE

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

The Contractor shall furnish and install all vitrified clay pipe sewers and drains as specified and shown, complete, in accordance with the requirements of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. CONTRACTOR SUBMITTALS:

Section 01300.

B. EARTHWORK:

Section 02200.

C. PRECAST CONCRETE MANHOLES:

Section 15056.

D. CAST-IN-PLACE CONCRETE:

Section 03300.

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. COMMERCIAL STANDARDS:

Reference	Title
ASTM C12	Recommended Practice for Installing Vitrified Clay Pipe Lines
ASTM C301	Method of Testing Vitrified Clay Pipe
ASTM C425	Specification for Compression Joints for Vitrified Clay Pipe and Fittings
ASTM C700	Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated

Reference	Title
ASTM C828	Recommended Practice for Low-Pressure Air Test of Vitrified Clay Pipe Lines (4 to 12-inches).

1.04 SUBMITTALS

A. SHOP DRAWINGS:

The Contractor shall submit shop drawings of pipe and fittings in accordance with the requirements in Section 01300.

B. CERTIFICATION:

The Contractor shall furnish a certified affidavit of compliance for all pipe and other products or materials furnished under this Section, as specified in the referenced standards and the following supplemental requirements:

1. Hydrostatic test reports.
2. Three-edge bearing strength test reports.

1.05 QUALITY ASSURANCE

A. TESTING AT MANUFACTURER'S PLANT:

All pipe shall be subject to a hydrostatic pressure test and a 3-edge bearing test at the manufacturer's plant. The Construction Manager may select at random and test as specified one length of pipe for each 1,000 feet or fraction thereof to be installed under this contract for the test as specified in ASTM C301. The cost of pipe and the test shall be borne by the Contractor. Pipe will be acceptable under the test requirements specified herein when all test specimens conform to the test requirements. Should any of the test specimens fail to meet the test requirements, the manufacturer will be allowed to retest 2 additional specimens for each specimen that failed, and the pipe shall be acceptable only when all of the retest specimens meet the strength requirements.

B. INSPECTION OF MATERIALS:

All pipe and fittings shall be true, circular, and concentric with the barrel of the pipe, cut off on a plane at right angles to the longitudinal axis of the pipe. At no point shall the thickness of the shell of the extreme outer end of the spigot be less in thickness than the shell of the main body of the pipe. Socket ends shall be square with the longitudinal axis and shall be true, circular, and concentric with the barrel of the pipe.

1.05 B.

All pipe and fittings shall have smooth interiors and shall be free from injurious cracks, checks, blisters, broken extremities, or other imperfections.

The following imperfections in the barrel or socket of a pipe or fitting will be considered injurious and cause for rejection:

1. A single crack in the barrel of the pipe or fitting extending through the entire thickness, regardless of the length of such crack, a single crack which extends through 1/5 of the barrel thickness and is over 3 inches long. Any surface fire crack which is more than 1/32 inch wide at its widest point.

2. Lumps, blisters, pits, or flakes on the interior surface of a pipe or fitting.

3. When spigot or socket of the pipe varies from a true circle more than 3 percent of its nominal diameter.

4. Any piece broken from the spigot end which extends through the barrel.

5. Tramp clays, grog, or other foreign matter which is fused permanently to the exterior or interior surface of the pipe or fittings.

PART 2--PRODUCTS

2.01 PIPE AND FITTINGS

All pipe and fittings shall conform to the following requirements:

1. Clay pipe and fittings shall be "Extra Strength", glazed, unless otherwise shown, and shall conform to the requirements of ASTM C700.

2.02 PIPE DESIGN CRITERIA

A. GENERAL:

Vitrified clay pipe shall be designed in accordance with the requirements of ASTM C12 as applicable and as modified in this section.

B. THREE-EDGE BEARING STRENGTH DETERMINATION:

The required three-edge bearing strength shall be determined using the following equation:

$$\text{Required three-edge Bearing strength} = \frac{\text{Design load x factor of safety}}{\text{Bedding factor}}$$

Where:	Required three-edge Bearing strength	=	Three-edge bearing Test strength in lbs/linear foot
	Design load	=	Calculated load on pipe in lbs/linear foot
	Factor of safety	=	1.75 minimum
	Bedding factor	=	Varies, see drawings for appropriate trench configuration to obtain required three-edge bearing strength.

C. DESIGN LOAD DETERMINATION:

The earth loads will be computed using the following 2 equations for trench or embankment loading as applicable:

1. Trench Condition:

$$W_d = C_d \, w \, B_d^2$$

Where:	W_d	=	Earth load in pounds per linear foot
	C_d	=	Calculation coefficient
	K_u'	=	0.13
	w	=	110 lbs/ft^3
	B_d	=	Trench width at top of pipe, feet

2. Positive Projecting Embankment Condition:

$$W_c = C_c \, w \, B_c^2$$

Where:	W_c	=	Earth load in pounds per linear foot
	C_c	=	Calculation coefficient (based on $r_{sd}p$ of 0.75)
	w	=	110 lb/ft^3
	B_c	=	Outside diameter of pipe, feet

The above 2 formulas are based on a depth of cover of 10 feet or greater. For depths of cover of less than 10 feet HS-20 live load shall be included. For depths of cover of 3 feet or less, HS-20 live load and impact factors shall be as recommended by AASHTO in "Standard Specifications for Highway Bridges".

2.03 JOINTS

Except where open joints are shown, joints in vitrified clay pipe shall be made up using a factory-made bell and spigot compression joint for all pipe diameters, or a synthetic rubber collar with stainless steel or plastic shear ring and stainless steel take-up clamps, bolts, and nuts, for plain-end pipe up to 12-inch size, meeting the requirements of ASTM C425.

PART 3--EXECUTION

3.01 GENERAL

The sewer shall be constructed to the alignment and grade shown. The grade line shown on the profile is the invert or interior bottom of the pipe. The excavation shall be made a sufficient distance below the grade line to allow for the placing of the sewer invert and the supporting foundation if such foundation is shown. Should the trench be excavated to a depth greater than required, the Contractor shall refill such excess excavation according to the requirements of Section 02200.

3.02 INSTALLATION

Installation of pipe shall be in accordance with ASTM C12. Pipe laying shall proceed upgrade with spigot ends pointing in direction of flow. After a section of pipe has been lowered into the prepared trench and immediately before joining the pipe, the ends of the pipe to be joined shall be cleaned, and the rubber gasket lubricated, all in accordance with the pipe manufacturer's written instructions. Assembly of the pipe length shall be in accordance with the recommendations of the manufacturer of the type of joint used. All special tools and appliances required for joining the pipe shall be provided by the Contractor. When cutting or machining of the pipe is necessary, only tools and methods recommended in writing by the pipe manufacturer and approved by the Engineer shall be employed.

The Contractor shall take all necessary precautions to prevent excavated or other foreign material from getting into the pipe during the laying operations. At all times, when laying opera

tions are not in progress and at the close of the day's work, the ends of the pipe in the trench shall be closed to prevent entry to animals and foreign materials.

All necessary precautions shall be taken to prevent uplift or floating of the pipe prior to the completion of the backfilling operation. The Contractor shall assume full responsibility for any damage due to this cause and shall, at its own expense, restore and replace the pipe to its specified conditions and grade if it is displaced due to floating.

END OF SECTION

SECTION 15060

CEMENT MORTAR LINED AND COATED STEEL PIPE

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies cement mortar lined and coated steel pipe and fittings.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
API STD 1104-83	Welding Pipelines and Related Facilities
ASME (1983)	Boiler and Pressure Vessel Code
ASTM A36/A36M-84a	Structural Steel
ASTM A283/A283M-84	Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes, and Bars
ASTM A570/A570M-85	Hot-Rolled Carbon Steel Sheet and Strip, Structural Quality
AWWA C200-80	Steel Water Pipe 6 Inches and Larger
AWWA C205-80	Cement-Mortar Protective Lining and Coating for Steel Water Pipe--4 In. and Larger--Shop Applied
AWWA C206-82	Field Welding of Steel Water Pipe
AWWA C207-78	Steel Pipe Flanges for Waterworks Service--Sizes 4 In. Through 144 In.
AWWA C208-83	Dimensions for Steel Water Pipe Fittings
AWWA C600-82	Installation of Ductile-Iron Water Mains and Their Appurtenances

Reference (cont'd)	Title
AWWA C601-81	Disinfecting Water Mains
AWWA M11-85	Steel Pipe--A Guide for Design and Installation

B. DESIGN REQUIREMENTS:

Pipe and fittings shall be designed in accordance with AWWA C200. Buried pipe and fittings shall be designed for a maximum deflection of 2 percent of the internal diameter for the trench conditions specified plus an imposed wheel load equal to H-20 truck loading. Minimum cylinder thickness shall be 14 gage (U.S. standard) for rubber gasketed joints and 12 gage (U.S. standard) for lap welded joints unless otherwise specified. The diameter specified for pipe and fittings shall be the nominal inside diameter after lining.

C. JOINTS:

Joints shall conform to the requirements set forth under AWWA C200. Welded joints shall be lap welded in accordance with AWWA C206. Flanges where specified shall be steel plate flanges conforming to AWWA C207.

D. FITTINGS AND APPURTENANCES:

Fittings and appurtenances shall conform to AWWA C208 and shall be designed in accordance with AWWA M11.

E. TESTING:

Factory testing shall conform to the requirements of AWWA C200, except that at the manufacturer's option, fittings and specials not made from hydrotested cylinders may be checked by the dye-penetrant method.

PART 2--PRODUCTS

2.01 PIPE MATERIALS

Steel shall conform to the requirements of ASTM A570, Grade 30 or 33, or ASTM A283, Grade C or D, or ASTM A36.

2.02 PIPE MANUFACTURE

Pipe shall be straight or spiral seam in accordance with AWWA C200.

2.03 PIPE LINING AND COATING

Unless specified otherwise, pipe lining and coating shall be cement mortar in conformance with AWWA C205. Fittings and specials larger than 24 inches, not fabricated from centrifugally lined straight sections, shall require 2 x 4 x 13 gage self-furring wire mesh reinforcement for hand applied lining.

2.04 JOINT GASKETS

Joint gaskets shall be as specified in Section 15075.

2.05 PRODUCT DATA

Affidavits of Compliance with AWWA C200 and Contractor's layout drawings shall be provided in accordance with paragraph 00710-4.02.

PART 3--EXECUTION

3.01 PIPE LAYING

A. GENERAL:

Pipe shall be provided in accordance with AWWA M11. Welded joints shall be in accordance with AWWA C206.

Sleeve-type mechanical pipe couplings shall be provided in accordance with AWWA M11 and Section 15085 of this project manual.

Mechanical joints or push-on O-ring gasket joints shall be provided and assembled in accordance with the manufacturer's instructions.

B. RUBBER GASKET JOINTS:

Rubber gasket joints for cement mortar lined and coated steel pipe shall be assembled in accordance with the manufacturer's instructions. After the joint has been made, the position of the rubber gasket shall be verified. Joints in which gaskets are not properly positioned shall be fully separated, rejointed, and checked. Joints shall be mortared as follows.

1. INSIDE JOINT SPACE: For pipe 21 inch diameter and smaller, prior to assembling the joint, the inside shoulder of the bell shall be moistened and "buttered" with a stiff mortar consisting of one part portland cement to 1-1/2 parts sand. After the joint is assembled, excess mortar shall be removed to provide a smooth and continuous joint surface.

For pipe 24 inch diameter and larger, after the pipe zone bedding and backfill have been completed, the inside joint recess shall be moistened, then filled and pointed with a stiff cement mortar consisting of one part portland cement to 1-1/2 parts of sand. The finished joint shall be smooth and flush with the adjacent pipe surfaces. Interior joint pointing operations shall not be conducted within two joints of pipe laying operations.

2. OUTSIDE JOINT SPACE: The outside joint space shall be field coated using a cement mortar as follows.

After jointing mortar coated pipe, a cloth or band at least 8 inches in width shall be centered and secured over the exterior joint recess. The band shall be bound to the pipe by the use of steel box strapping or by an equivalent method and shall completely and snugly encase the outside joint except for an opening near the top where mortar grout is to be poured into the joint recess.

After the band is properly secured, the joint recess shall be moistened with water and then filled with mortar consisting of one part portland cement to two parts of sand mixed with water to the consistency of thick cream. The mortar grout shall completely fill the outside annular space between the ends of the pipe and around the complete circumference. After the recess has been filled, the opening shall be closed and the mortar allowed to set before bedding and backfilling at the joint.

C. WELDED JOINTS:

Welded joints or partially welded joints shall be welded by the shielded electric arc method in accordance with ASME Boiler Code (Class I) and API STD 1104. Welded joints shall be mortared as specified for rubber gasket joints.

D. SLEEVE AND MECHANICAL JOINTS:

Sleeve and mechanical joints when buried shall be concrete encased.

3.02 TESTING

Hydrostatic testing shall be conducted in accordance with Section 4 of AWWA C600 and the test pressures listed in Section 15050, or 125 percent of the design pressure listed. Unless otherwise specified, allowable leakage shall be 0.02 gallons per hour per inch diameter per 100 feet of pipeline.

END OF SECTION

SECTION 15061

STEEL PIPE

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies steel pipe and fittings.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ANSI B16.3-77	Malleable Iron Threaded Fittings, Class 150 and 300
ANSI B16.9-78	Factory-Made Wrought Steel Buttwelding Fittings
ANSI B16.11-80	Forged Steel Fittings, Socket-Welding and Threaded
ASME (1983)	Boiler and Pressure Vessel Code
ASTM A36/A36M-84a	Structural Steel
ASTM A47-84	Ferritic Malleable Iron Castings
ASTM A53-84	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A105/A105M-85	Forgings, Carbon Steel, for Piping Components
ASTM A106-85	Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A120-84	Pipe, Steel, Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless, for Ordinary Uses
ASTM A197-79	Cupola Malleable Iron
ASTM A234/A234M-85	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures

Reference	Title
ASTM A283/A283M-84	Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes and Bars
ASTM A536-84	Ductile Iron Castings
ASTM A570/A570M-85	Hot-Rolled Carbon Steel Sheet and Strip, Structural Quality
ASTM A572/A572M-85	High Strength Low Alloy Columbium-Vanadium Steels of Structural Quality
AWWA C200-80	Steel Water Pipe 6 Inches and Larger
AWWA C203-78	Coal-Tar Protective Coatings and Linings for Steel Water Pipelines--Enamel and Tape--Hot-Applied
AWWA C205-80	Cement-Mortar Protective Lining and Coating for Steel Water Pipe--4 In. and Larger--Shop Applied
AWWA C206-82	Field Welding of Steel Water Pipe
AWWA C207-78	Steel Pipe Flanges for Waterworks Services--Sizes 4 In. Through 144 In.
AWWA C208-83	Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C209-84	Cold-Applied Tape Coating for Special Sections, Connections, and Fittings for Steel Water Pipelines
AWWA C210-84	Coal-Tar Epoxy Coating System for the Interior and Exterior of Steel Water Pipe
AWWA C214-83	Tape Coating Systems for the Exterior of Steel Water Pipelines
AWWA C600-82	Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA M11-85	Steel Pipe--A Guide for Design and Installation
SSPC-82	Steel Structures Painting Council Specifications

B. TESTING:

Factory testing shall conform to the requirements of ASTM A53, ASTM A106, ASTM A120, or AWWA C200 as applicable.

PART 2--PRODUCTS

2.01 PIPE MATERIALS

Steel pipe and fittings shall be provided in accordance with ASTM A53, ASTM A106, ASTM A120, or AWWA C200 as specified in Section 15050, Piping Systems.

Steel for pipe fabricated to meet requirements of AWWA C200 shall conform to the requirments of ASTM A36, ASTM A572, Grade 42, ASTM A570, Grades 33 and 36, or ASTM A283, Grade D. Steel for ASTM A53 and ASTM A106 pipe shall be Grade B.

2.02 PIPE MANUFACTURE

Unless otherwise specified, ASTM A53 pipe shall be Type E, electric resistance welded or Type S, seamless pipe as specified in Section 15050. The minimum wall thickness for ASTM A53, ASTM A106, or ASTM A120 pipe shall be Schedule 40 for pipe 10 inch diameter and less and 3/8 inch for pipe 12 inch through 24 inch diameter. Increased shell thickness shall be provided where specified.

AWWA C200 pipe shall be straight or spiral seam. The minimum wall thickness shall be 7 gage for pipe 6 inch through 24 inch diameter and 1/4 inch for pipe 26 inch diameter and larger. Increased shell thickness shall be provided where specified.

2.03 CONNECTIONS

Connections shall be as specified in Section 15050 and shall conform to Section 15085.

2.04 FITTINGS AND APPURTENANCES

Malleable iron threaded fittings and appurtenances shall conform to the requirements of ASTM A47 or ASTM A197, ANSI B16.3.

Steel fittings and appurtenances shall conform to the requirements of ASTM A234 or ASTM A105, ANSI B16.11.

Fabricated steel fittings and appurtenances shall conform to AWWA C208.

Unless otherwise specified, all fittings shall be rated for pressure and loadings equal to the pipe.

2.05 PIPE LINING

A. COAL TAR EPOXY:

Unless otherwise specified, pipe and fittings shall be lined with coal tar epoxy as specified in AWWA C210 to a minimum thickness of 20 mils in not less than two coats.

B. COAL TAR ENAMEL:

Where specified, pipe and fittings shall be lined with coal tar enamel as specified in AWWA C203.

C. CEMENT MORTAR:

Where specified, pipe and fittings shall be lined with cement mortar as specified in AWWA C205. Fittings and specials larger than 24 inches, not fabricated from centrifugally lined straight sections, shall require 2-inch by 4-inch by 13-gage self-furring wire mesh reinforcement for hand-applied lining.

D. EPOXY:

Where specified, steel pipe and fittings shall be epoxy lined with not less than 10 mils of epoxy suitable for temperatures of 225 degrees F. Epoxy lining shall be 3M Scotchkote 306, Porter MCR 65 High Solids Epoxy, or equal. Surfaces shall be prepared in accordance with SSPC-SP 10 Near White Blast Cleaning, and the lining applied as recommended by the manufacturer.

E. GLASS LINING:

Where specified, pipe and fittings shall be glass lined with a vitreous material to a minimum thickness of 10 mils. Glass lining shall provide continuous coverage as tested by a low voltage holiday detector with only isolated voids permitted due to casting anomalies. Voids, other than isolated pinholes, shall be cause for rejection.

Pipe and fittings shall have all internal welds ground smooth and any voids or slag holes ground out, rewelded and ground smooth.

Glass lining shall be Ferrock MEH-32, Ervite SG-14, or equal.

2.06 PIPE COATING

A. COAL TAR EPOXY:

Unless otherwise specified, pipe and fittings for buried installation shall be coated with coal tar epoxy, shop applied in accordance with AWWA C210 to a minimum thickness fo 20 mils in not less than two coats.

B. POLYETHYLENE TAPE:

Where specified, pipe and fittings shall be coated and wrapped with prefabricated multilayer cold applied polyethylene tape coating in accordance with AWWA C214. The coating application shall be a continuous step operation in conformance with AWWA C214, Section 3. The total coating thickness shall be not less than 50 mils for pipe 24 inches and smaller and not less than 80 mils for pipe 26 inches and larger.

2.07 FUSION EPOXY COATING AND LINING

Where specifed, steel pipe and fittings shall be fusion epoxy coated and lined. The fusion epoxy coating shall be 3M Scotchkote 203, or equal. Surface preparation shall be in accordance with SSPC-SP 10 Near White Blast Cleaning. The application method shall be by the fluidized bed method and shall attain 12 mils minimum dry film thickness.

Field welds, connections and otherwise damaged areas shall be coated and patched according to the manufacturer's instructions with 3M Scotchkote 306.

2.08 JOINT GASKETS

Joint gaskets shall be as specified in Section 15075.

2.09 PRODUCT DATA

Affidavits of Compliance with AWWA C200 or ASTM A53, ASTM A106 or ASTM A120, as applicable, and Contractor's layout drawings shall be provided in accordance with paragraph 00710-4.02.

PART 3--EXECUTION

3.01 INSTALLATION

A. GENERAL:

Pipe shall be installed in accordance with AWWA M11, Chapter 16. Welded joints shall be in accordance with AWWA C206 and Section 15085.

Sleeve-type mechanical pipe couplings shall be provided in accordance with AWWA M11 and Section 15085.

Pipe lining and coatings at field joints shall be applied as specified in paragraphs 15061-2.05 and 2.06.

Unless otherwise specified, buried mechanical couplings and valves shall be field coated as specified in Section 09900.

B. ANCHORAGE:

Anchorage shall be provided as specified. Calculations and drawings for proposed alternative anchorage shall be submitted in accordance with Section 01300.

3.02 TESTING

Hydrostatic testing shall be in accordance with Section 4 of AWWA C600 except that test pressures and allowable leakage shall be as listed in Section 15050.

END OF SECTION

SECTION 15062

DUCTILE IRON PIPE

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies ductile iron pipe, ductile or gray iron fittings and gaskets.

B. DEFINITION:

Where cast iron pipe is specified, the term and symbol shall mean ductile iron pipe.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ANSI A21.52-82	Ductile-Iron Pipe, Centrifugally Cast, in Metal Molds or Sand Lined Molds for Gas
ANSI B1.20.1-83	Pipe Threads, General Purpose (Inch)
ANSI B16.1-75	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800
ANSI B18.2.1-81	Square and Hex Bolts and Screws Inch Series Including Hex Cap Screws and Lag Screws
ANSI B31.1-83	Power Piping
ASTM A716-82	Ductile-Iron Culvert Pipe
AWWA C104-80 (ANSI A21.4-80)	Cement-Mortar Lining for Ductile-Iron and Gray-Iron Pipe and Fittings for Water
AWWA C110-82 (ANSI C21.10-82)	Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In., for Water and Other Liquids
AWWA C111-80 (ANSI A21.11-80)	Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings

Reference (cont'd)	Title
AWWA C115-83 (ANSI A21.15-83)	Flanged Ductile-Iron and Gray-Iron Pipe With Threaded Flanges
AWWA C150-81 (ANSI A21.50-81)	Thickness Design of Ductile-Iron Pipe
AWWA C151-81 (ANSI A21.51-81)	Ductile-Iron Pipe, Centrifugally Cast, in Metal Molds or Sand-Lined Molds, for Water or Other Liquids
AWWA C153-84 (ANSI A21.53-84)	Ductile-Iron Compact Fittings, 3 In. Through 12 In. for Water and Other Liquids
AWWA C600-82	Installation of Ductile-Iron Water Mains and Their Appurtenances

PART 2--PRODUCTS

2.01 GENERAL

Pipe design, materials and manufacture shall comply with the following documents:

Item	Document
Thickness design	AWWA C150
Manufacturing requirements	
Water or other liquid	AWWA C151
Gas	ANSI A21.52
Gravity service pipe	ASTM A716
Joints	
Rubber gasket	AWWA C111
Threaded flange	AWWA C115
Fittings	AWWA C110/AWWA C153
Cement mortar lining	AWWA C104

2.02 GASKETS

Gasket stock shall be a synthetic rubber compound in which the elastomer is neoprene. The compound shall contain not less than 50 percent by volume neoprene and shall be free from factice, reclaimed rubber and other deleterious substances. Gaskets shall, in addition, comply with AWWA C111.

2.03 FLANGE ASSEMBLIES

Flange assemblies shall be provided as specified in Section 15085.

Corrosion-resistant bolts and nuts for use with ductile iron joints are an acceptable substitute for alloyed bolts and nuts. Galvanized or cadmium-plated steel bolts and nuts are not acceptable substitutes for stainless steel.

2.04 JOINTS

A. PUSH-ON AND MECHANICAL JOINTS:

The plain ends of push-on pipe and mechanical joint pipe shall be marked with paint to show the required depth of penetration for making the joint.

B. MECHANICALLY RESTRAINED JOINTS:

All joints on the force main shall be mechanically restrained joints and shall be designed to allow separation of the joint after installation. Restrained joints shall be "Lok-Fast" Restrained Joint by American Cast Iron Pipe, "TR FLEX" Restrained Joint by U.S. Pipe or equal. Restrained joints utilizing retainer glands are not acceptable.

C. BALL AND SOCKET FLEXIBLE JOINT PIPE:

Ball and socket flexible joint pipe shall be the boltless type and shall allow a maximum joint deflection of 15 degrees. Each joint shall be provided with a retainer lock to prevent rotation after assembly.

D. BONDING AND ELECTRICAL CONDUCTIVITY:

All pipe joints on the force main shall be prepared for binding for electrical conductivity in accordance with the details shown. The Contractor shall furnish all materials required for joint bonding and electrolysis test station installations.

2.05 FITTINGS

Unless otherwise specified, fittings shall conform to AWWA C110. Ends shall be flanged, mechanical joint or push-on to suit the conditions specified. Gray cast iron fittings may be substituted for ductile iron fittings provided they conform to the specified requirements, and AWWA C153 compact ductile iron fittings, in sizes 3 through 12 inches, may be substituted for standard fittings except for Piping Systems 12, 15 and 16. Long radius elbows shall be provided where specified.

2.06 PIPE LINING

A. ASPHALTIC LINING:

Unless otherwise specified, pipe and fittings shall be lined with asphaltic material as specified in AWWA C151.

B. CEMENT MORTAR LINING:

Where specified, interior surfaces of pipe and fittings shall be cement mortar lined in accordance with AWWA C104. Cement shall be ASTM C150, Type II or V, low alkali, containing less than 0.60 percent alkalies.

C. GLASS LINING:

Where specified, pipe and fittings shall be glass lined with a vitreous material to a minimum thickness of 10 mils. Glass lining shall provide continuous coverage as tested by a low voltage holiday detector with only isolated voids permitted due to casting anomalies. Voids, other than isolated pinholes, shall be cause for rejection.

Ductile or cast iron pipe shall be bored, machined, or grit blasted to remove any voids, protrusions or surface irregularities to obtain a smooth continuous surface for glass lining. Pipe shall be at least Class 53 on diameters of 6 inches or greater except for pipe to be bored or machined which shall be of a suitable wall thickness to assure boring or machining will not impair minimum wall thickness required for Class 53. Four-inch pipe shall be Class 56. Fittings shall be ground or grit blasted to remove any voids, protrusions or surface irregularities.

Glass lining shall be Ferrock MEH-32, Ervite SG-14, or equal.

2.07 PIPE COATING

A. ASPHALTIC COATING:

Unless otherwise specified, pipe and fittings shall be coated with asphaltic material as specified in AWWA C151.

2.08 PRODUCT DATA

The following information shall be provided in accordance with paragraph 00710-4.02:

1. Shop drawings.

2. Alignment drawings.

3. Certification that each length of pipe has been tested physically for ductility and has satisfactorily passed such tests.

4. Certifications specified in the following documents:

ANSI A21.52, paragraph 52-4.2
ASTM A716, paragraph 4.2
AWWA C110, paragraph 10-4.3
AWWA C111, paragraph 11-5.1
AWWA C115, paragraph 15-4.2
AWWA C151, paragraph 51-4.2
AWWA C153, paragraph 53-5.3

PART 3--EXECUTION

3.01 INSTALLATION

A. GENERAL:

Piping runs specified on the drawings shall be followed as closely as possible. Proposed deviations shall be submitted in accordance with Section 01300.

Pipe shall be installed in accordance with AWWA C600.

Connections to existing structures and manholes shall be made so that the finished work will conform as nearly as practicable to the requirements specified for the new manholes, including necessary concrete work, cutting and shaping. Concrete mortar shaping within any structure and manhole shall be as specified.

B. INSULATING SECTIONS:

Where a metallic nonferrous pipe or appurtenance is connected to ferrous pipe or appurtenance, an insulating section shall be provided as specified in paragraph 15085-3.05.

C. ANCHORAGE:

Anchorage shall be provided as specified. Calculations and drawings for proposed alternative anchorage shall be submitted in accordance with Section 01300.

3.02 ACCEPTANCE TESTING

Hydrostatic pressure tests shall be conducted in accordance with Section 4 of AWWA C600 except that test pressures and allowable leakage shall be as listed in Section 15050.

The Contractor shall conduct the tests in the presence of the Construction Manager.

END OF SECTION

SECTION 15064

PLASTIC PIPE

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies polyvinylchloride, chlorinated polyvinylchloride, polyethylene, and polypropylene pipe and fittings.

B. PIPE DESIGNATIONS:

For use in the Piping System Specification Sheets (PIPESPEC) in Section 15050 and in this section, the following plastic pipe designations are defined:

Designation	Definition
PVC	Polyvinylchloride
CPVC	Chlorinated polyvinylchloride
PE	Polyethylene
PP	Polypropylene

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASTM D1248-84	Polyethylene Plastics Molding and Extrusion Materials
ASTM D1784-81	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
ASTM D1785-83	Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D2146-82	Propylene Plastic Molding and Extrusion Materials

Reference (cont'd)	Title
ASTM D2241-84	Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR)
ASTM D2464-76	Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2466-78	Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2467-76	Socket-Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2564-84	Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings
ASTM D2657-79	Heat-Joining Polyolefin Pipe and Fittings
ASTM D2665-85	Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D3034-85	Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM F402-80	Safe Handling of Solvent Cements and Primers Used for Joining Thermoplastic Pipe and Fittings
ASTM F437-82	Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F438-82	Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40
ASTM F439-82	Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F441-84	Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
ASTM F477-76	Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F493-85	Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings

PART 2--PRODUCTS

2.01 PVC PIPE

A. PRESSURE PIPE:

PVC material for pipe and fittings shall conform to ASTM D1784, Class 12454-B. Pipe and fittings shall either be in accordance with ASTM D1785 or shall conform to ASTM D2241 for standard dimension ratios: 160 psi pipe--SDR 26; 200 psi pipe--SDR 21; 250 psi--SDR 17. Pressure rating for pipe shall be in excess of test pressure specified in Section 15050. Neoprene gaskets with push-on joints shall conform to ASTM F477.

Schedule 80 PVC socket type fittings shall conform to ASTM D2467. Schedule 40 PVC fittings shall conform to ASTM D2466. PVC solvent weld cement for socket connections shall meet the requirements of ASTM D2564. Schedule 80 PVC threaded fittings shall conform to ASTM D2464. Fittings for gasketed pipe shall be ductile iron or steel push-on IPS-sized pressure fittings rated for use with the specified class of PVC pipe. Unless otherwise specified, fittings shall be lined and coated in accordance with Section 15061 or Section 15062 as applicable.

B. NONPRESSURE PIPE:

1. GRAVITY SEWER PIPE: PVC material for sewer pipe and fittings shall conform to Class 12454-B, as defined in ASTM D1784. Pipe and fittings shall meet the requirements of ASTM D3034 for SDR 35. Neoprene gaskets with push-on joints shall conform to ASTM F477.

2. DRAIN, WASTE AND VENT PIPE: PVC material for drain waste and vent (DWV) pipe and fittings shall conform to Class 12454-B, ASTM D1784. Pipe and fittings shall conform to ASTM D2665. Unless otherwise specified, connections shall be solvent weld. Connections to traps, closet flanges, and nonplastic pipe shall be with approved adapter type fittings designed for intended use. Solvent weld cement for socket connections shall meet requirements of ASTM D2564.

2.02 CPVC PIPE

CPVC material for pipe and fittings shall conform to ASTM D1784, Class 23447-B. Pipe and fittings shall be in accordance with ASTM F441. Neoprene gaskets with push-on joints shall conform to ASTM F477.

Schedule 80 CPVC socket type fittings shall conform to ASTM F439. Schedule 40 CPVC socket type fittings shall conform to ASTM F438. CPVC solvent weld cement for socket connections shall meet the requirements of ASTM F493. Schedule 80 CPVC threaded type fittings shall conform to ASTM F437.

2.03 PE PIPE

PE pipe shall meet the requirements of ASTM D1248, Type III, Grade 3, Class C, 100 psi or as specified in Section 15050, whichever is higher. Fittings shall be of the same material, molded socket fusion for sizes 4 inch diameter and smaller and molded or fabricated butt fusion for sizes 6 inch and larger. Fittings shall be 125 psi or as specified in Section 15050, whichever is higher. Heat fusion welding shall be in conformance with ASTM D2657.

2.04 PP PIPE

A. PRESSURE PIPE:

PP pipe and fittings shall be formulated of polypropylene conforming to ASTM D2146, SDR 11, butt fusion type. Pipe shall be 150 psi rated in all sizes. Heat fusion welding shall be in conformance with manufacturer's recommendation.

B. DRAIN, WASTE AND VENT PIPE:

PP drain, waste and vent (DWV) pipe and fittings shall be made from flame retardant, Schedule 40, polypropylene (PPFR) plastic as defined in ASTM D2146. Pipe and fittings used for buried piping and in concealed locations shall be joined by electrical fusion coils energized by a variable low-voltage power supply to completely fuse the interface between the pipe and socket and form a completely homogenous structure. Unless otherwise specified, mechanical joint fittings may be used under bench or in exposed locations where future disassembly is desired. The mechanical method shall be in conformance with the manufacturer's recommendation.

2.05 PRODUCT DATA

The following information shall be provided in accordance with paragraph 00710-4.02:

1. Manufacturer's certificates of compliance with the specified standards and Contractor's layout drawings.

PART 3--EXECUTION

3.01 INSTALLATION

PVC pipe 3 inches in diameter and smaller shall be joined by means of socket fittings and solvent welding in conformance with ASTM F402. Unless otherwise specified, PVC pipe 4 inches in diameter and greater shall be joined by means of gasketed push-on joints and steel or ductile iron push-on or mechanical joint fittings. Fittings shall be lined and coated as specified in

Section 15061 or 15062. Unless otherwise specified, PVC and CPVC piping exposed to sunlight shall be painted with coating system L-2 as specified in Section 09900.

Connections to different types of pipe shall be by means of flanges, specified adapters or transition fittings. Where sleeve type couplings are used, both shall be uniformly torqued in accordance with pipe manufacturer's recommendation. Foreign material shall be removed from the pipe interior prior to assembly.

Unless otherwise specified, PE pipe and fittings 4 inch diameter and smaller shall be joined by means of thermal socket fusion and pipe 6 inch and larger by thermal butt fusion. Butt-fusion joining of the pipes and fittings shall be performed with special joining equipment in accordance with procedures recommended by pipe manufacturer. Tensile strength at yield of butt-fusion joints shall not be less than pipe. Flanged adapters shall be provided for connection to valves and where specified.

3.02 TESTING

Testing of plastic piping shall be as specified in Section 15050.

END OF SECTION

SECTION 15065

STAINLESS STEEL PIPING

PART 1--GENERAL

This section specifies stainless steel pipe and fittings.

PART 2--PRODUCTS

2.01 STAINLESS STEEL PIPE AND FITTINGS

Stainless steel pipe and fittings shall conform to Section 15050, Piping System 1.

2.02 STAINLESS STEEL BOLTS

Bolts, nuts and washers shall conform to ASTM A320, type 304.

2.03 PRODUCT DATA

Contractor's layout drawings and catalog data demonstrating compliance with this specification and giving full description of all stainless steel piping shall be provided.

PART 3--EXECUTION

3.01 TESTING

The testing of all stainless steel piping shall be as specified in Section 15050, Piping Systems.

END OF SECTION

SECTION 15066

COPPER PIPING

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies copper piping, tubing, couplings and fittings.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ANSI B16.22-80	Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ANSI B16.26-83	Cast Copper Alloy Fittings for Flared Copper Tubes
ASTM B32-83	Solder Metal
ASTM B88-83	Seamless Copper Water Tube

PART 2--PRODUCTS

2.01 COPPER TUBING

Copper tubing shall be seamless copper, conforming to ASTM B88. Unless otherwise specified, copper tubing shall be Type L, drawn, where used in exposed service and Type K, annealed or drawn for buried service.

2.02 COUPLINGS AND FITTINGS FOR COPPER TUBING

Unless otherwise specified, couplings and fittings for copper tubing 1/2 inch and smaller nominal diameter shall be compression type, brass or bronze, capable of holding the full bursting strength of the tubing; shall meet the requirements of ANSI B16.26; and shall be Swagelok, Gyrolok, or equal.

Couplings and fittings for copper tubing larger than 1/2 inch nominal diameter shall be wrought copper or bronze, solder joint pressure fittings and shall conform to ANSI B16.22.

2.03 SOLDER

Solder to be used in copper piping shall be ASTM B32, Alloy Grade 50B.

2.04 PRODUCT DATA

Contractor's layout drawings and catalog data demonstrating compliance with this specification and giving full description of the copper piping shall be provided in accordance with paragraph 00710-4.02.

PART 3--EXECUTION

3.01 FABRICATION

A. SOLDER JOINTS:

All pipe and fittings to be jointed with solder shall be free from all burrs and wire brushed or steel wool cleaned. After cleaning, a paste flux shall be evenly and sparingly applied to the surfaces to be joined. Solder shall then be applied and flame passed toward the center of the fitting until the solder disappears. All excess solder shall be removed while it is still plastic. Absolutely no acid flux or acid wipe shall be used in making solder joints.

B. TAKEDOWN COUPLINGS:

Takedown couplings shall be screw union type and shall be provided in accordance with paragraph 15085-3.01 C.

C. DIELECTRIC PROTECTION:

Copper tubing or fittings shall not be permitted to come in contact with steel piping, reinforcing steel, or other steel at any location. Electrical checks shall be made to assure no contact is made between copper tubing and steel elements. Wherever electrical contact is demonstrated by such tests, the Contractor shall provide dielectric protection as specified in paragraph 15085-3.01 E.

3.02 INSTALLATION, CLEANING, DISINFECTION, AND TESTING

The installation, cleaning, disinfection, and testing of copper piping shall be as specified in Section 15050.

END OF SECTION

SECTION 15075

JOINT GASKETS

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies rubber gaskets for push-on compression type joints used with fabricated steel pipe, steel pipe, reinforced concrete pipe, concrete cylinder pipe, and cement mortar lined and coated steel pipe.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASTM D395-84	Rubber Property--Compression Set, Test for for
ASTM D412-83	Rubber Properties in Tension, Test for
ASTM D471-79	Rubber Property--Effect of Liquids, Test for
ASTM D573-81	Rubber--Deterioration in an Air Oven, Test for
ASTM D1149-81	Rubber Deterioration--Surface Ozone Cracking in a Chamber (Flat Specimens), Test for
ASTM D2240-85	Rubber Property--Durometer Hardness, Test for

PART 2--PRODUCTS

2.01 MATERIALS

Gasket stock shall be a synthetic rubber compound in which the elastomer is neoprene. The compound shall contain no less than 50 percent by volume neoprene and shall be free from factice, reclaimed rubber and other deleterious substances.

2.02 PHYSICAL REQUIREMENTS

The compound shall meet the following physical requirements when tested in accordance with the specified ASTM standards.

A. TENSILE (ASTM D412):

The tensile strength shall be 1500 psi minimum and the ultimate elongation shall be 425 percent minimum.

B. HARDNESS (ASTM D2240, TYPE A DUROMETER):

1. INITIAL TEST: The compound shall have a minimum hardness of 45 ± 5 for pipe diameters less than 90 inches and 55 ± 5 for pipe diameters greater than 90 inches.

2. SUBSEQUENT TEST: After conducting the initial test, the test specimen and the durometer shall be conditioned at -10 degrees C for 48 hours and then shall be tested. The increase in hardness over the initial test value shall not exceed 15 points.

C. COMPRESSION SET (ASTM D395):

The compression set shall not exceed 20 percent when compressed for 22 hours at 70 degrees C.

The test specimens shall be circular discs cut from the gaskets. Test specimens shall be 0.500 (± 0.005 - 0.025) inches in height. The diameter of the test specimen shall be that of the gasket but not to exceed 1.129 ± 0.010 inches in diameter.

D. AGING (ASTM D573):

The test specimen deterioration shall be less than 20 percent reduction in tensile strength, 40 percent reduction in ultimate elongation, and 15 points increase in hardness.

E. EFFECT OF LIQUIDS (ASTM D471):

The maximum volume change in oil and in water shall be as follows:

1. Oil: 100 percent in ASTM oil No. 3.

2. Water: 15 percent.

The test specimens shall have a thickness of 0.080 ± 0.005 inches and shall be circular discs cut from the gasket.

F. OZONE CRACKING (ASTM D1149):

The test specimen shall be a gasket loop mounted to give at least 20 percent elongation. There shall be no cracking visible at two times magnification of the gasket after 100 hours exposure to 1 mg/l ozone at 40 degrees C.

2.03 PRODUCT DATA

In accordance with paragraph 00710-4.02, the Contractor shall provide certified copies of test reports indicating that the gasket material has been tested and that the results of the tests comply with the requirements specified.

PART 3--EXECUTION

The gaskets shall be installed in accordance with the manufacturer's recommendations.

END OF SECTION

SECTION 15085

PIPING CONNECTIONS

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies the following methods of connecting metallic piping: flanges, threading, mechanical couplings, dielectric unions, and welding.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and the listed documents, the requirements of this section shall prevail.

Reference	Title
ANSI B1.1-82	Unified Inch Screw Threads (UN and UNR Thread Form)
ANSI B1.20.1-83	Pipe Threads, General Purpose (Inch)
ANSI B16.1-75	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800
ANSI B16.5-81	Pipe Flanges and Flanged Fittings
ANSI B18.2.1-81	Square and Hex Bolts and Screws Inch Series Including Hex Cap Screws and Lag Screws
ANSI B18.2.2-72	Square and Hex Nuts (R1983)
ANSI B31.1-83	Power Piping
ANSI B31.3-84	Chemical Plant and Petroleum Refinery Piping
ASME Section IX (1986)	Boiler and Pressure Vessel Code; Welding and Brazing Qualifications
AWWA C206-82	Field Welding of Steel Water Pipe
AWWA C207-78	Steel Pipe Flanges for Waterworks Service - Size 4 In. Through 144 In.

Reference	Title
AWWA M11-85	Steel Pipe--A Guide for Design and Installation

PART 2--PRODUCTS

2.01 FLANGE ASSEMBLIES

A. FLANGES:

Cast iron flanges shall be faced in accordance with ANSI B16.1. Where companion flanges are used, the flanges on pipe shall be refaced to be flush with the companion flange face. Class 150 and Class 300 forged steel flanges shall be raised face conforming to ANSI B16.5. Lightweight slip-on flanges shall be plain face conforming to AWWA C207, Class B and ANSI B16.5. Unless otherwise specified, steel flanges shall be ANSI B16.5, Class 150 or AWWA C207, Class D. Plain faced flanges shall not be bolted to raised face flanges.

B. GASKETS:

Gasket material shall be as specified in paragraph 15085-2.03.

Gaskets for plain faced flanges shall be the full face type. Thickness shall be 1/16 inch for pipe 10 inches and less in diameter and 1/8 inch for pipe 12 inches and larger in diameter. Unless otherwise specified, gaskets for raised face flanges shall match the raised face and shall be 1/16 inch thick for pipe 3-1/2 inches and less in diameter and 1/8 inch thick for pipe 4 inches and larger.

C. BOLTS:

Flange assembly bolts shall be ANSI B18.2.1 standard square or hexagon head carbon steel machine bolts with ANSI B18.2.2 standard hot pressed hexagon nuts. Threads shall be ANSI B1.1, standard coarse thread series; bolts shall be Class 2A, nuts shall be Class 2B. Bolt length shall conform to ANSI B16.5. Flange assembly bolts and nuts for submerged or buried service shall be noncorrosive alloy metal regardless of any other protective coating.

2.02 MECHANICAL COUPLINGS

A. SLEEVE-TYPE COUPLINGS:

Unless otherwise specified, sleeve-type mechanical pipe couplings shall be Rockwell Type 411, Dresser Style 38, or equal,

with the stop removed from the middle ring. Reducing couplings shall be Rockwell Type 413, Dresser Style 62, or equal. Sleeve-type flanged coupling adapters shall be Rockwell Type 913, Dresser Style 128, or equal. Insulating couplings shall be Rockwell Type 416, Dresser Style 39, or equal.

Gaskets shall be as specified in paragraph 15085-2.03.

B. PLAIN END COUPLINGS:

Plain end pipe couplings for pipe sizes 6 inches and smaller shall be Gustin-Bacon 200, Victaulic Style 99, or equal for Schedule 80 pipe and Gustin-Bacon 205, Victaulic Style 90, or equal for lighter weight pipe. Plain end couplings for pipe sizes 8 inches and larger shall be Gustin-Bacon 200, Victaulic Style 99, or equal.

Gaskets shall be as specified in paragraph 15085-2.03.

C. GROOVED END COUPLINGS:

Grooved end flexible-type couplings shall be Gustin-Bacon 100, Victaulic Style 77, or equal. Grooved end rigid-type couplings shall be Gustin-Bacon 125, Victaulic Style 07 Zero-Flex, or equal. Flexible-type couplings shall be used for all piping greater than 12 inches in diameter and for pipe 12 inches in diameter and less in rack-mounted tunnel piping applications. All other applications for piping 12 inches in diameter and less shall utilize rigid-type couplings. Grooved end flanged coupling adapters shall be either Gustin-Bacon 154, Victaulic Style 741, or equal. Snap-joint grooved end couplings shall be Gustin-Bacon 115, Victaulic Style 78, or equal. Cut grooves are not permitted on fabricated or lightwall pipe.

Gaskets shall be as specified in paragraph 15085-2.03.

2.03 GASKETS

Gaskets designated in Section 15050 shall be as follows:

1. EPDM: ethylene-propylene-diene-terpolymer.

2. Neoprene: neoprene.

3. Nitrile: nitrile (Buna N).

4. Neoprene, C.I.: neoprene with cloth insert.

5. Neoprene, oil resistant: neoprene with oil-resisting characteristics.

6. TFE: noncreeping tetrafluoroethylene (TFE) with insert filler.

7. Compressed gasketing consisting of organic fibers (Kevlar), fillers and styrene butadiene rubber (SBR) binder.

8. TFE bonded EPDM: TFE bonded to EPDM in full-face gasket having concentric-convex molded rings.

2.04 THREAD

Pipe thread dimensions and size limits shall conform to ANSI B1.20.1.

2.05 DIELECTRIC UNIONS

Dielectric unions shall be EPCO, Capital, or equal.

2.06 COATINGS

Unless otherwise specified, flange assemblies and mechanical sleeve type couplings for buried installation shall be field coated as specified in Section 09900.

2.07 PRODUCT DATA

In accordance with paragraph 00710-4.02, the Contractor shall provide for each welder, a welder qualification certificate indicating the welder is certified for pipe welding in accordance with ASME Boiler and Pressure Vessel, Section IX. Each welder's certificate shall be provided to the Construction Manager prior to that welder working on the job.

PART 3--EXECUTION

3.01 INSTALLATION

A. PIPE CUTTING, THREADING AND JOINTING:

Pipe cutting, threading and jointing shall conform to the requirements of ANSI B31.1.

B. PIPE WELDING:

Pipe shall be welded by ASME-certified welders using shielded metal arc, gas shielded arc or submerged arc welding methods. Welds shall be made in accordance with the requirements of ANSI B31.1 for piping Systems 8, 26, and 28 specified in Section 15050. Welds shall be made in accordance with the requirements of ANSI B31.3 for piping System 20 specified in Section 15050.

Welds for piping systems not specified above shall be made in accordance with AWWA C206.

C. TAKEDOWN COUPLINGS:

Takedown couplings shall be screw unions, flanged or grooved end mechanical coupling type joints and shall be provided as specified. Flanged or grooved end joints shall be employed on pipelines 2-1/2 inches in diameter and larger. Where piping passes through walls, takedown couplings shall be provided within 3 feet of the wall, unless specified otherwise.

A union or flanged connection shall be provided within 2 feet of each threaded end valve.

D. FLEXIBILITY:

Unless otherwise specified, piping 2 inches in diameter and larger passing from concrete to earth shall be provided with pipe couplings or flexible joints as specified within 2 feet of the structure. Steel and ductile iron pipe shall be provided with one such coupling or joint; other pipe shall be provided with two such couplings or joints. Where required for resistance to pressure, mechanical couplings shall be restrained in accordance with AWWA M11, paragraph 13.10, Tables 13-6 and 13-7, and Figure 13-17.

E. DIELECTRIC CONNECTIONS:

Where a copper pipe is connected to steel or cast iron pipe, an insulating section of rubber or plastic pipe shall be provided. The insulating section shall have a minimum length of 12 pipe diameters. Dielectric unions as specified in paragraph 15085-2.05 may be used instead of the specified insulating sections. Where copper pipe is supported from hangers, it shall be insulated from the hangers, or copper-plated hangers shall be used.

END OF SECTION

SECTION 15090

EXPANSION JOINTS AND FLEXIBLE METAL HOSE

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies piping expansion joints and flexible metal hose.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This paragraph references the following document. It is a part of this section as specified and modified. In case of conflict between the requirements of this section and the listed document, the requirements of this section shall prevail.

Reference	Title
ASTM A276-83	Stainless and Heat-Resisting Steel Bars and Shapes

B. PERFORMANCE AND SERVICE CONDITIONS:

Expansion joints shall be suitable for pressure, temperature and service as specified in the Piping System Specification Sheets (PIPESPEC) without crimping of corrugations.

Flexible metal hose shall be suitable for a line pressure more than twice the test pressure listed in the PIPESPEC.

C. DESIGN REQUIREMENTS:

Live lengths for flexible metal hose shall be based upon the service conditions listed under paragraphs 15090-1.02 A and B and a design life of 1,000,000 full displacement cycles.

PART 2--PRODUCTS

2.01 EXPANSION JOINTS

A. METAL CONSTRUCTION:

1. GENERAL: Corrugated type expansion joints shall be suitable for a minimum of 100,000 pressure, temperature and deflection cycles.

2. FREE-FLEXING TYPE: Free-flexing type expansion joints shall have an ASTM A276, type 304 stainless steel corrugated member. Joints shall be rated for 50 psi and 850 degrees F.

3. CONTROLLED-FLEXING TYPE: Controlled-flexing type expansion joints shall have an ASTM A276, type 304 stainless steel corrugated member and nickel iron control rings. Joints shall be rated for 300 psi and 500 degrees F.

4. STEEL EXPANSION COMPENSATOR TYPE: Steel expansion compensator type expansion joints shall be Flexonics Model H Expansion Compensator, Keflex 7QS, or equal. Compensators to have 2-ply stainless steel bellows and carbon steel shroud and end fittings. Compensators shall be rated for 175 psi maximum working pressure and 750 degrees F.

5. BRONZE EXPANSION COMPENSATOR TYPE: Bronze expansion compensator type expansion joints shall be Flexonics Model HB Expansion Compensator, Keflex 7Q, or equal. Compensators shall have 2-ply phosphor bronze bellows and brass shrouds and end fittings. Internal parts shall be of nonferrous metals. Compensators shall be rated for 150 psi maximum working pressure and 406 degrees F.

B. RUBBER-AND-FABRIC CONSTRUCTION:

1. GENERAL: Rubber-and-fabric expansion joints shall be of resilient arch type and shall be standard or tapered, as specified. Tapered rubber-and-fabric expansion joints shall be concentric or eccentric, as specified. The cover elastomer shall be chlorobutyl for weather and ozone resistance.

Rubber-and-fabric expansion joints shall have control units to prevent excessive axial elongation and to accept the static pressure thrust in the piping system.

Rubber-and-fabric expansion joints shall be provided with retaining rings, or backup rings. Retaining rings shall be 3/8-inch thick steel, split, either galvanized or zinc shield coated.

Rubber-and-fabric expansion joints shall have 6-inch face-to-face dimension for pipe up to 8 inches and 8-inch face-to-face dimension for pipe 10 inches and 12 inches.

2. SPOOL TYPE: Spool type expansion joints shall be constructed of multiple plies of woven fabric impregnated with elastomer and reinforced with solid rectangular steel rings embedded in the body. Spool type expansion joints shall be suitable for a minimum temperature of 180 degrees F. Spool type expansion joints shall be Garlock Style #204, Belmont Style #5204, Uniroyal Style 4150, or equal.

3. HIGH PRESSURE SPOOL TYPE: High pressure spool type expansion joints shall be synthetic rubber and asbestos spool type, single arch suitable to a minimum of 240 degrees F and shall be Garlock Style #204 HP, Belmont #5204 Class II, American Rubber Style P&LD, or equal.

4. FLOWING ARCH TYPE: Flowing arch type expansion joints shall be Belmont Style 5100, Garlock Style 8100. Flowing arch type expansion joints shall have ductile iron floating flanges, and no metal parts shall come in contact with the fluid. Tube materials shall be compatible with the contained fluid at temperatures and pressures as specified in the PIPESPEC. The assembled expansion joints shall be equipped with restraints. Number and sizes of restraints shall be as determined by the manufacturer.

5. FILLED ARCH TYPE: Filled arch type expansion joints shall have arches filled with soft elastomers vulcanized to the carcass under the tube or linear to prevent contact with the fluid carried.

C. POLYVINYLCHLORIDE CONSTRUCTION:

Polyvinylchloride expansion joints shall be Celanese "Chemtrol" CPVC slip type with teflon impregnated seal rings, Certain-teed Fluid Tite PVC, Johns-Manville PVC double bell expansion joint, or equal.

D. TEFLON CONSTRUCTION:

Teflon expansion joints shall be molded TFE bellows and shall be Metra Flex T-2, Resistoflex R-6905, or equal.

2.02 FLEXIBLE METAL HOSE

A. GENERAL:

Flexible metal hose shall be corrugated type stainless steel with stainless steel fittings, and shall be provided with stainless steel single or double braid, as specified. End connections shall be attached by the heliarc welding process using stainless steel welding rod.

B. BRAIDED TYPE:

1. TYPE A: Type A braided flexible metal hose shall be Keflex Type KFCS, Flexonics Series 401M, or equal.

2. TYPE B: Type B braided flexible metal hose shall be Flexonics RW-81, Anaconda, or equal.

C. UNBRAIDED TYPE:

Unbraided metal hose shall be Flexonics Series 400 M, Anaconda, or equal.

2.03 PRODUCT DATA

Details for installation of expansion joints shall be provided to the Construction Manager in accordance with paragraph 00710-4.02.

PART 3--EXECUTION

3.01 INSTALLATION

Expansion joints and anchors shall be located and spaced as specified by the Expansion Joint Manufacturer's Association under ambient conditions.

Expansion joints shall not be installed during times of temperature extreme or in a fully compressed or fully expanded condition.

3.02 ALIGNMENT

Piping systems shall be aligned prior to installation of expansion joints. Alignment shall be provided by fitting a rigid pipe spool in place of the expansion joint. Prior to testing of the piping system, the pipe spool shall be replaced with the specified expansion joint. Pipe spools shall be provided in accordance with the manufacturer's recommended dimensions for expansion joints.

END OF SECTION

SECTION 15095

PIPING APPURTENANCES

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies pipeline thermometers, flow and level gages, pressure gages, strainers, steam traps, vents and drains.

PART 2--PRODUCTS

2.01 PIPELINE THERMOMETERS

A. GENERAL:

The operating temperature range for pipeline thermometers shall be suitable for the temperature range specified in the Piping System Specification Sheets, Section 15050. Pipeline thermometers shall indicate fluid temperatures within the pipeline to an accuracy of plus or minus 2 percent of thermometer full scale.

Pipeline thermometers shall be provided with threaded thermowell mountings, designed to permit removal of the thermometer without depressurization or loss of process fluid. For insulated pipes a thermowell with a lagging extension shall be provided.

B. BIMETALLIC THERMOMETERS:

Bimetallic type thermometers shall be of the adjustable angle type mounted for convenient viewing. Bimetallic thermometers shall have type 304 stainless steel case. Thermometer dials shall be a minimum of 5 inches in diameter and shall be equipped with an external adjustment mechanism for zero reset. Bimetallic thermometers shall be Ashcroft Type EH, Marsh Mastertherm, or equal.

C. FILLED THERMOMETERS:

Filled type thermometers shall have minimum scale length of 9 inches and shall be of the adjustable angle type mounted for convenient viewing. Filled thermometers shall consist of a type 304 stainless steel frame and a mercury-filled pyrex tube. The thermometer tube shall be recessed into the frame. Filled thermometers shall be Princo, Ametek, or equal.

2.02 FLOW AND LEVEL GAGES

A. ROTAMETERS:

Unless otherwise specified, rotameters for purges and other low capacity services shall be Brooks Sho-Rate "50," Wallace & Tiernan 3-inch purge meter, Schutte-Koerting, or equal, with integral needle valve and flow controller. Meter tubes shall be glass, floats shall be stainless steel, and cases shall be aluminum or stainless steel. Units shall have a 3-inch minimum scale.

Rotameters for high capacity service shall be glass tube-type with a 5-inch scale and stainless steel frame. Flow range shall be as specified and scales shall indicate the units of flow. Rotameters shall be as manufactured by Brooks, Wallace & Tiernan, Schutte & Koerting, or equal.

B. SIGHT GAGES:

Sight gages shall be 3/4-inch Penberthy 205 Series, Lunkenheimer Fig. 589, or equal, automatic water gage complete with pyrex gage glass and gage glass protector. Overall length of gages, type of mounting, and orientation of set shall be as specified.

C. FLOW INDICATORS:

Flow indicators shall be provided where specified. Each indicator shall consist of a bronze body with threaded ends and a sight glass with rotary wheel. Pressure ratings for flow indicators shall match pipe pressure ratings. Indicators shall be as manufactured by Jacoby-Tarbox, Schutte & Koerting, Eugene Ernst Products, or equal.

2.03 PRESSURE DEVICES

A. GAGE COCKS:

Gage cocks shall be Robertshaw 1303, Ashcroft 1095, or equal. The exposed threads of each gage cock shall be protected by a brass plug.

B. PRESSURE SENSORS:

Pressure sensors (tubular chemical seals) are specified in Section 17001.

2.04 STRAINERS

A. AIR AND GAS STRAINERS:

Air and gas line strainers shall be Y-pattern, cast iron body, with 40 mesh Monel screens packed with Everdur wool. Air line strainers shall be fitted with a brass blowoff cock. Strainers shall be Crane 988-1/2 or 989-1/2, Leslie, or equal.

B. STEAM AND WATER STRAINERS:

Steam and water strainers shall be of Y-pattern, unless otherwise specified. Steam strainers shall have carbon steel body; water strainers shall have cast iron body. Strainers shall have 304 stainless steel screens and tapped and plugged blowoff connections. Screen perforations shall be 0.020 inch for steam service and 0.045 inch for water service. Strainers shall be Leslie Co., Charles M. Bailey Co., or equal.

C. FUEL OIL STRAINERS:

Fuel oil strainers shall be of the basket type and shall have cast iron body with 304 stainless steel screens. Screen perforation shall be 3/64 inch. Strainers shall be Bailey No. 1, Mueller, or equal.

2.05 STEAM TRAPS

Steam traps shall be of the float and thermostatic type, suitable for working pressure specified in the Piping System Specification Sheets. Bodies shall be of cast iron or semisteel. Float assemblies, seats and air vents shall be of stainless steel. Steam traps shall be Armstrong Series A, Hoffman, or equal.

2.06 PRODUCT DATA

Manufacturer's product data shall be provided in accordance with paragraph 00710-4.02.

PART 3--EXECUTION

3.01 APPLICATION

A. PIPELINE THERMOMETERS:

Bimetallic thermometers shall be provided at the inlet and outlet of each process stream at each heat exchanger and boiler. Thermometers for sludge service shall be provided at elbows with the process sensor oriented in the direction of sludge flow.

Filled thermometers shall be provided at process inlet and outlet connections for engines and chillers where required within 20 feet of any pump and adjacent to process taps for temperature sensing instrumentation.

B. GAGE TAPS:

Gage taps shall be provided on the suction and discharge of pumps, fans, compressors, vacuum pumps and blowers. Gage taps shall consist of a 1/4-inch gage cock attached by a threaded nipple to the pipeline, duct or equipment.

C. VENTS AND DRAINS:

Manual air vents shall be provided at the high points of each reach of pipeline where specified. Air vents shall consist of bronze cock and copper tubing return. Air vents shall be taken to the nearest floor with cock mounted 4 feet above the floor. Vents in piping systems for fluids containing solids shall be 1-inch nonlubricated eccentric plug valves fitted with quick couplers.

Drains shall be piped to a sump, gutter, floor drain or other collection point with a valve mounted 4 feet above the floor. Drain valves shall be threaded end gate valves of the size specified. When drains cannot be run to collection points, they shall be routed to a point of easy access and shall have hose gate valves of the size specified.

END OF SECTION

SECTION 15101

GATE VALVES

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies iron-body, bronze-mounted, solid-wedge gate valves.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ANSI B16.1-75	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250 and 800
ASTM A126-84	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
AWWA C500-80	Gate Valves 3 Through 48 In. NPS, for Water and Sewage Systems

B. DESIGN CRITERIA:

Gate valves 3 inches through 48 inches in size shall comply with AWWA C500, including applicable hydrostatic testing. Gate valves smaller than 3 inches shall be subject to hydrostatic tests at the test pressure.

PART 2--PRODUCTS

2.01 MATERIALS

Materials of construction shall be as follows:

Component	Material
Body	
3 inches and smaller	Bronze
Larger than 3 inches	Cast iron, ASTM A126, Class B

Component (cont'd)	Material
Wedge	
3 inches and smaller	Bronze
Larger than 3 inches	Cast iron, ASTM A126, Class B
Mounting	Bronze
Stem	Bronze, AWWA C500, Section 3.12
Seat rings	Bronze, Grade A, AWWA C500, Section 3.8

2.02 MANUFACTURE

A. GENERAL:

The body shall be provided with screwed-on seat rings. Exposed gate valves shall be rising stem type. Buried or submerged gate valves shall be of the nonrising stem type. Rising stem valves shall be provided with a Teflon braid packing. Nonrising stem valves shall be provided with O-ring stem seals.

B. END CONNECTIONS:

Gate valve end connections shall be flanged or threaded as specified. Threaded ends shall not be provided on gate valves with end connections larger than 4 inches. End flanges shall be integral with the gate valve body and be faced and drilled in accordance with ANSI B16.1 for 125-pound flanges.

C. MANUAL OPERATORS:

Unless specified otherwise, valves less than 12 inch size shall be provided with handwheels, and valves 12 inches and larger shall be provided with geared operators.

D. BYPASS:

Gate valves shall be provided with a bypass valve sized by the manufacturer.

2.03 PRODUCT DATA

The following information shall be provided in accordance with paragraph 00710-4.02:

1. Affidavits of compliance, as required by AWWA C500.
2. Hydrostatic test results.

PART 3--EXECUTION

Gate valves shall be installed in the closed position.

END OF SECTION

SECTION 15103

BUTTERFLY VALVES

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies butterfly valves for air, gas, steam and water service.

B. TYPES:

1. TYPE A: Valves used in the following piping systems for sizes 3 inches and larger shall be designated Type A. Where 2-1/2-inch valves are specified, substitute Type B.

Piping Systems

7
10
11
13
14

2. TYPE B: Valves used in the following piping systems shall be designated Type B:

Piping Systems

1
28

3. TYPE C: NOT IN CONTRACT.

4. TYPE D: Valves used in the following piping systems shall be designated Type D:

Piping System

22

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ANSI B16.1-75	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250 and 800
ANSI B16.5-81	Pipe Flanges and Flanged Fittings
ASTM A48-83	Gray Iron Castings
ASTM A108-81	Steel Bars, Carbon, Cold-Finished, Standard Quality
ASTM A126-84	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A216/A216M-84	Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service
ASTM A276-84	Stainless and Heat-Resisting Steel Bars and Shapes
ASTM A436-84	Austenitic Gray Iron Castings
ASTM A536-84	Ductile Iron Castings
AWWA C504-80	Rubber-Seated Butterfly Valves

PART 2--PRODUCTS

2.01 MATERIALS

A. TYPE A:

Type A valves are specified according to size as follows.

1. TYPE A, SIZE 3 THROUGH 24 INCHES: Type A valves from 3 through 24 inches in size shall be constructed of the following materials:

Component	Material
Shaft	Stainless steel, ASTM A276, type 304, or
	Carbon steel, ASTM A108, with stainless steel journals
Disc	Cast iron, ASTM A436, type 1 (Ni-Resist), or
	Cast iron, ASTM A48, Class 40

Component	Material
Seat sealing surface	Neoprene or Buna N
Body	Cast iron, ASTM A126, Class B

2. TYPE A, SIZE 30 THROUGH 72 INCHES: Type A valves from 30 through 72 inches in size shall be constructed of the following materials:

Component	Material
Shaft	Stainless steel, ASTM A276, type 304
Disc	Ductile iron, ASTM A536, or cast iron, ASTM A48, Class 40
Seat sealing surface	Neoprene or Buna N
Disc edge	Stainless steel, ASTM A276, type 304
Body	Cast iron, ASTM A126, Class B

B. TYPE B:

Type B valves shall be constructed of the following materials:

Component	Material
Shaft	Stainless steel, ASTM A582, type 416
Disc	Cast iron, ASTM A126, Class B
Seat sealing surface	Neoprene or Buna N--air and gas services Nordel--(high temp water)
Body	Cast iron, ASTM A126, Class B
Disc edge	Nickel

C. TYPE C:

Type C valves shall be constructed of the following materials:

Component	Material
Shaft	Stainless steel, ASTM A276, type 316
Disc	Carbon steel, ASTM A216
Seat sealing surface	Teflon
Disc edge	Nickel
Body	Carbon steel, ASTM A216

D. TYPE D:

Type D valves shall be constructed of the following materials:

Component	Material
Shaft	Stainless steel, ASTM A276, type 304
Disc	Polypropylene
Seat	EPT
Body	Rigid polyvinylchloride (PVC)

2.02 MANUFACTURE

A. GENERAL:

Valves shall be the stub or through shaft design. Wafer type ends are not acceptable for buried service. Unless otherwise specified, valve flange drilling shall be per ANSI B16.1, Class 125.

B. TYPE A:

Type A valves shall be designed in accordance with AWWA C504. Shafts shall be turned, ground and polished. Shaft dimensions and operator torque shall be chosen for the pressure specified in Section 15050 and Class B as specified in AWWA C504. When carbon steel shafts and stainless steel journals are used, static seals shall be provided to isolate the interior of the disc and the shaft from the process fluid.

Type A valves, size 3 through 24 inches, shall have seats that are vulcanized, bonded, mechanically secured, or clamped to the body or disc.

Type A valves, size 30 through 72 inches, shall have seats retained in the valve body. Valve seats shall be field adjustable and field replaceable. Discs for valves shall be of the flow-through type with a 360-degree seating design.

C. TYPE B:

Valves shall be rated at 175 psig and provide driptight shutoff up to the full valve rating on dead-end or isolation service. Seat shall be mechanically held in place and shall be field replaceable. Valve ends shall be as specified in Section 15050.

Type B valves, size 2 through 20 inches, shall have seats that are bonded to a rigid reinforcing ring.

Type B valves, size 24 through 36 inches, shall have adjustable seats bonded to a bronze retention ring that is held in place by type 304 stainless steel retaining screws.

D. TYPE C (SIZE 2 THROUGH 20 INCHES):

Type C valves shall be high-pressure, high-temperature, corrosion-resistant valves capable of providing driptight shutoff to 225 psig and operating at 300 degrees F temperature. Valves shall be wafer or single-flange lugged design compatible for use with flanges to ANSI B16.5, Class 150.

Type C valves shall have seats that are pressure energized to assure positive shutoff. Seat shall seal effectively with flow in either direction.

E. TYPE D:

Valves shall have a molded PVC body. The disc shall be polypropylene with an encapsulated metal reinforcing insert. The liner shall be neoprene which serves as the flange gasket.

2.03 MANUAL OPERATORS

A. GENERAL:

Manual operators shall be designed in accordance with AWWA C504 and shall have a disc position indicator designating the opened and closed position of the valve.

B. TYPE A:

Manual operators for Type A valves shall be of the traveling nut, rack and pinion, or worm gear type. Operators shall be equipped with adjustable mechanical stop-limiting devices to prevent overtravel of the disc in the open and closed positions and shall be self-locking and designed to hold the valve in any intermediate position between full open and full closed.

For valves 30 inches in diameter and less, the operator components shall withstand an input torque of 450 ft-lbs at the extreme operator positions without damage. For valves 36 inches in diameter and larger, operator components shall withstand an input torque of 300 ft-lbs at extreme operator positions without damage.

Operator for buried service shall include an AWWA operating nut and shall be gasketed and grease packed for submerged operation at water pressures to 10 psig. Operators for exposed service shall include a handwheel and be gasketed for weatherproof service.

C. TYPES B, C AND D:

Operators for Type B, Type C, and Type D valves 6 inches in diameter and smaller shall be latch lock levers. Valves shall be capable of being locked in at least five intermediate positions between fully open and fully closed.

2.03 C.

Operators for Type B and Type C valves 8 inches in diameter and larger shall be the traveling nut or worm gear type. Operators for exposed service shall be gasketed for weatherproof service. A handwheel or chain wheel shall be provided for each operator as required in Section 15185.

2.04 PRODUCT DATA

Affidavits of compliance with AWWA C504 for Type A valves shall be provided in accordance with paragraph 00710-4.02.

PART 3--EXECUTION

Valves shall be installed in accordance with the manufacturer's recommendations.

END OF SECTION

SECTION 15110

ECCENTRIC PLUG VALVES

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies eccentric plug valves.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section insofar as specified and modified herein. In case of conflict between the requirements of this section and the listed documents, the requirements of this section shall prevail.

Reference	Title
ANSI B16.1-75	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250 and 800
ASTM A126-84	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A276-84	Stainless and Heat-Resisting Steel Bars and Shapes
ASTM A436-84	Austenitic Gray Iron Castings
ASTM A536-84	Ductile Iron Castings
AWWA C504-80	Rubber Seated Butterfly Valves

B. PROOF OF DESIGN TESTS:

The Contractor shall furnish the Construction Manager three certified copies of a report from an independent testing laboratory certifying successful completion of proof-of-design testing conducted in accordance with AWWA C504, Section 5.5, except that where the word "disc" appears in the standard, it is understood to mean "plug." In lieu of testing the valves at an independent testing laboratory, proof-of-design testing may be performed at the valve manufacturer's laboratory, but must be witnessed by a

representative of a qualified independent testing laboratory, and all test reports must be certified by the laboratory representative. Proof-of-design testing shall have been performed on not less than three 6-inch diameter valves, with all three test units demonstrating full compliance with the test standards. Failure to satisfactorily complete the test shall be deemed sufficient evidence to reject all valves of the proposed make or manufacturer's model number.

PART 2--PRODUCTS

2.01 MATERIALS

Materials of construction shall be as follows:

Component	Material
Body	Cast iron, ASTM A126, Class B
Plug	Cast iron, ASTM A126, Class B, or cast iron, ASTM A436 (Ni-resist), or ductile iron, ASTM A536
Plug facing	Neoprene or Buna-N
Body seats	
Less than 3 inches	Cast iron, ASTM A126, Class B
3 inches and larger	Stainless steel, ASTM A276, type 304 or nickel
Packing	Buna V-flex or TFE

2.02 MANUFACTURE

A. GENERAL:

Valves shall be straight flow, nonlubricated, resilient plug type suitable for driptight, bidirectional shutoff at the specified valve design pressure. Port areas for the valve shall be at least 70 percent of the adjacent full pipe area. Valve body seats consisting of nickel for valves 3 inches and larger shall be constructed of a welded-in overlay of not less than 90 percent pure nickel. Upper and lower journal bearings shall be replaceable, sleeve-type, corrosion-resistant, and permanently lubricated. Packing shall be self-adjusting chevron type replaceable without disassembling the valve.

Unless otherwise specified, valves shall, as a minimum, conform to the following pressure ratings:

Size, inches	Design pressure, psig
12 and smaller	175
14 through 36	150
42 through 54	125

B. END CONNECTIONS:

Valves 3 inches and smaller shall have threaded ends. Valve flange drilling for valves larger than 3 inches shall be per ANSI B16.1, Class 125.

C. MANUAL OPERATORS:

Unless otherwise specified, valves 6 inches and smaller shall be provided with a lever type manual operator. Valves larger than 6 inches shall be provided with totally enclosed, worm gear operators. Where specified, manual operators shall have an adjustable stop. Operator components shall be sized for the valve design pressure in accordance with AWWA C504, Section 3.8.

2.03 PRODUCT DATA

Manufacturer's product data shall be provided in accordance with paragraph 00710-4.02.

Proof-of-design tests shall be provided as specified in paragraph 15110-1.02 B.

PART 3--EXECUTION

Unless otherwise specified, valves shall be provided with the seat downstream away from flow.

END OF SECTION

SECTION 15118

SPRING-LOADED SWING CHECK VALVES

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies spring-loaded swing check valves.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASTM A126-84	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A276-84	Stainless and Heat-Resisting Steel Bars and Shapes
AWWA C508-82	Swing-Check Valves for Waterworks Service, 2 In. Through 24 In. NPS

PART 2--PRODUCTS

2.01 ACCEPTABLE PRODUCTS

Check valves shall be Golden Anderson Fig. 250-D with outside lever and spring, APCO Series 6000 CLS, or equal.

2.02 MATERIALS

Materials of construction shall be as follows:

Component	Material
Body, cover	Cast iron, ASTM A126, Class B
Disc	Cast iron, ASTM A126, Class B
Seat rings	Bronze, AWWA C508

Component	Material
Hinge shafts and hinge pins	Stainless steel, ASTM 276, type 304
Shaft bushings	Bronze, AWWA C508

2.03 MANUFACTURE

Disc, disc arm, shaft, keyways, lever and spring shall be capable of closing within .05 seconds of pump stoppage and fluid moving at velocity of 8 feet per second. Spring tension shall be adjustable. The valve design shall permit mounting levers and springs on either side of the valve body.

Valves shall be provided with a clear opening equal to or greater than the connecting piping, with no raised seating surface. Seats shall be threaded onto the body or fitted with an O-ring seal and locked in place with stainless steel screws or pins and shall be replaceable. Shafts shall be provided with stuffing box and packing or O-ring seals at each end which are externally replaceable.

Unless otherwise specified, valves shall, as a minimum, conform to the following pressure ratings:

Size, inches	Working pressure, psig	Hydrostatic test pressure, psig
2 through 12	175	350
14 through 30	150	300

2.04 PRODUCT DATA

Manufacturer's catalog information including dimensions, cross-sectional views, details of construction and materials list shall be provided in accordance with paragraph 00710-4.02.

PART 3--EXECUTION

Spring loaded swing check valves shall be installed in accordance with the manufacturer's recommendations.

END OF SECTION

SECTION 15119

DOUBLE DISC CHECK VALVES

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies double disc check valves of the center pivot, double disc, spring type. The valve shall fit as a wafer between piping flanges.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASTM A126-84	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A276-84	Stainless and Heat-Resisting Steel Bars and Shapes
ASTM A536-84	Ductile Iron Castings

PART 2--PRODUCTS

2.01 MATERIALS

Materials of construction shall be as follows:

Component	Material
Body and disc	Cast iron, ASTM A126, Class B, or ductile iron, ASTM A536
Seal	Buna-N
Spring, hinge pin and stop pin	Stainless steel, ASTM A276, type 316

2.02 MANUFACTURE

The check valve discs shall be spring-loaded, normally closed, by means of one or more torsion springs. Seating shall be resilient and watertight.

Unless otherwise specified, valves shall, as a minimum, conform to the following pressure ratings:

Working pressure, psig	Hydrostatic test pressure, psig
175	300

2.03 PRODUCT DATA

Manufacturer's product data shall be provided in accordance with paragraph 00710-4.02.

PART 3--EXECUTION

Double disc check valves shall be installed in accordance with the manufacturer's recommendations.

END OF SECTION

SECTION 15124

REDUCED PRESSURE PRINCIPLE BACKFLOW PREVENTERS

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies reduced pressure principle backflow preventers.

B. EQUIPMENT LIST:

Backflow preventers shall be as follows:

Connection size, inch	Capacity, gpm	Max pressure loss, psi
3/4	30	7.5
2	160	8.5

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following document. It is a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed document, the requirements of this section shall prevail.

Reference	Title
AWWA C506-78	Standard for Backflow Prevention Devices--Reduced Pressure Principle and Double Check Valve Types

B. TESTING:

Backflow preventers shall meet the factory and field test provisions of AWWA C506.

PART 2--PRODUCTS

2.01 ACCEPTABLE PRODUCTS

Backflow preventers shall be Clayton, Badger, or equal.

2.02 PRODUCT DATA

The following information shall be provided in accordance with paragraph 00710-4.02:

1. Affidavit of Compliance with AWWA C506.

2. Certificate of Approval as specified in AWWA C506.

PART 3--EXECUTION

Reduced pressure principle backflow preventers shall be installed in accordance with the manufacturer's recommendations.

END OF SECTION

SECTION 15147

SOLENOID VALVES

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies 2- and 3-way solenoid valves, direct or pilot operated type, for control of process fluids. Valves for air cylinder pilot duty are specified in Section 15185.

B. DESIGN REQUIREMENTS:

Unless otherwise specified, solenoid valves shall be designed to seal the pressurized (supply) port upon deenergization.

Valves shall be listed by Underwriters Laboratories Inc. in accordance with UL 429 and UL 1002. Solenoid valves for gas service shall be approved by Factory Mutual Engineering Corporation. The maximum acceptable operating pressure differential for pilot operated valves shall be 5 psi.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASTM A48-83	Gray Iron Castings
UL 429-82 (1985)	Electrically Operated Valves
UL 1002-84 (1985)	Electrically Operated Valves for Use in Hazardous Locations, Class I, Groups A, B, C, and D, and Class II, Groups E, F, and G

PART 2--PRODUCTS

2.01 ACCEPTABLE PRODUCTS

A. DIRECT ACTING TYPE:

Valves shall be Automatic Switch Company, modified as necessary to provide the specified features. The Owner knows of no equal.

B. PILOT TYPE:

Valves shall be Cla-Val Co., Golden Anderson, or equal, modified as necessary to provide the specified features.

2.02 MATERIALS

A. DIRECT ACTING TYPE:

Materials of construction shall be as follows:

Component	Material
Body	Brass or stainless steel, type 304
Seal	Teflon or Buna-N
Disc	Teflon or Buna-N

B. PILOT TYPE:

Materials of construction shall be as follows:

Component	Material
Main valve body	Cast iron, ASTM A48
Pilot control body	Brass

2.03 MANUFACTURE

A. GENERAL:

Solenoid valves shall be rated for continuous duty at 24 volts DC. Valves shall be threaded or flanged.

B. DIRECT ACTING TYPE:

Valves shall have combination NEMA 7C, 7D and 4 enclosures. Solenoids shall have fully encapsulated, Class H coils.

C. PILOT TYPE:

Valves shall have combination NEMA 7, 9 and 9A enclosures. Solenoids shall have molded, Class F coils.

2.04 PRODUCT DATA

Manufacturer's product data shall be provided in accordance with paragraph 00710 4.02.

PART 3--EXECUTION

Solenoid valves shall be installed in accordance with the manufacturer's recommendations.

Valves with piping connections less than 1-1/2 inches in diameter shall be direct-acting type.

Valves with piping connections 1-1/2 inches in diameter and greater shall be pilot operated globe body type.

END OF SECTION

SECTION 15150

SPECIALTY VALVES

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies specialty valves which are auxiliary to process piping systems.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following document. It is a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed document, the requirements of this section shall prevail.

Reference	Title
ASTM A126-84	Gray Iron Castings for Valves, Flanges, and Pipe Fittings

PART 2--PRODUCTS

2.01 SHEAR GATES

Shear gates shall be provided with a lift handle of sufficient length to permit operation from the operating levels specified. Shear gates shall be iron body with bronze seat and disc rings. Shear gates shall be Clow F-3000, Mueller A-2520, or equal.

2.02 FLAP GATES

Flap gates shall be heavy-duty, double-hinge type. Body and cover shall be cast iron conforming to ASTM A126, Class B. The body shall be provided with a resilient neoprene seat bonded in a groove machined in the body. The seal shall provide positive shutoff. The cover shall have a phosphor bronze seat facing, securely mounted in a dovetail groove around the periphery of the gate opening. Upper pivot shall be adjustable for gate sensitivity, and lower pivot shall incorporate a provision to align the cover. Gate design shall prevent cover from wedging into gate opening. Lubrication fittings shall be provided for each pivot.

Unless otherwise specified, wall thimbles shall be minimum 8-inch deep F-section, formed of ASTM A126, Class B cast iron with the gate mounting face machined flat to form a true bearing surface.

Thimble opening shall be the same as the gate size specified on the drawings. All anchor bolts shall be hot-dip galvanized. Fasteners and bushings shall be naval bronze.

Flap gates shall be Rodney Hunt Series FV-AC or FV-ACP, Armco Heavy Duty Series, or equal.

2.03 MUD VALVES

Mud valves shall be iron body, bronze mounted with spigot ends and nonrising stems. Stems shall be bronze with steel extension shafts where indicated. Operating nuts shall be enclosed in floor boxes or mounted on angle supports as specified and shall be suitable for operation with T-handle wrenches provided with the valves. Operating nuts shall be AWWA standard size. Mud valves shall be Clow F-3080, Mueller A-25601, or equal.

2.04 RELIEF VALVES

Pressure and vacuum relief valves shall be of the weight loaded type. The pressure limit shall be as specified. Valves shall be anodized aluminum body and trim with Buna-N or neoprene seats. Valves shall be Varec 2010-51 series, Oceco V130 series, or equal.

2.05 SAFETY VALVES

Safety valves for air shall be ASME certified, Lunkenheimer Figure 1226 or 1227, Crane 2550 or 2551, or equal. Size and pressure settings shall be as specified or as required for the service intended. Safety and pressure relief valves for cold and hot water shall be Crane 2606, McDonnell and Miller 230, or equal.

2.06 AIR RELEASE VALVES

Air release valves shall be float operated, simple lever type. Valves shall be suitable for pressures up to 150 psi. Body and cover shall be cast iron, float shall be type 316 stainless steel, seat shall be synthetic rubber, and other internal parts shall be type 316 stainless steel. Valves shall be APCO Model 200A, Crispin P10, or equal.

2.07 SEWAGE AIR RELEASE VALVES

Sewage air release valves shall have an elongated body. The body and cover shall be cast iron. The float shall be stainless steel. Sewage air release valves shall be APCO Model 400, Crispin S20, or equal.

2.08 HOSE VALVES

Unless specified otherwise, hose valves shall be a brass angle valve, composition disc, Crane 17, Lunkenheimer 214, Powell 151, or equal with threaded nipple adapter for hose connection.

2.09 FLUSHING COCKS

Flushing cocks shall consist of a DeZurik 159/118-S, Homestead 1112, or equal, neoprene-faced eccentric plug valve with a hose nipple adapter if required. Unless specified otherwise, flushing cocks shall be 1 inch in diameter.

2.10 QUICK DISCONNECTS

Quick disconnects shall not be disconnectable under pressure. Quick disconnects for air service shall be Swagelok, Milton Quick-Change, or equal, and shall be 1/2 inch, unless otherwise specified. Quick disconnects for water service shall be EverTite Part B, Gate Part B, or equal, and shall be 1 inch, unless specified otherwise.

2.11 STOP AND DRAIN VALVES

Stop and drain valves shall be Hays 1000, James Jones Co., or equal.

2.12 PRODUCT DATA

The following information shall be provided in accordance with paragraph 00710-4.02:

1. Manufacturer's product data.

PART 3--EXECUTION

Specialty valves shall be installed in accordance with the manufacturer's recommendations.

END OF SECTION

SECTION 15180

CONTROL VALVE SCHEDULE

PART 1 - GENERAL

1.01 DESCRIPTION

This section is a schedule of the control valves for this work.

1.02 VALVE SIZING

Where the specific valve is smaller than the connected pipe, the Contractor shall provide reducers.

1.03 SCHEDULE

Automatic operator types are specified in Section 15185 and for use in the control valve schedule are defined as follows:

Operator Type	Service Type	Definition
1	Throttling	Electric motor
2	Isolating	Electric motor
3	Throttling	Spring diaphragm
4	Isolating	Spring diaphragm
5	Throttling	Pneumatic cylinder
6	Isolating	Pneumatic cylinder

CONTROL VALVE SCHEDULE

Type of valve:

Control valve number	Services	Valve size, inches	Operator type	Positioner[a]	Number of valves	NEMA enclosure	Open/close time, seconds

[a]Positioner = NC - normally closed
NO - normally open
I - Intermediate (maintains valve position during failure)

END OF SECTION

SECTION 15185

VALVE AND GATE OPERATORS AND OPERATOR APPURTENANCES

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies manual and powered operators for valves and gates, and operator appurtenances.

B. TYPES:

For use in the control valve schedule in Section 15180 and in this section, powered operators are defined as follows:

Operator type	Service	Definition
1	Throttling	Electric motor
2	Isolating	Electric motor
3	Throttling	Spring diaphragm
4	Isolating	Spring diaphragm
5	Throttling	Pneumatic cylinder
6	Isolating	Pneumatic cylinder

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASTM A519-84	Seamless Carbon and Alloy Steel Mechanical Tubing
ASTM B584-85	Copper Alloy Sand Castings for General Applications
AWWA C500-80	Gate Valves 3 Through 48 In. NPS, for Water and Sewage Systems
JIC P-1-1975	Pneumatic Standards for Industrial Equipment and General Purpose Machine Tools
NEMA ICS-2-83 (1984)	Industrial Control Devices, Controllers and Assemblies

PART 2--PRODUCTS

2.01 OPERATORS

A. GENERAL:

Operators shall be factory-mounted on the valve or gate and provided as a unit.

Each valve body or operator shall have cast thereon the word OPEN, an arrow indicating the direction to open, and flow direction arrows.

B. MANUAL OPERATORS:

1. GENERAL: Manual operators shall have operating torques less than 80 foot-pounds. Unless specified otherwise, each manual operator shall be provided with an operating wheel.

Unless specified otherwise, the direction of rotation of the operator shall be counterclockwise for opening.

2. WRENCH NUTS: Wrench nuts shall comply with Section 3.16 of AWWA C500. A minimum of two operating keys, but no less than one key per every ten valves, shall be provided for operation of the wrench nut operated valves.

3. CHAIN WHEELS: Chain wheels shall be ductile iron. Operating chains shall be galvanized.

C. POWERED OPERATORS:

1. TYPE 1 OPERATORS: Type 1 operators shall be Limitorque Type SMB or SMC, Rotork 1400 or 1600 Series, Raymond Control Systems (RCS) Type TN, or equal, modified to provide the following features:

a. A thermistor for thermal protection embedded in the motor windings.

b. Two independent and fully adjustable DPDT rotary type position switches as specified in paragraph 15185-2.02 D.

c. Two rotary type limit switches; one for opening, one for closing at end of travel.

d. A double torque switch.

e. Thermal overload protection for each leg of the 3 phase power supply, and control voltage transformer.

f. Position transmitter.

Valve operator shall be provided with a solid state controller as specified in paragraph 15185-2.02 A.

Valve operators shall be sized for an operating torque equal to twice the maximum required valve operating torque under specified flow conditions. Torque switches shall be set to disengage motor power at 75 percent of the shaft's design torque.

Operators shall be suitable for use with 460 volt, 3 phase, 60 Hz power.

Position transmitter shall be 1000 ohm potentiometer coupled directly to shaft of rotary motion valves and to the operator gear train of linear motion valves or gates.

2. TYPE 2 OPERATORS: Type 2 operators shall be the same as Type 1 operators except the controller shall be an electromechanical starter as specified in paragraph 15185-2.02 B.

3. TYPE 3 OPERATORS: Type 3 operators shall have a cast aluminum or pressed steel body with polyester reinforced neoprene or nitrile rubber diaphragm. Diaphragm size shall be sufficient to operate the valve with a supply air pressure to the pilot valve or positioner not more than 40 psig. Type 3 operators shall be provided with electropneumatic positioner as specified in paragraph 15185-2.02 C.

4. TYPE 4 OPERATORS: Type 4 operators shall be the same as Type 3 operators except the controller shall be provided with pilot valve and position switches as specified in paragraphs 15185-2.02 D and E.

5. TYPE 5 OPERATORS: Type 5 operators shall be double acting unless valve schedule specifies spring return. Operators shall be heavy-duty type with totally enclosed scotch-yoke mechanism to provide 90-degree rotation. Bearing surfaces including inside cylinder wall and guides shall be coated with a permanent dry-film lubricant and corrosion inhibitor. Operators shall be suitable for use with nonlubricated dry instrument quality air. Cylinder shall be steel, ASTM A519, Grade 1018; piston shall be gray iron, bearings shall be bronze, ASTM B584, Grade 88-10-2; and seals shall be lip or cup type of duro-nitrile elastomer. Steel cylinder rod shall be electroplated with nickel. Operators shall be sized to provide not less than two times the peak torque required by the valves with 60 psig air supply. Type 5 operators shall be provided with electropneumatic positioner and position switches as specified in paragraphs 15185-2.02 C and D. Operator shall be Bettis, Rotork, or equal.

6. TYPE 6 OPERATORS: Type 6 operators shall be the same as Type 5 operators except the controller shall be as specified in paragraphs 15185-2.02 D and E.

2.02 POWERED OPERATOR CONTROLS

A. SOLID STATE CONTROLLER:

Controller shall accept a 4 to 20 mA DC signal into a maximum load of 250 ohms and shall be electrically isolated. Controller shall be Limitorque Modutronic 30, Rotork Folomatic, Raymond Control Systems (RCS) R1, or equal. Controller positioning accuracy shall be 1.0 percent of travel or better with operating speeds of 12 inches per minute for linear operators and 180 degrees per minute for rotary operators.

B. ELECTROMECHANICAL REVERSING CONTROLLER:

Controller shall be an unfused disconnect type combination starter in compliance with NEMA ICS. Controller shall operate on 115 volts AC maximum. Open/close pushbuttons shall be provided for local operation and terminals provided for remote open/close momentary contact pushbuttons. Unless otherwise specified, operation shall provide full travel from a momentary open or close command.

C. ELECTROPNEUMATIC POSITIONER:

Electropneumatic positioner shall be characterizable-cam force-balance type with moving parts including feedback spring enclosed in a gasketed weatherproof case. Positioner shall control double acting or single acting pneumatic operators as required in response to a 4 to 20 milliampere instrumentation signal. Electrical resistance of signal input shall not exceed 400 ohms. Positioner gain shall be 150 with 50 psig air supply, resolution 0.1 percent of span, deadband 0.2 percent of span, hysteresis 1.0 percent of span, and supply/exhaust capacity 25 scfm at 75 psig supply pressure or better. Positioner shall be field reversible and shall be provided with square-root, linear and square relation cams. Positioner shall be suitable for supply pressure from 18 to 150 psig and shall be provided with a filter regulator assembly complete with gage. Positioner for double-acting service shall be provided with integral shutoff/equalizing valve assembly. Positioners for flow loops shall be provided with gain suppression spring and speed control valves in the cylinder lines.

D. POSITION SWITCHES:

Position switches shall have Form C (SPDP) contacts rated not less than 10 amperes at 120 volts AC and 0.8 power factor at 24 volts DC. Unless specified otherwise, one set of limit switches shall be set to actuate when the valve is less than 3 percent open and the second set shall be set to actuate when the valve is more than 97 percent open. Limit switches shall be enclosed in a NEMA 7 explosionproof case and shall be rotary type positively coupled to the actuator.

E. SOLENOID PILOT VALVES:

Pilot valves shall be plug-in units (pneumatic and electric connections) with lapped spool in floating sleeve suitable for continuous service on dry, nonlubricated instrument quality air. Pilot valves shall be four-way, five-port, double solenoid, two position, with integral speed control needles and mufflers on each exhaust port. Pilot valves shall be suitable for three-way operation by blocking the unused cylinder port. Valves with C_v less than or equal to 1.0 shall be direct solenoid actuated; valves with C_v greater than 1.0 shall be solenoid pilot actuated and suitable for supply pressures between 25 and 125 psig. Pilot valves shall be provided with nonlocking recessed manual override and shall comply with JIC P-1, except that NEMA 7D cases shall be provided in hazardous areas.

Pilot valves shall be sized to provide full stroking of the operator and connected control valve in 3 seconds with speed control needles fully open. Filter regulators with gage shall be provided with pilot valves except that a common filter regulator shall be used for manifolded pilot valves.

Solenoids shall be rated 24 volts DC, not to exceed 250 milliamperes. Pilot valves shall be Numatics, Ross series 70, or equal. Where three or more valves are mounted at a common location, Numatics Flexiblok, Ross, or equal, manifolds shall be provided.

2.03 OPERATOR APPURTENANCES

A. VALVE BOXES:

Valve boxes shall be cast iron and shall have suitable base castings to fit properly over the bonnets of their respective valves and heavy top sections with stay-put covers. Covers shall be hot-dip galvanized.

B. FLOOR BOXES:

Floor boxes shall be hot-dip galvanized. Where the operating nut is in the concrete slab, the floor box shall be bronze bushed. Where the operating nut is below the slab, the opening in the bottom of the box shall be sufficient for passage of the operating key.

C. ADJUSTABLE SHAFT VALVE BOXES:

Adjustable shaft valve boxes shall be concrete or cast iron Brooks No. 3RT, Christie G5, Empire 7-1/2 valve extension box, or equal. Box covers on waterlines shall be impressed with the letter "IV." Gas line covers shall be impressed with the letter "G."

2.04 PRODUCT DATA

The following information shall be provided in accordance with paragraph 00710-4.02.

1. Manufacturer's product data.

PART 3--EXECUTION

3.01 APPLICATION

A. MANUAL OPERATORS:

1. GENERAL: Valves and gates shall be provided with manual operators, unless specified otherwise. Manual operators shall be positioned so that they can readily be operated.

2. WRENCH NUTS: Wrench nuts shall be provided on buried valves, on valves which are to be operated through floor boxes, and where specified. Extended wrench nuts shall be provided if necessary so that the nut will be within 6 inches of the valve box cover.

3. CHAIN WHEELS: Unless otherwise specified, valves with centerlines more than 7 feet 6 inches above the specified operating level shall be provided with chain wheels and operating chains. Chain wheel operated valves shall be provided with a chain guide. Operating chains shall be looped to extend within 4 feet of the specified operating level below the valve. For plug-type valves 8 inches and larger, the operator shall be provided with a hammer blow wheel.

Hooks on adjacent piping shall be provided for chain storage where chain hangs in foot traffic.

B. POWERED OPERATORS:

Control valves and gates with powered operators shall be specified in Section 15180.

Powered operators shall have their manual operating accessory, where specified, mounted and operable from the floor.

C. POWERED OPERATOR CONTROLS:

1. ELECTROPNEUMATIC POSITIONER: Electropneumatic positioners shall be provided for throttling services.

2. CONTROLLERS FOR TYPE 4 AND TYPE 6 OPERATORS: Two sets of adjustable limit switches and a solenoid pilot valve shall be provided for isolating services.

Pilot valves shall be separately mounted from cylinders at a height not to exceed 6 feet above the floor or a permanent work platform.

D. OPERATOR APPURTENANCES:

1. VALVE BOXES: Valve boxes extending to finished surfaces shall be provided for buried valves.

2. FLOOR BOXES: Floor boxes shall be provided for wrench operation of valves located below concrete slabs. Each floor box and cover shall be of the depth required for installation in the slab.

END OF SECTION

SECTION 15250

INSULATION FOR EXPOSED PIPING AND EQUIPMENT

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies insulation for exposed piping and related equipment and appurtenant surfaces.

B. TEMPERATURE CLASSES:

Insulation for exposed piping and equipment is classified for the following temperature ranges: low and medium.

Low temperature class insulation shall be suitable for an operating temperature range of minus 100 to plus 100 degrees F.

Medium temperature class insulation shall be suitable for an operating temperature range of 100 to 800 degrees F.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASTM B209-85	Aluminum and Aluminum-Alloy Sheet and Plate
ASTM C543-82	Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM C552-79	Cellular Glass Block and Pipe Thermal Insulation
ASTM E96-80	Water Vapor Transmission of Materials

Reference (cont'd)	Title
FEDSPEC L-P-535E-79	Plastic Sheet (Sheeting) "Plastic Strip" Poly (Vinyl Chloride) and Poly (Vinyl Chloride-Vinyl Acetate), Rigid
FEDSPEC HH-I-558B(3)-76	Insulation, Blocks, Boards, Blankets, Felts Sleeving (Pipe and Tube Covering), and Pipe Fitting Covering, Thermal (Mineral Fiber, Industrial Type)

PART 2--PRODUCTS

2.01 GENERAL

Piping insulation shall be tubular. Insulation for valves, fittings, expansion joints, flanges, and other connections shall be segmented sections, molded, or blanket type coverings of the specified type and thickness of pipe insulation. Equipment insulation shall be blanket or rigid board type cut to fit the surface.

2.02 INSULATION

A. GENERAL:

Low temperature class insulation shall be of the unicellular elastomeric thermal, cellular glass, or fiberglass type.

Medium temperature class insulation shall be of the cellular glass or fiberglass type.

B. UNICELLULAR ELASTOMERIC THERMAL TYPE:

Unicellular elastomeric thermal type insulation shall conform to the requirements of ASTM C534, Type I.

C. CELLULAR GLASS TYPE:

Cellular glass type insulation shall conform to the requirements of ASTM C552, Type II.

D. FIBERGLASS TYPE:

Fiberglass type insulation shall conform to the requirements of FEDSPEC HH-I-558B.

2.03 INSULATION JACKETS

A. LAMINATED JACKETS:

Laminated jackets shall consist of aluminum and white kraft paper. Jackets shall have a perm rating for water vapor transmission of not more than 0.02 in accordance with Procedure A of ASTM E96.

B. ALUMINUM JACKETS:

Aluminum jackets shall be constructed of smooth finish aluminum sheet conforming to ASTM B209, alloy 5005, temper H16, with integral vapor barrier. Jackets shall be 0.016 inch thick.

Sheet metal screws shall be aluminum or stainless steel.

Jackets shall be secured with 0.020 by 3/4-inch type 304 stainless steel expansion bands.

2.04 INSULATION COVERS

A. POLYVINYLCHLORIDE (PVC) COVERS:

Polyvinylchloride covers shall be one piece, premolded polyvinylchloride conforming to FEDSPEC L-P-535E, Composition A, Type II, Grade E4.

B. ALUMINUM COVERS:

Aluminum covers shall be constructed of smooth finish aluminum sheet conforming to ASTM B209, alloy 5005, temper H16, with integral vapor barrier. Covers shall be 0.016 inch thick.

2.05 SHIELDS

Shields shall be 16-gage galvanized steel sheet, formed into a half cylinder. Shield length shall be as recommended by the insulation manufacturer.

2.06 FLASHING

Flashing shall include aluminum caps, sealant and reinforcing. Aluminum caps shall be 20 gage thick and shall be cut to completely cover the insulation. Sealants shall be as recommended by the insulation manufacturer.

Reinforcement in flashing heated up to 370 degrees F shall be nylon fabric. Reinforcement in flashing for hotter surfaces shall be wire mesh or as recommended by the insulation manufacturer.

2.07 PRODUCT DATA

The following information shall be provided in accordance with paragraph 00710-4.02:

1. Manufacturer and manufacturer's type designation.

2. Samples, for each insulation material type, of typical jacket and closures for fittings, valves and appurtenances.

3. Descriptive literature and catalog data for materials to be used showing methods of installation.

4. Certification of ratings for water vapor transmission and puncture and stiffness as specified in paragraph 15250-2.03 A.

PART 3--EXECUTION

3.01 INSTALLATION

A. GENERAL:

Insulation shall be applied over clean, dry surfaces. Double layer insulation, where specified, shall be provided with staggered section joints.

B. PIPE SUPPORTS:

Hangers, anchors, pipe guides and other support elements shall interrupt jackets, covers, and insulation except for chilled water supply or return (CWS, CWR) piping.

C. PROTECTION:

Insulation and jackets shall be protected from crushing, denting, and similar damage during construction. Vapor barriers shall not be penetrated or otherwise damaged. Insulation, jacket, and vapor barriers damaged during construction shall be removed and new material shall be installed.

D. PIPING INSULATION:

1. GENERAL:

a. PIPE: Piping shall be continuously insulated along its entire length including all in-line devices such as valves, fittings, flanges, couplings, strainers and other piping appurtenances. Unless otherwise specified, piping insulation shall be

provided with laminated jackets specified in paragraph 15250-2.03 A. Insulation shall be butted firmly together and jacket laps and joint strips provided with lap adhesive. Jackets shall be provided with their seams located on the underside of pipe.

PVC covers specified in paragraph 15250-2.04 A shall not be provided with medium- or high-temperature-class insulation.

b. FITTINGS, CONNECTIONS, FLANGES AND VALVES: Fitting, connection, flange and valve insulation shall be provided with rigid covers specified in paragraph 15250-2.04. Insulation shall be secured in place with 20-gage wire and a coat of insulating cement. Covers shall overlap the adjoining pipe insulation and jackets. Covers shall be provided with their seams located on the underside of fittings and valves.

2. LOW TEMPERATURE CLASS:

a. PIPE: Insulation shall have ends sealed off with a vapor barrier coating.

b. FITTINGS, CONNECTIONS, FLANGES AND VALVES: For pipe sizes 2 inches and less, insulation shall be provided with rigid PVC covers specified in paragraph 15250-2.04 A. Covers shall be sealed at edges with vapor barrier adhesive. The ends of covers shall be secured with vinyl tape. The tape shall overlap the jacket and the cover at least 1 inch. Vapor barrier shall not be penetrated.

For pipes 2-1/2 inches and larger, insulation shall be provided with rigid aluminum covers specified in paragraph 15250-2.04 B. Covers shall be mechanically secured by corrosion-resistant tacks pushed into the overlapping throat joint.

3. MEDIUM- AND HIGH-TEMPERATURE CLASS:

a. PIPE: Insulation shall have ends sealed with end joint strips and held in place by waterproof adhesive.

b. FITTINGS, CONNECTIONS, FLANGES AND VALVES: Insulation shall be provided with rigid aluminum covers specified in paragraph 15250-2.04 B. Covers shall be mechanically secured by corrosion-resistant tacks pushed into the overlapping throat joint.

4. OUTDOOR PIPING:

a. PIPE: Insulation shall be provided with aluminum jackets specified in paragraph 15250-2.03 B.

b. FITTINGS, CONNECTIONS, FLANGS AND VALVES: Insulation shall be provided with rigid aluminum covers specified in paragraph 15250-2.04 B.

E. MECHANICAL EQUIPMENT INSULATION:

1. GENERAL: Insulation shall fit the contours of equipment and shall be provided with 1/2- by 0.015-inch galvanized steel bands. Weld pins or stick clips with washers may be used for flat surfaces and spaced a maximum 18 inches apart. Joints shall be staggered and voids filled with insulating cement. Insulation shall be provided with laminated jackets specified in paragraph 15250-2.03 A.

2. LOW TEMPERATURE CLASS: Insulation shall have joints, breaks, and punctures sealed in facing with fire-retardant vapor barrier adhesive reinforced with 4-inch tape.

Insulation shall be provided with a layer of open-weave glass cloth embedded into a wet coat of fire-retardant adhesive. Seams shall overlap at least 2 inches. A finish coat of fire-retardant adhesive shall be provided.

3. MEDIUM- AND HIGH-TEMPERATURE CLASS: Joints shall be covered and cemented in place with 4-inch-wide strips of the same material as the laminated jackets specified in paragraph 15250-2.03 A.

4. OUTDOOR EQUIPMENT: Insulation shall be provided with a coat of weatherproof mastic and a layer of open-weave glass cloth embedded into a wet tack coat. Seams shall overlap at least 2 inches. A finish coat of weatherproof mastic shall be provided. The total coating thickness shall be a minimum of 1/8 inch.

F. SHIELDS:

Unless otherwise specified, metal shields shall be provided at pipe supports. Inside face of each shield shall be coated with insulation adhesive to prevent movement. Additional support shall be provided at each shield as specified on the drawing details.

G. FLASHING:

Flashing shall be provided at jacket penetrations and terminations. Clearance for flashing shall be provided between insulation system and piping supports.

A heavy tack coat of sealant shall be troweled over the insulation, extending over the jacket edge 1 inch and over the pipe or protrusion 2 inches. Reinforcement shall be streteched over the

tack coat after clipping to fit over pipe and jacket. Clipped reinforcing shall be strapped with a continuous band of reinforcing to prevent curling. Sealant shal then be troweled over the reinforcement to a minimum thickness of 1/8 inch.

Aluminum caps shall be formed to fit over the adjacent jacketing and to completely cover coated insulation. Cap shall be held in place with a jacket strap.

3.02 INSULATION THICKNESS SCHEDULE

The insulating dimensional tolerances shall comply with the specified standards. The minimum insulation thicknesses, exclusive of jacket, shall be as follows:

Piping service[a]	Fluid temperature range, degrees F	Runouts up to 2 inches[b]	1 inch and less	1.25 to 2 inches	2.50 to 4 inches	5 and 6 inches	8 inches and larger
Heating:							
JWR,	120-200	0.5	0.75	1.0	1.0	1.0	1.5
JWS	120-200	0.5	0.75	1.0	1.0	1.0	1.5
Plumbing:							
HW	100-150	0.5	0.75	1.0	1.0	1.0	1.5
1W, 2W	55-65	0.5	0.5	1.0	1.0	1.0	1.0

[a]See Specification Section 15050.

[b]Runouts to individual terminal units (not exceeding 12 feet in length).

END OF SECTION

SECTION 15400

PLUMBING

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies drains, piping, appurtenances and general requirements for plumbing systems.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following document. It is a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed document, the requirements of the listed document shall prevail.

Reference	Title
UPC (1985)	Uniform Plumbing Code

PART 2--PRODUCTS

2.01 CLEANOUTS

A. GENERAL:

Unless otherwise specified, cleanouts shall be the same size as the pipe connected. Cleanouts shall be provided with clamping collars where waterproofing membranes are located in the floor. Cleanouts located inside buildings shall be provided with polished bronze covers. Bronze plug with tapered thread shall be provided for cleanouts on pressurized systems. Cleanouts on chemical waste or drain lines shall be of the same material and type of joint as the pipe.

B. TYPE I CLEANOUT:

Unless otherwise specified, Type I cleanouts shall be Josam series 56010, J. R. Smith series 4020, or equal.

C. TYPE II CLEANOUT:

Unless otherwise specified, Type II cleanouts shall be Josam series 56010(-12), J. R. Smith series 4140, or equal.

D. TYPE III CLEANOUT:

Unless otherwise specified, Type III cleanouts shall be Josam series 58500 (-20), J. R. Smith series 4420, or equal, with cast iron frame and cover as specified on the drawing details.

E. TYPE IV CLEANOUT:

Unless otherwise specified, Type IV cleanouts shall be Josam series 58500(-20), J. R. Smith series 4420, or equal.

F. TYPE V CLEANOUT:

Unless otherwise specified, Type V cleanouts shall be Josam series 58890, J. R. Smith series 4472, or equal.

2.02 DRAINS

A. FLOOR DRAINS:

1. GENERAL: Floor drains shall be provided with clamping collars where waterproofing membranes are located in the floor.

2. TYPE I FLOOR DRAIN: Unless otherwise specified, Type I floor drains shall be Josam series 32130, J. R. Smith series 2225, or equal.

3. TYPE II, III, AND IV FLOOR DRAINS: Unless otherwise specified, Type II, III, and IV floor drains shall be Josam series 32120, J. R. Smith series 2220, or equal.

4. TYPE V FLOOR DRAIN: Unless otherwise specified, Type V floor drains shall be Josam series 30000-A, J. R. Smith series 2010-A, or equal.

5. TYPE VI FLOOR DRAIN: Unless otherwise specified, Type VI floor drains shall be Josam series 49290 (-31), J. R. Smith series 3066, or equal.

B. ROOF DRAINS:

Unless otherwise specified, roof drains shall be J. R. Smith series 1330 (-TCRE), Josam series 22040 (-1-2-10T), or equal.

C. CONDENSATE DRAINS:

Unless otherwise specified, condensate drains shall be as specified for piping system 24 in Section 15050.

D. SCUPPER DRAINS:

1. TYPE I SCUPPER DRAIN: Unless otherwise specified, Type I scrupper drains shall be Josam series 24730, J. R. Smith series 1540, or equal.

2. TYPE II SCUPPER DRAIN: Unless otherwise specified, Type II scupper drains shall be Josam series 24700 (-22), J. R. Smith series 1510, or equal.

2.03 VALVE ACCESS COVERS

Access covers for concealed valves within structure interiors shall be 12 inch by 12 inch minimum, stainless steel, J. R. Smith series 4762 or 4767, Karp 214-M or 214-P, or equal. Two keys or wrenches shall be provided for each type of key-operated valve.

2.04 COUPLINGS, NIPPLES AND UNIONS

Couplings and nipples shall be of the same material as the pipe on which they are used.

Unions 2 inches and smaller shall be ground joint screwed pattern unions. Unions larger than 2 inches shall be flanged. Unions shall be packed with 1/16-inch thick rubber packing. Dielectric unions shall be as specified in paragraph 15085-2.04.

2.05 SINK HOSE BIBBS

Sink hose bibbs shall be Acorn No. 8126, Chicago 387-LF, or equal.

2.06 WATER HAMMER ARRESTERS

Water hammer arresters shall be Josam, J. R. Smith, Wade, or equal.

2.07 SLEEVES

Sleeves shall be 22-gage sheet metal.

2.08 ESCUTCHEONS

Escutcheons shall be chrome-plated cold rolled steel or stainless steel.

2.09 PRODUCT DATA

Brochures of plumbing equipment, including catalog data and installation information, shall be provided in accordance with paragraph 00710-4.02.

PART 3--EXECUTION

3.01 INSTALLATION

A. GENERAL:

Work shall be in accordance with the Uniform Plumbing Code.

Plumbing shall be provided to avoid obstructions, allow 7.5 feet minimum headroom, and keep openings and passageways clear.

No holes shall be made in structural members.

Torn and pierced waterproofing shall be repaired.

Fixtures, fittings, valves, and copper and brass items shall be wrapped with burlap or building paper. Wrapping shall be removed at completion of the work.

B. VALVES AND ACCESSORIES:

Valves shall be provided upstream of branches, apparatus and fixtures.

Valves on branch lines and at distribution points shall be provided with a 2-inch heavy brass disc, stamped and stenciled with 1/4-inch high letters, stating portion of system controlled by valve. Valve locations shall be shown on record drawings. The Contractor shall provide a chart of location and use of main valves.

Adjustable shaft valve boxes shall be provided for underground valves.

C. DIELECTRIC UNIONS:

Dielectric unions shall be provided at connections between pipe or fittings of different material.

D. ESCUTCHEONS:

Escutcheons shall be provided where pipes penetrate finished walls, ceilings or floors. Escutcheons shall be securely mounted allowing clearance for expansion.

E. PIPING:

Piping shall be carried in chases or recesses where provided in walls, through floors and partitions, and over ceilings. Unless otherwise specified, piping shall not be run in floor slabs.

3.01 E.

Pipes shall not be supported by plumbing fixtures or equipment. Changes in pipe size shall be made with reducing fittings. The use of bushings is not acceptable.

Where galvanized steel pipe is calked into a cast iron hub, a soil pipe adapter shall be provided on the calked end of the steel pipe.

Unless otherwise specified, underground piping outside buildings shall have a minimum cover of 24 inches. Piping under buildings shall have a minimum clearance from structure of 12 inches.

Hot and cold water piping shall be separated by at least 6 inches.

3.02 CLEANING AND FLUSHING

Piping and equipment shall be cleaned and flushed in accordance with paragraph 15050-3.05.

END OF SECTION

SECTION 15450

PLUMBING FIXTURES

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies plumbing fixtures, trim and fittings.

1.02 QUALITY ASSURANCE

A. WORK:

Work shall be in accordance with the Uniform Plumbing Code.

B. REFERENCES:

This section contains references to the following document. It is a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed document, the requirements of the listed document shall prevail.

Reference	Title
UPC (1985)	Uniform Plumbing Code

PART 2--PRODUCTS

2.01 LAVATORIES

A. COUNTER TOP MOUNTED (L-1):

Counter top mounted lavatories shall be vitreous china type, 19 inch diameter, with fitting ledge, front overflow, and 4-inch faucet openings. Lavatories shall be American Standard 0491.019, Kohler K-2201, or equal. Trim shall be American Standard 2103.786, Kohler K-7401-TL, or equal.

Lavatories shall be provided with chrome-plated strainer, tail piece, and tubular brass P-trap with flange.

2.02 SINKS

A. LABORATORY SINKS:

Laboratory sinks shall be as specified in Section 12346.

B. KITCHEN SINK (S-1):

Kitchen counter top sinks shall be of acid resisting enameled cast iron, 33 inch x 22 inch, with two compartments, fitting ledge, and three-hole drilling. Sinks shall be American Standard 7023.021, Kohler K-5943, or equal. Trim shall be American Standard 4150.132, Kohler K-7825-TL, or equal.

Sinks shall be provided with drain, strainer and stopper combination and shall be Elkay No. LK-99, Crane No. 8-5241, or equal.

C. SERVICE SINK (SS):

Service sinks shall be acid resisting enameled cast iron, plain back with rim guard, 22 inch x 18 inch, and shall be wall hanger type. Sinks shall be American Standrad 7692.023 with 8379.018 rim guard, Kohler K-6718, or equal. Trim shall be American Standard 8340.234, Kohler K-8907, or equal. Sinks shall be provided with chrome-plated strainer, wall mountings, and floor trap.

2.03 TOILETS

A. WATER CLOSET (WC-1):

Toilets shall be floor-mounted, elongated bowl, siphon jet action, bowl type of vitreous china with 1-1/2-inch top spud. Toilets shall be American Standard 9469.016, 18 inches high, elongated cadet. Toilets shall be provided with flush valves and with seats. Seats shall be white Olsonite 10CC. Flush valves shall be Sloan Royal 115-3.

B. WATER CLOSET (WC-2):

Toilets shall be floor-mounted, elongated bowl, siphon jet action, bowl type of vitreous china with 1-1/2-inch top spud. Toilets shall be American Standard 2221.018 Madera. Toilets shall be provided with flush valves and with seats. Seats shall be white Olsonite 10CC. Flush valves shall be Sloan Royal 110-3.

2.04 URINALS (U):

Urinals shall be vitreous china, wall-hung blowout type with flushing rim, 1-1/4-inch top spud, and 2-inch outlet. Urinals shall be American Standard 6570.014, Kohler K-5007T, or equal. Urinals shall be provided with flush valves and support brackets. Flush valves shall be Delany 452-HVB, Sloan Royal 180, or equal.

2.05 SHOWER FITTINGS (SF):

Shower fittings shall consist of Symmons Model 4-500 Safetymix, concealed valve, and Symmons Super Shower Head 4-131F-2 for 2 gpm flow rate, NU-ARM Shower head bracket fitting.

2.06 ELECTRIC WATER COOLER (EWC):

Full recessed, electric and refrigerated water cooler, stainless steel cabinet. Approved for handicapped use. Electronically activated control with 8-gph capacity. Water passages fully insulated. Manufacturer: Haws HWC T8HO, Cordley, or equal.

2.07 HOT WATER HEATER (HWH):

Hot water heater shall have 80-gallon capacity, electric immersion elements, glass-lined, magnesum anode, insulated to ASHRAE Standard 90A-80, pressure temperature code relief valve. Provide two 3-kW elements, 460 volt, 3 phase. Pipe relief valve drain to outside of building. Manufacturers shall be State, Rheem, A.O. Smith, Bradford-White, or equal.

2.08 BOOT SPRAY WASH (BSW)

Boot spray wash shall be lever-handle type pre-rinse self-closing valve with angle head. Chicago No. 81. Fill valve with code vacuum breaker and handle, Chicago No. 860. Provide 60-inch flexible, stainless steel hose and #853 hose hook. Mount hook up 42 inches above basin receptor.

2.09 WALL HYDRANT (WH)

Wall hydrant shall be mild climate type, cast bronze with 3/4-inch outlet. Integral vacuum breaker-backflow preventer. Key handle. Satin Nikaloy finish. Manufacturer shall be Josam 71070, Woodford, or equal.

2.10 PRODUCT DATA

Manufacturer's catalog data shall be provided in acordance with paragraph 00710-4.02. Manufacturers: American Standard, Kohler, Briggs, Elkay, Haws, Just, or equal.

PART 3--EXECUTION

Fixtures shall be provided plumb and level.

Fixtures shall remain in manufacturer's packaging until installation.

Fixtures shall be provided with required holes for fittings and mounting hardware. Unoccupied fixture faucet holes are not acceptable. Exposed fixture setting bolts shall be fitted with china caps.

Fixtures shall be supported in accordance with manufacturer's recommendations. Wall mounted fixtures shall be provided with brackets and anchorage. Drop-eared fittings shall be provided at fixture outlets and securely fastened to backing.

Top of seat 19 inches to 18 inches above finish floor for handicapped waterclosets. Set shower mixing valves at 48 inches above floor. Set men's shower heads 6 feet 6 inches, women's shower heads 6 feet, 0 inches.

Exposed stop globe valve on each supply to each fixture connection accessibly located when building is completed; locate behind or below fixture served; otherwise in-branch piping as approved. Cast brass or 17-gage fixture traps with cleanout plugs.

Exposed metal parts and piping and under counters, polished chormium plated, unless specified otherwise. Baked white enamel escutcheons at ceiling, chrome-plated at walls and floors.

Approved gasket between each water closet and soil pipe with heavy cast iron flange, gas and watertight. Rough-in pipe to fixtures as shown on drawings or as required by Uniform Plumbing Code.

Openings into pipes shall be capped during construction.

Vitreous finished surfaces on lavatories, toilets, and sinks shall have heavy paper pasted thereon during construction.

END OF SECTION

SECTION 15460

EMERGENCY EYEWASH AND SHOWER AND EYEWASH UNITS

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies emergency eyewash and shower units and emergency eyewash units for indoor and outdoor use.

PART 2--PRODUCTS

2.01 EYEWASH AND SHOWER UNITS

A. INDOOR UNITS:

Indoor units shall be Haws 8300, Western 9304, or equal.

B. OUTDOOR UNITS:

Outdoor units shall be Haws 8300-FP, Western 9306, or equal.

2.02 EYEWASH UNITS

Eyewash units shall be Haws 7061, Western 461, or equal.

2.03 PRODUCT DATA

Manufacturer's catalog data shall be provided in accordance with paragraph 00710-4.02.

PART 3--EXECUTION

Outdoor eyewash and shower units shall be provided with supply valves and drains buried a minimum depth of 18 inches below ground.

END OF SECTION

SECTION 15663

ROOFTOP AIR CONDITIONING UNITS

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies a combination direct-expansion cooling air handling unit.

B. TYPE:

The unit shall be of the modular self-contained, single package type combination direction expansion cooling air conditioning unit. The unit shall be suitable for roof curb mounting and have its own automatic controls and motor starter. The unit shall be Trane, Carrier, Lennox, or equal, modified as needed to meet the requirements of these specifications.

C. EQUIPMENT LIST:

Item	Equipment number
MCC operations building air conditioning unit	ACU 9400
MCC pumping station air conditioning unit	ACU 10800

D. DESCRIPTION OF SYSTEM:

System shall use 90 to 95 percent return air with 5 to 10 percent outside air blown through the unit with an integral centrifugal fan and discharged down through the roof into the room. Outside air may be cooled through DX coils, or passed through the unit for filtered ventilation only.

1.02 QUALITY ASSURANCE

A. *UNIT RESPONSIBILITY:*

The Contractor shall cause the cooling unit and all appurtenances to be furnished by a single manufacturer, who shall assume complete responsibility for the adequacy of all components of the unit. All controls required to operate the system as specified shall be furnished by the same single manufacturer.

B. OPERATING REQUIREMENTS:

Equipment number	Airflow, scfm	External static pressure, inches, W.C.	Rated cooling capacity, btuh	Voltage-phase
ACU 9400	4,000	0.5	95,000[a]	460-3
ACU 10800	1,600	0.5	42,000[a]	460-3

[a]Cooling performance is based on 110 degrees F ambient, 80 degrees F entering dry bulb, 63 degrees F wet bulb, and leaving 56 degrees F dry bulb and 55.5 degrees F wet bulb.

C. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
AFBMA	Antifriction Bearing Manufacturers Association Standards on Load Ratings and Fatigue Life
AMCA	Air Movers and Control Association Test Code and Certified Ratings Program
ARI-430	Air Conditioning and Refrigeration Institute Certification
NEC-1987	National Electrical Code

1.03 ENVIRONMENTAL CONDITIONS

The equipment to be provided under this section shall be suitable for continuous service exposed to the weather at Avondale, Arizona. The job site is at an elevation of approximately 930 feet. Ambient air temperatures are expected to range between 30 and 120 degrees F, and the relative humidity is expected to range between 5 and 100 percent.

1.04 SUBMITTALS

The following material shall be submitted to the Construction Manager in accordance with the provisions of Sections 01300 and 11000.

1. Data required under Sections 11000 and 11060.

2. Cooling performance of unit together with supply fan performance and efficiency.

3. Support details.

4. Bearing ratings for the fan and motor at design conditions.

5. Certification that the units have been tested and rated in accordance with the applicable AMCA Standard Test Code and Certified Ratings Program.

6. Electrical control wiring diagrams.

1.05 ADDITIONAL WARRANTY

Provide an additional extended 4-year warranty on compressor parts and labor.

PART 2--PRODUCTS

2.01 MATERIALS

Components	Material
Cabinet casing	Galvanized steel, weatherproofed
Fan Wheel	Aluminum or galvanized steel
Fan housing	Aluminum
Base	Lubricated steel
Fasteners	Stainless steel
Coil tubes	Copper
Coil fins	Aluminum

2.02 CONSTRUCTION

A. GENERAL:

Unit shall be constructed on a roof mounting curb for downflow discharge and manually dampered outside air intake. Curb shall be mounted and weatherproofed before unit is installed.

B. FAN:

Single centrifugal fans shall be forward curved, statically and dynamically balanced. A fan vibration isolation system, as specified in Section 11021, shall be provided. Fan motors shall be high efficiency type as specified in Section 11060.

C. COMPRESSOR/CONDENSER:

Compressor(s) shall be field serviceable semi-hermetic complete with oil sight glass, overload protection, oil pressure switch, crankcase heaters, and pumpdown cycle. Capacity reduction shall be by hot gas bypass. Compressors shall be spring isolated as specified in Section 11021, suction and discharge line piping shall include braided wire flexible line isolators. Provide liquid line solenoid valve, sight glass and filter dryer. Provide 0 degree low ambient head pressure controller. Condenser fans shall be direct driven propeller type and have motor and safety guards to OSHA requirements. Fan motors shall be as specified in Section 11060.

D. DIRECT EXPANSION COIL:

Coils constructed of 1/2-inch seamless copper tubes with aluminum fins mechanical bonded to tubes. Coils shall be provided with thermostatic expansion valves, adjustable superheat controls and external equalizers.

E. FILTERS:

Filters shall be as specified in Section 15881.

F. ELECTRICAL:

The unit shall be supplied with a factory wired combination 460-volt motor starter completely wired. Each unit will be provided with a single point connection for 480V AC power supply.

G. CORROSION PROTECTION:

All ferrous surfaces except aluminum shall be shop primed at factory and finish coats of baked enamel for exterior installation.

H. FACTORY-FURNISHED CONTROLS:

Provide with the air conditioning unit a factory-mounted master control sequencer for cooling controls. Provide a combination cooling room thermostat with integral temperature thermistor to maintain room thermostat setpoint. Variable range deadband of 3F to 10F, set at 5F.

Provide a complete assembled, wired cooling system within the unit to maintain room thermostat setting. Controls shall be 24 volt solid state. Provide a terminal block at the unit for single point control connection. The units start/stop operation shall be from a remote contact provided by Division 16. Refer to electrical control diagrams.

2.03 PRODUCT DATA

Provide Operations and Maintenance data in accordance with Section 01730.

PART 3--EXECUTION

3.01 INSTALLATION

The unit shall be aligned, connected and installed at location shown and in accordance with the manufacturer's recommendations. Connect cooling coil pan drain.

3.02 TESTING

After installation of unit and accessories, unit shall be completely field-tested to ensure compliance with performance requirements as specified. Testing and balancing shall be in accordance with Section 15800.

3.03 FIELD CONTROLS

External wiring shall be provided under Division 16. Refer to electrical drawings.

END OF SECTION

SECTION 15776

AIR TO AIR HEAT PUMP

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies a single package air to air heat pump suitable for supplying conditioned air to a building.

B. TYPE:

Self-contained, rooftop, packaged, heat pump system shall be comprised of compressors, outdoor coil, outdoor coil fan, expansion valve, receiving valve, supply air fan, indoor coil, roof curb, filter and 0 to 25 percent outside air manually dampered intake with hood. An automatic room thermostat shall also be provided. Unit shall be preassembled at the factory.

C. EQUIPMENT:

Item	Equipment number
Operations building administration heat pump	HP 9405
Operations building heat pump	HP 9410

1.02 QUALITY ASSURANCE

A. GENERAL:

The heat pump shall be UL listed and ARI tested. The unit shall be supplied by a company generally engaged in the manufacture of heat pumps.

Power supply to the unit will be 460 volts only.

B. OPERATING REQUIREMENTS:

The unit shall be designed to comply with the following:

Air flow rate, scfm	2,000
External static pressure, inches W.C.	0.50
Fan motor horsepower	3/4
Refrigerant compressors, number	1
Compressor rated load kW, max (total)	5.75
Cooling capacity	
Total net cooling capacity, Btuh[a]	57,500
Total cooling capacity at design conditions, Btuh	48,850

Outside air design temperature, degrees F	110
Temperature air entering evaporator coil, dry bulb, degrees F	80
Temperature air entering evaporator coil, wet bulb, degrees F	63
EER minimum, Btu/watt	8.10
Heating capacity	
Heating capacity without supplemental[b]	27,400
Outside air design temperature, degrees F	30

[a]ARI certified cooling capacity.

[b]ARI certified low temperature heating capacity.

1.03 ENVIRONMENTAL CONDITIONS

Equipment supplied under this section will be located at Avondale, Arizona. Heat pump will be located outdoors where temperature is expected to range between 30 and 120 degrees F and relative humidity between 5 and 100 percent.

1.04 SUBMITTALS

Submittals shall comply with the requirements of Section 11000 and shall include the following:

1. The motor data required under Section 11060.

2. Cooling and heating performance at design conditions.

3. Certification that the units have been tested and rated in accordance with the applicable ARI Test Procedure and that they meet the required appliance efficiency standards.

1.05 INFORMATION TO BE PROVIDED

Before final acceptance of work, the Contractor shall provide the following:

1. Operations and maintenance data in accordance with Section 01730.

2. Maintenance manuals in accordance with Section 01730.

3. List of recommended spare parts.

PART 2--PRODUCTS

2.01 ACCEPTABLE PRODUCTS

Heat pump units shall be Trane BWC-060G, Carrier, Lennox, or equal. Provided as necessary to furnish the specified features and to meet specified operating conditions.

Component	Material
Cabinet	Galvanized steel
Coil tubes	Copper
Coil fins	Aluminum
Refrigerant piping	Copper

2.03 CONSTRUCTION

A. ENCLOSURE:

The chassis shall be in rigid angle iron frame construction with galvanized steel panel enclosure. The panels shall be removable for access to components requiring services or replacement. The panels shall be internally insulated with minimum 1-1/2-pound density, 1-inch-thick fiberglass insulation. The enclosure shall have standard epoxy type lacquer finish or baked enamel finish. The enclosure frame shall be provided with facilities for anchoring the unit to the concrete mounting curb. The unit shall be provided with condensate drainage pans.

B. SUPPLY FAN:

The supply fan shall be of centrifugal design with a belt driven, permanently lubricated standard motor. The fan assembly shall be independently mounted and vibration isolated from the enclosure.

C. COMPRESSOR:

The compressor shall be of hermetic design, independently mounted and vibration isolated from the enclosure.

D. COILS:

The evaporator shall be aluminum fin, copper tube construction with a galvanized coil casing manufactured from not less than 16-gage steel. The coil shall be tested for a minimum working pressure of 250 psig.

E. CONTROLS:

Control wiring and control components shall be furnished for a complete automatic system. The controls shall be mounted in a steel control cabinet enclosure integral with the unit and with an access panel. The wiring shall meet all local, Arizona state and national electrical and safety codes and shall include safety devices which will stop the heat pump in case of high or low refrigerant pressure. The unit shall be provided with an automatic defrost control. The units shall be provided with wiring and control components including room thermostat to facilitate the following control sequence:

The supply fan shall run continuously or when the heat pump unit is operating. The compressor shall be controlled by the room thermostat for both heating and cooling modes. The control system shall provide for automatic changeover from cooling to heating or heating to cooling.

F. FILTER:

The unit shall be provided with a filter cabinet and filters as specified in Section 15881.

PART 3--EXECUTION

3.01 INSTALLATION

The heat pump shall be installed in accordance with the manufacturer's instructions.

END OF SECTION

SECTION 15803

EVAPORATIVE COOLERS

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies evaporative coolers and accessories, centrifugal fan, filter media, water pump and valves.

B. TYPE:

The evaporative coolers shall be the two-speed wet-pad type and shall be Arvin Mastercool Model EC630D as manufactured by Arvin Industries, Inc., or equal, complete with blower, motor, pads, water pump, internal piping, controls and float switch.

C. EQUIPMENT LIST:

Item	Equipment number
Operations building evaporative cooler	EPR 9415

D. DESCRIPTION OF SYSTEM:

Outside air will be drawn through the wet evaporative cooler pads with a centrifugal fan and discharged down into the room. Water will circulate through distributor tubes and headers over the pads.

1.02 QUALITY ASSURANCE

A. WARRANTY:

Evaporative coolers shall be covered by the manufacturer's standard 5-year warranty. Warranty information shall be provided to the Owner.

B. PERFORMANCE REQUIREMENTS:

The evaporative cooler and accessories shall be designed to operate continuously.

C. OPERATING REQUIREMENTS:

Industry Std. rating, cfm	Certified capacity, cfm	Static pressure, inches,W.C.	Motor HP	Motor speed	Operating voltage
6,500	Hi-speed 4,275	0.2	3/4	2	120

The equipment to be provided under this section shall be suitable for continuous service exposed to the weather at Phoenix, Arizona. The job site is at an elevation of approximately 930 feet. Ambient air temperatures are expected to range between 30 and 120 degrees F. Other environmental conditions will be as specified in Section 01800.

1.04 SUBMITTALS

The following material shall be submitted to the Engineer in accordance with the provisions of Section 01300. All of the material stipulated herein shall be submitted in one complete submittal. The submittal shall consist of the following catalog data, drawings and descriptive material:

1. Evaporative cooler performance for the specified operation conditions (static pressure-capacity, horsepower-capacity, efficiency-capacity).

2. Maximum temperature ratings.

3. Motor data in accordance with Section 11060 (Form 11060-A specified in Section 01999).

1.05 OPERATING AND MAINTENANCE DATA

The Contractor shall provide the following additional information:

1. Operations and maintenance data in accordance with Section 01730.

2. Maintenance manuals in accordance with Section 01730.

PART 2--PRODUCTS

2.01 MATERIALS

Materials of construction shall be the manufacturer's standard.

2.02 CONSTRUCTION

A. CABINET:

The unit design shall allow accessibility to the fan, water distribution pan, and filter assemblies. Cabinet shall be corrosion resistant, natural earth tone material requiring no painting.

B. CENTRIFUGAL FAN:

Fan shall be balanced for smooth operation. Fan shafting shall be 1-inch-diameter solid steel. Fan housing shall be designed for minimum turbulence and smooth air flow. Fan shall discharge horizontally. Fan shall be belt driven and non-overloading. Belts shall run in sheaves.

C. WATER DISTRIBUTION:

The Contractor shall provide a valve and connect the 2W water supply service to the water distribution system on the cooler. The water distribution pan shall be corrosion resistant and have overflow provisions. Polycoat finish shall be used on exposed parts of unit.

D. MOTOR:

The centrifugal fan motor shall be two-speed designed specifically for evaporative cooler service and shall be equipped with thermal overload protection and moisture-resistant insulation and rotor protection. A 240-volt, single-phase, power supply will be provided. The motor shall comply with Section 11060.

E. BEARINGS:

Bearings shall be heavy duty, sintered bronze type.

2.03 SPARE PARTS

The following spare parts shall be furnished:

1--set V-belts
1--pump
1--set pads

2.04 CONTROLS

One set of controls shall be provided for each cooler. Controls shall include settings for HIGH FAN, LOW FAN, LOW COOL, AND HIGH COOL. "Cool" settings shall operate the fan at the selected speed and the water distribution pump. "Fan" settings shall operate only the fan at the selected speed. Controls shall be mounted in a NEMA 4X enclosure.

PART 3--EXECUTION

3.01 INSTALLATION

The evaporative coolers with all appurtenances shall be aligned, connected, and installed at the locations shown and in strict accordance with the evaporative cooler manufacturer's recommendations.

Power to the unit will be single source as specified. Field wiring and controls shall be provided to achieve the specified installation.

2W piping shall be piped to the unit's water connection. 2W supply piping shall be 1/2 inch diameter, provided with an isolating valve within the shop building.

END OF SECTION

SECTION 15809

HVAC SYSTEMS BALANCING

PART 1--GENERAL

1.01 SCOPE

This section specifies the labor and services necessary to test and adjust under actual operating conditions all air moving systems, including related heating, ventilating, and air conditioning (HVAC).

1.02 QUALITY ASSURANCE

A. RESPONSIBILITY:

The Contractor shall procure the services of an independent air balance and testing agency belonging to the Associated Air Balance Council (AABC) to perform air balancing, testing and adjustment of the building and HVAC systems. The Contractor shall submit a copy of the National Project Certification Performance Guaranty issued to the testing agency by the AABC as a part of the report specified in paragraph 1.03 B.3. Nothing herein shall be construed as relieving the Contractor of his overall responsibility for this portion of the work.

B. GENERAL:

Tests and adjustments shall include the complete testing of all air moving systems and necessary adjustments to the volume and control functions of the HVAC equipment to accomplish the design objectives shown and specified. The work shall include the balance of building and process air systems and verification of performance of automatic controls.

Effort has been made to include dampers and other equipment as required to balance the air systems. Contractor shall furnish and install, upon authorization by the Construction Manager, any additional such items required to satisfactorily balance the systems. The cost of additional equipment, including installation, will be borne by the Owner.

Where required, and authorized by the Construction Manager, fans shall be provided with larger or smaller sheaves by the Contractor, to drive the fans at speeds necessary to produce the indicated volumes. The cost of installing new sheaves will be borne by the Owner.

C. BALANCING:

1. GENERAL: Characteristics to be tested and adjusted to conform to values shown and specified include the following:

a. Total air flow rates delivered by fans and blower units, in actual cfm.

b. Flow rates at all diffusers and supply ducts, in actual cfm.

c. Distribution patterns at air terminal outlets.

2. AIR FLOW RATE MEASUREMENTS: The project is located at an elevation of 930 feet above sea level. Flow rates measured shall be appropriately converted as necessary to obtain values in actual cfm under field conditions. All flow rates shall be measured with supply and exhaust systems operating with filter bank resistance midway between the design values specified for clean and dirty filters, with all auxiliary systems in operation and with all doors and windows closed or under regular traffic.

Total air flow rates shall be tested in strict accordance with the latest edition of the ASHRAE Standard, "Method of Testing for Rating Unit Ventilators." Flow rates at louvers, diffusers, and air distribution patterns shall be tested in strict accordance with the latest edition of the ASHRAE Standard, "Method of Testing for Rating the Air Flow Performance of Outlets and Inlets."

3. ADJUSTMENTS: In all cases, air flow rates supplied or exhausted shall be within plus or minus 5 percent of the design values shown and specified. Air flow rates shall be obtained by adjustment of the fan speeds, dampers, or diffusers.

The deflection pattern of all supply outlets shall be adjusted to insure proper and uniform air distribution throughout the area served by such outlets.

Damper positions shall be permanently marked after air balance is complete so that they can be restored to their correct position if disturbed at any time.

Automatic control systems shall be adjusted for normal operating conditions.

Should any piece of apparatus, material or work fail to meet the specified requirements in these tests, the Contractor shall make the necessary corrections and retest the apparatus, material or work at no additional cost to the Owner.

D. STANDARDS:

The American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. - ASHRAE Standards.

1.03 INFORMATION TO BE PROVIDED

Before final acceptance of the work, the Contractor shall provide the Construction Manager with records of each component adjustment within each system required to achieve the design requirements shown and specified. These records shall also include air flow rates measured after the adjustment was completed.

END OF SECTION

SECTION 15842

ROOF EXHAUST FANS

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies roof mounted exhaust fans including fans, motors, dampers, curbs and accessories required for complete installations.

B. TYPE:

Fans specified under this section shall be of weatherproof, centrifugal, V-belt driven, curb mounted, low profile, exhaust fans. Fans shall be Greenheck Model GB, Aerovent Model CVB, or equal. Fans shall be modified as needed to meet the requirements of these specifications.

C. EQUIPMENT LIST:

Item	Equipment number
Training room	F 9422
Shower rooms exhaust fan	F 9423
Mens restroom exhaust fan	F 9424
Womens restroom exhaust fan	F 9425

1.02 QUALITY ASSURANCE

A. GENERAL:

All fans shall be the low profile type with bird screens. Fans shall bear the AMCA rating seal. Fans shall be designed for continuous operation.

B. OPERATING REQUIREMENTS:

Fans shall be designed to comply with the following:

Equipment number	Capacity, scfm	Static pressure inches W.C.	Fan speed, rpm	Maximum motor HP	Backdraft damper	Voltage phase
F 9422	350	.375	970	1/6	Yes	120-1
F 9423	345	.375	969	1/6	Yes	120-1
F 9424	190	.375	985	1/6	Yes	120-1
F 9425	340	.375	967	1/6	Yes	120-1

1.03 ENVIRONMENTAL CONDITIONS

The equipment to be provided uner this section shall be suitable for continuous service exposed to the weather at Avondale, Arizona. The job site is at an elevation of approximately 930 feet. Ambient air temperatures are expected to range between 30 and 120 degrees F, and the relative humidity is expected to range between 5 and 100 percent.

1.04 SUBMITTALS

All of the material stipulated herein shall be submitted in one complete submittal. Submittals shall comply with the requirements of Section 11000 and shall include the following:

1. Fan performance curves for the specified operation conditions.
2. The motor data required under Section 11060.
3. Bearing ratings for the fan and motor at design conditions.
4. Backdraft damper information.
5. Certification that the units have been tested and rated in accordance with the applicable AMCA Standard Test Code and Certified Ratings Program.

PART 2--PRODUCTS

2.01 MATERIAL

Fans shall have the following materials:

Component	Material
Hoods	Heavy aluminum
Fan wheels	Aluminum
Venturi throat	Spun Aluminum
Fan wheel shafts	Stainless steel
Fan housings	Heavy gage spun aluminum
Fasteners	Stainless steel
Curbs	Aluminum
Shroud	Aluminum

2.02 ROOF FAN CONSTRUCTION

A. FANS:

Exhaust fans shall be V-belt driven as specified. Exhaust fans shall be of the curb mounted, centrifugal, roof ventilator type, designed for high capacity with low noise characteristics. The housing shall be designed for minimum turbulence and smooth air flow and shall also be designed to provide easy access to the motor and fan unit.

Fans shall have wheels with backward curved blades, and wheels shall be statically and dynamically balanced at the factory. The fan inlet shall be provided with a venturi throat that is overlapped by the fan wheel for efficient performance. Fan wheel shafts shall be mounted in heavy-duty ball bearing pillow blocks with grease fittings rated, as specified in Section 11000, for minimum Class M3 (50,000 hours) bearing life.

Fans shall be furnished with adjustable pitch sheaves and adjustable motor supports suitable for a plus or minus 5 percent adjustment in operating speed.

B. MOTORS:

Motors shall be as specified in Section 11060. Motors shall be mounted on vibration isolators and shall be sealed from the exhaust air stream. The entire drive assembly and wheel, as a unit, shall be removable through the support structure without dismantling the fan housing.

Each fan housing shall contain a wiring post and watertight conduit penetration. Sealed ball bearing motors shall be provided for the fans. Motors shall be nonoverloading at any point on the fans' operating curves.

C. DAMPERS:

Fans shall be provided with spring loaded barometric type backdraft dampers at the fan intake side where indicated. Fan HP shall be increased if damper static pressure exceeds .10 inch w.g.

D. PREFABRICATED CURBS:

Each fan shall be provided with a prefabricated mounting curb. The outer shell of the curb shall be formed with an integral cant strip and mounting flange. The corner shall be mitered and welded continuously to form a one-piece leakproof shell. The bottom of the curb shall have a baseplate which encloses the lower edge of the roof insulation. A damper holding tray shall be provided. Wooden nailing strips shall be bolted to the top of the curb shell to provide means for easily attaching the flashing material to the curb.

E. ACCESSORIES:

All fans shall be equipped with coated steel bird screens.

2.03 SPARE PARTS

One set of spare V-belts shall be provided for each fan.

2.04 PRODUCT DATA

Provide Operations and Maintenance data in accordance with Section 01730.

PART 3--EXECUTION

3.01 INSTALLATION

Each fan, damper, and curb shall be installed as shown in the contract drawings and in accordance with the manufacturer's recommendations.

3.02 FIELD CONTROLS

External wiring shall be provided under Division 16. Refer to electrical drawings.

3.03 TESTING

After completion of installation, each fan shall be completely field tested to guarantee compliance with these specifications.

END OF SECTION

SECTION 15849

FUME HOOD EXHAUST AND SUPPLY FANS

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies centrifugal utility fans for exhausting corrosive fumes from laboratory hoods and supplying make-up air to the hood.

B. EQUIPMENT LIST:

Item	Equipment number
Fume hood supply fan	F 9420
Fume hood exhaust fan	F 9421

C. *OPERATING REQUIREMENTS:*

Fans shall be designed for continuous duty service with air containing corrosive and flammable vapors and gases from laboratory fume hoods and designed to comply with the following:

Equipment number	Capacity, scfm	Static pressure inches, W.C.	Wheel diameter	Wheel type	Fan speed, rpm	Minimum motor HP	Operating voltage and phase
F 9420	355	0.50	8.5	FC	998	.25	120/1
F 9421	505	0.50	8.5	FC	1,155	.25	120/1

D. BALANCE AND VIBRATION:

Fans specified in this section shall be statically and dynamically balanced at the factory. Vibration levels shall not exceed 0.1 inches per second.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. In case of a conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
AMCA Standard 210-74	Laboratory Methods of Testing Fans for Rating
AMCA Standard 2408-69	Operating Limits for Centrifugal Fans
NFPA 255-84	Surface Burning Characteristics of Building Materials

B. CERTIFICATION:

Fans shall be constructed to exceed the minimum pressure limits of AMCA Standard 2408-69. Fans shall be tested and rated in accordance with AMCA Standard 210 and shall bear the AMCA rating seal. Combustible components shall not exceed an NFPA flame spread rating of 25. Motors shall be UL labeled.

1.03 SUBMITTALS

Submittals shall comply with the requirements of Section 01300 and shall include the following information:

1. Manufacturer and manufacturer's type designation.
2. Manufacturer's catalog and/or other data confirming conformance to specified design, material and equipment requirements.
3. Predicted performance data and/or curves as applicable, developed for the specified design and operating requirements and characteristics.
4. Installation requirements showing clearance required for maintenance purposes.
5. Motor data form 11060-A as required in Section 11060.

1.04 ENVIRONMENTAL CONDITIONS

The equipment provided under this section shall be suitable for continuous services exposed to the weather at Avondale, Arizona. Other environmental conditions shall be as specified in Section 01800.

PART 2--PRODUCTS

2.01 ACCEPTABLE PRODUCTS

Fans shall be Redship, Kewaunee, or equal, modified as necessary to provide the specified features and to meet specified operating conditions.

2.02 MATERIALS

Component	Material
Fan wheel	Aluminum or coated steel
Fan housing	Mild steel
Shaft	Stainless steel

2.03 EQUIPMENT

A. GENERAL:

Fans shall be completely assembled as a packaged unit and shall be designed for outdoor installation.

B. FAN:

The fan shall be of the double bearing overhung design type, with bearings isolated from the air stream. Fan wheels shall have forward inclined type blades.

The fan housing shall be designed for minimum turbulence and smooth air flow. The fan housing shall be airtight, lock seam construction, and shall be reinforced to prevent vibration and pulsation. A venturi throat at the fan inlet shall overlap the fan wheel. Fans shall be mounted on vibration isolation systems as specified in Section 11021.

The interior surfaces of fans exposed to the air stream shall receive a two-part baked epoxy coating. The parts shall first be prime coated before the epoxy is applied. The epoxy shall be applied in at least two coats and shall not be less than 7 mils thick. External parts shall receive a baked enamel finish.

C. BEARINGS:

Bearings shall be self-aligning, grease lubricated and prelubed, roller or ball antifriction bearings of the pillow block type, complete with grease fittings. All bearings shall have an average rating life of 100,000 hours, as defined by AFBMA L-10.

D. MOTOR AND DRIVE ASSEMBLY:

Fan shall be provided with adjustable pitch sheaves and adjustable motor bases suitable for a plus or minus 5 percent adjustment in operating speed. Motors shall operate at 1,750 rpm and shall be as specified in Section 11060. The motor shall be non-overloading on all parts of the operating curve.

E. ACCESSORIES:

Fume hood fans shall include the following accessories:

1. Belt guard.
2. Weather cover.
3. Spark resistant construction.
4. Shaft seals.
5. Spring loaded, stainless steel backdraft damper.
6. Access doors.
7. Drain connection.

2.04 SPARE PARTS

One set of drive belts shall be provided for each fan.

2.05 PRODUCT DATA

The following information shall be provided in accordance with paragraph 00710-4.02:

1. Operation and maintenance data in accordance with Section 01730.

2. Certification that the units have been tested and rated in accordance with the AMCA Standard 210 Test Code and comply with the AMCA Certified Ratings Program.

3. Bearing ratings for the fan and motor at design conditions.

4. Motor data as specified in paragraph 11060-2.05.

PART 3--EXECUTION

3.01 GENERAL

Each fan shall be installed on roof as shown and in accordance with manufacturer's recommendations.

3.02 FIELD TESTING

Each fan shall be completely field tested to guarantee compliance with the project manual.

END OF SECTION

SECTION 15850

FUME HOOD EXHAUST DUCTWORK

PART 1--GENERAL

1.01 WORK INCLUDED

Includes exhaust ductwork from hoods to hood exhaust fans, all laboratory exhaust fan ductwork, and discharges from exhaust fans, equipment connections and reinforcing to make a complete exhaust system.

1.02 REQUIREMENTS OF REGULATORY AGENCIES

Install ductwork to meet requirements of the UMC, NFPA, SMACNA and ASHRAE Standards.

1.03 QUALITY ASSURANCE

Ductwork materials for systems handling corrosive gases and constructed per Section 8 of the Industrial Ventilation Manual. Published by American Conference of Governmental Industrial Hygienists.

PART 2--PRODUCTS

2.01 MATERIALS

A. METAL:

1. Stainless steel Type 304L.

B. MINIMUM GAGES:

For Class II ductwork as defined in Industrial Ventilation Manual conveying chemicals:

Diameter of straight ducts	Minimum U.S. Standard gage
To 18 inches	20
18 to 30 inches	18
Over 30 inches	16

Elbows and angles shall be two gages heavier than straight lengths of equal diameter.

C. REINFORCEMENT:

Reinforcement and stiffening angles, bars, straps and rods per SMACNA Standards.

D. JOINT SEALING:

Joints of welded construction. Longitudinal butt joints riveted or spot welded very 3 inches may be used with ceramic cement such as #33 sauereisen ceramic cement to provide an airtight seal.

E. FLEXIBLE CONNECTIONS:

1. MATERIAL: Ventfabrics "Ventfab."
2. STANDARD: NFPA, UL.

2.02 FABRICATION

Ductwork, elbows, takeoffs, and fittings to conform to SMACNA standards.

PART 3--EXECUTION

3.01 INSTALLATION

A. GENERAL:

Install ductwork and accessories to provide a system free from buckling, warping, breathing or vibration. Install in a neat and workmanlike manner. Provide stainless steel flashing and counter-flashing at roof penetrations. Install ductwork airtight and watertight.

B. FUME HOOD DUCT CONNECTIONS:

Make exhaust duct connection to fume hood with stainless steel band of the same type as the ductwork. Wrap Raychem Type TWDB heat shrunk duct band around connection point. Install hat shrunk duct band per manufacturer's recommendations.

C. DUCTWORK HANGING:

Ductwork hung from structure with rods, strap hangers, or trapeze supports. Install according to SMACNA standards. See SMACNA low pressure duct construction Table 5-3, Figure 5-6, Figure 5-7, and Appendix F for hanging methods.

D. SECTION DUCT ASSEMBLY:

Ductwork sections may be field assembled by jointing at site. Helium gas Tungsten-arc welding suitable for the specific stainless steel is acceptable as a jointing method. Flanged stainless steel duct and V grooved stainless steel band jointing system can be used upon approval. V-grooved bonding system requires ceramic joint sealer applied at all joints.

3.02 FLEXIBLE CONNECTION

A. GENERAL:

Install as recommended by manufacturer. Provide minimum 2 inches clearance between metal parts on fan connections, equipment connections, air distribution devices.

B. FAN OUTLET OVER 36 INCHES:

Minimum 4 inches and maximum 10 inches clearance between metal parts.

C. MOISTURE LADEN AIR AND EXTERIOR EXPOSURE:

Waterproof type.

3.03 TEST

Test ductwork system for leakage and noise and repair excessive leakage and noise.

See Section 15042, Tests.

END OF SECTION

SECTION 15855

SHEET METAL DUCTWORK

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section provides specifications for sheet metal ductwork for HVAC systems.

B. TYPE:

Ductwork shall be the low-pressure type designed and custom fabricated specifically for the applications shown under the conditions specified.

1.02 QUALITY ASSURANCE:

A. GENERAL:

Ductwork shall be fabricated to the configurations and dimensions shown. Dimensions shown indicate net free area. Ductwork shall be fabricated and installed by experienced personnel thoroughly familiar with the referenced construction and installation standards and able to complete the work with the requisite degree of quality. The Contractor shall be prepared to document the skill and workmanship of the proposed fabricator and installer.

B. DESIGN CRITERIA AND CONSIDERATIONS:

1. LOW-PRESSURE DUCTWORK: Unless otherwise specified or noted on the drawings, sheet metal gage, reinforcing, hanger and support systems, ductwork joint types, wall and roof penetrations, riser supports, and other basic design and construction details shall be in accordance with the latest revision of the Sheet Metal and Air Conditioning Contractors National Association (SMACNA) Low-Pressure Duct Construction Standards. Duct construction shall conform to 1-inch pressure class, using the appropriate seal class required to limit total system leakage to 5 percent or less of the specified required airflows.

2. CHANGE IN DUCT SIZE: Change in duct size shall be made by a uniformly tapering section. The change in direction of the tapering section shall not be more than 1 inch in 3 inches of run.

3. BENDS IN DUCT: With the exception of miter bends, all bends in ducts shall have inside radii equal to the duct width or diameter. Single wall turning vanes shall be provided at all miter bends in rectangular or square ducts.

4. DUCT SLEEVES: Whenever ducts extend through concrete or masonry walls, floors, or ceilings, they shall be provided with a sleeve.

5. DUCT OPENINGS: Access doors or handholes shall be installed in ducts at suitable locations to reach any movable devices in the ducts. The opening shall be of adequate size to reach in and maintain these devices. Duct test holes with patches in ducts shall be provided where necessary for balancing the system, and shall be coordinated between the trades responsible for installation and balancing.

6. FLEXIBLE CONNECTIONS: Flexible connections shall be installed at all duct connections to rotative equipment. Connections shall be installed with a minimum allowance of 1-inch slack all around. Flexible connection joints shall be airtight and removable without destroying their reusability.

C. STANDARDS:

SMACNA Low-Pressure Duct Construction Standards, latest edition

NFPA Standard 90A--Installation of Air Conditioning and Ventilating Systems

1.03 ENVIRONMENTAL CONDITIONS

The equipment to be provided under this section shall be suitable for continuous service in the locations shown. The job site is at an elevation of approximately 930 feet above sea level. Environmental conditions are specified in Section 01800.

PART 2--PRODUCTS

2.01 MATERIALS

Component	Material
Duct	Galvanized steel, FEDSPEC QQ-S-775, Class D
Duct sleeve	Galvanized steel, 10 gage
Flexible duct connector	Noncombustible, weather and ozone resistant, abrasionproof glass fabric with coating weighing not less than 24 ounces per square yard

2.02 EQUIPMENT

A. DUCT CONSTRUCTION:

Transverse stiffeners and joints shall be appropriately spaced to maintain duct cross-section integrity in accordance with the pressure class specified and at the prevailing operating velocities. Duct velocities within the Plant Control center have been designed to limit noise within the conditioned spaces to acceptable levels and duct construction shall be consistent with this objective.

Joint types shall be selected by the ductwork fabricator to suit the application. Joints shall not interfere with airflow in the ducts. All joints shall be crimped. Exterior duct joints shall be further secured by button punching or riveting. Exterior ducts shall be stiffened, braced, and supported in a manner designed to maintain duct integrity and cross-section under wind and snow loads specified on the structural drawings. Interior ducts shall be suitably braced and stiffened at floor and roof penetrations as well as over their unsupported length in a manner designed to maintain duct integrity and limit vibration and noise in accordance with recognized standards of the industry.

Duct support spacing shall be in accordance with the SMACNA standards for the pressure class and conditions specified and prevailing in the system. Supports shall be spaced to prevent visible duct deflection and loss of system integrity.

Visible duct deflection, loss of shape, or unwarranted noise or vibration resulting from faulty or inadequate support, reinforcing, metal gauge, fabrication, or joint spacing shall be corrected at no expense to the Owner.

B. SLEEVES:

Sleeve flanges shall not be less than 4 inches wide and shall be installed tight against each side of the barrier. Sleeves shall be 2 inches larger than the duct or external duct insulation. The space between the duct (or insulation) and sleeve shall be packed with commercial grade twisted asbestos rope. Duct flanges not less than 4 inches wide shall be installed tight against the wall on each side and fastened to the duct sleeves.

C. ACCESS DOORS:

Duct access doors shall be 12 inches by 12 inches unless otherwise indicated. Where size of duct will not accommodate this size, the door shall be as large as practical and shall be constructed of gage not less than the duct sheet. The doors shall be rigid and shall be provided with airtight gaskets and shall not vibrate or cause noise under the conditions of service. Doors in insulated ducts shall be the insulated type. Doors shall be hinged type with ventlock latch on outside.

D. FLEXIBLE CONNECTIONS:

Flexible duct connections shall be provided with the necessary angle, straps, bolts, clips, or other fasteners to secure the flexible material to the equipment and ducts.

E. TURNING VANES:

Turning vanes shall be 2-inch blades for ducts up to 18 inches in either direction and shall be 4-1/2-inch blades for larger ducts. All turning vane assembles shall be finished with an air-dried phenolic corrosion resistant coating prior to installation. All turning vanes shall be constructed of the same material as the duct in which they are installed.

F. CORROSION PROTECTION:

Ductwork exposed to view that is uninsulated or internally insulated shall be coated on all external surfaces in accordance with Section 09900.

PART 3--EXECUTION

3.01 INSTALLATION

Unless otherwise noted, installation of all ductwork shall conform to the referenced standards and Section 15858.

All ductwork sealing shall be by taping with canvas and Borden, In., Arabol paste. System leakage in excess of the allowable level specified shall be corrected by additional sealing at no expense to the Owner.

The inside of all ducts visible through grilles and registers shall be painted black, and exposed venting duct on roof shall be painted white.

3.02 DUCT MATERIAL SCHEDULE

Location	Duct material
All areas	Galvanized steel

END OF SECTION

SECTION 15856

FLEXIBLE DUCTWORK

PART 1--GENERAL

1.01 QUALITY ASSURANCE

A. ACCEPTABLE MANUFACTURERS:

Automation Industries, Inc., Clevepack Corp., Genflex, Johns-Manville.

B. DESIGN CRITERIA:

1. LOW PRESSURE: Operating conditions below 2 inches w.g. static pressure, 2,000 fpm velocity and 250 degrees F.

C. REQUIREMENTS OF REGULATORY AGENCIES:

UL 181, Standards for Life Safety, Air Ducts, Class 1.

PART 2--INSULATED FLEXIBLE AIR DUCT

A. DESCRIPTION:

Inner sleeve, insulation, and outer moisture barrier. Spring steel wire helix reinforced, airtight inner sleeve. Wire coated to prevent corrosion. 1-inch-thick fiberglass, 3/4-pound density. Integral fastening devices for duct hanging. UL listed Class 1 air duct. NFPA-90A. Working pressure 2-inch w.g.

B. MANUFACTURER:

Similar to Automation Industries, Inc., "Thermaflex M-KC."

2.01 FITTINGS

A. CONSTRUCTION:

Hot-dip galvanized steel. In conformance with ASHRAE standards.

B. SUPPLY AIR TAKE-OFF:

Expanded bell mouth with spin-in collar and damper and positive locking wing nut. Air extractor. Similar to Clevepak Corp. Type DESC.

C. COUPLING:

Double male coupling collar for joining sections of flexible duct.

PART 3--EXECUTION

3.01 INSTALLATION

Install ductwork and fittings as recommended by manufacturer.

Installation in workmanlike manner with no sagging or drooping. Sufficient length for long sweeping turns.

Joint sealing: Seal joints with approved duct tape at metal joint and also at vapor barrier joint. Duct joints on sheet metal collars.

Ductwork hangings as recommended by manufacturer.

3.02 TEST

Test ductwork system for leakage and noise and repair excessive noise and leakage.

END OF SECTION

SECTION 15858

DUCTWORK THERMAL INSULATION

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies internal and external thermal insulation for metal air ductwork systems.

B. TYPE:

External ductwork insulation shall be the flexible blanket type and have a reinforced foil kraft vapor barrier facing. Internal insulation shall be the rigid board type and have a smooth integral ductwork insulation shall be Knauf, Johns Manville, Owens Corning Fiberglass, or equal.

1.02 QUALITY ASSURANCE

A. INTERNAL DUCTWORK INSULATION:

Internal ductwork insulation shall be designed to comply with the following:

1.	Thickness, inches	1
2.	Temperature range, degrees F	40-250
3.	Density, pounds per cubic foot	3
4.	Moisture absorption, percent by volume	0.5
5.	Conductance, Btu per square foot per degree F per hour (based on mean temperature of 75 degrees F)	0.23

B. EXTERNAL DUCTWORK INSULATION:

External ductwork insulation shall be designed to comply with the following:

1.	Thickness, inches	1-1/2
2.	Temperature range, degrees F	40-250
3.	Density, pounds per cubic foot	3/4
4.	Moisture absorption, percent by volume	0.20
5.	Thermal conductivity, Btu inches per hour per square foot per degree F (based on mean temperature of 75 degrees F)	0.30

1.03 ENVIRONMENTAL CONDITIONS

The insulation to be provided under this section shall be suitable for continuous services in ventilating and air conditioning ductwork at Avondale, Arizona, and the environmental conditions specified in Section 01800. The job site is at an elevation of approximately 930 feet above sea level.

Internal insulation shall be suitable for continuous service inside sealed ductwork which is exposed to the weather and direct sun. External insulation shall be suitable for continuous service on the outside of ductwork in locations exposed to weather and direct sun.

PART 2--PRODUCTS

2.01 INTERNAL DUCTWORK INSULATION

Internal insulation shall be made from long, flame attenuated glass fibers bonded with a thermosetting resin. The air stream surface shall be covered with a tough, smooth, black fiberglass mat.

2.02 EXTERNAL DUCTWORK INSULATION

External insulation shall be made of long, extremely fine, flame attenuated glass fibers, bonded with a thermosetting resin. The facing shall be constructed out of reinforced foil kraft.

PART 3--EXECUTION

3.01 GENERAL

Ductwork insulation shall be provided where specified. Internal insulation shall be used in all exterior ducts exposed to weather that require insulation, and where specified. Where internal insulation is not specified and the ducts are not exposed to weather, either external or internal type insulation may be used to satisfy insulation requirements. Fresh air intake ducts shall be insulated only where specified. Exhaust air ducts need not be insulated. Acoustically lined ducts that meet the thermal requirements as specified need not be further insulated.

3.02 INTERNAL DUCTWORK INSULATION

Internal insulation shall be applied with edges tightly butted and shall be secured by applying 50 percent coverage (6-inch-wide strips on 12-inch centers) of vapor barrier adhesive approved by

the National Fire Protection Association. All leading and cross joint edges shall be coated with the same adhesive. In addition, internal insulation shall also be secured by mechanical fasteners such as speed clips or nail type stick clips fastened with adhesive. One mechanical fastener shall be used for every 1 square foot of duct surface. Fasteners shall be started a minimum of 2 inches from the leading edge of each section and a minimum of 3 inches from all cross joints.

3.03 EXTERNAL DUCTWORK INSULATION:

External duct insulation shall be applied with edges tightly butted and shall be secured by applying 50 percent coverage (6-inch-wide strips on 12-inch centers) of vapor barrier adhesive. All seams shall be sealed with 4-inch-wide tape with the ends of the tape overlapping at least 4 inches. Where the underside of horizontal ducts exceeds 24 inches in width, insulation shall be additionally secured by mechanical fasteners such as speed clips and nail type stick clips fastened with adhesive. One mechanical fastener shall be used for every 2 square feet of duct surface. All duct penetrations shall be sealed with a piece of the same facing material as the duct and installed with the same vapor barrier adhesive. External insulation and vapor barrier shall extend through all duct sleeves.

END OF SECTION

SECTION 15861

ACOUSTICAL LINING FOR DUCTS

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section includes acoustical lining for noise reduction and insulation in sheet metal ductwork used in heating, ventilating, and air conditioning applications.

B. TYPE:

Lining shall be the flexible fiberglass type.

1.02 QUALITY ASSURANCE

Acoustical lining furnished and installed under this section shall comply with the SMACNA Duct Liner Application Standard. Lining shall be installed where shown on the drawings or specified. The duct sizes noted indicate net free areas. Duct dimensions shall be increased by the thickness of the lining where lining is required.

1.03 ENVIRONMENTAL CONDITIONS

Equipment to be furnished shall be suitable for indoor installation. Temperature of the air flowing by the liner may range from 30 degrees F to 150 degrees F. Relative humidity may range from 30 percent to 90 percent.

PART 2--PRODUCTS

Component	Material
Lining	Fiberglass
Adhesive	Fire-resistant, NFPA 90A
Mechanical fasteners	Steel

PART 3--EXECUTION

All portions of duct designated on the drawings to receive duct liner shall be completely covered with liner. Ducts and plenums shall be lined with flexible duct liner 1 inch thick, with 1 1/2 pounds per cubic foot density of liner (not including any surface coating or facing).

Transverse joints shall be neatly butted and there shall be no interruptions or gaps. The liner surface designed to be exposed shall face the air stream. Duct liner shall be adhered to the sheet metal with 100 percent coverage of adhesive, and all exposed leading edges and all transverse joints coated with adhesive. The liner shall be additionally secured with impact applied, hardened steel mechanical fasteners which shall compress the duct liner sufficiently to hold it firmly in place.

END OF SECTION

SECTION 15863

DAMPERS

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies balancing dampers.

1.02 QUALITY ASSURANCE

Dampers shall have a pressure drop no greater than 0.07 inch of water column when wide open and operating with air velocities not less than 1,500 feet per minute.

PART 2--GENERAL

2.01 GENERAL

A. MATERIALS:

Damper blades shall be constructed of at least 16 gage 6063 T5 extruded aluminum. Frames shall be 2 inches by 1/2 inch by 1/8 inch extruded aluminum channel. Linkages and operators for damper blades shall also be aluminum. Bearings shall be self lubricating nylon or oil impregnated bronze. Damper jambs shall be flexible aluminum venetian blind type. Blades shall be provided with vinyl edge seals.

B. CONSTRUCTION:

Dampers shall be of heavy-duty construction and of the multiblade type. Dampers shall be of the opposed blade type unless otherwise specified or shown. The damper frame shall be of rigid construction and so designed that blade ends overlap for close fit. Dampers shall be center pivoted with two reinforcing bosses. The entire assembly shall operate freely and without binding. Dampers shall be sized and installed as shown.

2.02 BALANCING DAMPERS

Balancing dampers shall be furnished complete with a manual locking quadrant, unless otherwise specified, and position indicator dampers shall be operated externally to the ductwork. Motorized balancing dampers shall be furnished with linkages, blade drive ears, and mounting bracket for motor operators.

PART 3--EXECUTION

3.01 INSTALLATION

All dampers shall be aligned, installed and connected in strict accordance with the manufacturer's recommendations.

3.02 TESTING

All balancing dampers shall be tested for proper operation and control prior to acceptance.

END OF SECTION

SECTION 15867

MECHANICAL LOUVERS

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section includes specifications for all intake and exhaust air louvers and appurtenances as required for a complete installation.

B. TYPE:

Unless otherwise noted, louvers shall be of the stormproof, vertical wall type used for inlet and exhaust air ventilation. Louvers shall be Carnes FLLA, Construction Specialities, Airolite, Ruskins, or equal.

1.02 PERFORMANCE AND DESIGN REQUIREMENTS

A. GENERAL:

All equipment furnished under this section shall be the product of firms regularly engaged in the manufacture of this type of item and shall be of a single manufacture.

B. PERFORMANCE AND DESIGN REQUIREMENTS:

Louvers shall be suitable for air supply or discharge service and shall be sized as shown on the contract drawings. Wall louvers with any dimension greater than 24 inches shall be considered large louvers, unless otherwise noted, and shall be a minimum of 4 inches deep. Small louvers shall be 2 inches deep.

Maximum pressure drop through any air supply louver shall not exceed 0.06 inch of water column at 500 feet per minute velocity through its free area as determined in accordance with AMCA Standard 500. Maximum pressure drop through any exhaust air louver shall not exceed 0.12 inch of water column at 700 feet per minute through its free area.

C. STANDARDS:

All louvers shall bear the AMCA Certified Ratings seal for both Air Performance and Water Penetration.

1.03 SUBMITTALS TO BE PROVIDED

Submittals shall be in accordance with Sections 01300, and shall include a complete description of the louvers and accessories in sufficient detail to demonstrate compliance with these specifications.

PART 2--PRODUCTS

2.01 MATERIALS

Louver frames and blades shall be of 6063-T52 extruded aluminum alloy. Blades and frames for 2-inch-deep and 4-inch-deep louvers shall be 0.081 inch (12 gage) thick. Blades and fames for 6-inch-deep louvers shall have a thickness of 0.125 inch (8 gage). Unless otherwise specified, louvers shall have a clear anodized finish.

Louver bird screens shall be removable, 1/2-inch mesh, 14-gage (0.063 inch) aluminum secured within a 10-gage extruded aluminum frame.

All fastenings shall be stainless steel or aluminum as shown.

2.02 WALL LOUVER CONSTRUCTION

A. BLADES:

Blades shall be of the fixed type with interlocking blade braces to provide an uninterrupted horizontal line. Intake louvers shall have a center baffle to enhance weatherproofing. Slideable interlocked mullions shall have provisions for expansion and contraction.

B. FRAMES:

Louver frames shall be assembled by welding. Heads, sills and jambs shall be one-piece structural members, and shall have an integral caulking slot and retaining bead.

C. SCREENS:

Louver screens shall be furnished on all louvers serving ventilation air intakes or exhausts and shall be furnished with a removable louver bird screen mounted on the interior face but independent of the louver. All louvers shall be furnished with a removable insect screen in an extruded aluminum frame that is mounted on the interior face of the louvers.

2.03 PRODUCT DATA

The following information shall be provided in accordance with paragraph 00710-4.02:

1. Certified results on pressure drop test data and water penetration data for all louvers.

PART 3--EXECUTION

3.01 INSTALLATION

Equipment specified in this section shall be aligned, connected and installed as shown and in accordance with the manufacturer's recommendations. A bituminous coat shall be applied to all aluminum surfaces in contact with concrete or masonry.

END OF SECTION

SECTION 15872

CEILING GRILLES

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies ceiling grilles and extractors associated with the heating, ventilating and air conditioning systems.

1.02 QUALITY ASSURANCE

All ceiling grilles and extractors shall be installed as shown and shall be of the size and capacity indicated thereon.

1.03 SUBMITTALS

Submittals shall comply with the requirements set forth in sections 01300 and 11000 and shall include descriptive information sufficient to demonstrate compliance with these specifications.

PART 2--PRODUCTS

2.01 GENERAL

A factory applied finish of baked white enamel shall be provided. Each unit shall be set flat against the room surface finish or duct and shall have a gasket or seal. Ceiling grilles shall be as specified on the drawings.

2.02 RECTANGULAR CEILING SUPPLY AIR GRILLE (CSG)

A. Type: Carnes SK Series

1. Material: Steel
2. Frame: S frame
3. Blow: As shown on drawings

B. Accessories

1. MOdel KXEA direction changer

2.03 RECTANGULAR CEILING RETURN OR EXHAUST GRILLE (CRG)(CEG)

A. Type: Carnes Model RSLA Return Air and Exhaust Air Grille

1. Material: Steel

2.04 ACCEPTABLE PRODUCTS

Grilles shall be Carnes, Agitair, Independent, Krueger, Millair, Titus, Tuttle & Bailey, or equal.

PART 3--EXECUTION

3.01 INSTALLATION

A. GENERAL:

Install as recommended by manufacturer. Center on building's features. See reflected ceiling plans. Align grille and diffuser faces. Set ceiling line. Install accessories. Boots aligned for neat fit to grilles and diffusers.

B. PAINTING:

Paint visible ductwork and insulation behind grille flat black.

3.02 TESTING AND BALANCING

Leave all volume dampers in wide open position and position direction changers for maximum airflow prior to final air balancing. Testing, adjusting, and balancing shall be performed as specified in Section 15809.

3.03 CLEANING

Touch up marks and abrasions to match original finish.

END OF SECTION

SECTION 15881

DISPOSABLE FILTERS

PART 1--GENERAL

1.01 QUALITY ASSURANCE

A. AMERICAN MANUFACTURERS:

American Air Filter; Industrial 5700, Cambridge; Filterman; Farr 30/30.

B. REQUIREMENTS OF REGULATORY AGENCIES:

1. National Bureau of Standards: Atmospheric Dust Spot Test, Cottrell Precipitate and Lint Test.

2. UL: Class 2.

1.02 STANDBY COMPONENTS

Provide a new set for each air handling unit for final balancing, and provide an additional set of filters for Owner.

1.03 PRODUCT DELIVERY, STORAGE AND HANDLING

Deliver filters in manufacturer's original packaging. Store to keep clean from contamination by dust, water or other deteriorating elements. Handle to prevent physical damage or contamination.

PART 2--PRODUCTS

2.01 THROW-AWAY FILTERS

A. DESCRIPTION:

Throw-away type air filter. Factory adhesive film. Metal reinforced. Integral frame and stiffener. Slide-in type metal filter holder.

B. SIZE AND CAPACITY:

Nominal 2 inches thick, sized for maximum 500 fpm, 0.20 inch w.g. initial pressure drop.

C. EFFICIENCY:

Minimum 30 percent atmospheric dust, 70 percent Cottrell precipitate and lint.

PART 3--EXECUTION

3.01 INSTALLATION

Install in ductwork or in equipment. Arrange for good access.

3.02 CLEANING

Install new set of filters when ready for final balancing.

END OF SECTION

SECTION 15990

CATHODIC PROTECTION SYSTEM

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies all material equipment and services necessary to construct a cathodic protection system. All buried pipelines, fittings and valves requiring cathodic protection shall be cathodically protected as shown and as specified herein. The work includes dielectric isolation, pipeline continuity bonds, sacrificial anodes, test stations, wiring and cables, and testing for the affected piping systems.

B. PIPING SYSTEMS:

All buried D.I. pipe, utilized as the force main crossing the Agua Fria River, shall be provided with cathodic protection.

1.02 QUALITY ASSURANCE

The Contractor shall cause all materials and equipment in this section to be the product of firms regularly engaged in the design and installation of cathodic protection system components. The Contractor shall be prepared to document the cathodic protection system components manufacturer's technical competence, skill, resources and ability to complete the work specified herein with the requisite degree of quality in a timely and efficient manner.

1.03 SUBMITTALS

A. ANODE SCHEDULE:

The Contractor shall submit to the Construction Manager, prior to installation, detailed drawings and data on the anodes and anode installations furnished under this section for approval. Drawings shall show anode locations along the pipeline. In general, anodes will be spaced evenly along the length of the pipeline at the spacings herein specified.

B. TEST REPORTS:

The Contractor shall submit to the Construction Manager five copies of the cathodic protection system testing reports. The test reports shall include a description of all testing procedures employed and all data and results of the required testing including continuity testing, native p/s potentials, insulator testing, anode adjustment, and final p/s potentials.

PART 2--PRODUCTS

2.01 MATERIALS

A. DIELECTRIC ISOLATION:

1. GENERAL: All buried and metallic piping included in the cathodic protection system shall be dielectrically isolated from all other piping, hangers, brackets, steel reinforcing, and all other metal structures.

2. DIELECTRIC INSULATORS: Flange dielectric insulation sets shall contain full faced gaskets, full length sleeves, and double washers or as specifically indicated on the drawings. Insulation material for the flange insulation sets shall be phenolic resin, and flange faced gaskets shall be neoprene faced phenolic resin. All insulating materials shall be of a type designated by the manufacturer as suitable for use at the operating and test pressures specified in Section 15050.

3. WALL PENETRATIONS: All penetrations through reinforced concrete walls shall be constructed to prevent metal-to-metal contact between the pipe and reinforcing steel in the wall.

4. PIPE SUPPORTS: Any pipe hangers, supports, brackets and saddles installed on the buried side of dielectric insulators on the protected pipe shall be dielectrically isolated from the pipe by insertion of dielectric insulating material between the hanger and the pipe.

B. ELECTRICAL CONTINUITY BONDING:

All buried pipe included in the cathodic protection system shall be bonded for electrical continuity as shown on the drawings. Bell and spigot joints and flexible couplings shall be bonded as shown.

C. ANODES:

Anodes shall be prepackaged magnesium anodes as indicated on the drawings. Anodes shall be installed on underground piping as shown on the drawings and in the specifications.

Each magnesium anode shall be a magnesium ingot of the following composition:

Aluminum, percent maximum	0.01
Manganese, percent	0.5 to 1.3
Zinc	0.05
Silicon	0.05
Copper, percent maximum	0.02
Nickel, percent maximum	0.001
Iron, percent maximum	0.03
Other impurities, percent maximum	0.05 each or 0.3 maximum total
Magnesium	Remainder

2.02 TEST STATIONS

Test stations shall consist of a terminal plate mounted as shown on the drawings and placed in a concrete valve box. A cast iron cover for vehicular traffic having the word "ANODE" cast on the lid shall be provided on the concrete valve box at each test station. A test station shall be installed at each anode location unless otherwise indicated on the drawings.

PART 3--EXECUTION

3.01 INSTALLATION

A. DIELECTRIC INSULATORS:

Dielectric insulators shall be installed on the exposed flanges or couplings which are connected to buried cathodically protected piping.

B. ANODES:

1. SIZE AND SPACING: Magnesium anode size and spacing for D.I. piping systems shall be two 17 pound anodes at 100 feet maximum spacing.

2. PLACEMENT: Each anode shall be cast with a perforated galvanized steel core. One end of the strap is accessible for the lead wire connection. The anode lead wire shall be No. 8 AWG solid copper wire with Type THW insulation and shall be connected to steel strap core with silver solder. The connection shall be mechanically secure before soldering and shall have at least 1-1/2 turns of wire at the connection. The entire connection shall be insulated by filling the anode recess with an electrical potting compound. The anode shall be packaged in a permeable cloth bag.

The native soil backfill shall be firmly packed around the magnesium anode within the cloth bag by means of adequate vibration so that the anode is completely surrounded with a minimum 1/2 inch of backfill material. The earth backfill placed around the package anode shall be tightly compacted, and the installed anode shall be flooded with a minimum of 15 gallons of water before final backfill.

3.02 TESTING

A. GENERAL:

All cathodically protected pipe, fittings and valves shall be tested for electrical continuity, anode current output and pipe-to-soil potential adjustment, and dielectric isolation from other structures after all connections have been made. Defective connections and required adjustments shall be corrected to the satisfaction of the Construction Manager and then retested.

The testing shall be performed under the direct supervision of a corrosion specialist, regularly engaged in this type of work. All test boxes shall be permanently identified, within the test box, by a code or numbering system set up by the corrosion specialist for purposes of recording the test results and future monitoring. All required testing, identification system coding, and test recording by the corrosion specialist shall be accomplished by the Contractor as a part of this contract.

B. ANODE CURRENT ADJUSTMENT:

Anode current output and pipe-to-soil potentials shall be regulated by installing an adjustable resistor into the anode circuit at test stations as necessary. Variable resistors shall be (1) vitreous coated adjustable resistors with slide bar, (2) nickel-chromium resistance wire, or (3) circular rheostat type. Resistors shall have a capacity in ohms which exceeds the required setting by 50 percent.

Maximum current output from the anodes shall not exceed 48 milliamperes for the 17 pound anodes.

C. CONTINUITY TESTING:

Tests shall be conducted by measuring response of the pipe, fitting or valve to the application of cathodic protection test current. An auxiliary ground will be installed at a minimum of 10 feet from the pipeline. The positive terminal of a portable test rectifier unit shall be connected to the auxiliary ground. The negative terminal shall be connected to the pipeline at a test station. The test rectifier shall be adjusted to provide sufficient DC current to adjust the pipe to the desired potential. The current output and voltage of the rectifier shall then be recorded.

Measurements of pipe-to-soil potential shall be made with the test current turned both "off and on." The pipe-to-soil potential shall be measured at representative locations along the full length of the pipeline to be tested. In addition, measurement shall be taken across dielectric insulating fittings. The pipe-to-soil potentials shall be measured with a potentiometer/voltmeter circuit of a Multi-Combination Meter and with respect to a portable copper sulfate reference electrode placed at grade. Contact to the pipe shall be made at test stations installed for that purpose. All measurements shall be duly recorded, certified as to their accuracy by the corrosion specialist, and submitted to the Construction Manager.

If the pipe-to-soil potential is made more negative by application of the test current, electrical continuity of the pipeline is indicated between that point and the point at which the test rectifier negative connection was made. Dielectric isolation across insulating fittings shall be indicated by the pipe-to-soil potential being made more positive or no potential shift by application of the test current. Multiple test setups may be necessary so that the full length of the pipelines are demonstrated to be electrically continuous and dielectrically isolated from other structures. In the event that electrical continuity or dielectric isolation are not achieved as indicated to be necessary, the Contractor shall perform required repairs to the satisfaction of the Construction Manager.

END OF SECTION

DIVISION 16

ELECTRICAL

Section	Title
16000	GENERAL REQUIREMENTS FOR ELECTRICAL WORK
16110	RACEWAYS, FITTINGS AND SUPPORTS
16115	MANHOLES, HANDHOLES AND PULL BOXES
16120	CONDUCTORS, WIRE, AND CABLE
16140	WIRING DEVICES
16175	MISCELLANEOUS ELECTRICAL DEVICES
16176	LOCAL CONTROL PANELS
16310	LOW VOLTAGE SWITCHGEAR
16431	SHORT CIRCUIT AND COORDINATION REPORT
16440	INSTRUMENT TRANSFORMERS, METERS, SWITCHES AND ACCESSORIES
16450	GROUNDING SYSTEM
16460	DRY-TYPE TRANSFORMERS (600 VOLTS AND LESS)
16470	LIGHTING AND POWER DISTRIBUTION PANELBOARDS
16500	LIGHTING FIXTURES
16920	600 VOLT MOTOR CONTROL CENTERS
16925	PROGRAMMABLE LOGIC CONTROLLER (PLC)

SECTION 16000

GENERAL REQUIREMENTS FOR ELECTRICAL WORK

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies general requirements for electrical work. Detailed requirements for specific electrical items are specified in other sections but are subject to the general requirements of this section. The electrical drawings and schedules included in this project manual are functional in nature and do not specify exact locations of equipment or equipment terminations.

B. DEFINITIONS:

1. ELEMENTARY OR SCHEMATIC DIAGRAM: An elementary or schematic diagram shows all circuits and device elements of an equipment item or assembly or any defined functional portion thereof. Such a diagram emphasizes the device elements of a circuit and their functions as distinguished from the physical arrangement of the conductors, devices, or device elements of a circuit system.

2. ONE-LINE DIAGRAM: A one-line diagram shows by means of single lines and graphical symbols the course of an electrical circuit or system of circuits and the components, devices or parts used therein. Physical relationships are usually disregarded.

3. BLOCK DIAGRAM: A block diagram is a diagram of a system, instrument, computer, or program in which selected portions are represented by annotated boxes and interconnecting lines.

4. WIRING DIAGRAM OR CONNECTION SYSTEM: A wiring or connection diagram includes all of the devices in a system and shows their physical relationship to each other including terminals and interconnecting wiring in an assembly. This diagram shall be (a) in a form showing interconnecting wiring only by terminal designation (wireless diagram), or (b) a panel layout diagram showing the physical location of devices plus the elementary diagram.

5. INTERCONNECTION DIAGRAM: An interconnection diagram is a special form of wiring diagram that shows only the external connections between motor control centers, control panels and associated equipment, machinery, terminal boxes and external components.

6. ARRANGEMENT, LAYOUT, OR OUTLINE DIAGRAMS: An arrangement, layout, or outline drawing is one which shows the physical space and mounting requirements of a piece of equipment. It may also indicate ventilation requirements and space provided for connections or the location to which connections are to be made.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
NFPA-70-87	National Electrical Code (NEC)
UBC-1985	Uniform Building Code

B. IDENTIFICATION OF LISTED PRODUCTS:

Electrical equipment and materials shall be listed for the purpose for which they are to service, by an independent testing laboratory. Three such organizations are Underwriters Laboratories (UL), Canadian Standards Association (CSA), and Electrical Testing Laboratories (ETL). Independent testing laboratory shall be acceptable to the inspection authority having jurisdiction.

When a product is not available with a testing laboratory listing for the purpose for which it is to serve, the product may be required by the inspection authority, to undergo a special inspection at the manufacturer's place of assembly. All costs and expenses incurred for such inspections shall be included in the original contract price.

C. FACTORY TESTS:

Where specified in the individual product specification section, factory tests shall be performed at the place of fabrication and performed on completion of manufacture or assembly. The costs of factory tests shall included in the contract price.

1.03 SUBMITTALS

A. GENERAL:

Submittals shall be provided in accordance with Section 01300 and where applicable shall be identified by the specified equipment number and specification section. Submittals shall consist of those specified under individual specification sections.

B. SUBSTITUTIONS:

If the Contractor elects to provide or use an equal to the named material or equipment, the Contractor shall make written application in accordance with paragraph 00710-4.06. Where single source products are specified, they shall be provided in accordance with paragraph 00710-4.05 B.

1.04 DRAWINGS

Where the Contractor is required to provide information on drawings as part of the specified work, such drawings shall be prepared on 22-inch by 34-inch polyester plastic (Mylar) drafting media complete with borders and title blocks clearly identifying project name, equipment and the scope of the drawing. Drawing quality and size of presentation shall be such as to permit 50-percent reduction of such drawings for insertion in operation and maintenance manuals.

1.05 PROJECT/SITE CONDITIONS

A. GENERAL:

Unless otherwise specified, eauipment and materials shall be sized and derated for an ambient temperature of 50 degrees C at an elevation ranging from sea level to 3000 feet without exceeding the manufacturer's stated tolerances.

B. CORROSIVE AREAS:

The following areas are designated as corrosive:

1. Interior of the chlorination building.

2. Interior of the odor reduction facility building.

3. Interior of the ferrous chloride metering room at the interceptor pumping station.

C. HAZARDOUS (CLASSIFIED) AREAS:

The following areas are designated as hazardous (classified) Class 1, Division 1, Group D areas:

1. Raw sewage wet well at the interceptor pumping station.

2. Raw sewage wet well at the headworks.

3. Raw sewage channels from the discharge of the raw sewage pumps to the slide gates at the north end of the bar screen channels and to the top of the channels.

D. SEISMIC:

Electrical equipment and supports shall be braced in accordance with UBC for Seismic Zone 2.

1.06 STORAGE OF MATERIALS AND EQUIPMENT

Materials and equipment shall be stored as specified in paragraph 01605-3.0 E.

Equipment and materials to be located indoors shall be stored indoors and sealed with plastic film wrap.

1.07 ELECTRICAL NUMBERING SYSTEMS

A. RACEWAY NUMBERS:

Raceway numbers have been assigned as follows.

Raceway numbers are prefixed for one or more of the following functions:

Raceway Prefix	Type of Function
C	Control and/or 120V or less power
N	Pneumatic tubing
P	Power 208V to 600V
S	Low level signal (less than 90 volt communication or less than 30 volt instrumentation)
X	Spare

Prefixes are followed by a 4-digit number. Where there is more than one raceway to a particular piece of equipment, a letter suffix is added to distinguish the raceways.

Example:

Raceway number = P3109A

where:	P	=	conduit contains power
3109	I	=	unique 4-digit number
	A	=	letter to distinguish from other raceways to same equipment

B. TAG NUMBERS:

Conductors shall be identified with numbers at both ends with printed heat shrinkable or slip-on sleeves. These tag numbers shall consist of the equipment number followed by a dash followed by the conductor number specified on the control diagram.

Example:

Tag number = 1900 - L1

where: 1900 = cable number
L1 = conductor number

Conductors which are in parallel or in series between eauipment shall have the same conductor number. Neutral conductors shall have the same conductor number. Wherever possible, the conductor number shall be the same as the terminal to which it connects.

When factory wired equipment has terminal numbers different than the conductor numbers shown on the control diagrams, both shall be shown on the interconnection diagram, and a copy of the interconnection diagram shall be fastened to the inside of the equipment cabinet.

PART 2--PRODUCTS

2.01 EQUIPMENT AND MATERIALS

A. GENERAL:

Equipment and materials shall be new and free from defects. All material and equipment of the same or a similar type shall be of the same manufacturer throughout the work. Standard production materials shall be used wherever possible.

B. EQUIPMENT FINISH:

Unless otherwise specified, electrical equipment and materials shall be painted by the manufacturer as specified in paragraph 09900-3.03 H.

C. GALVANIZING:

Where specified, galvanizing shall be in accordance with Section 05910.

2.02 WIRE MARKERS

Each power and control conductor shall be identified at each terminal to which it is connected. Conductors size No. 10 AWG or smaller shall have identification sleeves. Conductors shall be identified in accordance with paragraph 16000-1.07 B. The letters and numbers that identify each wire shall be machine printed on sleeves with permanent black ink. The figures shall be 1/8 inch high. Sleeves shall be yellow or white tubing, sized to fit the conductor insulation. The sleeves shall be shrunk to fit the conductor with hot air after installation. They shall be TMS Thermofit Marker System by Raychem Co., sleeve style wire marking system by W. H. Brady Co., or equal. Adhesive strips are not acceptable. Conductors No. 8 AWG and larger shall use cable markers of the locking tab type. Tabs shall be white plastic with conductor identification number permanently embossed.

2.03 NAMEPLATES

Nameplates shall be made from laminated phenolic plastic. The nominal size of the nameplates shall be 3/4 inch high by 2 inches long. Nameplates shall have white backgrounds with 3/10-inch black letters. If abbreviations are required because of space limitations, abbreviations shall be submitted to the Construction Manager prior to manufacture. Nameplates shall be fastened using self-tapping stainless steel screws. The use of adhesives will not be permitted on the outside of enclosures.

2.04 TERMINAL BLOCKS

Unless otherwise specified, terminal blocks shall be panhead strap screw type. Terminals shall be provided with integral marking strips which shall be permanently identified with the connecting wire numbers as shown on the drawings. Terminal blocks for P-circuits (power 208-600 volts) shall be rated not less than the conductor current rating and shall not be rated less than 600 volts AC. Terminal blocks for C-circuits (control and/or power 120 volts or less power) and S-circuits (signal) shall be rated not less than 20 amperes and shall not be rated less than 600 volts AC. Terminals shall be tin-plated. Insulating material shall be nylon.

2.05 PRODUCT DATA

A. GENERAL:

Product data specified under individual specification sections shall be provided in accordance with paragraph 00710-4.02.

In addition to product data specified under individual specification sections, the following material shall be provided in accordance with paragraph 00710-4.02 and within the time period specified.

B. CATALOG CUTS:

Within 120 days of "Notice to Proceed," the Contractor shall provide catalog cuts of equipment, devices, and materials requested by the individual specification sections. Catalog information shall include technical specifications and application information, including ratings, range, weight, accuracy, etc. Catalog cuts shall be edited to show only the items, model numbers, and information which apply.

Catalog cuts shall be assembled in a folder. Each folder shall contain a cover sheet, indexed by item, and cross-referenced to the appropriate specification paragraph.

C. OPERATION AND MAINTENANCE INFORMATION:

Operation and maintenance information shall be provided on an item-by-item basis in accordance with Section 01730. Operation and maintenance information shall be provided at the time of equipment, device, or material site delivery, or at a certain stage of project completion as required by Section 01730, whichever is the earlier. Full-size drawings shall be reduced to 11 x 17 inches.

D. TEST RESULTS:

The Contractor shall provide the test results for motors and electrical systems on the forms specified in Section 16030. A file of the original test results shall be maintained by the Contractor. Prior to acceptance of work, the result file shall be provided to the Construction Manager.

E. INTERCONNECTION DIAGRAMS:

The Contractor shall prepare interconnection diagrams depicting all cable requirements together with their actual terminations as specified below.

2.05 E.

Interconnection diagrams shall be drawn similar to the typical interconnection diagram specified on the drawings. The interconnection diagrams shall indicate wiring between panels, terminal boxes, remotely mounted devices, and motor control centers. The diagrams shall interface with the manufacturer's internal connection diagrams for panels. The diagrams shall indicate the terminations to terminal blocks of field devices at each end of the cable, the number of conductors in the cable, the size of wire, and the number of spare conductors. For each termination, the diagrams shall indicate the terminal number, wire color, and wire number as it appears on the wire marker. All terminal blocks, including spares, shall be indicated on the diagrams. Interconnection diagrams shall be provided to the Construction Manager prior to installation of equipment.

F. FUNCTIONAL CHECKOUT PROCEDURES:

Description of functional checkout procedures specified under paragraph 16000-3.02 C shall be provided 10 days prior to performing functional checkout tests.

PART 3--EXECUTION

3.01 GENERAL

A. CONSTRUCTION:

The work under Division 16 shall be performed in accordance with these specifications.

Unless otherwise detailed or dimensioned, electrical layout drawings are diagrammatic. The Contractor shall coordinate the location of electrical material or equipment with the work. Minor changes in location of electrical material or equipment made prior to installation shall be made at no cost to the Owner.

B. HOUSEKEEPING:

Electrical equipment shall be protected from dust, water and damage. Motor control centers, switchgear, and buses shall be wiped free of dust and dirt on the outside kept dry and shall he vacuumed on the inside within 30 days of acceptance of the work.

Before final acceptance, the Contractor shall touch up any scratches on equipment as specified in paragraph 09900-3.03 H.

Electrical equipment temporarily exposed to weather, debris, liquids, or damage during construction shall be protected as specified in paragraph 01605-3.0 F.

3.02 TESTING

A. GENERAL:

Prior to energizing the electrical circuits, the tests shall be performed as specified in Section 16030. Unless otherwise specified, a 1000-volt megohmmeter shall be used for resistance measurements.

The measurements of the tests shall be recorded on the specified forms and provided in accordance with paragraph 16000-2.05 D.

B. INSULATION RESISTANCE MEASUREMENTS:

1. GENERAL: General insulation resistance measurements shall be made on conductors and energized parts of electrical equipment. Minimum acceptable values of insulation resistance shall be in accordance with the applicable ICEA, NEMA or ANSI standards for the equipment or material being tested, unless otherwise specified. The ambient temperature at which insulation resistance is measured shall be recorded on the test form.

2. CONDUCTOR AND CABLE TESTS: The phase-to-ground insulation resistance shall be measured for all circuits 120 volts and above except lighting circuits. Measurements may be made with motors and other equipment connected.

Insulation resistance measurements shall be recorded in a format similar to Form 16000-A, contained in Section 01999. Insulation with resistance of less than 10 megohms is not acceptable.

3. MOTOR TESTS: The Installed Motor Test Form, 16000-B, contained in Section 01999, shall be completed for each motor after installation. All motors shall have their insulation resistance measured before they are connected. Motors 50 HP and larger shall have their insulation resistance measured at the time of delivery as well as when they are connected. Insulation resistance values less than 10 megohms are not acceptable.

The Contractor shall verify that motors are connected to rotate in the correct direction. Verification may be accomplished by momentarily energizing the motor, provided the Contractor confirms that neither the motor nor the driven equipment will be damaged by reverse operation.

C. FUNCTIONAL CHECKOUT:

Functional testing shall be performed in accordance with the requirements of Section 16030. Prior to functional testing, all protective devices shall be adjusted and made operative. Prior to energization of equipment, the Contractor shall perform a functional checkout of the control circuit. Checkout shall consist of energizing each control circuit and operating each control, alarm or malfunction device and each interlock in turn to verify that the specified action occurs. Contractor shall submit a description of his proposed functional test procedures prior to the performance of functional checkout as specified in paragraph 16000-2.05 G.

3.03 RECORD DOCUMENTS

Record documents refer to those documents maintained and annotated by the Contractor during construction, and include record drawings in accordance with Section 01720, and the following additional schedules, lists, and drawings:

Conduit Schedule (16110, part 3)
Interconnection Diagrams (16000, part 2)
Original Submittal Drawings (16000, part 1)

END OF SECTION

SECTION 16110

RACEWAYS, FITTINGS AND SUPPORTS

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies raceways for electrical conductors including fittings and supports. Raceways shall be provided for power, control, instrumentation, grounding, lighting, receptacles, and signaling systems. Raceways include conduits, and tubing systems. For the purpose of this specification, conduit and tubing is described collectively as conduit.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and the listed documents, the requirements of this section shall prevail.

Reference	Title
ANSI C80.1-83	Rigid Steel Conduit-Zinc Coated
ANSI C80.3-83	Electrical Metallic Tubing-Zinc Coated
ASTM A193/A193M-85	Alloy-Steel and Stainless Steel Bolting Materials for High Temperature Service
FEDSPEC WW-C-581E-77	Conduit, Metal, Rigid and Intermediate; and Coupling, Elbow, and Nipple, Electrical Conduit; Zinc Coated
JIC EMP-1-67	Electrical Standards for Mass Production Equipment
NEMA ICS 6-83	Enclosures for Industrial Controls and Systems
NEMA TC2-83 (1981)	Electrical Plastic Tubing (EPT) and Conduit (EPC 40 and EPC 80)
NEMA 250-85	Enclosures for Electrical Equipment (1000 volts maximum)
NFPA 70-87	National Electric Code (NEC)

PART 2--PRODUCTS

2.01 RACEWAY

A. STEEL CONDUIT:

1. RIGID STEEL CONDUIT: Rigid steel conduit shall comply with ANSI C80.1 with smooth finished surfaces. Conduit shall be galvanized. Unless otherwise specified, minimum size shall be 3/4 inch.

2. NOT USED

3. FITTINGS: Locknuts shall be extra heavy electro-galvanized steel for sizes through 2 inches. Locknuts larger than 2 inches shall be electrogalvanized malleable iron. Bushings shall be electrogalvanized malleable iron with insulating collar. Grounding bushings shall be locking type and shall be provided with a feed-through compression lug for securing the ground cables. Unions shall be electrogalvanized ferrous alloy type Appleton UNF or UNY, Crouse-Hinds JNF or UNY, or equal. Threadless fittings are not acceptable. Conduit bodies shall be ferrous alloy type with screw taps for fastening covers. Gaskets shall be made of neoprene.

Expansion fittings in embedded runs shall be watertight and shall be provided with an internal bonding jumper. The expansion material shall be neoprene and shall allow for 3/4-inch movement in any direction.

B. NOT USED

C. ELECTRICAL METALLIC TUBING:

Electrical metallic tubing shall be electrogalvanized and shall be ANSI C80.3. EMT fittings shall be compression type. Minimum size shall be 3/4 inch.

D. FLEXIBLE METAL CONDUIT:

Flexible metal conduit shall be formed from spirally wound galvanized steel strip with successive convolutions securely interlocked. Minimum size shall be 1/2 inch. Fittings shall be compression type. Flexible metal conduit shall be provided with ground wire.

E. LIQUIDTIGHT FLEXIBLE STEEL CONDUIT:

Liquidtight flexible steel conduit shall be formed from spirally wound galvanized steel strip with successive convolutions securely interlocked and jacketed with liquidtight plastic cover.

Minimum size shall be 1/2 inch. Fittings for liquidtight conduit shall have cadmium-plated malleable iron body and gland nut with cast-in lug, brass grounding ferrule threaded to engage conduit spiral and O-ring seals around the conduit and box connection and insulated throat. Forty-five and 90-degree fittings shall be used where applicable.

F. EXPLOSIONPROOF FLEXIBLE CONDUIT:

Explosionproof flexible conduit shall be suitable for use in Class I, Division 1, Groups C and D hazardous areas as specified in NEC and shall be watertight.

G. RIGID NONMETALLIC CONDUIT:

Rigid nonmetallic conduit shall be NEMA TC2, type EPC-40-PVC, or EPC-80-PVC high impact, polyvinylchloride (PVC). Fittings used with PVC conduit shall be PVC solvent weld type. Nonmetallic conduits shall be UL listed for their respective applications. Minimum size shall be 1 inch embedded.

H. WIREWAYS:

Wireways and auxiliary gutters shall be JIC EMP-1 sectional flanged oiltight type with hinged covers and shall be 8 inches by 8 inches in cross section unless otherwise specified.

2.02 BOXES AND FITTINGS

A. SHEET METAL BOXES:

Boxes and fittings installed in areas where electrical metallic tubing is specified may be standard UL approved sheet steel type.

B. CAST FERROUS ALLOY BOXES:

Boxes shall be hot-dip galvanized cast ferrous alloy unless otherwise specified. Integrally cast threaded hubs or bosses shall be provided for conduit entrances and shall provide for full 5-thread contact on tightening. Drilling and threading shall be done before galvanizing. A full body neoprene gasket shall be provided with the cover. Type 304 stainless steel screws shall be provided for covers. Where two or more devices are located together, outlet and device boxes shall be gang type. Device covers shall be suitable for boxes with neoprene gaskets to fit the devices and boxes used. Cover plates shall be hot-dip galvanized cast ferrous alloy unless the particular device requires a cover that is not manufactured in this material. Device boxes shall be FD boxes as manufactured by Crouse-Hinds, Appleton, or equal.

C. FLOOR BOXES:

Floor boxes shall be hot-dip galvanized cast boxes with an NEMA 4 rating. Boxes shall be provided with a recessed ring neoprene gasket, hot-dip galvanized steel checker cover plates and type 304 stainless steel machine screws of not less than 1/4 inch diameter. The cover screws shall be flat head type of recessed socket head screws with no material projecting above the level of the cover.

D. WELDED BOXES SHEET STEEL:

Boxes larger than FD boxes shall be fabricated from welded steel and hot-dip galvanized after fabrication. Before finish is applied, a grounding pad drilled for two bolted grounding lugs or a grounding stud shall be welded to the inside of the box. Hardware shall be 304 stainless steel. Boxes shall, as a minimum, meet NEMA 12 and JIC EMP-1 requirements.

Electrogalvanized sheet steel boxes may be used where electrical metallic tubing is specified. Boxes shall be a minimum of 4 inch square. Covers shall have raised edges to be flush with walls and ceiling surfaces.

E. BOXES AND FITTINGS IN OUTDOOR OR CORROSIVE AREAS:

Boxes and fittings located outdoors or in corrosive areas shall be Nonmetallic NEMA 4X.

F. EXPLOSIONPROOF BOXES AND SEAL FITTINGS:

In areas specified as Class I, Division 1 or 2, hazardous, boxes and fittings shall be NEMA 7, Groups C and D, explosion-proof, in addition to the requirements specified in paragraph 16110-2.02 E. Seal fittings for conduit systems in hazardous atmosphere locations shall be hot-dip galvanized cast ferrous alloy. Sealing compound shall be hard type, Chico A, or equal, UL listed for explosionproof sealing fittings.

G. TERMINAL CABINETS:

Terminal cabinets located indoors shall be NEMA 12. Cabinets located outdoors and in corrosive areas shall be NEMA 4X. Cabinets shall be provided with hinged doors. The equipment mounting panel shall be 12-gage sheet steel with grounding stud. Cabinets shall be provided with channel mounted terminal blocks rated 30 amperes, 600 volt AC. Terminals shall be No. 8 minimum, screw type, suitable for ring tongue or locking spade terminals.

H. HUBS:

Threaded hubs for connection of conduit to junction, device or terminal boxes shall be made of cast ferrous alloy, electroplated with zinc and shall have insulated liner and insulating bushings. The hubs shall utilize a neoprene 0-ring and shall provide a water-tight connection.

2.05 RACEWAY SUPPORTS

A. CONDUIT SUPPORTS:

Hot-dip galvanized framing channel shall be used to support groups of conduit. Individual conduit supports shall be one-hole galvanized malleable iron pipe straps used with galvanized clamp backs and nesting backs where required.

B. CEILING HANGERS:

Ceiling hangers shall be adjustable galvanized carbon steel rod hangers as specified. Straps or hangers of plumber's perforated tape are not acceptable. Unless otherwise specified, hanger rods shall be 1/2-inch all-thread rod and shall meet ASTM A193. Hanger rods in corrosive areas and those exposed to weather or moisture shall be stainless steel.

C. STRUCTURAL ATTACHMENTS (RACKS):

Structural attachments shall be constructed from hot-dip galvanized framing channel as specified. All field cuts shall be treated with zinc enriched paint.

2.06 DUCT BANKS

Concrete used for duct banks shall be Class E with red oxide added as specified in Section 03300.

2.07 UNDERGROUND MARKING TAPE (STRETCH TYPE)

Underground marking tape shall be for early warning protection of digging around buried power and communication lines. Tape shall be low density polyethylene plastic, nominally 6 inches wide and 4 mil thickness. The plastic color shall be red for electrical lines, orange for telephone lines. A warning shall be imprinted continuously along the length, with message reading similar to: "CAUTION - STOP DIGGING - BURIED ELECTRIC (TELEPHONE) LINE BELOW." Tape shall be Brady "Identoline"; Services and Materials "Buried Underground Tape"; Somerset (Thomas & Betts) "Protect-A-Line"; or equal.

2.08 PRODUCT DATA

The Contractor shall provide catalog cuts for all materials provided under this section in accordance with paragraph 00710-4.02.

PART 3--EXECUTION

3.01 CONDUIT

A. GENERAL:

1. CONDUIT LOCATIONS: Unless otherwise specified, conduit locations shall be provided as specified in Table. A.

Table A, Conduit Locations

	Conduit type	Location
1.	Rigid steel	Exposed noncorrosive areas, hazardous (classified) areas
2.	Rigid nonmetallic, Schedule 40	Embedded or encased
3.	Rigid nonmetallic, Schedule 80	Exposed indoor, corrosive non-hazardous areas or direct buried
4.	Electrical metallic tubing	Within stud walls, above suspended ceilings
5.	Flexible metal	Lighting fixture connections (in suspended ceilings)
6.	Liquidtight flexible metallic	Final raceway connections to all equipment and instruments which require flexibility

Raceway in areas of new construction shall be considered diagrammatic unless dimensioned.

2. CONDUIT RUNS BETWEEN BOXES: The Contractor shall limit the numher of directional changes of the conduit to total not more than 270 degrees in any run between pull boxes. Conduit runs shall be limited to 400 feet, less 100 feet for every 90 degrees of change in direction. Bends and offsets shall be avoided where possible but, where necessary, shall be made with a hickey or conduit bending machine, or shall be factory preformed bends. Turns shall be made with cast metal fittings or conduit bends. Welding, brazing or otherwise heating of conduit is not acceptable.

3. JUNCTION AND PULL BOXES: Where required for pulling cable and as necessary to meet the requirements of paragraph 16110-3.01 A.2, the Contractor shall provide cast junction or pull boxes. Pull boxes used for multiple conduit runs shall not combine circuits fed from different MCCs, switchboards, or switchgear.

4. CONDUIT TERMINATIONS: Conduit entering NEMA 1 type sheet steel boxes or cabinets shall be secured by locknuts on both the interior and exterior of the box or cabinet and shall have an insulating grounding or bonding bushing constructed over the conduit end. Conduit entering all other boxes shall be terminated with a threaded hub. Surface-mounted cast boxes and nonmetallic enclosures shall have threaded hubs. Joints shall be made with standard couplings or threaded unions. Metal parts of nonmetallic boxes and plastic coated boxes shall be bonded to the conduit system. Running threads shall not be used in lieu of conduit nipples, nor shall excessive thread be used on any conduit. The ends of conduit shall be cut square, reamed, and threaded with straight threads. Rigid steel conduit shall be made up tight and without thread compound. Exposed male threads on rigid steel conduit shall be coated with electrically conductive zinc-rich paint.

PVC conduit entering fiberglass boxes or cabinets shall be secured by threaded bushings on the interior of the device and shall be terminated with a threaded male terminal adapter having a neoprene O-ring. Joints shall be made with standard PVC couplings.

B. CONDUIT SUPPORT:

Exposed rigid steel shall be run on supports spaced not more than 10 feet apart and shall be constructed with runs parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceiling. Exposed PVC conduit shall be run on supports spaced not more than 3 feet apart for conduits up to 1 inch, 5 feet apart for conduits 1-1/4 inches to 2 inches, and 6 feet apart for conduits 2-1/2 inches and larger. No conduit shall approach closer than 6 inches to any object operating above 40 degrees C. PVC conduit shall not be provided where it will be damaged by heat.

Steel conduit shall be supported away from the structures using hot-dip galvanized malleable iron straps with nesting backs. Where three or more conduits are located in a parallel run, they shall be spaced out from the wall using framing channel. Runs of individual conduit suspended from the ceiling shall be supported with galvanized carbon steel rod hangers. Where three or more conduits are suspended from the ceiling, steel racks shall be constructed.

Conduit rack and tray supports shall be secured to concrete walls and ceilings by means of cast-in-place anchors. Individual conduit supports may use cast-in-place anchors, die-cast, rustproof alloy expansion shields or cast flush anchors. Wooden plugs, plastic inserts or gunpowder-driven inserts are not acceptable as a base to secure conduit supports.

C. CONDUIT ENCASEMENT OR EMBEDMENT (STRUCTURES AND DUCT BANKS):

Conduit constructed in concrete which is in contact with the earth shall be separated from the earth by at least 3 inches of concrete. Clearances equal to the nominal conduit diameter, but not less than 1-1/2 inches, shall be maintained between conduits encased in slabs. Clearances of less than 1-1/2 inches at conduit crossing and terminating locations are acceptable. Concrete shall be as specified in paragraph 16110-2.04.

Expansion fittings shall be provided whenever embedded conduit crosses building expansion joints, between two adjacent structures, and between a duct bank and structure.

Duct banks shall be placed on an undisturbed soil base. A Class B1 backfill as specified in Section 02200 shall be used as a base when an undisturbed soil base is not available. Backfill over the duct bank shall be consistent with the backfill required for the immediate area. The fill shall be brought up to finish grade.

Plastic conduit spacers shall be located 5 feet on centers. The spacers shall be secured to the conduits by wire ties. The duct bank shall be securely anchored to prevent conduit flotation while the concrete is being placed. Conduit runs shall be water-tight. Conduit run shall be arranged to slope towards manholes to provide for drainage.

The ends of conduits shall be protected from damage during construction by using plastic plugs. A 1/4-inch hole shall be drilled in the lower portion of the plug to provide drainage.

All raceways installed under this contract which are without conductors shall be provided with a nylon pull rope. These raceways include raceways identified as "spare."

Conduits shall be thoroughly swabbed inside imnediately upon completion of pouring concrete. After the concrete has set, but before backfilling, a mandrel having a diameter equal to the nominal conduit inside diameter minus 1/2 inch, and not less than 4 inches long, shall be pulled through each conduit. The mandrel shall be lead covered or painted white to indicate any protrusion on the inside of the conduit.

D. CONDUIT PENETRATIONS:

Unless otherwise specified, conduit routed perpendicular through floors, walls or other concrete structures shall pass through cast-in-place openings wherever possible. In cases where cast-in-place openings are not possible, appropriate size holes shall be bored through the concrete to accommodate the conduit passage. The size and location of the holes shall not impair the structure's integrity. After completion, grout or caulk around conduit and finish to match existing surroundings. Unless otherwise protected, conduits that rise vertically through the floor shall be protected by a 3-1/2-inch high concrete pad with a sloping top.

Conduits entering manholes and handholes shall be horizontal. Conduits shall not enter through the concrete bottom of handholes and manholes.

Wherever conduits penetrate outdoor concrete walls or ceilings below grade, the Contractor shall provide a watertight seal as manufactured by O. Z. Gedney Co., Type CSMC; Thunderline Corp., Link Seal; or equal.

E. CONDUIT SEPARATION:

Signal conduits shall be separated from AC power or control conduits. The separation shall be a minimum of 12 inches for rigid steel conduits and 24 inches for nonmetallic conduits.

F. CONDUIT SEALS FOR HAZARDOUS OR CORROSIVE AREAS:

Each conduit passing from a hazardous or corrosive area into a nonhazardous or noncorrosive area shall be provided with a sealing fitting which may be located on either side of the boundary. The seal shall be located at the boundary in accordance with NEC.

Seal fittings for conduit systems in hazardous atmosphere locations shall be hot-dip galvanized cast ferrous alloy. Sealing compound shall be hard type, Chico A, or equal, UL listed for explosionproof sealing fittings. Sealing compound shall be non-hardening type, for corrosive areas.

G. NOT USED

H. LIQUIDTIGHT FLEXIBLE CONDUIT:

The length of flexible liquidtight conduit shall not exceed 15 times the trade diameter of the conduit. The length of liquidtight conduit shall not exceed 36 inches.

3.02 NOT USED

3.03 NOT USED

3.04 RACEWAY NUMBERING SYSTEM

A. GENERAL:

Each conduit shall be identified by a specified number. The numbering system is specified in paragraph 16000-1.05 A.

B. CONDUIT IDENTIFICATION:

Conduit numbers shall be pressure stamped into a noncorrosive metal tag. A tag with number shall be fixed to each end of each conduit and at each manhole, pull box and handhole with type 304 stainless steel wire.

END OF SECTION

SECTION 16115

MANHOLES, HANDHOLES AND PULL BOXES

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section provides specifications for all concrete electrical manholes, handholes and pull boxes.

B. TYPE:

Manholes, handholes and pull boxes shall be precast concrete with minimum 6-inch wall thickness.

1.02 ENVIRONMENTAL CONDITIONS

See Section 01800. The manholes, handholes and pull boxes may be subject to corrosive soil, moisture, hydrogen sulfide gas, and methane gas.

PART 2--PRODUCTS

2.01 MATERIAL

A. CONCRETE:

The structural concrete shall be 3,000-psi strength at 28 days.

The aggregate shall be free of deleterious substances causing reaction with hydrogen sulfide.

The cement shall be portland cement conforming to ASTM C150 Type II.

B. REINFORCING STEEL:

All reinforcing shall be sufficiently tied to withstand any displacement during placement of concrete. All bars shall be hard grade billet steel conforming to ASTM A615. Bars 1/4-inch round and smaller shall be deformed in accordance with ASTM A305.

Design loads shall consist of dead load, live load, impact and, in addition, loads due to water table and any other loads which may be imposed on the structure.

Live loads shall be for H-20 loading per AASHO standards for highway and bridges. Design wheel load shall be 16 KIPS.

C. COVERS:

Manholes, handholes and pull boxes shall be provided with cast iron or galvanized steel covers and mounting rings reinforced for H-20 loading.

Pull boxes, larger than 2 feet by 3 feet square shall have a two-piece rectangular cover. Pull boxes, 2 feet by 3 feet square or smaller shall have a one-piece rectangular cover. Covers shall be bolted down with recessed bolt heads.

Each manhole, handhole and pull box cover shall be identified by a cast in label. The cover shall be inscribed with the cast letters ELECT for electrical service or COM for communication or instrumentation. In addition, the identification number of the manhole or pull box shall be installed by means of a bead weld in letters not less than 1 inch high.

Where located in streets or other traffic bearing areas, covers shall be of the heavy street traffic type. When located in sidewalks or other nonvehicular traffic areas, covers may be of the parkway type.

D. SUMPS:

Pull boxes, handholes and manholes shall have a sump of approximately 2 cubic foot capacity filled with gravel, or where indicated a plumoed drain or a concrete lined sump pit shall be provided suitable for use with sump pumps where shown. Knockouts or openings shall be provided in the covers or near the top of the manhole for sump pump discharge tube installations, where sump pumps are provided.

E. INSERTS:

Concrete inserts for cable racks shall be provided in the walls of each manhole and pull box, one in a 4-foot wall and two in a 6-foot or 8-foot wall.

Cable pulling eye bolts shall be provided opposite each conduit entry area, and the inserts shall be designed to provide a minimum of 5,000 pounds tensile strength to accommodate all cable pulls.

F. CONDUIT ENTRANCES:

Entries of conduits through walls shall be terminated in a bell flush with the interior wall.

G. MANHOLES:

Manholes may be of single- or multiple-section construction. Multiple sections shall be fitted to form watertight joints using tongue and groove joint with flexible plastic adhesive sealing compound.

2.02 SCHEDULE

Pull box sizes shall be as scheduled at the end of this section.

PART 3--EXECUTION

The precast base section shall be placed on a prepared base of 6 inches of sand or gravel for even distribution of load before leveling. A plastic preformed joint sealant shall be applied between sections. The joint sealant compound shall be impermeable to water, have a high immediate bonding strength, and maintain permanent plasticity. The assembly shall be so located that surrounding paving shall slope up 1 inch above finish to prevent water settling on the cover. In unpaved areas, the slope shall be up 3 inches.

MANHOLE/HANDHOLE SCHEDULE

Name	Plan reference	Minimum dimensions, width by length by depth, feet
PPB-1	E10/E501/E901	6x6x6
IPB-1	E10/E501/E901	4x4x6
PPB-2	E10/E101	6x6x6
IPB-2	E10/E101	4x4x6
PPB-3	E10/E301	6x6x8
IPB-3	E10	4x4x6
PPB-4	E10/E302/E701/E751	6x6x6
IPB-4	E10	4x4x6
PPB-5	E10	6x6x6
IPB-5	E10	4x4x6
PPB-6	E10	2x2x4
PPB-7	E10/E501	4x4x6
IPB-7	E10/E501	2x2x4
PPB-8	E10/E601/E651	3x3x4
IPB-8	E10/E601/E651	2x2x4
PPB-9	E10	2x2x4
PPB-10	E10/E501	3x3x4
IPB-10	E10/E501	2x2x4

END OF SECTION

SECTION 16120

CONDUCTORS, WIRE, AND CABLE

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies conductors and cables rated 600 volts used for power, lighting, receptacle, signal, and control circuits.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASTM B3-74	Soft or Annealed Copper Wire
ASTM B8-81	Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B33-81	Tinned Soft or Annealed Copper Wire for Electrical Purposes
ASTM B189-81	Lead Coated and Lead-Alloy-Coated Soft Copper Wire for Electrical Purposes
NEMA WC7-82	Cross-Linked-Thermosetting Insulated Wire and Cable for the Transmission and Distribution of Electric Energy
ICEA S-68-516	Ethylene-Propylene-Rubber-Insulated Wire
IEEE 383-74	Type Test of Class IE Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations
NFPA 70-87	National Electric Code (NEC)
UL 44-83	Rubber-Insulated Wires and Cables
UL 83-83	Thermoplastic-Insulated Wires and Cables

PART 2--PRODUCTS

2.01 GENERAL

With the exception of lighting and receptacle circuits, the type, size and number of conductors shall be as specified on the drawings or schedules. Lighting and receptacle circuit conductors are unscheduled and shall be sized by the Contractor in accordance with the NEC to limit voltage drop to 3 percent.

2.02 COLOR CODING

A. CONTROL CONDUCTORS:

Control conductors color coding shall be manufacturer's standard.

B. POWER CONDUCTORS:

Single-conductor power conductors shall have the following colors for the indicated voltage:

	600V or less
Phase A	Black
Phase B	Red
Phase C	Blue
Ground	Green
Neutral	White

Multiconductor power cable colors shall be manufacturer's standard.

Cables sized No. 4 AWG and larger may be black with colored 3/4-inch vinyl plastic tape applied in 3-inch lengths around the cable at each end. The cables shall be labeled at terminations and in pull boxes, handholes and manholes.

2.03 LIGHTING AND RECEPTACLE CIRCUIT COlIDUCTORS

Lighting conductors shall be stranded except for No. 12 AWG which shall be solid. Minimum conductor size shall be 12 AWG.

Conductors shall be provided with the following characteristics:

1.	Voltage:	600 volts.
2.	Conductor:	Bare annealed copper; stranded in accordance with ASTM B8.
3.	Insulation:	THWN/THHN, 90 degree C dry, 75 degree C wet, polyvinylchloride (PVC) per UL 83.
4.	Jacket:	Nylon.
5.	Flame resistance:	UL 83.
6.	Manufacturer:	Okonite; Okoseal-N, Series 116-67-XXXX; or equal.

2.04 POWER AND CONTROL CONDUCTORS AND CABLE, 600 VOLT

A. SINGLE CONDUCTOR:

Single conductor cable shall be stranded and shall be used in conduits for power and control circuits.

Conductors shall be provided with the following characteristics:

1.	Voltage:	600 volts.
2.	Conductor:	Coated, Class B, stranded, annealed copper per ASTM B8.
3.	Insulation:	RHW/RHH, 90 degrees C dry, 75 degrees C wet, composite of ethylene propylene rubber (EPR) and chlorosulfonated polyethylene (CSPE) per ICEA UL 44 and NEMA WC-7.
4.	Jacket:	Chlorosulfonated polyethylene (CSPE).
5.	Flame resistance:	IEEE 383.
6.	Manufacturer:	Okonite, Okonite-Okolon, Series 112- 11-xxxa; Anaconda; Durasheath EP; or equal.

2.05 NOT USED

2.06 NOT USED

2.07 SIGNAL CABLES

A. GENERAL:

Signal cable shall be provided for instrument signal transmission, alarm, communication and any circuit operating at less than 100 volts. Cables shall be color coded black and white for pairs or black, white and red for triads. Circuit shielding shall be provided in addition to cable shielding. Circuits for type a and b signals specified in paragraph 17000-1.01 C.8 shall be provided in compliance with the instrument manufacturer's recommendations.

B. SINGLE CIRCUIT:

Cable shall consist of one pair or triad, No. 16 AWF conductors with 15 mils of 90 degree C polyvinylchloride (PVC) insulation, 4 mils nylon conduit or jacket, twisted on a 2-inch lay, and covered with a 100 percent 0.35 x 0.5 mil aluminum-Mylar tape shield with No. 18 AWG 7-strand tinned copper drain wire and a 45 mil PVC jacket overall. Cable shall be UL listed, Type TC, rated 600 volts. Cable shall be Okonite, Okoseal-N Type P-OS, or equal.

C. MULTIPLE CIRCUIT:

Cable shall consist of four or more pairs or triads which are made up of No. 18 AWG conductors with 15 mils of 90 degree C PVC insulation, 4 mils nylon jacket, twisted on a staggered lay 1-1/2 to 2-1/2 inches, and covered with a 100 percent 0.35 x 0.5 mil aluminum-Mylar tape shield with No. 22 AWG 7-strand tinned copper drain wire. Overall cable shield shall be 2.35 mil aluminum-Mylar tape with a No. 20 AWG 7-strand tinned copper drain wire. Cable shall be UL listed, Type TC, 600 volts. Cable shall be Okonite, Okoseal-N Type SP-OS, or equal.

2.08 PORTABLE CORD

Portable cord shall be UL listed, Type SO for sizes No. 10 AWG and smaller. Cords with conductors larger than No. 10 AWG shall be UL listed, Type G. Cords shall contain an equipment grounding conductor. Cable characteristics shall be as follows:

1.	Conductors:	Flexible rope stranded per ASTM B189 and B33. Conductors shall be coated except ground conductors may be uncoated.
2.	Insulation:	Insulation shall be ethylene propylene (EPR) as per ICEA S-68-516 and rated for continuous operation at 90 degrees C.
3.	Jacket:	Heavy-duty neoprene as per ICEA S-S8-516.
4.	Manufacturer:	Okonite: Okocord

2.09 SPLICING AND TERMINATING MATERIALS

A. 600 VOLT CONDUCTOR AND CABLE CONNECTORS:

Connectors shall be tool applied compression type of correct size and UL listed for the specific application. Connectors shall be tin-plated high conductivity copper. Connectors for wire sizes No. 10 AWG and smaller shall be nylon self-insulated, ring tongue or locking-spade terminals. Connectors for wire sizes No. 8 AWG and larger shall be one-hole lugs up to size No. 3/0 AWG, and two-hole or four-hole lugs for size No. 4/0 and larger. Mechanical clamp, dimple, screw-type connectors are not acceptable.

In-line splices and taps shall be used only where specified, or by written consent of the Construction Manager. When used, they shall be of the same construction as other connectors. Splices shall be compression type, made with a compression tool die approved for the purpose, as made by Thomas and Betts Corp., or equal. Splice shall be covered with a heat-shrinkable sleeve or boot.

B. NOT USED

C. PORTABLE CABLE FITTINGS:

Portable cable fittings for terminating the cable shall provide a watertight seal between the cord and the terminator and between the terminator and mounting hub. The cable terminator shall be provided with a neoprene liner which grips the cord jacket when the back nut on the fitting is tightened.

2.10 PRODUCT DATA

Information shall be provided in accordance with paragraph 00710-4.02. The Contractor shall provide the following information:

1. Catalog cuts showing general information of the conductors and cable.

2. Cable pulling data as specified in paragraph 16120-3.04 B.3.g.

PART 3--EXECUTION

3.01 GENERAL

Each power and control conductor shall be identified at each terminal to which it is connected. The marking system shall comply with paragraph 16000-2.02.

Pulling wire and cable into conduit shall be completed without damaging or putting undue stress on the cable insulation. Soapstone, talc or UL listed pulling compounds are acceptable lubricants for pulling wire and cable. Grease is not acceptable. Raceway construction shall be complete, cleaned, and protected from the weather before cable is placed.

Whenever a cable leaves a raceway, a cable support shall be provided.

When flat bus bar connections are made with unplated bar, the Contractor shall scratch-brush the contact areas. Bolts shall be torqued to the bus manufacturer's recommendations.

3.02 600 VOLT CONDUCTOR AND CABLE

Conductors in panels and electrical equipment, No. 6 AWG and smaller, shall be bundled and laced at intervals not greater than 6 inches, spread into trees and connected to their respective terminals. Lacing shall be made up with plastic cable ties. Lacing is not necessary in plastic panel wiring duct.

Slack shall be provided in junction and pull boxes, handholes and manholes. Slack shall be sufficient to allow cables or conductors to be routed along the walls of the box. Amount of slack shall be equal to largest dimension of the box. Where plastic panel wiring duct is provided for wire runs, lacing is not required.

Conductors crossing hinges shall be bundled into groups not exceeding 12 and shall be so arranged that they will be protected from chafing when the hinged member is moved.

Stranded conductors shall be terminated as described in paragraph 16120-2.09 A, except where terminals will not accept such terminations. In these cases, the conductors shall be terminated directly on the terminal block. Compression lugs and connectors shall be installed using manufacturer's recommended tools.

Raceway fill limitations shall be as defined by NEC and the following:

> Lighting and receptacle circuits may be in the same conduit in accordance with derating requirements of the NEC. However, lighting and receptacle circuits shall not be in conduits with power or control conductors.

Solid wire shall not be lugged nor shall electrical spring connectors be used on any except for solid wires in lighting and receptacle circuits. Lugs and connectors shall be installed with a compression tool.

All splices and terminations are subject to inspection by the Construction Manager prior to and after insulating. Terminations at 460 volt motors shall be made by bolt-connecting the lugged connectors. Connections shall be insulated and sealed with factory-engineered kits. Motor connection kits shall consist of heat-shrinkable, polymeric insulating material over the connection area and a high dielectric strength mastic to seal the ends against ingress of moisture and contamination. Bolt connection area shall be kept free of mastics and fillers to facilitate rapid stripping and re-entry. Motor connection kits shall accommodate a range of cable sizes for both in-line and stub-type configurations. Connection kits shall be independent of cable manufacturer's tolerances.

In-line splices and tees, where approved, shall be made with tubular compression connectors and insulated as specified for motor terminations, except that conductors No. 10 AWG and smaller may be spliced using self-insulating connectors as specified in paragraph 16120-2.09 A. Splices and tees in underground handholes or pull boxes shall be insulated using Scotch-cast epoxy resin splicing kits. Terminations at devices with 120V pigtail leads shall be made using self-insulating tubular compression connectors.

Terminations at solenoid valves, 120 volt motors, and other devices furnished with pigtail leads shall be made using self-insulating tubular compression connectors.

Conductor and cable markers shall be provided at splice points.

3.03 SIGNAL CABLE

Circuits shall be run as individually shielded twisted pairs or triads. In no case shall a circuit be made up using conductors from different pairs or triads. Triads shall be used wherever 3-wire circuits are required. Terminal blocks shall be provided at instrument cable junctions, and circuits shall be identified at such junctions unless otherwise specified. Signal circuits shall be run without splices between instruments, terminal boxes, or panels.

Shields are not acceptable as a signal path, except for circuits operating at radio frequencies and utilizing coaxial cables.

Common ground return conductors for two or more circuits are not acceptable.

Unless otherwise specified, shields shall be bonded to the signal ground bus at the control panel and isolated from ground and other shields at other locations. Terminals shall be provided for running signal leads and shield drain wires through junction boxes.

Spare circuits and the shield drain wire shall be terminated on terminal blocks at both ends of the cable run and be electrically continuous through terminal boxes. Shield drain wires for spare circuits shall not be grounded at either end of the cable run.

Terminal boxes shall be provided at instrument cable splices. If cable is buried or in raceway below grade at splice, an instrument stand shall be provided as specified with terminal box mounted approximately 3 feet above grade.

3.04 NOT USED

3.05 PORTABLE CORD

Portable cord feeding permanent equipment, such as pendant cords, pumps, cranes, hoists, and portable items shall have a wire mesh cord grip of flexible stainless steel wire to take the tension from the cable termination. Connection of portable cords to permanent wiring shall be accomplished with the use of terminals. In-line taps and splices shall be used only where specified.

3.06 TESTING

A. GENERAL:

The Contractor shall test conductors and cable in accordance with paragraph 16000-3.02 B and Section 16030.

B. SIGNAL CABLE:

Each signal pair or triad shall be tested for electrical continuity. Any pair or triad exhibiting a loop resistance of less than or equal to 50 ohms shall be deemed satisfactory without further test. For pairs with greater than 50 ohm loop resistance, the Contractor shall calculate the expected loop resistance considering loop length and intrinsic safety barriers if present. Loop resistance shall not exceed the calculated value by more than 5 percent.

Each shield drain conductor shall be tested for continuity. Shield drain conductor resistance shall not exceed the loop resistance of the pair or triad.

Each conductor (signal and shield drain) shall be tested for insulation resistance with all other conductors in the cable grounded.

Instruments used for continuity measurements shall have a resolution of 0.1 ohms and an accuracy of better than 0.1 percent of reading plus 0.3 ohms. A 500 volt megohmmeter shall be used for insulation resistance measurements.

END OF SECTION

SECTION 16140

WIRING DEVICES

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies wiring devices consisting of receptacles, plugs, switches and appurtenances.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
NEMA ICS 6-83	Enclosures for Industrial Controls and Systems
NEMA WD-1-83	General Requirements for Wiring Devices
NFPA 70-87	National Electrical Code (NEC)

PART 2--PRODUCTS

2.01 GENERAL

Wiring devices shall be UL approved for the current and voltage specified and shall comply with NEMA WD-1. Devices shall contain provisions for back wiring and side wiring with captively held binding screws. Devices shall be brown, except those located in finished areas shall be ivory.

2.02 RECEPTACLES AND PLUGS

A. GENERAL:

Receptacles shall be grounding type.

B. 120V RECEPTACLES:

1. IMDOOR, CLEAN AREAS: Receptacles shall be duplex 20 amp, NEMA 5-20R, and shall accept NEMA 5-15P or 5-20P plug caps. Receptacles shall be Hubbell 5362, General Electric 4108-2, or equal. Where the manufacturer of cord connected equipment requires and isolated ground, a receptacle with isolated ground shall be provided. Isolated ground receptacles shall be Hubbell IG-5362, or equal.

2. OUTDOOR, PROCESS OR CORROSIVE AREAS: Receptacle shall be duplex, 20 ampere, NEMA 5-20R, and shall accept NEMA 5-15P or 5-20P plug caps. Receptacle and plug caps shall be corrosion resistant, marine duty with yellow polycarbonate weatherproof lift covers. Manufacturer shall be Hubbell 53CM62/53CM21, General Electric, or equal.

C. 250V RECEPTACLES:

Receptacles shall be duplex 15 amp, NEMA 6-15R, and shall accept NEMA 6-15P plug caps. Receptacles and plug caps shall be Hubbell 5662, Arrow Hart 5662, or equal.

D. PLUG CAPS:

Male plug caps for 120 volt and 250 volt receptacles shall be of the cord grip armored type with heavy phenolic housing, of the same manufacture as the receptacle. Plug caps shall be rated 15 amps. One plug cap shall be provided for every four receptacles furnished, with a minimum of two plug caps being provided. Plug caps shall be delivered to the Construction Manager.

2.03 SWITCHES

A. GENERAL PURPOSE (INDOOR, CLEAN AREAS):

General purpose switches shall be quiet AC type, specification grade, and shall be provided in accordance with rated capacities as required. Switches shall match receptacles in color. Switches shall be manufactured by General Electric, Hubbell, or equal, as follows:

	15A, 120-277V		20A, 120-277V	
	G.E. Co.	Hubbell	G.E. Co.	Hubbell
Single:	GE5931	1201	GE5951	1221
Three-way:	GE5933	1203	GE5953	1223
Four-way:	GE5934	1204	GE5954	1224
SPST momentary:	GE5953	1206		---
Three position center off momentary:	GE5935	1556	--	1557

B. NOT USED

C. SWITCHES FOR OUTDOOR, PROCESS, OR CORROSIVE AREAS:

Switches shall be 20 amp presswitch type with weatherproof/ corrosion resistant neoprene plate as manufactured by Hubbell or Arrow-Hart as follows:

	Hubbell with 17CM50 plate	Arrow-Hart with 2881 plate
Single pole	17CM81	2991
Double pole	17CM82	2992
3-way	17CM83	2993
4-way	17CM84	2994

Switches in outdoor or corrosive areas shall be mounted in "FS" type copper-free aluminum or PVC mounting boxes.

2.04 DEVICE PLATES

Device plates shall be provided with switches. In noncorrosive indoor areas, receptacle device plates shall be made of sheet steel, zinc electroplated with chrome finish as manufactured by Crouse-Hinds, Appleton, or equal.

Device plates in corrosive or outdoor areas shall be corrosion-resistant/marine-duty type. Device plates for explosionproof equipment shall be factory provided with the equipment.

Device plates shall be provided with engraved laminated phenolic nameplates with 1/8-inch white characters on black background.

Nameplates for switches shall identify panel and circuit number and area served. Nameplates for receptacles shall identify circuit and voltage if other than 120 volts, single phase.

2.05 NOT USED

2.06 PRODUCT DATA

In accordance with paragraph 00710-4.02, the Contractor shall provide catalog cuts for all materials provided under this section.

PART 3--EXECUTION

Boxes shall be independently supported by galvanized brackets, expansion bolts, toggle bolts, or machine or wood screws as appropriate. Wooden plugs inserted in masonry or concrete shall not be used as a base to secure boxes, nor shall welding or brazing be used for attachment.

Unless otherwise noted, receptacles and switches installed in sheet steel boxes shall be flush mounted. Flush mounted receptacles shall be located 18 inches above the floor.

Switch boxes shall be mounted 48 inches above the floor. receptacles installed in cast device boxes shall be located 48 inches above the floor.

Wiring devices shall be tested for correct operation.

END OF SECTION

SECTION 16175

MISCELLANEOUS ELECTRICAL DEVICES

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies miscellaneous electrical control and power devices, relays, magnetic contactors, disconnect switches, manual starters, and overcurrent protection.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
NEMA ICS-1-83	General Standards For Industrial Controls and Systems
NEMA ICS-2-83	Industrial Control Devices, Controllers, and Assemblies
NEMA ICS-6-83	Enclosures for Industrial Controls and Systems
NEMA KS 1-83	Enclosed Switches

PART 2--PRODUCTS

2.01 CONTROL DEVICES

A. PUSHBUTTONS:

Pushbuttons shall be flush head, heavy-duty, with NEMA rating to match enclosure type, 600 volts, 10 amperes continuous. The pushbutton operators shall be red for stop functions and black for all other functions. The escutcheon legend shall be as specified on the drawings. Unless otherwise specified, pushbuttons shall be momentary contact type.

B. SELECTOR SWITCHES:

Selector switches shall be heavy-duty, with NEMA rating to match enclosure type, rated 600 volts, 10 amperes continuous. Unless otherwise specified, selector switches shall have maintained position contacts. Switches shall be provided with contact blocks and numher of positions as required to perform the specified operations. The escutcheon legend shall be as specified on the drawings.

C. INDICATING LIGHTS:

AC indicating lights shall be the push-to-test transformer type with 6.3 volt lamps. They shall be heavy-duty, with NEMA rating to match enclosure type. The escutcheon and lens color shall be as specified. DC indicating lights shall be the full voltage type. DC lamps may be tested as a group using a common lamp test button. Unless otherwise specified, indicating lights shall be equipped with colored lenses in accordance with the following schedule:

Color	Typical Function	Example
Red	Danger, abnormal condition, fault condition	Voltage applied; cycle in automatic; faults in air, water, lubricating or filtering systems; ground detector circuits.
Amber (yellow)	Attention	Motors running; machine in cycle; unit or head in forward position.
Green	Safe conditions (security)	End of cycle; unit or head returned; motors stopped; motion stopped; contacts open.
White or clear	Normal condition	Normal pressure of air, water lubrication

D. CONTROL STATIONS:

Unless otherwise specified, control stations indoors shall be NEMA 12. Control stations located outdoors and in corrosive areas shall be nonmetallic NEMA 4X. The pushbuttons shall have protective Hypalon boots. Control stations located in hazardous areas shall be NEMA 7. When indicating lights are specified, control station shall be sized to accommodate the transformer type lights. The control stations shall be Allen-Bradley 800 H series, Crouse-Hinds NCS series, or equal.

2.02 CONTROL RELAYS

A. LOAD-SWITCHING CONTROL RELAYS:

Control relays used for switching loads (solenoids, actuators, contactors, motor starter coils, etc.) shall be heavy-duty machine tool type. Relays that have contacts used for remote interlocking or for which the switching load is not shown shall also be heavy-duty machine tool type.

Contacts shall, as a minimum, be 4-pole and be field interchangeable to either normally open or normally closed. Relay shall be capable of accepting a 4-pole adder.

AC relays shall have NEMA A600 contact ratings and electrical clearances for up to 600 volts. DC relays shall have NEMA P300 contact ratings and electrical clearances of up to 250 volts.

Relays shall be Allen Bradley Bulletin-700, Square D Class 8501, or equal.

B. LOGIC SWITCHING CONTROL RELAYS:

Control relays used for switching logic (other relays, etc.) shall be Potter Blumfield series KUP, Struthers-Dunn Frame 219, or equal. Relays shall have a minimum of three SPDT contacts rated 10 amps resistive at 120V AC or 28V DC. Relay shall be plug-in type with heavy-duty, barrier-protected screw terminal sockets and clear polycarbonate dust cover with clip fastener. AC models shall have neon lamp indicator wired in parallel with coil.

C. SIGNAL-LEVEL SWITCHING CONTROL RELAYS:

Control relays used for switching DC milliamp signals shall be Potter Blumfield Series KHS, Magencraft Class 78, or equal. Relays shall have a minimum of 2 SPDT, hermetically sealed, gold-flashed bifurcated contacts rated 3 amps resistive at 120V AC or 28V DC. Relay shall be plug-in type with heavy-duty, barrier-protected screw terminal sockets. Cover shall be either metal or clear polycarbonate.

D. TIMING RELAYS:

1. SOLID STATE: Solid state timing relays shall be pulse count type using a high frequency RC oscillator and integrated circuit counter for timing. Electrolytic capacitators shall not be used in the timing circuits. Time delays from 0.1 seconds to 48 hours shall be available with each timer model adjustable over

a 20:1 range. On-delay, off-delay and single-shot timing models shall be available. Timer shall reset in 0.03 seconds or less. Timer accuracy shall be plus or minus 2.0 percent under normal conditions. The timing relay shall have two NEMA form-C timed contacts. Solid state timing relays shall be Agastat, STA series, or equal.

2. PNEUMATIC: Pneumatic timing relays shall be sealed head pneumatic type with time delays available from 0.1 seconds to 60 minutes. Each relay model shall be adjustable over a 10:1 timing range with a calibrated linear dial. Timing repeatability shall be within 5 percent or better for set time delays of less than 200 seconds. Relays shall be provided with two NEMA form-C timed contacts and one form-C instantaneous contact. Two additional NEMA form-C timed contacts shall be provided where specified. Unsealed body type timing relays are not acceptable. Timing relays shall be Agastat 7000 series. The Engineer knows of no equal.

3. MOTOR DRIVEN TIMERS: Motor driven timers shall be driven by a synchronous motor which starts timing when initiated by an external signal. Time settings shall be made by turning a knob on the front of the dial. A neon pilot light visible from the front of the timer shall glow red when the timer motor is energized. visual indication shall be provided by a cycle progress pointer which advances to zero from the setting back to zero as time progresses. There shall be two sets of "instantaneous" NEMA form-C contacts which actuate when the timing is initiated. There shall be one set of "delayed" NEMA form-C contacts which actuates when the unit has timed out. When the timing cycle is completed, the timer shall automatically reset.

The timer shall be mounted in a one-piece molded case that will be permanently mounted and wired. The timer shall be Eagle Cycleflex reset timer, HP5 series; Automatic Timing Controls, series 305D; or equal.

2.03 MAGNETIC CONTACTORS

A. LIGHTING CONTACTOR:

Lighting contactors shall be 100 percent rated for ballast and tungsten lighting, resistance and other nonmotor loads.

Contactor shall be rated 600V, 60 hz with the ampere rating and number of poles as shown on the drawings. A minimum of two poles shall be provided. Contactor shall be designed in accordance with NEMA ICS 2-211B for industrial-duty applications.

The following options shall be available and shall be provided when called out on the drawings:

Auxiliary contacts rated 5 amps at 600V AC.
Timer or time clock attachment.
Transient suppression module for 120V AC control circuits.

Contactors shall be either electrically or mechanically held as specified.

Contactors shall be available in combination with disconnecting means and overcurrent protection mounted in the same enclosure.

Contactors shall be Allen Bradley Bulletin 500L or 500LP, Square D Class 8903, or equal.

B. MOTOR CONTACTORS:

Motor contactors shall be designed for continuous operation of induction motors at 600 volts or less at 60 Hz and shall comply with NEMA ICS 2-210. Unless otherwise specified, minimum contactor size shall be NEMA size 1. The contactor shall be supplied with a normally open auxiliary contact for use as a hold-in contact as a minimum. Additional contacts shall be provided as specified. The coil voltage, frequency and number of poles shall be as specified.

2.04 SAFETY DISCONNECT SWITCHES

Safety disconnect switches shall be heavy-duty, nonfusible, safety type rated 600 volts AC. Unless otherwise specified, indoor enclosures shall be NEMA 12; enclosures installed in outdoor or corrosive areas shall be NEMA 4X, nonmetallic; and enclosures installed in hazardous areas shall be NEMA 7. Switch enclosures located in classified areas shall be suitable for the specified classification. The operating handle shall be capable of being padlocked in the "off" position. The operator shall be a positive, quick-make, quick-break mechanism. Switch mechanisms shall be provided with one auxiliary contact that opens before the switchblades. This auxiliary contact shall be rated B150, per NEMA ICS 2-125.

Switches shall be horsepower rated for motors and shall comply with NEMA KS-1. Switches shall be provided with defeatable door interlocks that prevent the door from opening when the operating handle is in the "on" position. Switches shall have line terminal shields. Switches shall be Westinghouse Type H-600; General Electric Mill Duty, Type TH; or equal. NEMA 4X switches shall be Crouse-Hinds NCB; Square D with "Krydon" enclosure; or equal.

2.05 OVERCURRENT PROTECTION

A. CIRCUIT BREAKERS:

Circuit breakers shall be thermal magnetic, molded case type with the ampere rating as specified. Unless otherwise specified, circuit breaker interrupting rating shall be 10,000 amperes symmetrical for service at 240 volts and below and 22,000 amperes symmetrical for service above 240 volts.

2.06 ELAPSED TIME INDICATORS

Elapsed time indicators shall be panel mounted, nonresettable, six digit, hour indicator, rated 120 volts AC, 60 Hz.

2.07 PRODUCT DATA

The following information shall be provided in accordance with paragraph 00710-4.02:

1. Operation and maintenance items 2 through 10 as specified in Section 01730

2. Manufacturer's catalog data for all material provided under this section shall be assembled in a folder with each page clearly marked with the item and reference number to the specification.

PART 3--EXECUTION

Control stations, contactors and safety disconnect switches shall be mounted 48 inches above the floor.

Miscellaneous electrical devices shall be tested in accordance with Section 16030.

END OF SECTION

SECTION 16176

LOCAL CONTROL PANELS

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies local control panels used for housing electrical control and process equipment.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
JIC EGP-1-67	Electrical Standards for General Purpose Machine Tools
NEMA 250-79	Enclosures for Electrical Equipment (1000 Volts Maximum)
NFPA 70-87	National Electrical Code (NEC)

B. ASSEMBLY:

The local control panels shall conform to the requirements of JIC, EGP-1-67.

C. FACTORY TESTING:

Prior to shipment, the manufacturer shall test the functional operation of the local control panel as described in the sequence of operation, paragraph 15176-2.09, Item 1.

1.03 SUBMITTALS

The following submittals shall be provided in accordance with Section 01300:

1. Arrangement drawings of the local control panel enclosure indicating the front door and rear panel equipment arrangement and dimensions. A list of materials and components shall accompany the layout drawings.

2. Elementary and internal connection diagrams.

PART 2--PRODUCTS

2.01 GENERAL

Local control panels shall comprise enclosures, wiring, process and electrical control devices.

2.02 ENCLOSURES

A. GENERAL:

Enclosures shall comply with the requirements of NEMA 250.

B. MANUFACTURER:

The enclosures shall be made by Hoffmann Engineering Company, Bulletin A; E.M. Wiegman and Co., Inc.; or equal.

C. CLASSIFICATION:

Unless otherwise specified, enclosures installed indoors shall be NEMA 12. Enclosures installed outdoors or in corrosive areas shall be NEMA 4X, nonmetallic. Enclosures installed in hazardous areas shall meet the NEC requirement for that area.

D. SIZE:

Unless otherwise specified, the minimum enclosure area, height by width, shall be twice the sum of the area of the individual components mounted on the back panel. The enclosure depth shall depend on the type of components used but shall be no less than 6 inches.

E. COLOR:

The enclosure shall be the manufacturer's standard color.

F. MOUNTING:

Unless otherwise specified, the enclosures shall have provisions for wall mounting.

2.03 PANEL WIRING

A. INTERNAL WIRING:

Internal wiring shall be single conductor 90 degree C copper wire and UL listed for panel wiring. Wire size shall be in accordance with NEC.

Internal wiring shall be color coded as follows:

Type	Color
Power (AC)	Black
Neutral	White
Control	Red
Foreign voltage	Yellow
DC	Blue
Ground	Green

B. WIRE MARKERS:

Wire markers shall comply with paragraph 16000-2.02.

C. WIRING METHODS:

Plastic wireway with covers shall be used to route groups of wires. Plastic spiral wrap shall be used for exposed wires.

Wires that cross door hinges shall be enclosed in plastic spiral wrap.

2.04 CONTROL DEVICES

Control devices shall comply with Section 16175.

2.05 INDICATING LIGHTS

Indicating lights shall be equipped with colored lenses in accordance with the following schedule:

Color	Typical Function	Example
Red	Danger, abnormal condition, fault condition	Voltage applied; cycle in automatic; faults in air, water, lubricating or filtering systems; ground detector circuits.
Amber (yellow)	Attention	Motors running; machine in cycle; unit or head in forward position.

Color	Typical Function	Example
Green	Safe conditions (security)	End of cycle; unit or head returned; motors stopped; motion stopped; contacts open.
White or clear	Normal condition	Normal pressure of air, water lubrication

2.06 TERMINAL BLOCKS

Terminal blocks shall be provided in accordance with Section 16000-2.04 and shall be channel mounted. The terminal block assembly shall be mounted on channel standoffs. There shall be 15 percent spare terminals available for future use.

2.07 LABELING AND NAMEPLATES

A. LABELING:

Local control panel components shall be labeled to match the description on the elementary diagram. Internal components of the local control panel on the back side of the door shall be labeled with the same description as provided on the front side.

Labeling shall be permanently marked on or near each component. Plastic embossed labels such as "Dymo" tape will not be accepted.

B. NAMEPLATES:

External door-mounted components and the local control panel description shall be identified with plastic nameplates provided in accordance with paragraph 16000-2.03.

2.08 GROUNDING

All neutrals shall be grounded to the mounting plate using a copper bus or grounding lug. A grounding lug for a size No. 2 AWG bare copper conductor shall be provided to ground the panel to the plant's grounding system.

2.09 PRODUCT DATA

The following information shall be provided in accordance with paragraph 00710-4.02:

1. A written description of the elementary diagram "sequence of operation" (Reference JIC, EGP 1, Appendix B, for an example).

2. Operations and maintenance information Items 1 through 9 as specified in Section 01730.

PART 3--EXECUTION

3.01 GENERAL

Alternating current control circuits shall be 120 volts or less and grounded. Typically, only one voltage is supplied to a control panel. Any other voltages required shall be provided for by transformers or power supplies provided with the panel. One terminal of each load device shall be connected to the grounded conductor. Control contacts shall be installed in the ungrounded side of the circuit.

Signal and control wiring shall be separated and installed in separate wireways.

The panel shall be grounded to the plant grounding system as specified.

Local control panels shall be mounted at 48 inches above the floor.

A copy of the record drawing elementary diagram shall be placed on the inner panel door. Elementary diagram shall be enclosed in a transparent, protective jacket.

3.02 FIELD TESTING

Local control panels shall be tested in accordance with Section 16030.

END OF SECTION

SECTION 16310

LOW VOLTAGE SWITCHGEAR

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies switchgear rated 600 volts.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ANSI C37.20-74	Switchgear Assemblies Including Metal Enclosed Bus
ANSI C57.13-78	Requirements for Instrument Transformers
NEMA SG3-81	Low Voltage Power Circuit Breakers
NEMA SG5-81	Power Switchgear Assemblies

B. FACTORY TESTS:

After assembly, switchgear shall be tested for operation at the specified voltage and current ratings. The main circuits shall be given a dielectric test of 2200V for 1 minute between live parts and ground, and between opposite polarities. The wiring and control circuits shall be given a dielectric test of 1500V for 1 minute between live parts and ground.

Instrument transformers shall have ratio and phase angle tests made in conformance with ANSI C57.13.

Three copies of test results shall be provided to the Construction Manager.

1.03 SUBMITTALS

The following submittals shall be provided in accordance with Section 01300:

1. Electrical elementary diagrams and internal connection diagrams.

2. Manufacturer's data indicating interrupting, withstand and continuous current ratings of all equipment and components.

3. Dimensioned plan and elevation drawings showing switchgear layout.

PART 2--PRODUCTS

2.01 ACCEPTABLE PRODUCTS

Switchgear shall conform to NEMA SG5 and shall be Westinghouse Type DS; General Electric Type AKD-8, or equal.

2.02 MANUFACTURE

A. ENCLOSURE:

Switchgear shall be factory assembled and metal enclosed. Each unit shall consist of a stationary structure assembly and one or more air circuit breaker units, disconnecting devices, and other specified equipment. Switchgear shall be suitable for 600V, 3 phase maximum service. Each unit shall be provided with a breaker hoist for removing the breaker for maintenance.

B. STATIONARY STRUCTURE:

Stationary structure shall be a self-contained steel unit housing one or more individual breakers or instrument compartments and a rear compartment for buses and outgoing cable connections. Structure shall be provided with removable steel plates on the top and sides, and each breaker compartment shall be equipped with primary and secondary contacts, rails, and stationary levering mechanism. A rear hinged cover shall be provided for each cable compartment, and a front hinged door shall be provided for each breaker and metering compartment.

Structures shall be provided with horizontal and vertical barriers to separate different voltage classes, buses and incoming cables.

C. FINISH:

The finish shall comply with paragraph 16000-2.01.B.

2.03 BUS BARS

A. GENERAL:

Buses shall be copper.

B. MAIN BUS:

Main horizontal bus shall extend through all sections of the switchgear with vertical connections to circuit breakers in each section.

As a minimum, main bus shall have a continuous rating at least equal to the main circuit breaker or the power source and shall be braced to withstand stresses resulting from the maximum short-circuit current available. Minimum bracing shall be 65,000 amperes symmetrical.

Buses shall be mounted on heavy-duty glass polyester supports, and main bus joints shall be silver-plated and bolted using a minimum of two bolts. Shipping splits and provisions for future bus extensions shall have silver-plated bolted connections.

Switchgear units will be connected single ended or double ended as specified. Double ended units shall be two single ended units connected by bus duct and a tie breaker.

C. NEUTRAL BUS:

Neutral bus, when specified, shall have the same capacity of the main bus.

D. GROUND BUS:

A ground bus having a momentary rating at least equal to the highest momentary rating of any circuit breaker in the assembly shall extend the length of the bottom of the switchgear. Each end of the ground bus shall be provided with clamp type terminals for one No. 4/0 bare copper ground wire.

2.04 CIRCUIT BREAKERS

A. GENERAL:

Circuit breakers shall conform to NEMA SG3. Breaker element shall consist of a three-pole manually operated or electrically operated, as specified, electrically and mechanically trip-free power circuit breaker with solid state, overcurrent trip device, arc quenchers, manual stored energy closing mechanism, mechanical pushbutton trip and position indicator. Breaker element shall be suitable for mounting on the drawout mechanism in the circuit breaker compartment.

B. DISCONNECTING DEVICES AND DRAWOUT MECHANISM:

Disconnecting devices shall be the self-aligning type with the disconnecting fingers mounted on the breaker. The drawout mechanism shall rigidly hold the circuit breaker in the fully connected, test, and fully disconnected positions. Interlocks shall be provided to prevent moving the circuit breaker from the fully connected, test, or fully disconnected positions unless the breaker is open. Interlocks shall also prevent closing the breaker between any of these positions.

The drawout mechanism shall be designed so that the breaker can be racked to any position without opening the door. A hasp on the breaker escutcheon shall be provided that can receive three padlocks when the breaker is in the open position.

C. AUXILIARY SWITCHES:

Unless otherwise specified, breakers shall be equipped with one normally open and one normally closed auxiliary switch. Switches shall be rated 10 amperes, 600 volts AC and wired to terminal blocks.

D. SOLID STATE TRIPPING DEVICES:

Solid state tripping devices shall consist of current sensors logic assembly, magnetic latch release, and required interconnecting wiring. Tripping devices shall be automatic and self-contained within the breaker frame, and shall not require any external relaying or power supplies.

Tripping device shall be provided with manually resettable fault indicators. As a minimum, fault indicators shall provide indication of tripping caused by overload, short circuit or ground fault.

Tripping functions shall be field adjustable and shall provide, the following tripping characteristics:

1. OVERLOAD TRIPPING:
   a. Adjustable ampere setting
   b. Adjustable long-time delay

2. SHORT CIRCUIT TRIPPING:
   a. Adjustable short-time pick-up
   b. Adjustable short-time delay
   c. Adjustable instantaneous pick-up

3. GROUND FAULT TRIPPING:
   a. Adjustable ground fault pick-up
   b. Adjustable ground fault delay

2.05 PANEL INSTRUMENT AND ACCESSORIES

Panel instrument and accessories shall be as specified. They shall be provided in accordance with Section 16440.

2.06 PROTECTIVE RELAYING

Protective relaying shall be as specified.

The tripping devices and instrument transformer ratios specified are preliminary and are subject to confirmation with the coordination study in Section 16431.

2.07 EQUIPMENT IDENTIFICATION

A. NAMEPLATES:

In addition to the manufacturer's identification, switchgear shall be provided with phenolic nameplates showing switchgear, main breaker, and feeder breaker designations as specified. Nameplates shall comply with paragraph 16000-2.03.

B. CONDUCTOR MARKERS:

Conductor markers shall comply with paragraph 16000-2.02.

2.08 WIRING

A. CONDUCTORS:

Internal switchgear wiring shall consist of single conductor 90 degree C copper wire and UL listed for panel wiring. The wire shall be sized to suit load requirements. Minimum size shall be No. 14 AWG.

B. TERMINAL BLOCKS:

Terminal blocks shall comply with paragraph 16000-2.04.

C. CABLE CONNECTORS:

Cable connectors for outgoing power cables shall be suitable for use with aluminum or copper conductors. They shall be UL listed as a compression connector and shall be sized for the specified conductor.

Conical washers shall be used for each connection.

2.09 PRODUCT DATA

The following information shall be provided in accordance with paragraph 00710-4.02:

1. Arrangement and layout drawings of the switchgear enclosures depicting equipment and bus arrangement and dimensions including areas of permissible cable entries. A list of material and components shall accompany the layout drawings.

2. Catalog data and instruction manuals on all electrical devices and components mounted on or within the switchgear.

3. Results of factory tests and field breaker setting tests as specified in paragraphs 16310-1.02.B and 16310-3.02.

4. Operation and maintenance information items 1 through 9 as specified in Section 01730.

5. Manufacturer's product information.

6. Manufacturer's certification and calculations that the equipment meets the seismic requirements of paragraph 16000-2.05.

PART 3--EXECUTION

3.01 PROTECTIVE DEVICE SETTINGS

The protective devices shall be adjusted to the settings specified in the coordination study in Section 16431 prior to energizing the switchgear.

3.02 FIELD TESTS

Each switchgear breaker shall be tested in accordance with Section 16030.

END OF SECTION

SECTION 16431

SHORT CIRCUIT AND COORDINATION REPORT

PART 1--GENERAL

1.01 DESCRIPTION

A. GENERAL:

This section specifies that the Contractor prepare a short circuit and coordination study for the electrical power system. The short circuit and coordination study report shall provide an evaluation of the electrical power system and the model numbers and settings of the protective devices.

1.02 REFERENCES

This section contains references to the following documents. Thev are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
IEEE 141-76	Recommended Practice for Electric Power Distribution for Industrial Plants
IEEE 242-75	Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems

1.03 SCHEDULE

The report shall be completed and a copy sent to the switchgear manufacturers 90 days before the switchgear is shipped to the job site. The report shall be provided to the Construction Manaqer 150 days before the switchgear is shipped to the job site.

1.04 SUBMITTALS

The report specified in paragraph 16431-2.01 shall be provided in accordance with Section 01300.

PART 2--PRODUCTS

2.01 REPORT

The product shall be a certified report summarizing the short circuit and coordination study and conclusions or recommendations which may affect the integrity of the electric power distribution system. As a minimum, the report shall include the following:

1. The equipment manufacturer's information used to prepare the study.

2. Assumptions made during the study.

3. Short circuit calculations listing short circuit levels at each bus.

4. Coordination study time-current curves including the instrument transformer ratios, model numbers of the protective relays, and the relay settings associated with each breaker.

5. Comparison of short circuit duties of each bus to the interrupting capacity of the equipment protecting that bus.

6. All data which were used as input to the report. These data shall include cable impedances, source impedances, equipment ratings, etc.

PART 3--EXECUTION

3.01 GENERAL

Provide a short circuit and coordination study on the electrical power distribution system as specified. The studies shall be performed in accordance with IEEE Standards 141 and 242 and shall utilize the ANSI method of short circuit analysis in accordance with ANSI C37.010. The studies shall be performed using actual equipment data for both existing and new equipment. The coordination study shall use the data from the same manufacturer of protective relay devices as being provided by the switchgear manufacturer.

3.02 QUALIFICATIONS

The short circuit and coordination report shall be performed by the manufacturer of the switchgear or by an electrical testing service who is regularly engaged in power system studies. The

studies shall be signed by the professional electrical engineer, registered to practice engineering in the state in which the project is located, responsible for the studies.

3.03 SHORT CIRCUIT STUDY

The Contractor shall be responsible to obtain and verify all data needed to perform the study.

As a minimum, the short circuit study shall include the following:

A. One-Line Diagram

1. Location and function of each protective device in the system, such as relays, direct-acting trips, fuses, etc.

2. Type designation, current rating, range or adjustment, manufacturer's style and catalog number for all protective devices.

3. Power, voltage ratings, impedance, primary and secondary connections of all transformers.

4. Type, manufacturer, and ratio of all instrument transformers energizing each relay.

5. Nameplate ratings of all motors and generators with their subtransient reactances. Transient reactances of synchronous motors and generators and synchronous reactances of all generators.

6. Sources of short circuit currents such as utility ties, generators, synchronous motors, and induction motors.

7. All significant circuit elements such as transformers, cables, breakers, fuses, reactors, etc.

8. Emergency as well as normal switching conditions.

9. The time-current setting of existing adjustable relays and direct-acting trips, if applicable.

B. Impedance Diagram

1. Available MVA or impedance from the utility company.

2. Local generated capacity impedance.

3. Bus impedance.

4. Transformer and/or reactor impedances.

5. Cable impedances.

6. Equipment impedances.

7. System voltages.

8. Grounding scheme (resistance grounding, solid grounding, or no grounding).

C. Calculations

1. Determine the paths and situations where short circuit currents are the greatest. Assume bolted faults and calculate the 3-phase and line-to-ground short circuits of each case.

2. Calculate the maximum and minimum fault currents.

3.04 COORDINATION STUDY

As a minimum, the coordination study for the power distribution system shall include the following on 5-cycle, log-log graph paper:

1. Time-current for each protective relay or fuse showing graphically that the settings will provide protection and selectivity within industry standards. Each curve shall be identified, and the tap and time dial settings shall be specified.

2. Time-current curves for each device shall be positioned to provide for maximum selectivity to minimize system disturbances during fault clearing. Where selectivity cannot be achieved, the Construction Manager shall be notified as to the cause.

3. Time-current curves and points for cable and equipment damage.

4. Circuit interrupting device operating and interrupting times.

5. Indicate maximum fault values on the graph.

6. Sketch of bus and breaker arrangement.

END OF SECTION

SECTION 16440

INSTRUMENT TRANSFORMERS, METERS,
SWITCHES AND ACCESSORIES

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies accessories for switchgear assemblies.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ANSI C37.20-74 (1981)	Switchgear Assemblies Including Metal-Enclosed Bus
ANSI C39.1-81	Requirements for Electrical Analog Indicating Instruments
ANSI C57.13-78	Requirements for Instrument Transformers

PART 2--PRODUCTS

2.01 INSTRUMENT TRANSFORMERS

A. GENERAL:

Instrument transformers shall be molded dry-type in accordance with ANSI C57.13. Transformer volt-ampere rating shall be suitable for carrying the specified load without overheating or exceeding the permissible accuracy for the transformer.

B. POTENTIAL TRANSFORMERS:

Potential transformers shall have an ANSI accuracy class of 0.3. They shall be equipped with current limiting fuses.

C. CURRENT TRANSFORMERS:

Current transformers shall be furnished with the specified ratios. The accuracies shall conform to ANSI C37.20.

2.02 PANEL METERS

All indicating meters shall be 4-1/2-inch square, semiflush mounted switchboard type. The movement shall be taut-band with an accuracy of plus or minus 1 percent of full scale. The case shall be black. The scale shall be white with black markings. The length of the scale shall be greater than 7 inches over a deflection angle of 250 degrees. The meters shall be manufactured in accordance with applicable requirements of ANSI C39.1.

2.03 INSTRUMENT SWITCHES

Instrument switches shall be provided with contact blocks and positions specified. Switches shall be of the rotary-cam type and contacts shall have positive wiping action of silver-to-silver contact buttons. Switches shall be provided with escutcheon plates and pistol-grip handles. Switches shall be General Electric, SBM; Westinghouse, W-2; or equal.

Voltmeter and ammeter switches shall have four positions with the escutcheon legend as follows:

Voltmeter	OFF	1-2	2-3	3-1
Ammeter	OFF	Phase A	Phase B	Phase C

2.04 NOT USED

2.05 INDICATING LIGHTS

Switchboard indicating lights shall be resistor type of the voltage specified. Bulbs shall be the telephone type with a slide base.

2.06 NAMEPLATES

Nameplates shall be provided in accordance with paragraph 16000-2.03.

2.07 PRODUCT DATA

The following information shall be provided in accordance with paragraph 00710-4.02:

1. Operation and maintenance items 1 through 10 as specified in Section 01730.

2. Manufacturer's product data indicating the general features and dimensions of devices.

3. Burden, accuracy class and ratio data for instrument transformers.

PART 3--EXECUTION

All accessories and devices shall be installed per the switchgear manufacturer's instructions.

END OF SECTION

SECTION 16450

GROUNDING SYSTEM

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies the system for grounding electrical equipment, exposed nonenergized metal surfaces of equipment, and metal structures.

1.02 REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
IEEE 81-83	Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System, Guide for
NFPA 70-87	National Electric Code (NEC)

PART 2--PRODUCTS

2.01 CABLE

Ground cable shall be annealed bare copper, concentric stranded as specified. If cable sizes are not specified, the minimum sizes shall be as follows:

480V switchgear	4/0 AWG
480V MCC and switchboards	2/0 AWG
Lighting panels	2 AWG
Exposed metal	2 AWG

Ground cables shown around structures for grounding leads to equipment and exposed metal shall be 4/0 AWG minimum.

2.02 GROUND RODS

Ground rods shall be copper covered steel, 3/4-inch diameter and 10 feet long. Rods shall have threaded type removable caps so that extension rods of same diameter and length may be added where necessary.

2.03 COMPRESSION CONNECTORS

Compression connections shall be cast copper as manufactured by Thomas and Betts, or equal.

2.04 BOLTED CONNECTORS

Bolted connectors shall be Burndy, O. Z. Gedney, or equal.

2.05 PRODUCT DATA

Ground resistance readings specified in paragraph 16450-3.05 shall be provided in accordance with paragraph 00710-4.02.

PART 3--EXECUTION

3.01 GENERAL

Embedded and buried ground connections shall be made by compression connectors utilizing diamond or hexagon dies and a hand compression tool for wire sizes 2 AWG and smaller and a hydraulic pump and compression head for wire sizes 2/0 AWG and larger. Tools and dies shall be approved for this purpose; dimple compressions are not acceptable. Compression connections shall be prepared in accordance with the manufacturer's instructions. Exposed ground connections to equipment shall be made by bolted clamps unless otherwise specified. No solder shall be used in any part of the ground circuits.

Embedded ground cables and fittings shall be securely attached to concrete reinforcing steel with tie wires and prevented from displacement during concrete placement. As each part of the grounding system which is laid below finished grade is completed, the Construction Manager shall be notified 2 hours prior to backfilling.

Grounding conductors which are extended beyond concrete surfaces for equipment connection shall be extended a sufficient length to reach the final connection point without splicing. Minimum extension shall be 3 feet. Grounding conductors which project from a concrete surface shall be located as close as possible to a corner of the equipment pad, protected by conduit, or terminated in a flush grounding plate. Exposed grounding conductors shall be supported by noncorrosive metallic hardware at

4-foot intervals or less. Grounding conductors for future equipment shall be terminated using a two-hole copper flush mounted grounding plate, Cadwell, or equal.

Ground conductors, except signal conductor shields, entering enclosures shall be bonded together to the enclosure if it is metallic and to metallic raceways within or terminating at the enclosure. Prior to making ground connections or bonds, the metal surface at the point of connection shall be cleaned.

Compression-type lugs shall be used in accordance with manufacturer's recommendations.

Grounding conductor shall not be used as a system neutral.

Lightning arresters shall be directly connected to the ground system using copper conductors, sized as specified.

Metallic sheaths or shields of shielded power cable shall be terminated by a copper grounding strip provided with cable connection for connection to the grounding system.

Grounding system shall be provided in compliance with the NEC.

3.02 RACEWAY GROUND

Metallic conduits shall be assembled to provide a continuous ground path. Metallic conduits shall be bonded using insulated grounding bushings.

Grounding bushings shall be connected to the grounding system using conductors sized in compliance with NFPA 70. Cable trays shall have No. 2/0 AWG bare copper ground conductor run on the outside of each tray. Conductor shall be connected to each section or fitting using a carriage bolt and clamp.

3.03 EQUIPMENT AND ENCLOSURE GROUND

Electrical and distribution equipment shall be connected to the grounding system. Cables shall be sized as specified.

Nonelectrical equipment with metallic enclosures shall be connected to the grounding system.

3.04 ISOLATED GROUNDING

Where the manufacturer of equipment supplied from 120 volt instrument power panels requires an isolated ground, the Contractor shall provide an additional isolated ground conductor from the equipment through the instrument power panel for connection to a single point ground bus in the automatic transfer switch

enclosure. The isolated ground conductor shall have green insulation with a yellow stripe and shall be run in the same raceway as the power and neutral conductors.

The neutral conductor from the ultra-isolation transformers shall be grounded only at the single point ground bus in the automatic transfer switch.

3.05 GROUNDING SYSTEM TESTS

The Contractor shall test each grounding connection to determine the ground resistance. The grounding test shall be IEEE Standard 81. A plot of ground resistance readings for each isolated ground rod or ground mat shall be provided to the Construction Manager on 8-1/2 x 11 inch size graph paper. The current reference rod shall be driven at least 100 feet from the ground rod or grid under test. The measurements shall be made at 10-foot intervals beginning 25 feet from the test electrode and ending 75 feet from it, in direct line between the ground rod or center of grid and the current reference electrode.

A grounding system that shows greater than 2 ohm resistance for the flat portion of the plotted data shall be considered inadequately grounded. The Contractor shall add additional parallel connected ground rods and/or deeper driven rods until the ground resistance measurements meet the 2 ohm requirement. Ground rods required over that specified will be paid for as extra work. Use of salts, water or compounds to attain the specified ground resistance is not acceptable.

END OF SECTION

SECTION 16460

DRY-TYPE TRANSFORMERS (600 VOLTS AND LESS)

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies dry-type transformers rated 600 volts and less used for power distribution, lighting and control purposes.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ANSI/IEEE C57.12.01-79	General Requirements for Dry-Type Distribution and Power Transformers
ANSI/UL 506-79	Specialty Transformers
NEMA ST20-86	Dry-Type Transformers for General Application

PART 2--PRODUCTS

2.01 ACCEPTABLE PRODUCTS

Transformers rated 10 KVA and smaller shall be single phase unless otherwise specified on the drawings. Transformers rated 15 KVA and greater shall be 3 phase unless otherwise specified. Transformers shall conform to ANSI/IEEE C57.12.01 and ANSI/UL 506. The voltage, frequency, number of phases and KVA rating shall be as specified. Transformers shall be General Electric, Square D, Westinghouse, or equal.

2.02 INSULATION

Transformers 15 KVA and above shall have a Class 220 insulation system in accordance with NEMA ST20. Transformers 25 KVA and greater shall be designed not to exceed 80 degree C temperature rise.

2.03 COILS

Transformer coils shall be copper or aluminum. Transformer coils 15 KVA and above shall be impregnated with varnish. Transformer coils 10 KVA and below shall be encapsulated.

2.04 WINDING CONFIGURATION

Transformers shall have electrically isolated primary and secondary windings. Primary and secondary winding configurations shall be as specified. Provisions shall be made to permit separate grounding of the neutral conductor and the enclosure. Single-phase transformers shall be the four winding type.

2.05 TRANSFORMER TAPS

Transformers 15 KVA and above shall be provided with two 2-1/2 percent full capacity taps above normal voltage and four 2-1/2 percent full capacity taps below rated voltage on the primary winding.

2.06 TERMINAL COMPARTMENTS

Terminal compartments shall be sized to permit termination of cables specified. Terminal connections shall be made in the bottom third of the enclosure. The terminals shall be copper and sized for the cable specified.

2.07 ENCLOSURES

Transformers rated 15 KVA and smaller shall be provided with weatherproof, nonventilated enclosures.

Indoor transformers rated greater than 15 KVA shall be provided with dripproof, ventilated enclosures. Outdoor transformers shall have weatherproof enclosures.

2.08 MOUNTING

Transformers 45 KVA and below shall be suitable for wall mounting. Transformers over 45 KVA shall be floor mounting type.

2.09 SOUND LEVELS

The sound levels shall not exceed the following values:

KVA	dB
0-9	40
10-45	42
50-150	45
225-300	50
500	54

2.10 PRODUCT DATA

The following information shall be provided in accordance with paragraph 00710-4.02:

1. Manufacturer's verification that the unit has been built and tested in accordance with the specified ANSI standards.

2. Manufacturer's verification of the sound levels of each unit if different from the specified NEMA ST20 standards.

3. Operation and maintenance information, items 2 through 7 as specified in Section 01730.

4. Manufacturer's product literature.

PART 3--EXECUTION

3.01 GENERAL

Transformer enclosures and neutrals shall be bonded together and grounded.

3.02 TESTING

Transformers shall be tested in accordance with Section 16030.

END OF SECTION

SECTION 16470

LIGHTING AND POWER DISTRIBUTION PANELBOARDS

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies panelboards for lighting and power distribution.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
NFPA 70-87	National Electrical Code (NEC)
UL 67-79	Underwriters Laboratories, Electric Panelboards
UL 489-80	Molded-Case Circuit Breakers and Circuit Breaker Enclosures
UL 50-80	Cabinets and Boxes

PART 2--PRODUCTS

2.01 ACCEPTABLE PRODUCTS

Panelboards shall be circuit breaker, dead front type, with bus bar construction.

2.02 ARRANGEMENT AND CONSTRUCTION

The front of the panel shall have concealed trim clamps and hinges. The locks shall be flush with cylinder tumbler-type with spring loaded door pulls. The fronts shall not be removable with doors in the locked position. All panelboard locks shall be keyed alike.

Gutter space shall be provided on all sides of the breaker assembly to neatly connect and arrange incoming wiring.

Panelboard shall be composed of individually mounted circuit breakers designed to be removable without disturbing other breakers.

A directory holder with clear plastic plate and metal frame shall be mounted on the inside of the door.

2.03 BUS

Bus shall be tin-plated copper and shall have current ratings as shown on the panelboard schedules, sized in accordance with UL 67. Ratings shall be determined by temperature rise test. Minimum bus size shall be 100 amperes. Panel fault withstand rating shall be equal to the interrupting rating of the smallest circuit breaker in the panel.

Panelboards shall be provided with a separate ground bus and, where specified, with a full capacity neutral bus.

The neutral bus of instrument power panels shall be mounted on insulated stand-offs.

2.04 CIRCUIT BREAKERS

Circuit breakers shall be molded-case type provided for the current ratings and pole configurations specified on the panelboard schedule. Circuit breakers rated 120/208 volt and 120/240 volt alternating current shall have a minimum interrupting current rating of 18,000 amperes (symmetrical) at 240V AC. Circuit breakers rated 277/480 volt alternating current shall have a minimum interrupting current rating of 25,000 amperes (symmetrical) at 480V AC or as specified on the panelboard schedule.

Circuit breakers shall be bolt-on type.

Circuit breakers shall be listed in accordance with UL 489 for the service specified.

Load terminals of circuit breakers shall be solderless connectors.

2.05 FINISH

Panelboard cabinet shall be fabricated from hot-dip galvanized steel in accordance with UL 50. Panelboard fronts shall have a gray, baked enamel finish.

2.06 PRODUCT DATA

The following information shall be provided in accordance with paragraph 00710-4.02:

1. Manufacturer's certification that bus bracing is capable of withstanding the specified short circuit condition.

2. Operation and maintenance information items 2 through 9 as specified in Section 01730.

3. Quantity and rating of circuit breakers provided with each panelboard.

PART 3--EXECUTION

3.01 GENERAL

The Contractor shall type in the circuit description on the circuit directory as shown on the final record drawings or panelboard schedule.

3.02 TESTING

Panelboards shall be tested for proper operation and function.

3.03 SCHEDULE

The following panelboard schedules are part of this specification.

PANELBOARD SCHEDULE

NAMEPLATE: LPA
LOCATION: OPERATIONS BUILDING MCC ROOM
MOUNTING: SURFACE
FEEDER ENTRY: TOP

VOLTAGE: 120/208. 3 PH, 4 WIRE
MAIN DEVICE:
BUS SIZE: 225 AMPERE
SHORT CIRCUIT RATING: 14,000 AIC SYMM.

LOAD DESCRIPTION	LOAD IN WATTS	BKR AMP/ POLE	CIRCUIT AND PHASE	BKR AMP/ POLE	LOAD IN WATTS	LOAD DESCRIPTION
LIGHTING, EAST OPERATIONS BLDG	1000	20/1	1 A 2	20/1	1360	RECEPTACLES, EAST OPERATIONS BLDG
LIGHTING, LAB	1600	20/1	3 B 4	20/1	1360	RECEPTACLES, EAST OPERATIONS BLDG
LIGHTING, CONTROL ROOM & LAB	1300	20/1	5 C 6	20/1	900	RECEPTACLES, WEST OPERATIONS BLDG
LIGHTING, HALL & MEN'S ROOM	1500	20/1	7 A 8	20/1	900	RECEPTACLES, WEST OPERATIONS BLDG
LIGHTING, MEN'S & WOMEN'S ROOM	900	20/1	9 B 10	20/1	1360	RECEPTACLES, SHOP & GEN ROOM
LIGHTING, TRAINING ROOM	1400	20/1	11 C 12	20/1	1360	RECEPTACLES, SHOP & GEN ROOM
LIGHTING, SHOP	1300	20/1	13 A 14	20/1	1080	RECEPTACLES, LAB
LIGHTING, GENERATOR ROOM	800	20/1	15 B 16	20/1	900	RECEPTACLES, LAB
LIGHTING, MCC ROOM	1200	20/1	17 C 18	20/1	900	RECEPTACLES, LAB
LIGHTING, EXTERIOR OPERATIONS BLDG	400	20/1	19 A 20	20/1	1800	RECEPTACLES, NORTH SITE
LIGHTING, GENERAL SITE SECURITY	880	20/1	21 B 22	20/1	1080	RECEPTACLES, SOUTH SITE
LIGHTING, NORTH SITE	1660	20/1	23 C 24	20/1		SPARE
LIGHTING, SOUTH SITE	650	20/1	25 A 26	20/1	1800	LAB DISHWASHER
SPARE		20/1	27 B 28	20/1	1500	FUME HOOD
SPARE		20/1	29 C 30	20/1	1500	FUME HOOD
SPARE		20/1	31 A 32	20/1	400	ORT LIGHTING
SPARE		20/1	33 B 34	20/1	720	ORT RECEPTACLES
SPARE		20/1	35 C 36	20/1	1500	REFERIGERATOR
SPACE			37 A 38	20/1		SPARE
SPACE			39 B 40	20/1		SPARE
SPACE			41 C 42	20/1		SPARE

TOTAL LOAD IN WATTS PHASE A: 12190
PHASE B: 11100
PHASE C: 11720

REMARKS:

PANELBOARD SCHEDULE

NAMEPLATE: ELPA
LOCATION: OPERATIONS BUILDING MCC ROOM
MOUNTING: SURFACE
FEEDER ENTRY: TOP

VOLTAGE: 120/208V, 3 PH, 4 WIRE
MAIN DEVICE:
BUS SIZE: 100 AMPERE
SHORT CIRCUIT RATING: 14,000 AIC SYMM.

LOAD DESCRIPTION	LOAD IN WATTS	BKR AMP/ POLE	CIRCUIT AND PHASE	BKR AMP/ POLE	LOAD IN WATTS	LOAD DESCRIPTION
LIGHTING, OPERATIONS BLDG	800	20/1	1 A 2	20/1	1200	INSTRUMENT AIR COMPRESSOR
SPARE		20/1	3 B 4	20/1	1200	INSTRUMENT AIR DRYER
SPARE		20/1	5 C 6	20/1		SPARE
SPACE			7 A 8			SPACE
SPACE			9 B 10			SPACE
SPACE			11 C 12			SPACE
SPACE			13 A 14	20/1		
SPACE			15 B 16	20/1	1000	MCC 1/2 CONTROL SECTION
SPACE			17 C 18	20/1	1000	MCC E1 CONTROL SECTION
SPACE			19 A 20	20/1		SPARE
SPACE			21 B 22	30/2	2000	INSTRUMENT PANEL "A"
SPACE			23 C 24	30/2	2000	INSTRUMENT PANEL "A"

TOTAL LOAD IN WATTS PHASE A: 2000
PHASE B: 4200
PHASE C: 3000

REMARKS:

PANELBOARD SCHEDULE

NAMEPLATE: ELPB
LOCATION: CHLORINATION BUILDING
MOUNTING: SURFACE
FEEDER ENTRY: TOP

VOLTAGE: 120/208V, 3 PH, 4 WIRE
MAIN DEVICE:
BUS SIZE: 100 AMP
SHORT CIRCUIT RATING: 14,000 AIC SYM.

LOAD DESCRIPTION	LOAD IN WATTS	BKR AMP/ POLE	CIRCUIT AND PHASE	BKR AMP/ POLE	LOAD IN WATTS	LOAD DESCRIPTION
INTERIOR LIGHTING	1100	20/1	1 A 2	20/1	1080	GENERAL RECEPTACLES
INTERIOR LIGHTING	1000	20/1	3 B 4	20/1	50	CHLORINE HEATER RECEPTACLE (SOUTH)
EXTERIOR LIGHTING	550	20/1	5 C 6	20/1	50	CHLORINE HEATER RECEPTACLE (NORTH)
SPARE		20/1	7 A 8	20/1	50	CHLORINE LEAK DETECTOR, ASH 6540
SPARE		20/1	9 B 10	20/1	50	CHLORINATOR 1, CFR 6510
SPARE		20/1	11 C 12	20/1	50	CHLORINATOR 2, CFR 6520
SPACE			13 A 14	20/1	50	EFFLUENT FLOWMETER, FIT 6100
SPACE			15 B 16	20/1		SPARE
SPACE			17 C 18	20/1		SPARE
SPACE			19 A 20			SPACE
SPACE			21 B 22			SPACE
SPACE			23 C 24			SPACE

TOTAL LOAD IN WATTS PHASE A: 2280
PHASE B: 1100
PHASE C: 650

REMARKS: NEMA 3R/12 ENCLOSURE

END OF SECTION

SECTION 16500

LIGHTING FIXTURES

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies lighting fixtures and their installation.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of these documents shall prevail.

Reference	Title
NFPA 70-87	National Electrical Code (NEC)
NEMA LE1	Fluorescent Luminaries

1.03 SUBMITTALS

The following material shall be submitted to the Construction Manager in accordance with the provisions of Section 01300. All of the material stipulated herein shall be submitted in one complete submittal and shall consist of the following data, drawings, and descriptive material:

1. Table of utilization factors for calculation of illumination levels by the zonal cavity method.

2. Catalog information describing fixture make, materials and dimensions.

PART 2--PRODUCTS

2.01 LIGHTING MATERIALS

Unless otherwise specified, lighting materials, including fixtures, accessories, and hardware, shall conform with the detailed requirements specified on the Lighting Fixture Schedule in the drawings. Lighting fixtures shall be provided where specified on the drawings.

2.02 BALLASTS

A. FLUORESCENT MAGNETIC:

Ballasts for fluorescent lamps shall be nonleaking, filled with thermosetting compound, rated for 120 volt service, unless otherwise specified. Two lamp ballasts shall be used where applicable. Ballasts for fixtures located in covered unheated areas and open areas shall be low temperature type. Ballasts shall be Class P, protected type, high power factor and shall carry the CBM and UL label. Ballasts shall be designed for case temperature lower than the nominal UL 90 degree C requirement.

Rapid start and slim-line fixtures shall be provided with ultrapremium grade, energy-saver ballasts with full light output. Approved "series" with 2-F40 Rapid Start 120V (277V).

1. Advance "Mark III Kool-Koil," #R-2S40-TP (#V-2S40-TP).

2. GE "Super Premium Maxi-Miser I," #8G1024 (#8G1039).

3. Universal "Watt Reducer," #446-L-SLH-XXTC-P, (#443-L-SLH-TC-P).

B. NOT USED

C. NOT USED

D. HIGH PRESSURE SODIUM:

Ballasts for high pressure sodium lamps shall be autotransformer or isolation transformer high power factor type. Starting current shall not exceed normal running current.

2.03 LAMPS

A. ACCEPTABLE PRODUCTS:

Lamps shall be General Electric, North American Philips (Norelco), Sylvania, Venture Lighting International, or equal.

B. GENERAL:

Lamps shall be as specified on the Lighting Fixture Schedule.

Unless otherwise specified, fluorescent lamps shall be warm white.

Unless otherwise specified, high pressure sodium lamp envelopes shall be clear.

Incandescent lamps shall be rated 130V AC. 1Jnless otherwise specified, lamp shape shall be standard A or PS and envelope shall be frosted inside.

C. SPARES:

Spares shall be provided for lamps except medium base incandescent lamps less than 300 watts. Number of spares shall be equal to 5 percent of each rating type, with a minimum of one standard manufacturer's package.

2.04 EXTERIOR LIGHTING POLES

A. GENERAL:

Lighting poles shall be provided with pole cap and all necessary fixture mounting hardware.

2.05 SITE JUNCTION BOXES

Junction boxes for the distribution of outdoor lighting circuits shall be precast concrete, set flush with the ground. Size shall be approximately 10.5 x 17.25 x 12 inches deep. Lid shall be cast iron with cast inscription: "STREET LIGHTING". Boxes shall be Brooks Products, Christy Concrete Products, Forni Corporation, Utility Vault Company, or equal. Example: Brooks catalog No. 3-1/2PB.

2.06 PHOTOELECTRIC CELL UNITS

Photoelectric cell units shall consist of a cadmium sulfide cell housed in a plug receptacle assembly. The plug receptacle assembly shall be three-prong polarized locking type. Assembly shall be suitable for outdoor mounting and shall be rated for 1800 VA at 120V maximum capacity.

2.07 NOT USED

2.08 PRODUCT DATA

The following information shall be provided in accordance with paragraph 00710-4.02:

1. Operation and maintenance items 2 through 10 as specified in Section 01730.

PART 3--EXECUTION

3.01 GENERAL

The location and type of fixtures and receptacles are shown on the drawings. Raceways and wire shall be provided from the fixtures, switches and receptacles to the lighting panel in accordance with the NEC. Raceways shall be provided in accordance with Section 16110. Wire shall be provided in accordance with Section 16120.

Fixtures labeled to require conductors with a temperature rating exceeding 75 degrees C shall be spliced to circuit conductors in a separately mounted junction box. Fixture shall be connected to junction box using flexible conduit with a temperature rating equal to that of the fixture.

Photoelectric cells shall be oriented toward the north.

Labels and marks, except the UL label, shall be removed from exposed parts of the fixtures. Fixtures shall be cleaned when the project is ready for acceptance.

Where recessed fixtures are required, the fixture shall be provided with mounting hardware for the ceiling system specified. Catalog numbers given on the Lighting Fixture Schedule shall not be used for selection of mounting hardware, but only as a reference to the type of fixture required. A concealed latch and hinge mechanism shall be provided to permit access to the lamps and ballasts and for removal and replacement of the diffuser without removing the fixture from ceiling panels. Fixtures recessed in concrete shall have protective coating of bituminous paint.

Fixtures shall be aligned and directed to illuminate an area as specified. Fixtures shall be directly and rigidly mounted on their supporting structures. Unless otherwise specified, conduit system shall not be used to support fixtures. Where brackets or supports for lighting fixtures are welded to steel members, the welded area shall be treated with rust-resistant primer and finish paint.

Underground and outdoor wire splices shall be in accordance with Section 16120.

3.02 LIGHTIWG FIXTURE SCHEDULE

A. EXAMPLE CATALOG NUMBERS:

The manufacturer's catalog numbers listed are examples of the basic model, or series, and the overall quality required. While the referenced catalog numbers attempt to be as definitive as

available literature permits, such items as voltage, mounting style, modifications, and other special features may not be included. The Contractor, supplier, and manufacturer shall verify and provide all of the specified requirements.

END OF SECTION

SECTION 16920

600 VOLT MOTOR CONTROL CENTERS

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies freestanding, factory assembled 600 volt motor control centers (MCC).

B. EQUIPMENT LIST:

MCCs specified herein shall be furnished by a single manufacturer. Refer to schedule in Part 3 of this specification section.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ANSI/NEMA ICS 1-83	General Standards for Industrial Controls and Systems
ANSI/NEMA ICS 2-83	Industrial Control Devices, Controllers and Assemblies
JIC EMP 1-67	Electrical Standards for Mass Production Equipment
UL 845-80	Motor Control Centers

1.03 SUBMITTALS

The following information shall be provided in accordance with Section 01300:

1. Elementary connection and interconnection diagrams as required in paragraph 16920-2.07, in accordance with JIC EMP 1 and/or NEMA ICS standards.

2. Time current curves for all protection devices.

3. List of starters and feeder tap compartments indicating the size and type of circuit protection.

4. Interrupting, withstand and continuous current rating of:

   a. Bus bars
   b. Feeder tap units
   c. Starter units
   d. Main incoming units

PART 2--PRODUCTS

2.01 ACCEPTABLE PRODUCTS

Motor control centers shall comply with ANSI/NEMA ICS 2-322, AC General-Purpose Motor Control Centers, and UL 845 and shall be Square D Model 5, Allen-Bradley Bulliten 2100, or equal.

2.02 SERVICE

Motor control centers shall be rated 600 volts, 60 hertz, 3 phase, 3-wire, and shall be suitable for operation at the specified voltages and short circuit capacities.

2.03 STRUCTURE AND CONSTRUCTION

A. STRUCTURE:

Motor control centers shall be made of No. 14 gage steel minimum and each section shall be 90 inches high by 20 inches wide by 20 inches deep. The individual unit compartments shall be a minimum of 12 inches high. There shall be 72 inches available for stacking starter units. Compartments shall have pan-type doors with a minimum of two quarter-turn hold-down latches; and neoprene gaskets.

A full height vertical wireway, 20 square inch minimum, shall be provided for each vertical motor control center section. The wireway shall contain full height removable doors. Horizontal wireways shall be provided top and bottom, extending the length of motor control centers.

Bottom channel sills shall be mounted front and rear of the vertical sections extending the full length of the motor control center lineup. A removable lifting angle shall be mounted on top and shall extend the width of the motor control center lineup.

B. CONSTRUCTION:

Motor control centers located indoors shall have NEMA 1, gasketed enclosures; motor control centers located outdoors shall be NEMA 1 gasketed in a NEMA-3R weatherproof walk-in enclosure.

Starter units, size 4 and smaller, and feeder tap units less than 225 amperes shall be drawout plug-in construction with hardened, plated copper free-floating stabs, steel spring backups. The door shall have interference tabs which prevent door closure if unit is improperly installed. Units shall be latched in the position to assure proper bus contact. The unit disconnect device shall be interlocked to prevent removal or reinsertion of a unit when the disconnect is in the "ON" or "TRIPPED" positions.

Circuit breaker disconnect operators shall be capable of accommodating three padlocks for locking in the "OPEN" position.

Hardware for mounting future starter and feeder tap units shall be provided at compartments specified as "FUTURE."

2.04 CONTROL SECTION

A separate vertical section shall be provided where specified. This section shall contain programmable logic controller remote I/O and other control devices as specified. The programmable controller or remote I/O equipment shall be as specified in Section 16925. The width of the control section specified is approximate. The actual width provided shall be sized by the Contractor to accommodate the equipment provided. The door shall be full height and have a keyed handle with a three-point latch. All control sections shall be keyed alike.

The control section shall be of similar construction to the other MCC vertical sections. The vertical bus is not required. Provisions shall be made for the horizontal bus to continue through the control section. The control section shall be completely barriered and contain an equipment mounting panel made of 10-gage steel which is supported off the back of the enclosure by mounting studs. The usable depth shall be minimum 17 inches. Slotted plastic wireways shall be provided as required to contain the wiring in a neat appearance.

2.05 FINISH AND COLOR

The finish and color shall be in accordance with paragraph 16000-2.01.

2.06 BUS

A. GENERAL:

Bus shall be tin-plated copper with bolted connections between vertical and horizontal bus bars. Access for tightening these connections shall be from the front, without the need for tools on the rear of the connection. Insulated horizontal and vertical bus barriers shall be provided. Barriers shall be fabricated from high-strength, glass-filled polyester resin. Unless otherwise specified, the bus shall be braced to withstand a fault current of 25,000 amperes, RMS, symmetrical.

B. HORIZONTAL BUS:

Unless otherwise specified, the main horizontal bus shall be rated a minimum 600 amperes continuous.

C. VERTICAL BUS:

Unless otherwise specified, the vertical bus shall be rated a minimum 300 amperes continuous.

D. NEUTRAL BUS:

Where specified, a neutral bus shall be provided. The neutral bus shall have the same rating as the main horizontal bus.

E. GROUND BUS:

A 1/4-inch by 2-inch ground bus shall be provided the full length of the motor control center. Ground bus shall be located at the bottom of the motor control center. Provide a lug to terminate a bare 4/0 AWG copper ground conductors at each end of the ground bus.

2.07 WIRING

A. GENERAL:

Motor control centers shall be provided with NEMA Class II, Type B wiring. All starter units shall have terminal blocks for control wiring. Terminal blocks shall be provided for power wiring for starters size 2 and smaller. Motor control centers shall be provided with all necessary interconnecting wiring and interlocking. When a control section, as described in paragraph 16920-2.04, is specified on the drawings or schedules, wire directly to the relays or programmable controller's input/output modules as part of the interconnecting wiring. Provide elementary and connection diagrams for each starter unit and an interconnection diagram for the entire motor control center.

B. POWER WIRE:

Power wire shall be copper 90 degrees C "MTW" insulated, sized to suit load; minimum power wire size shall be No. 12 AWG copper stranded.

C. CONTROL WIRE:

Control wire shall be No. 16 AWG stranded copper wire, rated 90 degrees C and UL listed for panel wiring.

D. TERMINATIONS AND CABLE CONNECTIONS:

1. TERMINALS: Control wiring shall be lugged with ring-tongue or locking spade crimp type terminals made from electrolytic copper, tin-plated.

2. CABLE CONNECTORS: Cable connectors for use with stranded copper wire, sizes No. 8 AWG to 1000 MCM, shall be UL listed. Dished conical washers shall be used for each bolted connection. Connectors shall be reusable and shall be rated for use with copper conductors. Incoming line and outgoing feeder compartments shall be provided with crimp type lugs, 3M, Burndy, or equal.

E. CONDUCTOR MARKERS:

Markers used for identification shall meet the requirements of paragraph 16000-2.02.

2.08 FEEDER BRANCH CIRCUIT PROTECTION

A. GENERAL:

Feeder tap unit shall consist of circuit breakers for feeder branch circuit protection.

B. NOT USED

C. CIRCUIT BREAKERS (THERMAL MAGNETIC) :

Thermal-magnetic circuit breakers shall be molded case equipped with toggle type handle, quick-make, quick-break over center switching mechanism that is trip-free so that breaker cannot be held closed against short circuits and abnormal currents. The tripped position shall be clearly indicated by breaker handle maintaining a position between "ON" and "OFF." All poles shall open, close, and trip simultaneously. Minimum short circuit capacity shall be 22,000 amps symmetrical.

2.09 MOTOR STARTER UNITS

A. GENERAL:

Motor starter units shall be combination type with contactor and motor circuit protector as specified on the drawings or the MCC schedule. The starter units shall have a minimum combination UL listing of 22,000 amps RMS, symmetrical or as specified in the schedule.

B. NOT USED

C. MOTOR CIRCUIT PROTECTORS:

The molded case motor circuit protector shall operate on the magnetic principle with a current sensing coil in each of the three poles to provide an instantaneous trip for short circuit protection. The trip setting shall be adjustable from 700 to 1300 percent of the motor full load amperes from the front of the breaker. The motor circuit protector shall be set at its lowest position at the factory.

D. CONTROL TRANSFORMERS:

Each control transformer shall be rated 480/240-120V, single phase, 2 wire, 60 Hz. The transformer shall be sized for the load it feeds but shall not be less than the minimum ratings as follows:

NEMA starter size	Minimum transformer volt-ampere rating
1	100
2	150
3	200
4	300

Each control transformer shall be provided with time-delay, slow-blow secondary fuse rated to interrupt 10,000 amperes short circuit at 250 volts AC. Two primary fuses rated to interrupt 200,000 amperes at 600 volts shall be provided on all starters.

Fuse holder for secondary fuse shall be drawout indicating type and mounted on the door of the compartment. Fuse holders for primary fuses shall be fuse clips with full barriers between fuses.

E. CONTACTORS:

Unless otherwise specified, contactors shall be full voltage, 3-pole, 600 volt AC, NEMA size 1 minimum. Contacts shall be double break, silver-cadmium oxide, and weld resistant. Contacts shall be isolated to prevent arcing. Coils and magnets shall be capable of being removed or replaced without special tools.

Reversing, multispeed, and reduced voltage starters shall have additional contactors, overload relays, and auxiliary relays as required, and shall have mechanically interlocked contactor coils to prevent simultaneous engagement.

F. TRANSIENT SURGE SUPPRESSOR:

A transient surge suppressor shall be provided in each starter. Suppressor shall be encapsulated in a small module suitable for mounting directly to the starter coil. Additional panel space for suppressor shall not be required. Suppressors shall be rated 120V AC.

G. AUXILIARY CONTACTS:

Contactors shall be equipped with auxiliary contacts, rated 10 amperes at 120 volts AC. Unless otherwise specified on the drawings, each contactor shall be equipped with two normally open and two normally closed electrically isolated auxiliary contacts. Auxiliary contacts shall be wired out to terminal blocks. Refer to drawings for actual quantities required.

H. OVERLOAD RELAY:

The overload relay with three heater elements shall protect the power wiring and motor from excessive overcurrents. The relay shall be ambient compensated and have adjustment from 90 to 110 percent of the normal heater rating. The sensing element shall be bimetal type and conform to ANSI/NEMA ICS 2-222.06, Class 20 tripping time. Sensing elements for submersible pump motor shall be Class 10 tripping time.

I. TERMINAL BLOCKS:

Terminal blocks shall be screw type rated 600 volts; 20 amperes for control wiring and 30 amperes power wiring (starters size 3 and larger shall terminate the power leads directly to the contactor). The number of terminal blocks shall be specified on the drawings. Terminal blocks shall be provided with integral marking strips and shall be permanently marked with the conductor number as specified on the drawings. Internal wiring shall be connected on one side of the terminal block; outgoing conductors shall be connected to the other side.

2.10 MISCELLANEOUS

A. GENERAL:

Control devices such as pushbuttons, selector switches, indicating lights and overload reset pushbuttons shall be mounted on the unit compartment door.

The control devices shall comply with the requirements of paragraph 16175-2.01.

B. ELAPSED TIME INDICATOR:

Where specified, the elapsed time indicator shall be as specified in paragraph 16175-2.06. The indicator shall be mounted on the unit compartment door.

C. NAMEPLATES:

Nameplates shall meet the requirements of paragraph 16000-2.03.

2.11 NOT USED

2.12 NOT USED

2.13 NOT USED

2.14 SPARE PARTS

One set consisting of the following spare parts shall be provided:

1--set each fuse size and type
10--indicating light bulbs

2.15 PRODUCT DATA

The following information shall be provided in accordance with paragraph 00710-4.02:

1. Manufacturer's certification and calculations that the equipment complies with the seismic requirements of paragraph 16000-1.05 D.

2. Manufacturer's certification that the following items are capable of interrupting and/or withstanding the specified short circuit condition:

   a. Bus bar bracing
   b. Feeder tap units
   c. Starter units

3. Operation and maintenance information items 2 through 9 as specified in Section 01730.

4. Dimensions and weights.

5. Installation instructions.

6. Manufacturer's product data.

PART 3--EXECUTION

3.01 GENERAL

The motor control centers shall be erected in accordance with the recommendations of the manufacturer and with the details specified herein.

Field wiring shall meet the requirements of paragraph 16120-3.02. Cables larger than No. 6 AWG which hang from their vertical connections shall be supported within 2 feet of the connection.

The overload relay heater elements shall be provided by the Contractor and sized based on the actual full load amperes of the motor connected to the starter.

The motor circuit protectors shall be adjusted by the Contractor to the lowest setting not causing false tripping.

3.02 FIELD TESTS

Motor control centers shall be tested in accordance with Section 16030.

3.03 MCC SCHEDULES

The following schedules are part of this specification.

MOTOR CONTROL CENTER ELEVATION

MCC: 1 (PAGE 1 OF 1)

	20"	20"	20"	20"	20"	20"	32"
90" NOMINAL HEIGHT	SECTION 1	SECTION 2	SECTION 3	SECTION 4	SECTION 5	SECTION 6	SECTION 7
A							
			3AB	4AB	5AB		
	1AC	2AC				6AC LEFT	6AC RIGHT
B							
C							
			3CD	4CD	5CD		
D							
	1DF	2DF				6DF LEFT	6DF RIGHT
E							
			3EF	4EF	5EF		
F							
							7AL
G							
			3GH	4GH	5GH		
		2GI				6GI LEFT	6GI RIGHT
H							
I							
	1GL		3IJ	4IJ	5IJ		
J							
		2JL				6JL	
K							
			3KL	4KL	5KL		
L							
	SPACE	SPACE	SPACE	SPACE	SPACE	SPACE	SPACE

VOLTS: 480 PHASE: 3 WIRE: 3 HERTZ: 60

HORIZONTAL BUS AMPS: 600 AMPS

VERTICAL BUS AMPS: 300 AMPS
(600A FOR INCOMMING SECTION)

ENCLOSURE NEMA TYPE: NEMA 1 GASKETED

ENCLOSURE DEPTH: 20 INCHES

SHORT CIRCUIT BRACING: 22,000 AMPS SYM.

MOTOR CONTROL CENTER SCHEDULE

MCC: 1 (PAGE 1 OF 3)

UNIT LOCATION	SERVICE DESIGNATION NAMEPLATE ENGRAVING	MOTOR HP	SPACE FACTOR (NOTE 2)	FUNCTION	STARTER NEMA SIZE	SWITCH/FUSE OR CB FRAME/TRIP AMPS (NOTE 1)	CONTROL DIAGRAM AND NOTES
1AC	SPACE	---	2	------	------	-------	
1DF	AERATION PUMP 1, P 3111	50	3	FVNR	3	100 MCP	CD/E22D1
1GL	AERATION BLOWER 1, B 3121	100	6	FVNR	5	225 MCP	CD/E23A1
2AC	SPARE	---	3	FVNR	3	100 MCP	CD/E20A
2DF	AERATION PUMP 2, P 3112	50	3	FVNR	3	100 MCP	CD/E22D2
2GI	HOLDING TANK AERATION BLOWER 1, B 7511	30	3	FVNR	3	100 MCP	CD/E27C1
2JL	MECHANICAL BAR SCREEN 1, SCR 1211	1.5	3	FVR	1	7 MCP	CD/E21A
3AB	SPARE	---	3	FVNR	1	7 MCP	CD/E20A
3CD	SLUDGE COLLECTOR 1, COL 5100	1	2	FVNR	1	3 MCP	CD/E23C1
3EF	RSS PUMP 1, P 5111	10	2	FVNR	2	15 MCP	CD/E23E1
3GH	THICKENED SLUDGE PUMP 1, P 7131	0.5	2	FVNR	1	3 MCP	CD/E25E1
3IJ	PRESSURIZATION PUMP 1, P 7111	10	2	FVNR	2	30 MCP	CD/E25C1
3KL	SCREENINGS DEWATERING CONVEYOR, CNV 1220	2	2	FVNR	1	7 MCP	CD/E21C
4AB	SPACE	---	2	------	------	-------	

NOTES:

1 BRANCH CIRCUIT PROTECTION PROVIDED BY: SWITCH/FUSE XXX CIRCUIT BREAKER (NOTE 3)
---- ----

2 MAXIMUM SPACE ALLOWED - SEE MOTOR CONTROL CENTER ELEVATION SHEET.

3 MOTOR CIRCUIT PROCETECTORS (MCP) ARE TO BE PROVIDED ON ALL CIRCUIT BREAKER COMBINATION STARTER UNITS. THERMAL MAGNETIC CIRCUIT BREAKERS ARE TO BE PROVIDED ON ALL BRANCH FEEDER UNITS.

MOTOR CONTROL CENTER SCHEDULE

MCC: 1 (PAGE 2 OF 3)

UNIT LOCATION	SERVICE DESIGNATION NAMEPLATE ENGRAVING	MOTOR HP	SPACE FACTOR (NOTE 2)	FUNCTION	STARTER NEMA SIZE	SWITCH/FUSE OR CB FRAME/TRIP AMPS (NOTE 1)	CONTROL DIAGRAM AND NOTES
4CD	SPARE	---	2	FVNR	1	3 MCP	CD/E20A
4EF	RSS PUMP 3, P 5211	10	2	FVNR	2	30 MCP	CD/E23E3
4GH	WASTE SLUDGE PUMP 1, P 7521	5	2	FVNR	1	15 MCP	CD/E27B1
4IJ	WASTE SLUDGE THICKENER, DAF 7100	0.25	2	FVNR	1	3 MCP	CD/E25A
4KL	SERVICE AIR COMPRESSOR 1, CP 9111	5	2	FVNR	1	15 MCP	CD/E26C1
5AD	SPACE	---	4	------	------	-------	
5EF	SPARE	---	2	FVNR	2	100 MCP	CD/E20A
5GH	TANK DRAIN PUMP 1, P 5511	5	2	FVNR	1	15 MCP	CD/E26A3
5IJ	DRYING BED DECANT PUMP 1, P 7611	3	2	FVNR	1	7 MCP	CD/E26A1
5KL	ML CHANNEL BLOWER 1, B 3211	20	2	FVNR	2	50 MCP	CD/E22F1
6AC LEFT	ORT CONTROL PANEL	10.8 TOTAL:	.5 OF 3	FDR	------	40/3 CB	
6AC RIGHT	ORT AIR COMPRESSOR, CP 1850	15	.5 OF 3	FDR	------	50/3 CB	
6DF LEFT	TRANSFORMER		.5 OF 3	FDR	------		
6DF RIGHT	SPARE	---	.5 OF 3	FDR	------	20/3 CB	

NOTES:

1 BRANCH CIRCUIT PROTECTION PROVIDED BY: SWITCH/FUSE XXX CIRCUIT BREAKER (NOTE 3)
---- ----

2 MAXIMUM SPACE ALLOWED - SEE MOTOR CONTROL CENTER ELEVATION SHEET.

3 MOTOR CIRCUIT PROCETECTORS (MCP) ARE TO BE PROVIDED ON ALL CIRCUIT BREAKER COMBINATION STARTER UNITS. THERMAL MAGNETIC CIRCUIT BREAKERS ARE TO BE PROVIDED ON ALL BRANCH FEEDER UNITS.

MOTOR CONTROL CENTER SCHEDULE

MCC: 1 (PAGE 3 OF 3)

UNIT LOCATION	SERVICE DESIGNATION NAMEPLATE ENGRAVING	MOTOR HP	SPACE FACTOR (NOTE 2)	FUNCTION	STARTER NEMA SIZE	SWITCH/FUSE OR CB FRAME/TRIP AMPS (NOTE 1)	CONTROL DIAGRAM AND NOTES
6GI LEFT	SPACE	---	.5 OF 3	FDR	------	-------	
6GI RIGHT	SPARE	---	.5 OF 3	FDR	------	30/3 CB	
6JL	INCOMMING LINE TERMINALS	---	3	MAIN	------	-------	MAIN TERMINALS ONLY (USE COMPRESSION LUGS)
7AL	MCC 1 AND 2 CONTROL SECTION	---	12	CONTROL	------	-------	LOCATED BETWEEN MCC 1 AND 2 (32"WIDE)

NOTES:

1 BRANCH CIRCUIT PROTECTION PROVIDED BY: SWITCH/FUSE XXX CIRCUIT BREAKER (NOTE 3)
---- ----

2 MAXIMUM SPACE ALLOWED - SEE MOTOR CONTROL CENTER ELEVATION SHEET.

3 MOTOR CIRCUIT PROCETECTORS (MCP) ARE TO BE PROVIDED ON ALL CIRCUIT BREAKER COMBINATION STARTER UNITS. THERMAL MAGNETIC CIRCUIT BREAKERS ARE TO BE PROVIDED ON ALL BRANCH FEEDER UNITS.

MOTOR CONTROL CENTER ELEVATION

MCC: 2 (PAGE 1 OF 1)

	20"	20"	20"	20"	20"	20"	20"	20"
90" NOMINAL HEIGHT	SECTION 1	SECTION 2	SECTION 3	SECTION 4	SECTION 5	SECTION 6	SECTION 7	SECTION 8
A								
		2AB	3AB	4AB				
	1AC LEFT	1AC RIGHT						
B								
					5AD	6AD		
C								
		2CD	3CD	4CD				
D								
	1DF LEFT	1DF RIGHT						
E								
		2EF	3EF	4EF	5EF	6EF		
F								
G								
					5GH	6GH		
	1GL LEFT	1GL RIGHT		4GI				
H								
I								
		2GL	3GL		5IJ	6IJ		
J								
	1JL			4JL				
K								
					5KL	6KL		
L								
	SPACE	SPACE	SPACE	SPACE	SPACE	SPACE	SPACE	SPACE

VOLTS: 480 PHASE: 3 WIRE: 3 HERTZ: 60 ENCLOSURE NEMA TYPE: NEMA 1 GASKETED
HORIZONTAL BUS AMPS: 600 AMPS ENCLOSURE DEPTH: 20 INCHES
VERTICAL BUS AMPS: 300 AMPS SHORT CIRCUIT BRACING: 22,000 AMPS SYM.
(600A FOR INCOMMING SECTION)

MOTOR CONTROL CENTER SCHEDULE

MCC: 2 (PAGE 1 OF 3)

UNIT LOCATION	SERVICE DESIGNATION NAMEPLATE ENGRAVING	MOTOR HP	SPACE FACTOR (NOTE 2)	FUNCTION	STARTER NEMA SIZE	SWITCH/FUSE OR CB FRAME/TRIP AMPS (NOTE 1)	CONTROL DIAGRAM AND NOTES
1AC LEFT	HEAT PUMP 1, HP 9405	7.1KW	.5 OF 3	FDR	------	20/3 CB	
1AC RIGHT	HEAT PUMP 2, HP 9410	7.1KW	.5 OF 3	FDR	------	20/3 CB	
1DF LEFT	WATER HEATER	6KW	.5 OF 3	FDR	------	20/3 CB	
1DF RIGHT	MONORAIL HOIST, H 6530	3.5	.5 OF 3	FDR	------	20/3 CB	
1GI LEFT	SPARE	---	.5 OF 3	FDR	------	20/3 CB	
1GI RIGHT	SPARE	---	.5 OF 3	FDR	------	20/3 CB	
1JL	INCOMMING LINE TERMINALS	---	3	MAIN	------	-------	
2AB	GRIT REMOVAL UNIT, MME 1300	2	2	FVNR	1	7 MCP	CD/E21D
2CD	GRIT PUMP, P 1310	15	2	FVNR	2	30 MCP	CD/E21E
2EF	RSS PUMP 2, P5112	10	2	FVNR	2	30 MCP	CD/E23E2
2GL	AERATION BLOWER 2, B 3122	100	6	FVNR	5	225 MCP	CD/E23A2
3AB	GRIT DEWATERER, SEP 1330	0.75	2	FVNR	1	3 MCP	CD/E22A
3CD	SPARE	---	2	FVNR	1	7 MCP	CD/E20A
3EF	RSS PUMP 4, P5212	10	2	FVNR	2	30 MCP	CD/E23E4

NOTES:

1 BRANCH CIRCUIT PROTECTION PROVIDED BY: SWITCH/FUSE XXX CIRCUIT BREAKER (NOTE 3)
---- ----

2 MAXIMUM SPACE ALLOWED - SEE MOTOR CONTROL CENTER ELEVATION SHEET.

3 MOTOR CIRCUIT PROCETECTORS (MCP) ARE TO BE PROVIDED ON ALL CIRCUIT BREAKER COMBINATION STARTER UNITS. THERMAL MAGNETIC CIRCUIT BREAKERS ARE TO BE PROVIDED ON ALL BRANCH FEEDER UNITS.

MOTOR CONTROL CENTER SCHEDULE

MCC: 2 (PAGE 2 OF 3)

UNIT LOCATION	SERVICE DESIGNATION NAMEPLATE ENGRAVING	MOTOR HP	SPACE FACTOR (NOTE 2)	FUNCTION	STARTER NEMA SIZE	SWITCH/FUSE OR CB FRAME/TRIP AMPS (NOTE 1)	CONTROL DIAGRAM AND NOTES
3GL	AERATION BLOWER 3, B 3123	100	6	FVNR	5	225 MCP	CD/E23B3
4AB	SPARE	---	2	FVNR	1	3 MCP	CD/E20A
4CD	SPARE	---	2	FVNR	2	30 MCP	CD/E20A
4EF	RS CHANNEL BLOWER, B 1500	25	2	FVNR	2	50 MCP	CD/E22C
4GI	AERATION PUMP 3, P 3113	50	3	FVNR	3	100 MCP	CD/E22D3
4JL	HOLDING TANK AERATION BLOWER 2, B 7512	30	3	FVNR	3	100 MCP	CD/E27C2
5AD	SPACE	---	4	------	------	-------	
5EF	ML CHANNEL BLOWER 2, B 3212	20	2	FVNR	2	50 MCP	CD/E22F2
5GH	TANK DRAIN PUMP 2, P 5512	5	2	FVNR	1	15 MCP	CD/E26B4
5IJ	THICKENED SLUDGE PUMP 2, P 7132	0.5	2	FVNR	1	3 MCP	CD/E25E2
5KL	PRESSURIZATION PUMP 2, P 7112	10	2	FVNR	2	30 MCP	CD/E25C2
6AD	SPACE	---	4	------	------	-------	
6EF	DRYING BED DECANT PUMP 2, P 7612	3	2	FVNR	1	7 MCP	CD/E26B2
6GH	SLUDGE COLLECTOR 2, COL 5200	1	2	FVNR	1	3 MCP	CD/E23C2

NOTES:

1 BRANCH CIRCUIT PROTECTION PROVIDED BY: SWITCH/FUSE XXX CIRCUIT BREAKER (NOTE 3)
---- ----

2 MAXIMUM SPACE ALLOWED - SEE MOTOR CONTROL CENTER ELEVATION SHEET.

3 MOTOR CIRCUIT PROCETECTORS (MCP) ARE TO BE PROVIDED ON ALL CIRCUIT BREAKER COMBINATION STARTER UNITS. THERMAL MAGNETIC CIRCUIT BREAKERS ARE TO BE PROVIDED ON ALL BRANCH FEEDER UNITS.

MOTOR CONTROL CENTER SCHEDULE

MCC: 2 (PAGE 3 OF 3)

UNIT LOCATION	SERVICE DESIGNATION NAMEPLATE ENGRAVING	MOTOR HP	SPACE FACTOR (NOTE 2)	FUNCTION	STARTER NEMA SIZE	SWITCH/FUSE OR: CB FRAME/TRIP AMPS (NOTE 1)	CONTROL DIAGRAM AND NOTES
6IJ	WASTE SLUDGE PUMP 2, P 7522	5	2	FVNR	1	15 MCP	CD/E27B2
6KL	SERVICE AIR COMPRESSOR 2, CP 9112	5	2	FVNR	1	15 MCP	CD/E26C2

NOTES:

1 BRANCH CIRCUIT PROTECTION PROVIDED BY: SWITCH/FUSE XXX CIRCUIT BREAKER (NOTE 3)
---- ----

2 *MAXIMUM SPACE ALLOWED - SEE MOTOR CONTROL CENTER ELEVATION SHEET.*

3 MOTOR CIRCUIT PROCETECTORS (MCP) ARE TO BE PROVIDED ON ALL CIRCUIT BREAKER COMBINATION STARTER UNITS. THERMAL MAGNETIC CIRCUIT BREAKERS ARE TO BE PROVIDED ON ALL BRANCH FEEDER UNITS.

MOTOR CONTROL CENTER SCHEDULE

MCC: E1 (PAGE 1 OF 2)

UNIT LOCATION	SERVICE DESIGNATION NAMEPLATE ENGRAVING	MOTOR HP	SPACE FACTOR (NOTE 2)	FUNCTION	STARTER NEMA SIZE	SWITCH/FUSE OR CB FRAME/TRIP AMPS (NOTE 1)	CONTROL DIAGRAM AND NOTES
1AL	CONTROL SECTION	---	12	------	------	-------	32" WIDE
2AB	SPARE	---	2	FVNR	1	7 MCP	CD/E20A
2CD	SUMP PUMP 1, P 3115	2	2	FVNR	1	7 MCP	CD/E27E1
2EF	STORM WATER PUMP 1, P 9511	5	2	FVNR	1	15 MCP	CD/E26B5
2GH	STORM WATER PUMP 3, P 9513	5	2	FVNR	1	15 MCP	CD/E26B7
2IJ	EFFLUENT PUMP 1, P 6211	15	2	FVNR	2	30 MCP	CD/E24A1
2KL	3W PUMP 1, P6311	20	2	FVNR	2	50 MCP	CD/E24C1
3AB	SPARE	---	2	FVNR	1	15 MCP	CD/E20A
3CD	SUMP PUMP 2, P 3116	2	2	FVNR	1	7 MCP	CD/E27E2
3EF	STORM WATER PUMP 2, P 9512	5	2	FVNR	1	15 MCP	CD/E26B6
3GH	STORM WATER PUMP 4, P 9514	5	2	FVNR	1	15 MCP	CD/E26B8
3IJ	EFFLUENT PUMP 2, P 6212	15	2	FVNR	2	30 MCP	CD/E24A2
3KL	3W PUMP 2, P6312	20	2	FVNR	2	50 MCP	CD/E24C2
4AH	SPACE	---	8	------	------	-------	

NOTES:

1 BRANCH CIRCUIT PROTECTION PROVIDED BY: SWITCH/FUSE XXX CIRCUIT BREAKER (NOTE 3)

2 MAXIMUM SPACE ALLOWED - SEE MOTOR CONTROL CENTER ELEVATION SHEET.

3 MOTOR CIRCUIT PROCETECTORS (MCP) ARE TO BE PROVIDED ON ALL CIRCUIT BREAKER COMBINATION STARTER UNITS. THERMAL MAGNETIC CIRCUIT BREAKERS ARE TO BE PROVIDED ON ALL BRANCH FEEDER UNITS.

MOTOR CONTROL CENTER SCHEDULE

MCC: E1 (PAGE 2 OF 2)

UNIT LOCATION	SERVICE DESIGNATION NAMEPLATE ENGRAVING	MOTOR HP	SPACE FACTOR (NOTE 2)	FUNCTION	STARTER NEMA SIZE	SWITCH/FUSE OR CB FRAME/TRIP AMPS (NOTE 1)	CONTROL DIAGRAM AND NOTES
4IJ	SPACE	---	2	------	------	-------	FOR FUTURE EFFLUENT PUMP 3
4KL	SPARE	---	2	FVNR	2	50 MCP	CD/E20A, FOR FUTURE 3W PUMP 3
5AC LEFT	TRANSFORMER "EA"		.5 OF 3	FDR	------		OPERATIONS BUILDING EMERGENCY PANEL
5AC RIGHT	TRANSFORMER "EB"		.5 OF 3	FDR	------		CHLORINE BUILDING EMERGENCY PANEL
5DF LEFT	SPARE		.5 OF 3	FDR	------	20/3 CB	
5DF RIGHT	SPARE		.5 OF 3	FDR	------	80/3 CB	
5GI LEFT	RAW SEWAGE PUMP 1, P 1111	40	.5 OF 3	FDR	------	80/3 CB	CD/E20E1
5GI RIGHT	RAW SEWAGE PUMP 2, P 1112	40	.5 OF 3	FDR	------	80/3 CB	CD/E20E2
5JL	INCOMMING LINE TERMINALS	---	3	MAIN	------	-------	

NOTES:

1 BRANCH CIRCUIT PROTECTION PROVIDED BY: SWITCH/FUSE XXX CIRCUIT BREAKER (NOTE 3)

2 MAXIMUM SPACE ALLOWED - SEE MOTOR CONTROL CENTER ELEVATION SHEET.

3 MOTOR CIRCUIT PROCETECTORS (MCP) ARE TO BE PROVIDED ON ALL CIRCUIT BREAKER COMBINATION STARTER UNITS. THERMAL MAGNETIC CIRCUIT BREAKERS ARE TO BE PROVIDED ON ALL BRANCH FEEDER UNITS.

MOTOR CONTROL CENTER ELEVATION

MCC: E1 (PAGE 1 OF 1)

	32"	20"	20"	20"	20"
90" NOMINAL HEIGHT	SECTION 1	SECTION 2	SECTION 3	SECTION 4	SECTION 5
A		2AB	3AB		
B					5AC LEFT / 5AC RIGHT
C		2CD	3CD		
D				4AH	
E		2EF	3EF		5EF LEFT / 5EF RIGHT
F	1AL				
G		2GH	3GH		
H					5GI LEFT / 5GI RIGHT
I		2IJ	3IJ	4IJ	
J					
K		2KL	3KL	4KL	5JL
L					
	SPACE	SPACE	SPACE	SPACE	SPACE

VOLTS: 480 PHASE: 3 WIRE: 3 HERTZ: 60 ENCLOSURE NEMA TYPE: NEMA 1 GASKETED
HORIZONTAL BUS AMPS: 600 AMPS ENCLOSURE DEPTH: 20 INCHES
VERTICAL BUS AMPS: 300 AMPS SHORT CIRCUIT BRACING: 22,000 AMPS SYM.
(600A FOR INCOMMING SECTION)

NOTE: [illegible] ARE TO BE PROVIDED [illegible] CIRCUIT BREAKER COMBINATION [illegible]
[illegible] ARE TO BE PROVIDED ON ALL [illegible]

END OF SECTION

SECTION 16925

PROGRAMMABLE LOGIC CONTROLLER (PLC)

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section provides specifications for a PLC system capable of performing the same function as relays, latching relays, current trips shift registers, timers, counters, stepping switches, sequences, or solid state logic systems.

The PLC shall use conventional ladder logic diagram format for programming.

B. ENVIRONMENTAL CONDITIONS:

The PLC shall be suitable for back plane mounting within control panel or motor control center. System shall be capable of functioning in operating ambient temperature of between 0 degrees C and 50 degrees C external to the panel enclosure, and 5 to 95 percent noncondensing relative humidity.

1.02 QUALITY CONTROL

System shall meet 1500V showering arc ammunity test per NEMA ICS 3-304.

1.03 SYSTEM CONFIGURATION

The system shall be configured and operate as follows:

The redundant processors shall be located at a central point and operate simultaneously. The system shall have bumpless transfer to the back-up processor upon failure of the primary unit. There shall be local I/O at the central location and three remote I/O locations. The remote I/O communication sahll be in a close-loop configuration with capability of continuous operation with loss of one of the communication links.

1.04 SUBMITTALS

Submittals shall be provided in accordance with Section 00710-3.04. In addition the following shall be provided:

1. List of parts by location.

2. Configuration drawing, showing all major components and their interconnection.

PART 2--PRODUCTS

2.01 ACCEPTABLE PRODUCTS

PLC system shall be Texas Instruments Model 650, Square D Model 500, or equal, modified as necessary to provide the specified features and to meet the specified operating conditions. All equipment bo be by single manufacturer or manufacturer-endorsed accessories.

2.02 HARDWARE

The PLC system shall consist of the following main components:

1. Two central processor units (CPU) memory and power supplies.

2. Input/output devices.

3. Programming accessories.

4. Communication interface.

5. Operator timer/counter interface module.

System shall oonsist of a chassis, logic cards, power supply, memory, and I/O cards. Logic cards, memory and I/O cards shall be plug-in style boards to accommodate immediate replacement of any component without disturbing field and wiring.

2.03 POWER SUPPLY

PLC (including all I/Os) shall be capable of operating from a 120V Ac, 60 Hz unregulated power source. One power source will be provided at each location. All additional power supplies for A/D convertors, I/O, etc, shall be derived from this one power source. Power supply shall be fused for short circuit and thermal overload protection.

2.04 PROCESSOR MEMORY

Memory shall be minimum size of 8K of user accessible memory PROM and RAM. Memory shall be permanent regardless of power disturbances and shall have a minimum retnetion time of six months. 'Core' type memory shall not be accepted.

Memory shall be programmable locally or remotely from the PLC installation.

System shall have the capacity to accommodate a minimum of 400 internal ooils and an unlimited amount of contacts per relay.

The CPU shall have floating point or matrix arithmetic (+, -, multiply, divide), boolean comparison (<, >, =, <>,), and some BASIC (LET, IF) capability.

Diagnostic indicators shall be provided in the CPU to pinpoint the source of fault.

2.05 INPUT/OUPUT SYSTEM (I/O)

The system shall consist of individual plug-in input and output modules or cards.

I/O system shall be capable of a minimum total of 1,032 discrete inputs and outputs, 344 analog inputs and outputs.

System shall be capable of supporting a minimum of 16 remote I/O stations.

A/D and D/A conversion shall be available to convert analog control signals to three-digit BCD numbers and vice-versa. Resolution shall be 1 part in 1,000 or smaller. Accuracy shall be 0.3 percent.

The system shall have available a remote input/output arrangement capable of operation up to a minimum of 5,000 feet from the CPU.

The remote I/O arrangement shall employ the same hardware components as the local I/O arrangement, except possibly those components which provide communication to the remote I/O.

Communication with the remote I/O arrangement shall be through a twisted pair shielded cable or coaxial cable.

Communication speed shall be selectable, with at least one update every 100 milliseconds.

Any number of remote discrete and analog I/O points (up to the system capacity) shall be available.

Diagnostic lights shall be provided for the I/O system. Lights shall be available to indicate power, continuity and parity status for the I/O system.

See appropriate drawing for configuration, I/O quantities, and types.

2.06 PROGRAMMING ACCESSORIES

CRT programming unit with all programming accessories shall be provided. Programmer shall be capable of "on-line" ore remote "off-line" operation, proram generation and modification, and program storage on tape of "floppy disk" for back-up. This unit shall be provided to the installation contractor for programming testing and start-up. Programmer shall execute programming in ladder diagram logic. All or part of the program shall be able to be printed from the programmer to a printer in ladder diagram logic form. The installation contractor will turn equipment over to the owner on completion of the contractor. Programmer shall be Square D class 8010 type SPR 'Delux' model programmer, Texas Instruments Model 200 VPU or equal.

A dot matrix printer and communication cable shall be provided, with users manual, to print diagrams and reports generated by the CRT programner. Printer shall be capable of 160 characters per second, bidirectional printing, 80 character per second emphasized/ enhanced printing, and full 96 character ASCII printing. Printer shall be Okidata 'Microline 92' or equal.

Timers, counters and registers within system shall be externally accessible; that is, they shall be capable of being set and monitored from a Timer, Counter Access Module (TCAM). TCAM shall be mounted on the panel face. TCAM shall access timer, counter, and storage registers by a keypad or thumbwheel switch. A LED 8-character display shall be included to read register content. Lock-out provisions shall be provided to deter tampering with time sets. The TCAM shall also transfer to the backup CPU upon primary unit failure.

System shall have all troubleshooting and diagnostics self-contained without requiring programming aids.

2.07 QUANTITIES

CPUs shall be supplied to accommodate redundant processing with bumpless transfer upon primary unit failure. PLCs shall be independent of each other and be capable of future communication via communication link.

2.08 SPARE PARTS

Contractor shall provide as spare parts to the Owner:

1. One of each type I/O cards used.
2. Two program back-up batteries.
3. Five of each type fuse used.
4. One program storage medium (i.e. tape, floppy disk).
5. One printer ribbon.

These are to be turned over directly to the Owner.

2.09 TROUBLESHOOTING

System shall have error indication for parity check. Upon proven parity error, all outputs shall be capable of "last condition" lock in or "all off" switch selectable in the field. I/Os shall have indicator lamps to determine status.

Operator shall have the capability to force any output or coil on or off only by key locking access.

Each chassis shall have a circuit board or fill board in each slot. Outputs shall be automatically disabled should a board be removed.

PART 3--EXECUTION

3.01 INSTALLATION SERVICES

The equipment will be installed by others under a separate contract. Installation shall be under the direction of factory trained personnel. The installation shall be certified by the manufacturer on Form 11000-A specified in Section 01999.

3.02 FIELD INSPECTION AND TESTING

On-site inspection, testing, and certification of the completed installations shall be provided by a qualified field service engineer. A minimum of 3 days of on-site field service shall be provided.

3.03 TRAINING

Training shall be provided for the Owner's personnel at the Owner's facility on operation, troubleshooting of both hardware and software, programming, and basic program generation. Supplier shall familiarize himself with the program written by the installation contractor and use it for examples during training. Contractor shall provide a minimum of 3 days' training. Training shall be certified on Form 11000-B specified in Section 01999.

END OF SECTION

DIVISION 17

INSTRUMENTATION

Title	Title
17000	GENERAL REQUIREMENTS FOR INSTRUMENTATION AND INDUSTRIAL ELECTRONIC SYSTEMS
17110	PANELS
17120	ANNUNCIATOR SYSTEMS
17125	MICROPROCESSOR-BASED INSTRUMENTS
17130	POWER SUPPLY AND CONDITIONING EQUIPMENT
17140	INSTRUMENT AIR SUPPLY AND TRANSMISSION SYSTEMS
17200	GENERAL REQUIREMENTS FOR PROCESS INSTRUMENTATION SYSTEMS
17211	PROCESS TAPS AND PRIMARY ELEMENTS
17212	TRANSMITTERS
17216	PROCESS SWITCHES
17271	SIGNAL CONDITIONING MODULES
17274	MINIATURE CASE ELECTRONIC PANEL INSTRUMENTS
17275	MISCELLANEOUS PANEL INSTRUMENTS

SECTION 17000

GENERAL REQUIREMENTS FOR INSTRUMENTATION AND INDUSTRIAL ELECTRONIC SYSTEMS

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies general requirements which are applicable to all process control, instrumentation, communication, and signal systems.

Raceways and requirements for signal cables are specified in Division 16.

B. DESCRIPTION OF SYSTEM:

Major constituents of this system include, but are not limited to, all materials, equipment, and labor required to implement a complete operating system of instrumentation and controls. The system is to include a programmable logic controller arranged in a redundant, hot-backup configuration. There will be one main control room that will contain one instrumentation panel housing the programmable controller, an annunciator, various instruments, and other devices. There shall also be a personal computer-based operator interface system in the control room that will monitor data being processed by the programmable controller. For status, alarm, and information gathering purposes, the system shall also include primary elements for measurement of process variables. There shall be one central motor control room with three motor control centers, and a main switchgear structure in it. Remote input/output units for the programmable controller shall be located in the motor control centers.

There shall also be an instrumentation panel located at the interceptor pumping station that will house some of the instrumentation required at that site. Again, various process measurements will be required at this location.

C. DEFINITIONS:

1. GENERAL: The definitions of terminology used in these specifications shall be defined in ISA Standard S51.1 unless otherwise specified.

2. SOLID STATE: Circuitry or components of the type which convey electrons by means of solid material such as crystals or which work on magnetic principles such as ferrite cores. Vacuum tubes, gas tubes, slide wires, stepping motors, or other devices are not acceptable substitutes for solid state components or circuitry.

3. INTEGRATED CIRCUIT: A number of circuit elements inseparably associated on or within a continuous body to perform the function of a circuit.

4. TWO-WIRE TRANSMITTER: A transducer which derives operating power supply from the signal transmission circuit and therefore requires no separate power supply connections. As used in this specification, two-wire transmitter refers to a transmitter which produces a 4 to 20 milliampere current regulated signal in a series circuit with a 24-volt direct current driving potential and a maximum circuit resistance of 600 ohms.

5. GALTVANIC ISOLATION: Pertaining to an electrical node having no direct current path to another electrical node. As used in this specification, galvanic isolation refers to a device with electrical inputs and/or outputs which are galvanically isolated from ground, the device case, the process fluid, and any separate power supply terminals, but such inputs and/or outputs are capable of being externally grounded without affecting the characteristics of the devices or providing path for circulation of ground currents.

6. PANEL: An instrument support system which may be either a flat surface, a partial enclosure, or a complete enclosure for instruments and other devices used in process control systems. Panels may provide mechanical protection, electrical isolation, and protection from dust, dirt, and chemical contaminants which may be present in the atmosphere. Panel shall include consoles, cabinets and racks.

7. DATA SHEETS: Data sheets as used in this specification shall refer to ISA S20.

8. SIGNAL TYPES: The following types of signals are used in systems specified in this division.

a. LOW LEVEL ANALOG: A signal that has a full output level of 100 millivolts or less. This group includes thermocouples and resistance temperature detectors.

b. DIGITAL CODE: Coded information such as that derived from the output of an analog to digital converter or the coded output from a digital computer or other digital transmission terminal. This type includes those cases where direct line driving is utilized and not those cases where the signal is modulated.

c. PULSE FREQUENCY: Counting pulses such as those emitted from speed transmitters.

d. HIGH LEVEL ANALOG: Signals with full output level greater than 100 millivolts but less than 30 volts, including 4-20 mA transmission.

e. MODULATED SIGNALS: Signals emanating from modems or low level audio signals. Normal signal level is plus 4 dBm to minus 22 dBm. Frequency range is 300 to 10,OOU hertz.

f. DISCRETE EVENTS: Dry contact closures monitored by solid state equipment. If the conductors connecting to dry contacts enter enclosures containing power or control circuits and cannot be isolated from such circuits in accordance with NEC Article 725, this signal shall be treated as low voltage control.

g. LOW VOLTAGE CONTROL: Contact closures monitored by relays, or control circuits operating at less than 30 volts and 250 milliamperes.

h. HIGH LEVEL AUDIO SIGNALS: Audio signals exceeding plus 4 dBm, including loudspeaker circuits.

i. RADIO FREQUENCY SIGNALS: Continuous wave alternating current signals with fundamental frequency greater than 10 kilohertz.

9. SYSTEMS HOUSE: An organization engaged in the business of detail engineering, component purchase, assembly, programming and implementing process control and industrial electronic systems.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This division contains references to the following documents. They are a part of the section where referenced as specified and modified. In case of conflict between the requirements of this division and those of the listed documents, the requirements of this division shall prevail.

Reference	Title
ANSI B16.5-81	Pipe Flanges and Flanged Fittings
ANSI C57.13-78	Requirements for Instrument Transformers
ANSI MC96.1-82	Temperature Measurement Thermocouples

Reference	Title
API RP550-85	Manual on Installation of Refinery Instruments and Control Systems, Part I - Process Instrumentation and Control Sections 1 Through 13
ASME 1971	"Fluid Meters." Report of ASME Research Committee on Fluid Meters
ASTM A105-83	Forgings, Carbon Steel for Piping Components
ASTM A240-83	Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels
ASTM A269-83	Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A276-83	Stainless and Heat Resisting Steel Bars and Shapes
ASTM A312-83	Seamless and Welded Austenitic Stainless Steel Pipe
ASTM A515/A515M82	Pressure Vessel Plates, Carbon Steel for Intermediate and Higher-Temperature Service
ASTM B68-83	Seamless Copper Tube, Bright Annealed
ASTM D883-83	Plastics, Definition of Terms Relating to
AWWA C203-78	Coal Tar Protective Coatings and Linings for Steel Water Pipelines--Enamel and Tape--Hot-Applied
ISA RP7.1-56	Pneumatic Control Circuit Pressure Test
ISA S5.4-76	Instrument Loop Diagrams
ISA S7.3-75	Quality Standard for Instrument Air
ISA S7.4-81	Air Pressures for Pneumatic Controllers, Transmitters, and Transmission Systems

Reference	Title
ISA S20-75	Specification Forms for Process Measurement and Control Instrumentation, Primary Elements, and Control Valves
ISA S51.1-79	Process Instrumentation Terminology
MILSPEC MIL-I-46058C-80	Electrical Insulating Compound
NEMA 250-85	Enclosures for Industrial Controls and System
NFPA 70-87	National Electric Code (NEC)
SAMA PMC5-10-63	Resistance Thermometers
SAMA PMC6-10-63	Filled System Thermometers
SAMA PMC8-10-63	Thermocouple Thermometers
SAMA PMC17-10-63	Bushings and Wells for Temperature Sensing Elements
SAMA PMC21-4-66	Temperature-Resistance Values for Resistance Thermometer Elements of Platinum, Nickel, and Copper
UBC-1985	Uniform Building Code

B. SYSTEMS RESPONSIBILITY:

All instrumentation and industrial electronic systems shall be provided under the supervision of a single systems house, chosen by the Contractor, which is regularly engaged in the design and installation of such systems of similar scope and complexity. Contractor is responsible to the Owner for performance of all systems as provided in paragraph 00710-2.04.

1.03 ENVIRONMENTAL CONDITIONS

A. GENERAL:

Specified communication and process control equipment shall be modified, if necessary, to make it suitable for operation in the following ambient conditions. Indoor and outdoor field location temperatures and relative humidities are specified in Section 01800.

B. ALL AREAS:

Atmospheric contaminants:
Hydrogen sulfide: 0.1 mg/l
Ammonia: 0.5 mg/l
Chlorine: 0.01 mg/l
Dust: 50 ug/m^3

Electromagnetic radiation:
27-500 MHz: 10 volts/m

C. CONTROL ROOMS:

Temperature: 18 to 28 degrees C
Humidity: 20 to 80 percent

F. HiZARDOUS LOCATIONS:

Hazardous locations shall be as specified in paragraph 16000-1.05.

G. CORROSIVE LOCATIONS:

Corrosive locations shall be as specified in paragraph 16000-1.05.

1.04 FUNCTIONAL REQUIREMENTS

A. GENERAL:

The instrumentation and signal system functions reguired are specified on the drawings and in subsequent sections of this division.

B. DRAWINGS:

1. GENERAL: The drawings included in this project manual are functional in nature and do not show exact locations of equipment or interconnections between equipment. The Contractor, as part of his work, shall prepare detailed construction drawings as specified below.

Drawings shall be prepared on 22-inch by 34-inch drafting media. Media shall be vellum or mylar. Drawings shall have borders and title blocks identifying the project, system, revisions to the drawing, and type of drawing. Each revision of a drawing shall carry a date and brief descrietion of the revisions. Diagrams shall carry a uniform and coordinated set of wire numbers and terminal block numbers in compliance with panelwork wiring, Section 17110, to permit cross-referencing between contract documents and the drawings prepared by the Contractor.

2. ELEMENTARY AND LOOP DIAGRAMS: The Contractor shall provide elementary diagrams for all discrete loops. Loop diagrams shall be prepared in compliance with ISA S5.4 and shall be provided for all analog loops. Elementary diagrams and loop diagrams shall show circuits and devices of a system. These diagrams shall be arranged to emphasize device elements and their functions as an aid to understanding the operation of a system and maintaining or troubleshooting that system. Elementary and loop diagrams shall also show wire numbers, wire color codes, signal polarities, and terminal block numbers.

3. CONNECTION DIAGRAMS: Connection diagrams for panels shall be provided by the Contractor. Connection diagrams shall show components of a control panel in an arrangement similar to the actual layout of the panel. Internal wiring between devices within the panel shall be shown on these diagrams. Connection diagrams shall show all terminal blocks whether used for internal or field wiring. Those used for field wiring shall be clearly identified as such. Wiring diagrams shall indicate insulation color code, signal polarities, and shall show wire numbers and terminal block numbers.

4. INTERCONNECTION DIAGRAMS: Interconnection diagrams shall be provided by the Contractor for field wiring. Interconnection diagrams shall show each panel and field devices. Wire numbers, cable numbers, raceway numbers, terminal box numbers, terminal block numbers, panel numbers, and field device tag numbers shall be shown.

1.05 SUBMITTALS

Elementary and loop diagrams specified in paragraph 17000-1.04 B.2 shall be provided in accordance with Section 01300.

PART 2--PRODUCTS

2.01 MATERIALS AND QUALITY

Material shall be new, free from defects, and of the quality specified. Each type of instrument, instrument accessory, and device shall be by the same manufacturer throughout the work.

Electronic equipment shall be of solid state construction unless otherwise specified. Printed or etched circuit boards shall be glass epoxy of sufficient thickness to prevent warping. Solder shall be tin-lead plate, 55 to 75 percent tin, electrodeposited followed by tin emersion and reflow (fusing). Printed wiring shall have solder finish with no exposed copper on surface, edges, or in holes of finished product. Printed circuit boards in field mounted equipment shall be coated with 2 mils of a solderable conformal coating complying with MILSPEC MIL-I-46058C. Alignment and adjustments shall be noncritical, stable with temperature changes or

aging and accomplished with premium grade potentiometers. Components of standard electronic assemblies shall not be replaced with components of different characteristics in order to meet the performance requirements of this specification. Parts shall be as shown in the instruction manuals and shall be replaceable with standard commercial components of the same description without degrading the performance of the completed assembly.

2.02 PRODUCT DATA

A. GENERAL:

The following data shall be provided in accordance with paragraph 00710-4.02.

B. CATALOG CUTS:

The Contractor shall provide catalog cuts for equipment to be provided. Catalog information shall include technical specifications and application information for each piece of equipment. Catalog cuts shall be edited to indicate only those items, model or series of equipment which are being provided. All extraneous materials shall be crossed out or otherwise obliterated.

C. COMPONENT FABRICATION DRAWINGS:

Detailed circuit schematics, printed circuit board drawings, and chassis layouts shall be provided for electrical and electronic components.

D. CERTIFICATION:

1. TEMPERATURE: Type test data certified by the manufacturer shall be provided to demonstrate that field electronic devices are suitable for the specified ambient temperatures.

2. CORROSION: Data shall be provided showing design features of the electronic equipment provided to protect against damage by the specified atmospheric contaminants and specific evidence that similarly protected electronic equipment has operated in similar environments for a period of not less than 5 years without failure due to corrosion.

E. RECORD DRAWINGS AND SCHEDULES:

Drawings specified under paragraph 17000-1.04 B and all schedules included in Division 17 shall be provided as record drawings in accordance with Section 01720. Following start-up but prior to acceptance of the work, the Contractor shall provide full-size mylar reproducible prints of elementary, loop, connection and interconnection diagrams and full-size sepia reproducible prints of other drawings. Prints shall reflect the final constructed state of the instrumentation and control systems.

F. OPERATION AND MAINTENANCE INFORMATION:

Operation and maintenance information shall be provided in accordance with Section 01730, items 1 through 10.

PART 3--EXECUTION

3.01 INSTALLATION

A. GENERAL:

Installation and testing procedures shall be as specified in this and subsequent sections of this division.

Equipment shall be located so that it is readily accessible for operation and maintenance.

B. FIELD EQUIPMENT:

Equipment shall be provided as specified on the drawings such that ports and adjustments are accessible for in-place testing and calibration. Where possible, equipment shall be located between 48 inches and 60 inches above the floor or a permanent work platform. Instrumentation equipment shall be mounted for unobstructed access, but mounting shall not obstruct walkways. Equipment shall not be mounted where shock or vibration will impair its operation. Support systems shall not be attached to handrails, process piping or mechanical equipment except for measuring elements and valve positioners. Instruments and cabinets supported directly by concrete or concrete block walls shall be spaced out not less than 5/8 inch by framing channel between instrument and wall.

Steel used for support of equipment shall be hot-dip galvanized after fabrication. Support systems including panels shall be designed in accordance with UBC for seismic zone 2 and to prevent deformation greater than 1/8 inch under the attached equipment load and an external load of 200 pounds in any direction.

C. ELECTRICAL POWER CONNECTIONS:

Electric power wiring and equipment shall be in compliance with Division 16. Power disconnect switches shall be provided within sight of equipment and shall be labeled to indicate opened and closed positions and specific equipment served. "Within sight of" iS defined as having a clear unobstructed view from the equipment served and within 50 feet of the equipment served. Disconnect switches shall be mounted between 36 inches and 72 inches above the floor or permanent work platform. Where equipment location is such that the above requirements cannot be met by a single disconnect switch, two switches, one at the equipment and one at the work platform, shall be provided.

Each disconnect switch serving equipment located outdoors shall be provided with a surge arrestor, General Electric 9L15CCB001, or equal. The surge arrestor shall be bonded to the plant ground grid with a No. 8 AWG bare copper conductor.

D. SIGNAL CONNECTIONS:

Electric signal connections to equipment shall be made on terminal blocks or by locking plug and receptacle assemblies. Jacketed flexible conduit shall be used between equipment and rigid raceway systems except that flexible cable assemblies may be used where plug and receptacle assemblies are provided and the installation is not subject to mechanical damage in normal use. The length of flexible conduit or cord assemblies shall not exceed 2 feet. Flexible cable, receptacle and plug assemblies shall be used only where specified.

3.02 TESTS AND INSPECTIONS

A. GENERAL REQUIREMENTS:

Materials, equipment, and construction included under this specification shall be inspected in accordance with Section 00710 and subsequent sections of this division. Testing shall be performed by the Contractor in accordance with this and subsequent sections of this division.

No required test shall be applied without prior notice to the Construction Manager. Between 60 and 70 days before the commencement of any testing activity, the Contractor shall provide a detailed step-by-step test procedure, complete with forms for the recording of test results, testing equipment used, and identification of the individual performing or, if applicable, witnessing the test.

B. DELIVERY INSPECTION:

The Contractor shall notify the Construction Manager upon arrival of any material or equipment to be incorporated into the work and shall remove protective covers or otherwise provide access in order that the Construction Manager may inspect such items.

C. PIPING TESTING:

1. PNEUMATIC PIPING SYSTEMS: Pneumatic piping systems shall be tested for leaks in compliance with paragraph 17140-3.02 A.

2. LIQUID PIPING SYSTEMS: Liquid piping systems shall be tested for leaks in compliance with Section 15050.

END OF SECTION

SECTION 17110

PANELS

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies requirements for panels, cabinets, consoles, and racks for instrumentation and communication equipment. Additional requirements are specified in sections specifying the various instrumentation and communication systems.

B. TYPES:

The following types of panels are specified:

Type	Fabrication
1	Open panel with instruments, interconnections, and accessories sufface mounted.
2	NOT USED
3	NOT USED
4	Enclosed unit with front access only and face mounted instruments door mounted.

C. PANEL DESIGN:

1. GENERAL: The instrument schedule in paragraph 17000-3.02 specifies major panels and equipment on those panels. Additional panels are specified on the drawings. Panel size and equipment layout requirements are also specified on the drawings.

2. PANELBOARDS: Each panel containing 120-volt powered equipment with an aggregate load greater than 1,200 watts shall be provided with a panelboard as specified in Section 16470.

3. ANNUNCIATORS: Each panel containing alarm points shall be provided with one or more annunciators as specified in Section 17120.

4. POWER SUPPLIES: Each panel containing direct current powered instruments or serving as the termination point for transmission loop powered field instruments shall contain direct current power supply system as specified in Section 17130.

5. AIR SUPPLIES: Each panel containing pneumatically operated instruments shall contain a dual service regulator and distribution manifold as specified in Section 17140.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
EIA RS-310C-77	Racks, Panels, and Associated Equipment
Fed. Std-595A-68	Federal Standard Colors
NEMA 250-85	Enclosures for Electrical Equipment
NFPA 70-87	National Electric Code (NEC)
UL 94-80	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

1.03 SUBMITTALS

The following information shall be submitted in accordance with section 01300:

1. Dimensioned front view drawings

2. Panel assembly drawings including sections showing clearances between face and rear mounted equipment and identifying the devices.

3. Nameplate engraving schedule showing engraving by line, character size, and nameplate size.

PART 2--PRODUCTS

2.01 FABRICATION

A. GENERAL:

Panelwork shall be designed for the seismic requirements of paragraph 17000-3.01B. Structures and equipment shall be braced to prevent damage from specified forces. Equipment shall not be required to function properly during periods of seismic disturbance but shall be capable of manual restart following a disturbance.

Cutouts for future equipment shall be blanked off with suitable covers. Instrument tag numbers shall be identified on the panel rear. Nameplates shall identify face-mounted instruments. Instruments shall be mounted in a manner that allows ease of access to components and ease of removal.

Face-mounted instruments that are more than 6 inches deep, weigh more than 10 pounds, or exert more than a 4 ft-lb moment force on the face of the panel shall be supported underneath at the rear by a 1-inch x 1/8-inch thick steel angle.

Face-mounted equipment shall be flush or semiflush with flat-black escutcheons.

Cabinets less than 60 inches high shall be provided with floor stands to raise the top of the panel to 60 inches above the floor or work platform or, if panel weighs less than 100 pounds and wall space is available, wall mounting may be used in lieu of a floor stand.

B. TYPE 1 FABRICATION:

Panels shall be aluminum plate, 6063 alloy, 3/8-inch thickness. Plates over 2 feet in any dimension shall be braced with 1-1/2-inch aluminum angles for rigidity. Mounting hardware shall be type 316 stainless steel. Wiring shall be carried in rigid aluminum conduit with cast aluminum fittings. Equipment shall be surface mounted on the panel's front face.

C. TYPE 2 FABRICATION: NOT USED

D. TYPE 3 FABRICATION: NOT USED

E. TYPE 4 FABRICATION:

2.02 NOT USED

2.03 COATING

Panels, except Type 1, shall be coated as specified in paragraph 09900-3.03 H.

2.04 NAMEPLATES

Machine engraved laminated black phenolic nameplates with white lettering shall be provided for panel mounted equipment. Nameplate engraving shall be as specified and shall carry the instrument tag number in 3/32-inch minimum size lettering on the bottom line Nameplates shall be attached to the panel with a minimum of two self-tapping 316 stainless steel screws. The Contractor agrees that nameplate wording may be changed without additional cost or time if changes are made prior to commencement of engraving.

Machine embossed metallic adhesive labels shall identify tag number of instruments inside panels.

Nameplates shall be attached to panel surfaces, not to instruments.

2.05 INTERCONNECTION WIRING AND ELECTRICAL DEVICES

A. INTERCONNECTION WIRING:

Power and control wiring shall be single conductor stranded copper NFPA No. 70 Type MTW No. 16 AWG minimum. Wiring for signal types c, d, e, f, g, and h, as specified in paragraph 17000-1.01 C.8, shall be No. 16 AWG stranded copper NFPA No. 70 Type MTW. Wiring for signal types a and b, as defined in paragraph 17000-1.01 C.8, shall be provided with instruments and run continuously from measuring element to receiving instrument without splices.

Wiring shall be supported independently of terminations by lacing to panel support structure or by slotted flame retardant plastic wiring channels. Wiring channels shall comply with UL 94, Type V. Wiring channel fill shall not exceed 40 percent.

Wiring shall be tagged at terminations with machine printed plastic sleeves. Wire numbers shall consist of three parts. The prefix of the wire number shall be the instrument loop number. If an instrument loop number is not available, the lowest mechanical equipment number of all final drives in the circuit shall be used. Following the prefix shall be a code letter. Code letters and wire colors are given in the following tables:

Code	Description 120V AC wire	Color
L	Power	Red
C	Control	Violet
N	Neutral	White
PG	Ground	Green
SP	Power supply	Black
S	Signal (pos)	Black
SG	Signal ground	White
PG	Equipment ground	Green

The third part of the wire number shall be a number that identifies wires in a circuit that are electrically identical.

Wiring shall comply with the requirements of NFPA No. 7a as a minimum. Power and control wiring shall be carried in covered channels separate from low voltage signal circuits. An interior steel barrier shall be provided between AC control devices and the electronic equipment.

Terminal blocks shall be strap screw type rated for 600 volts. Each terminal strip shall have a unique identifying alphanumeric code at one end and a vinyl marking strip running the entire length of the terminal strip with a unique number for each terminal. Numbers shall be machine printed and 1/8 inch high. Wire connectors shall be locking fork tongue or ring tongue insulated crimp type terminals. No more than two connections shall be made to one terminal. Terminal blocks shall be Buchanan 0621-1, Allen-Bradley 1492-F3175, or equal.

Field connections shall be to separate terminal blocks. Terminal blocks for field terminations shall be in a separate part of the panel close to where the field cables enter the panel.

Circuits shall be fused. Fuses shall be 1/4 x 1-1/4 inch. Fuses on 120V AC circuits shall be ceramic tube type with 25,000 amperes interrupting capacity at 125 volts and neon blown fuse indicator lamps. Fuses for 24V DC circuits shall be fast acting glass tube type rated 1/8 or 1/10 amp for 4-20 mA loops and 1/2 amp for the power supply to individual instruments. Fuse holders for 120V AC shall be drawout type and molded from melamine plastic.

2.06 SURGE PROTECTION

Surge protectors shall be provided at panel external terminal blocks for types c,d,e,f, and g signal circuits as defined in paragraph 17000-1.01 C.8 which extend outdoors. Surge protectors shall be Joslyn Model 1663-08, Taylor 1020FA, or equal.

2.07 PRODUCT DATA

The following data shall be provided in accordance with paragraph 00710-4.02:

1. Panel wiring diagram

PART 3--EXECUTION

3.01 GENERAL

Control room cabinets shall be mounted on channel iron sills as specified. Sills shall be leveled so panel structures will not be distorted. Panels shall be shimmed to precise alignment so doors operate without binding. Sealant shall be provided under panels not located in dry control or electrical equipment rooms.

Field panels and cabinets shall be mounted in compliance with paragraph 17000-3.01 B.

Floor-mounted cabinets except in dry control rooms or electrical equipment rooms shall be mounted on 3-1/2-inch minimum height concrete pads or grouted bases as specified.

3.01

Each panel shall have its record connection and interconnection diagrams mounted behind a piece of plexiglass on the inside of one (or more) door(s).

3.02 COATING

Metal surfaces of panels, cabinets, and consoles shall be prepared, prime and finish coated in accordance with Section 09900.

END OF SECTION

SECTION 17120

ANNUNCIATOR SYSTEMS

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies requirements for annunciator systems required to support alarm points. Application requirements are specified in the instrument schedule, paragraph 17200-3.03.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ISA S18.1-79	Annunciator Sequences and Specifications
IEEE 472-74	Guide to Surge Withstand Capability (SWC) Tests

PART 2--PRODUCTS

2.01 ANNUNCIATOR SYSTEMS

Annunciators shall be back-lighted window type with window engraving as specified. Unless otherwise specified, windows shall accommodate four lines of 16 characters not less than 7/32 inches in height. Unless otherwise specified, windows shall be engraved white translucent plastic with black filled characters. Annunciator logic shall operate from the panel grounded 24-volt DC power supply system. Not less than 20 percent spare points complete with logic cards and blank windows shall be provided.

Sequence logic shall be solid-state logic type with one alarm point per logic card. Signal inputs shall be optically isolated, shall meet IEEE 472, and shall be field switchable for normally open or normally closed field contacts. Unless otherwise specified, the alarm sequence shall be ISA S18.1 designation A. Field contact follower relays with form C contacts shall be provided for all alarm points.

2.01

An internal electronic audible signal with output level adjustable from 68 to 90 dB (reference 0.0002 dynes/cm_2) shall be provided.

Annunciators shall be Panalarm Series 90, Rochester Instrument Systems Series 3100, or equal.

PART 3--EXECUTION

Annunciator systems shall be mounted and connected in panels specified in Section 17110. Annunciator points shall typically be driven by outputs from the programmable controller system. Windows shall be engraved as specified and filled with permanent black ink. Annunciators shall be tested as specified in Section 17200.

END OF SECTION

SECTION 17125

MICROPROCESSOR-BASED INSTRUMENTS

PART 1--GENERAL

1.01 SCOPE

This section specifies general requirements for microprocessor based control stations and indicators, which form a part of process control systems.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section references the following document. It is a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed document, the requirements of this section shall prevail.

Reference	Title
ISA S51.1-79	Process Instrumentation Terminology

1.03 SUBMITTALS

The following material shall be submitted to the Construction Manager in accordance with the provisions of Section 01300. All of the material stipulated herein shall be submitted in one complete submittal and shall consist of the following data, drawings, and descriptive material:

1. Catalog cuts for all instruments and accessories to be supplied. Catalog information shall include technical specifications and application information for each piece of equipment. Catalog cuts shall be clearly edited to indicate only those items, model or series of equipment which are being submitted. All extraneous materials shall be crossed out or otherwise obliterated.

PART 2--PRODUCTS

2.01 GENERAL

All microprocessor based instruments shall be of same manufacturer. Control stations and indicators shall be in a drawout panel-mount case. Case shall be capable of accommodating

all microprocessor based instruments without field modifications. Operator readouts and adjustments shall be face mounted. Microprocessor based instruments shall remain connected to the process in the drawout position. Control stations, indicator stations, and recorders shall be Yokogawa Hokushin Electric (YEW), Toshiba, or equal.

2.02 CONTROL STATION

A. GENERAL:

Configuration and timing adjustments shall be on a side panel, accessible when the control station is in the drawout position. The controller shall be preprogrammed to emulate control functions normally provided by conventional analog and cascade control modules in a single unit. Configuration to a specific set of functional requirements shall consist of assigning inputs, outputs, preprogrammed functions, and scale factors for process units. Operator displays shall be in process units.

Control station power supply shall be 24 volts DC unless otherwise specified. Control station dimensions shall be nominally 6 inches high by 3 inches wide by not more than 19 inches deep. Configuration, operating system, and preprogrammed functions shall be stored in nonvolatile read-only memory (UVPROM). Controller shall be YEW, SERIES 80 SLPC-210, Toshiba type 211D or equal.

B. INPUT/OUTPUT:

Input/output capacity shall be at a minimum as follows:

Type	Quantity
Analog inputs	4
Analog outputs	3
Discrete inputs	3
Discrete outputs	3

Analog inputs shall be 1 to 5 volts dc into not less than 250K ohms. Analog outputs shall be 4 to 20 milliamperes into 0 to 600 ohms and 1 to 5 volts dc into 5000 ohms or more. Discrete inputs shall be dry contacts excited by 24 volts dc from the controller, and discrete outputs shall be open collector rated 50 milliamperes at 30 volts dc. Solid state relays may be used on the discrete outputs to meet this requirement. Relays shall be Struthers Dunn type 221 or equal with General Electric MOV type V130LAIO or equal transient suppression.

C. PREPROGRAMMED FUNCTIONS:

The control station shall be, as a minimum, provided with the following preprogrammed functions:

1. Control Funtions (per ISA S51.1):

    a. Proportional
    b. Integral
    C. Derivative
    d. Floating
    e. Ratio
    f. Cascade

2. Mathematical Functions:

    a. Add
    b. Subtract
    C. Multiply
    d. Divide
    e. Square root

3. Limit Functions:

    a. Low limit
    b. High limit

4. Dynamic Functions:

    a. Lead/Lag
    b. Velocity limit
    c. Signal linerization
    d. Timer/Counter

5. Alarm Functions:

    a. Absolute
    b. Deviation
    c. Rate of change

6. Logical Functions:

    a. And
    b. Or
    c. Not
    d. Compare
    e. Branching
    f. Signal switching

Controller shall perform all functions including A/D conversion with 10 bit resolution or better; D/A conversion shall be 8 bit or better. Entire program shall be executed at least once every 0.2 seconds.

Cascade control shall have separate adjustments for proportional, integral, and derivitive for each loop in the controller. Controller shall be capable of discrete output initiation with time delay and wide span adjustments.

D. OPERATOR INTERFACE:

The operator interface shall include 100 segment minimum solid state bar graph indicators for process variable and set point, output indicator, manual/automatic selector, remote/local set point selector, set point raise/lower selector, and manual output raise/-lower selector.

2.03 INDICATOR STATION

A. GENERAL:

The indicator shall be preprogrammed to indicate process variables and provide alarm points as specified in Section 17000-3.04. Preprogrammed functions shall consist of assigning inputs, outputs, and scale factors for process units. Operator displays shall be in process units.

Indicator power supply shall be 24 volts unless otherwise specified. Indicator stations shall be nominally 6 inches high by 3 inches wide by not more than 19 inches deep. Preprogrammed functions shall be battery back-up during times that power is not applied. Indicator stations shall be YEW Series 80 SIHF, Toshiba TOSDIC 200 Series 228D, or equal.

B. *INPUT/OUTPUT:*

Input/output capability shall be at a minimum as follows:

Type	Quantity
Analog inputs(s)	1
Discrete outputs	2

Analog inputs shall be 1 to 5 volts dc into not less than 250k ohms. Discrete output shall be dry contact closures with a minimum rating of 100 mA at 24 volts dc. Solids state relays to increase output rating shall be Struthers Dunn type 221 or equal with General Electric MOV type V130LAIO or equal transient suppression.

C. PREPROGRAMMED FUNCTIONS:

Indicator stations shall be, as a minimum, provided with the preprogrammed functions:

1. Display functions:

   a. Process variable indication in process units.
   b. Alarm set points in process units.

2. Alarm functions:

   a. Output actuation on high process variable.
   b. Output actuation on low process variable.

Indicator shall have separate adjustments for alarm set points. Set points shall be front accessible and visible. Set point adjustments shall be disabled by a non-faceplate hardwired switch.

D. OPERATOR INTERFACE:

100 segment minimum solid state bar graph for process variable indication.

2.04 RECORDER STATION: NOT USED

2.05 PROGRAMMER

A programmer shall be supplied for programming the controller. The programmer shall be capable of configuring the controller for all functions available in the controller. The programmer shall be capable of loading directly on to PROM memory or reading an EPROM chip and loading it into the controller. The programmer shall be supplied with all applicable documentation for set-up trouble-shooting and repair.

2.06 SPARE PARTS

The contractor shall provide as spare parts to the Owner:

a. One program "chip".
b. Five of each type of fuse used.

2.07 PRODUCT DATA

In addition to the requirements of Section 16000-1.04 and 00710-3.05, the Contractor shall supply three sets of the following documents:

1. Printout or drawing of controller, indicator, and recorder configuration.

2. Programmer, controller, indicator, and recorder operation and maintenance manual.

3. Program listing of each loop.

PART 3--EXECUTION

3.01 GENERAL

Control stations shall be installed in panels specified in Section 17010 in compliance with manufacturer's instructions and the functional requirements specified in Section 17000 and on the drawings. Contractor shall provide all programming services necessary to implement the specified functions. Stations shall be tested in compliance with Section 17000. Non-volatile processor memory shall be tested by removing memory "chip" from controller and power removed from controller for a minimum of 24 hours. At the end of the test period, power shall be reapplied and the memory "chip" reinstalled. The controller shall operate as before test, after start-up procedure, without requiring reprogramming.

3.02 TRAINING

Training shall be provided for the Owner's personnel at the Owner's facility on operation, troubleshooting of both hardware and software, programming, and basic program generation. Program training shall be with the program written for the installation and use of it for examples during training. Contractor shall provide a minimum of 1 day training. Training shall be certified on Form 11000-B specified in Section 01999.

3.03 *CONTROLLER CONFIGURATION DATA*

Configuration of microprocessor-based controllers is specified on the sheets at the end of this section.

END OF SECTION

SECTION 17130

POWER SUPPLY AND CONDITIONING EQUIPMENT

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies requirements for power supply and conditioning equipment required to support the instrumentation and communication systems specified.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
NEMA 250-85	Enclosures for Electrical Equipment
NFPA 70-87	National Electrical Code (NEC)
UL 1012-82	Power Supplies

1.03 PLANT ELECTRICAL SUPPLY SYSTEM

Electric power for instrumentation and communication systems shall be obtained from the power distribution system specified in Division 16. This power is not regulated, wave forms may be distorted, and significant amounts of electrical noise may be present. The Contractor shall provide all necessary power supply and conditioning equipment to provide electrical power of the required voltages and current capacities and of adequate quality to ensure reliable operation of the instrumentation and communication systems. Unless otherwise specified, the Contractor shall assume that the power supply for instrumentation systems is 120 volts plus or minus 15 percent, 60 hertz plus or minus 3 hertz, 5 percent maximum harmonic distortion.

PART 2--PRODUCTS

2.01 GENERAL

Except for power supply units which form an integral part of an individual piece of equipment, all power supply and conditioning equipment shall comply with UL 1012 and shall be approved by UL,

CSA, or FM for the application. All power supply equipment shall be provided in redundant configurations such that failure of a single unit will not disable all or any part of the instrumentation and communication systems. Diode isolation shall be provided for redundant direct current supply units, and the power supply negative output terminal shall be grounded.

2.02 ALTERNATING CURRENT (AC) VOLTAGE REGULATORS

Regulators shall be of the solid-state tap-changing type, insensitive to line frequency variations between 47 and 63 hertz. Ferroresonant units are not acceptable. Output regulation for input voltage variation from 85 to 125 volts shall not exceed 3.3 percent. Output regulation for load variation from 0 to 100 percent shall not exceed 1.0 percent. Response time shall be 1.0 cycles or less. Voltage regulators serving panelboards and control panels shall have a load capacity not less than 200 percent of the connected load. Voltage regulators serving individual instruments shall have a load capacity not less than 125 percent of the connected load. Power loss in the regulator shall not exceed 2 percent of the regulator capacity, and harmonic distortion introduced by the regulator shall not exceed 0.1 percent. Regulator output shall be fully protected against internal faults, external overloads and short circuits. Three-phase units shall be 4-wire, wye-connected and capable of supporting 100 percent unbalanced load. Regulators shall be Topaz 73000 series, or equal.

2.03 NOISE-SUPPRESSION ISOLATION TRANSFORMERS

Isolation transformers shall be provided for AC powered instrumentation loads containing solid state circuitry where such is not included within the instrument. Isolation transformers shall be of the triple box shield type. Each coil shall be completely enclosed in a grounded conductive faraday shield, and the overall transformer enclosed in a faraday shield. Common mode noise attenuation between primary and secondary shall exceed 140 dB at 1.0 kHz. Isolation transformer dielectric strength shall be 2500 volts minimum. Isolation transformers serving panelboards and control panels shall have a load capacity not less than 200 percent of the connected load. Isolation transformers serving individual instruments shall have a load capacity not less than 125 percent of the connected load. Power loss in the isolation transformer shall not exceed 2.0 percent of the maximum load rating. Harmonic distortion introduced by the isolation transformer shall not exceed 0.1 percent. Three-phase units shall be 4-wire, wye-connected and capable of supporting 100 percent unbalanced load. Isolation transformers shall be Topaz, Ultra-Isolator Series 20, or equal.

2.04 DIRECT-CURRENT POWER SUPPLIES

Direct-current supplies for bulk 24-volt nominal instrumentation power shall be convection-cooled switching type. Line regulation shall be 0.4 percent for line variations from 105 to 132 volts, and load regulation shall be 0.4 percent for load variations from 0 to full load. Ripple and noise shall not exceed 100 mV peak-to-peak. Hold-up time at maximum load shall be not less than 16 milliseconds. Efficiency shall be better than 70 percent. Power supply shall be rated for continuous duty from 0 to 50 degrees C at rated load. Output shall be electronically current limited, and overvoltage crowbar shutdown shall be provided. Power supply output voltage shall be rated 28 volts DC, adjustable plus or minus 5 percent, and shall be set to provide 26.4 volts on the panel direct current bus. Power supplies shall be Lambda LJA series, or equal.

2.05 NOT USED

2.06 SURGE PROTECTION

Surge arrestors and capacitors shall be provided on the primary winding of isolation transformers supplying power to solid state systems. Surge protectors shall be mounted in a separate, NEMA 1 enclosure adjacent to the transformer and the incoming line passed through this enclosure. Surge arrestors shall be General Electric 9L15EC or equal. Surge capacitors shall be General Electric 9L18B, or equal.

2.07 PRODUCT DATA

The following data shall be provided in accordance with paragraph 00710-4.02:

1. Catalog data including performance parameters.

2. Wiring diagrams.

3. Operation and maintenance information items 1 through 9 as specified in Section 01730.

PART 3--EXECUTION

Power supply and conditioning equipment shall be mounted and connected in compliance with the manufacturer's instructions unless otherwise specified. Line side disconnect switches shall be provided for power supply and conditioning equipment. Line and load side overcurrent protection shall be provided for power supply and conditioning equipment in compliance with NFPA 70. Disconnect switches shall comply with Section 16175.

Small power supply and conditioning equipment may be mounted in the panel served. Larger units shall be mounted adjacent to the equipment served. Where unconditioned power is brought into control panels, it shall be enclosed in metallic raceways within the panel.

Power supply and conditioning equipment larger than 5 KVA load capacity supported from surfaces other than concrete shall be provided with sound isolators. Final raceway connections shall be a flexible conduit in compliance with Section 16110.

Power supply and conditioning equipment not designed for exposed mounting shall be housed in panels in compliance with Section 17110.

END OF SECTION

SECTION 17140

INSTRUMENT AIR SUPPLY AND TRANSMISSION SYSTEMS

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies requirements for instrument air supply equipment and pneumatic signal transmission systems and accessories. Additional requirements for mechanical equipment and piping are specified in Divisions 11 and 15.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASME SECTION VIII (1986)	Boiler and Pressure Code, Pressure Vessels
ASTM B68-83	Seamless Copper Tube, Bright Annealed
ASTM D883-86	Definition of Terms Relating to Plastics
ASTM D1248-84	Polyethylene Plastics Molding and Extrusion Materials
ISA RP7.3-81	Quality Standard for Instrument Air

PART 2--PRODUCTS

2.01 NOT USED

2.02 AIR SETS

Air sets shall consist of service regulator and 10 micron filter of capacity to serve 200 percent of the connected instrument or final element load. Air sets for individual field mounted instruments shall be nonadjustable or otherwise sealed to prevent tampering, shall be provided with 2-inch gage, and shall be Conoflow FH-60, Fairchild-Hiller 61112GF, or equal. Air sets for panels shall be adjustable with 3-1/2-inch or larger gage and shall be Conoflow-FH-60, Fairchild-Hiller 65232GF, or equal.

2.03 AIR SUPPLY PIPING, FITTINGS AND VALVES

Piping, fittings and valves shall comply with Section 15050, System 2. Minimum pipe size shall be 3/8 inch for individual instrument supply connections and 1/2 inch for multiple instruments or panels with pneumatic instruments. Larger size piping shall be provided where specified.

2.04 SIGNAL PIPING, FITTINGS AND VALVES

A. COPPER TUBING:

Signal tubing shall be ASTM B68 DHP soft annealed copper with an ASTM D883 PVC jacket. Tubing shall be 1/4-inch O.D. by 0.03-inch wall or 3/8-inch O.D. by 0.032-inch wall as specified.

B. PLASTIC TUBING:

Plastic tubing shall be high molecular weight virgin polyethylene in accordance with ASTM D1248, Type III, Class C, Grade 3 with 0.005 minimum wall thickness.

C. FITTINGS:

Fittings shall be type 316 stainless steel. Fittings shall be of the swage ferrule design and shall have components (nut, body and ferrule system) interchangeable with those of at least one other manufacturer. Flare and ball sleeve compression type fittings are not acceptable. Fittings shall be Parker CPI, Crawford Swagelok, Hoke Gyrolok, or equal.

D. VALVES:

Valves shall be 316 stainless steel body and trim with teflon seats and seals, quarter turn units as manufactured by Hoke, Nupro, or equal.

2.05 PRODUCT DATA

The following data shall be provided in accordance with paragraph 00710-4.02:

1. Operation and maintenance information shall be provided in accordance with Section 01730, items 1 through 10.

PART 3--EXECUTION

3.01 NOT USED

3.02 INSTRUMENT AIR PIPING

Instrument air piping shall be installed and tested as specified in Section 15050. Taps to instrument air headers shall be made on the top of the header and provided with an isolation valve. An additional isolation valve and air set shall be provided at each instrument or panel requiring instrument air.

3.03 PNEUMATIC SIGNAL PIPING

Signal tubing shall be 1/4-inch copper unless otherwise specified. Tubing for control air to pneumatic actuators shall be 3/8-inch copper. Copper tubing shall be supported at intervals not to exceed 3 feet. Plastic tubing shall be used only where specifically specified and shall be continuously supported in trays or conduits provided as specified in Division 16. Tubing shall be run parallel or perpendicular to walls and structural members. Signal tubing shall follow building surfaces closely unless carried in trays or conduit. Tubing supported directly from concrete or concrete block surfaces shall be spaced at least 1/8 inch from said surface by the use of suitable clamp backs.

Bends shall be formed to uniform radii without flattening the tube. Ends of tubing shall be square-cut and cleaned before being inserted into fittings. Compression fittings shall be used for splices, turns, and connections near instruments. Bulkhead assemblies shall be provided for termination of field tubing on panels.

END OF SECTION

SECTION 17200

GENERAL REQUIREMENTS FOR PROCESS INSTRUMENTATION SYSTEMS

PART 1--GENERAL

1.01 DESCRIPTIUN

A. SCOPE:

This section specifies general requirements which are applicable to all process instrumentation systems consisting of process sensors, monitoring and control instruments, and accessories required to provide a complete and functional monitoring and control system.

The Contractor shall provide, calibrate, and test the complete process instrumentation system. The Contractor shall also place the completed system in operation including tuning loops and make final adjustments to instruments as required during plant start-up. He shall provide the services of instrument technicians for testing and adjustment activities.

The Contractor shall examine the mechanical drawings and specifications to determine actual locations, sizes, materials and ratings of process connections. Process taps shall be indicated on pipe shop drawings as specified in paragraph 15050-2.04.

B. DESCRIPTION OF SYSTEM:

The system consists of discrete and analog process measurement devices feeding information to the programmable controller or other control devices. Field devices shall connect to input/output modules of the programmable controller located in the motor control centers or to devices located in the instrumentation panels at each site (see paragraph 17000-1.01 B).

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
API RP550-85	Manual on Installation of Refinery Instruments and Control Systems, Part I - Sections 1 Through 13

Reference	Title
ISA S20-75	Specification Forms for Process Measurement and Control Instrumentation, Primary Ele ments, and Control Valves
ISA S51.1-79	Process Instrumentation Terminology

1.03 SUBMITTALS

The following information shall be provided in accordance with Section 01300.

1. Within 30 days after "Notice to Proceed," the Contractor shall submit a list of the manufacturer and model series for each type of equipment proposed.

2. Component connection diagrams showing function and identification of terminals.

3. Data sheets in accordance with ISA S20, together with a complete list of instruments provided.

PART 2--PRODUCTS

2.01 INSTRUMENT INDEX

The instrument index, paragraph 17200-3.03, lists major instruments required to provide the process instrumentation system. All instrument functions specified on this list shall be provided by the Contractor. Additional instruments may be required to complete the instrument loops because of certain characteristics of the particular equipment selected by the Contractor. Such additional instruments shall be provided at no additional cost even though not specified in the instrument index or on the contract drawings.

In some cases, it is possible to combine the functions of two or more instruments specified in the instrument index into a single instrument. Functions which may be ordinarily combined into a single instrument are multiple alarms derived from a common transmission signal, and signal linearization may be combined into transmitters except where the nonlinear signal is used for specific purposes such as standardized flow calculations. Flow computers may be used in lieu of individual function modules for standardized flow calculations providing equivalent performance is provided. Alarm or safety functions derived directly from process measurements shall not be combined with instruments operating from

transmission signals. Alarm or safety functions shall not be combined into any instrument used for process control, indication, recording, or any combination thereof.

Standard instruments shall be modified as necessary to meet the specified application requirements.

2.02 PRODUCT DATA

The following data shall be provided in accordance with paragraph, 00710-4.02:

1. Test results as specified in paragraoh 17200-3.02 S.

2. Certificates of compliance as specified in paragraph 17000-2.02 D.

PART 3--EXECUTION

3.01 INSTALLATION

A. GENERAL:

Where installation procedures are not specified herein, API RP550 shall be used as a guide.

B. RACEWAY CONNECTIONS:

Final connections between rigid raceway systems and instruments shall be made with jacketed flexible conduit with a maximum length of 2 feet.

C. SIGNAL TRANSMISSION:

Signal transmission between electric or electronic instruments not located within a common panel shall be 4 to 20 milliamperes and shall operate at 24 volts DC unless otherwise specified. Milliampere signals shall be current regulated and shall not be affected by changes in load resistance within the unit's rating. Milliampere signals from field shall be converted to a 1- to 5-volt signal at the external terminals of each panel, and all instruments within the panel shall be parallel wired. Measurement loops shall be grounded at external terminals by bonding to the instrument panel signal ground bus. The Contractor shall provide isolating amplifiers for field equipment possessing a grounded input or output.

High frequency (greater than 1 kHz) pulse rate signals from field transmitters shall be converted to DC voltage signals at the panel.

Platinum resistance temperature detector (RTD) outputs shall be converted to milliampere transmission signals at the RTD; or, where specified, the RTD output may be carried to the panel and converted to a DC voltage signal.

All other transmission systems, such as impulse duration, low frequency pulse rate, and voltage regulated, will not be permitted except where specifically noted in the instrument index. When transmitters with nonstandard outputs are specified, their output shall be converted to 4 to 20 milliamperes at the field instrument.

Two-wire equipment located in hazardous areas shall be made safe for the specified conditions by use of equipment and barriers approved by Underwriters Laboratories Inc. (UL), Canadian Standards Association (CSA), or Factory Mutual (FM).

3.02 TESTS AND INSPECTIONS

A. GENERAL REQUIREMENTS:

Materials, equipment, and construction included under this specification shall be inspected in accordance with Sections 00710 and 17000 and this section. Testing shall be performed by the Contractor in accordance with Section 17000 and paragraph 17200-3.02.

B. INSTALLED TESTS AND INSPECTION:

1. TEST REPORTS: Test reports shall conform to the requirements of reference forms 17000-A through 17000-K included in Section 01999.

2. TEST EQUIPMENT: Test equipment used to simulate inputs and read outputs shall have a rated accuracy at the point of measurement at least three times greater than the component under test. Each test instrument shall be calibrated prior to the commencement of a testing activity and at the completion of a testing activity. Certified calibration reports traceable to the National Bureau of Standards shall be included with the test report.

Buffer solutions and reference fluids shall be provided by the Contractor for all tests of analytical equipment.

3. TESTING STAGES:

a. GENERAL: Each instrument loop shall be tested in the following sequence:

Testing sequence	Form reference
Wiring	17000-A
Individual components	17000-C through I
Individual loops	17000-J
Loop commissioning	17000-K

Testing of piping and wiring and individual components shall be completed with certified test reports provided to the Construction Manager prior to commencement of individual loop testing, which shall be completed with certified test reports provided to the Construction Manager prior to commencement of loop commissioning.

b. INDIVIDUAL COMPONENT CALIBRATION AND TEST: Each instrument and final element shall be field calibrated in accordance with the manufacturer's recommended procedure. Instruments shall then be tested in compliance with ISA S51.1 and the data entered on the applicable test form. Alarm trips, control trips, and switches shall he set to initial values specified in paragraph 17200-3.03 at this time. Final elements shall be checked for range, deadband, and speed of response.

Any component which fails to meet the required tolerances shall be repaired by the manufacturer or replaced, and the above tests repeated until the component is within tolerance.

c. LOOP TEST: Each instrument loop shall be tested as an integrated system. This test shall check operation from transmitter to readout components. Signals shall be injected at the signal connection to primary measuring elements.

If any output device fails to indicate properly, corrections to the loop circuitry shall be made as necessary and the test repeated until all instruments operate properly.

d. CLOSED-LOOP COMMISSIONING TEST: Commissioning test shall demonstrate stable operation of the loop under actual plant operating conditions. This test shall include adjustment of loop tuning parameters.

Tuning parameters (proportional gain, integral time constant, and derivative time constant) for each control loop shall be adjusted to provide 1/4-amplitude damping unless otherwise specified. A chart recording showing loop response to a step disturbance shall be provided for each loop. Two charts shall be made for cascade loops, one showing the secondary loop response

With its set point on manual, and the second showing overall loop response. Each control loop with "batch" feature shall be adjusted to provide optimum response following start-up from an integral action saturation condition. Chart recording shall be provided showing this response. Chart recordings shall be made at sufficient speed and amplitude to clearly show 1/4-amplitude damping and shall be annotated to show loop number and title, and settings of parameters and set point.

3.03 *INSTRUMENT INDEX*

SECTION 17211

PROCESS TAPS AND PRIMARY ELEMENTS

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies requirements for instrumentation elements that quantitatively convert the measured variable energy into a form suitable for measurement and process measurement accessories. Application requirements are specified in Section 17200.

1.02 REFERENCES

This section contains references to the following documents. Additional references are listed in Section 17000. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
API RP550-80	Manual on Installation of Refinery Instruments and Control Systems, Part 1 - Process Instrumentation and Control
ASTM A269-83	Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A276-83	Stainless and Heat Resisting Steel Bars and Shapes
SAMA PWC-17-10-63	Bushings and Wells for Temperature Sensing Elements

1.03 SUBMITTALS

Submittals shall be provided as specified in paragraph 17200-1.03.

PART 2--PRODUCTS

2.01 INSTRUMENTATION SPECIFICATION SHEETS (INSTRUSPEC)

General requirements for primary elements specified in this section are listed on INSTRUSPEC sheets in paragraph 17211-3.03.

2.02 VALVES

A. ISOLATION VALVES:

Valves shall be full port ball valves with ASTM A276, 316 stainless steel trim and body and with Teflon seats and packing. Valves shall be Parker CPI, Whitey, Hoke, or equal.

B. GAGE VALVES:

Gage valves shall be globe or angle pattern units machined from ASTM A276 bar stock and shall be provided with two 1/2-inch NPT ports. Valves shall be Anderson, Greenwood & Company H1, Hoke 2100, or equal.

C. ROOT VALVES:

Root valves shall be ASTM A276, type 316 stainless steel bar stock with 1/2-inch NPT male process connection and three 1/2-inch NPT female instrument connections. One instrument connection shall be provided with an ASTM A276, type 316 stainless steel bleed valve. ASTM 276, type 316 stainless steel plugs shall be provided for unused ports. Lagging type units shall be provided for insulated vessels and pipes. Root valves shall be Anderson, Greenwood & Company M5, Hoke 6800, or equal.

D. MANIFOLDS:

Manifolds shall be three-valve bar-stock type. Manifold body shall be machined from ASTM, type 316 stainless steel bar stock. Valves shall be globe configuration with 316 stainless steel ball seats and Teflon stem packing. Manifolds shall be designed for direct mounting to differential pressure transmitters in place of the flanges normally furnished. Fabricated manifolds or manifolds employing needle or soft seat valves are not acceptable. Purge taps, 1/8-inch NPT shall be furnished on manifolds where water purge is specified. Manifolds shall be Anderson Greenwood M4T, HEX HIM53, or equal.

2.03 TUBING AND TUBING FITTINGS

Instrument tubing between the process connection and instruments shall be 1/2-inch x 0.065-inch seamless seamless annealed ASTM A269 type 316 stainless steel.

Tubing fittings shall be type 316 stainless steel. Fittings shall be of the swage ferrule design and shall have components (nut, body and ferrule system) interchangeable with those of at least one other manufacturer. Flare and ball sleeve compression type are not acceptable. Fittings shall be Parker CPI, Crawford Swagelok, Hoke Gyrolok, or equal.

2.04 CHEMICAL SEALS

A. DIAPHRAGM:

Seal shall be the diaphragm type with flushing connection, type 316 stainless steel body and type 316L diaphragm unless otherwise specified. Fill fluid shall be DC200 silicone oil unless otherwise specified. Seal shall be Mansfield and Green Type SG, Ashcroft Type 101, or equal.

B. ANNULAR:

Seal shall be the in-line full stream captive sensing liquid type. Flexible cylinder shall be Buna-N unless otherwise specified. Seals shall be rated 200 psig with not more than 5-inch WC hysteresis. Fill fluid shall be DC200 silicone oil unless otherwise specified. Seals shall be Ronningen-Petter Iso-Ring, Red Valve series 40, or equal.

2.05 BUSHINGS AND THERMOWELLS

Bushings or thermowells shall comply with SAMA PMC17-10. Temperature taps shall be 1/2-inch NPT, and lagging extensions shall be provided on insulated vessels or pipes. Thermowells and bushings shall be machined from 316 stainless steel bar stock unless otherwise specified.

2.06 PURGE ASSEMBLIES

A. AIR:

Air purge assembly shall consist of a constant-differential relay, needle valve, check valve and 0.2 to 2.0 SCFH rotameter. Assembly shall be Moore Products 62VA, Fischer & Porter 10A3137N-3BR2110, or equal.

B. WATER:

Water purge assembly shall consist of a strainer, constant-differential regulator, needle valve, check valve, and 20 to 200 cc/m rotameter. Assembly shall be Moore Products 63BD4A, Fischer & Porter 10A3137N-53BR2110, or equal. Strainer shall be 155 micron wye-type, ASCO 8600A2, Crane, or equal.

2.07 PRODUCT DATA

Flow calculation for each differential-type flow element shall be provided in accordance with paragraph 00710-4.02.

PART 3--EXECUTION

3.01 INSTALLATION

A. PROCESS CONNECTIONS:

Unless otherwise specified, process taps shall comply with API RP550. Root valves shall be provided at taps, except temperature taps and pump discharge pressure taps. Process connections shall be arranged, where possible, such that instruments may be readily removed for maintenance without disruption of process units or draining of large tanks or vessels. Unions or flange connections shall be provided as necessary to permit removal without rotating equipment. Where process taps are not readily accessible from instrument locations, a block valve shall be provided at the instrument. Block valves shall also be provided for each instrument where multiple instruments are connected to one process tap.

B. ELECTRICAL CONNECTIONS:

Final connections between rigid raceway systems and instruments shall be made with jacketed flexible conduit with a maximum length of 2 feet.

3.02 TESTING

Testing requirements are specified in paragraph 17200-3.02.

3.03 INSTRUSPEC SHEETS

The following INSTRUSPEC sheets are included in this section:

3.03 INSTRUMENT SPECIFICATION SHEET--INSTRUSPEC

Instrument Identification:	LBE
Instrument Function:	Level measurement
Instrument Description:	Bubbler assembly
Power Supply:	As specified in Section 17140.
Signal Input:	N/A
Signal Output:	N/A
Process Connection:	N/A

Product Data:

Purge Rotameter Assembly:

Air: Air purge rotameter assembly shall consist of a constant-differential relay, needle valve, check valve and 0.2 to 2.0 standard cubic feet per hour (scfh) rotameter. Assembly shall be Fischer & Porter 10A3137N-53BR2110, Conoflow DH21-12, or equal.

High Pressure Purge:

Valve: Valve shall be a 3/8-inch, 3-way, 3-position ball valve with type 316 stainless steel body and ball and Teflon seats. In the "normal" position, back pressure from the bubble pipe shall be passed to the pressure instruments. In the "bleed" position, all ports shall be sealed. In the purge position, the instrument port shall be sealed and air shall be supplied directly from the air set to the bubble pipe. Nameplates shall be provided to define each position.

Bubble Pipe: Bubble pipe shall be 3/4-inch, Schedule 80, PVC. Bubble pipe shall be provided with two pipe tees at the top for connection of air purge supply line and static line. Top opening shall be provided with threaded plug for rodding out the bubble pipe. The bottom end of the bubble pipe shall be notched

Instrument Identification: LBE (continued)

approximately 3/4 inch deep by 1/2 inch wide. Two separate 1/4-inch tubes shall be provided from the bubble pipe, one to the high pressure purge valve, and one to the air purge rotameter.

Execution:

Installation: Mount and connect in Type 1 panels specified in Section 17110 in accordance with manufacturer's instructions and as specified on the drawings.

Calibration: Top of notch in bubble pipe shall be set at specified elevation with an accuracy of 0.01 foot or better.

3.03 INSTRUMENT SPECIFICATION SHEET--INSTRUSPEC

Instrument Identification:	PLG
Instrument Function:	Pressure measurement
Instrument Description:	Low range pressure gage
Power Supply:	N/A
Signal Input:	N/A
Signal Output:	N/A
Process Connection:	1/2-inch male NPT
Product Data:	Gage shall be 4-1/2-inch phenolic turret case construction with shatterproof glass window and 270-degree milled stainless steel movement. Unless otherwise specified, element shall be ASTM A269, type 316 stainless steel bellows. Gage shall be Ashcroft type 1188, or equal. Gage shall be provided with a porous metal type snubber with ASTM A276, type 303 stainless steel body and type 316 stainless steel filter disc.
Execution:	
Installation:	Install in accordance with manufacturer's instructions and the recommendations of API RP550 to the specified requirements. Root valves shall be provided at all process pressure taps except taps made for safety instruments. Gage valves shall be provided at the instrument where the instrument is not within sight of the root valve or where two or more instruments are connected to a single tap. Safety instruments shall not be

Instrument Identification:

PLG (continued)

connected to the same process tap as instruments used for control, indication, or recording. Unless otherwise specified, pressure instruments shall be located as close as practical to the process tap but shall be positioned to permit observation and maintenance.

Pressure gages may be supported from the process tap if this location permits observation from the floor or a permanent work platform. Pressure instruments shall be installed in such a manner that blowout discs are not obstructed.

Application/ Calibration:

Application, calibration, and set points shall be as specified in paragraph 17200-3.03.

3.03 INSTRUMENT SPECIFICATION SHEET--INSTRUSPEC

Instrument Identification:	PG
Instrument Function:	Pressure measurement
Instrument Description:	Pressure gage
Power Supply:	N/A
Signal Input:	N/A
Signal Output:	N/A
Process Connection:	1/2-inch male NPT
Product Data:	Pressure gages shall be 4-1/2-inch premium grade, glycerin filled units with bourdon tube element, 270-degree milled stainless steel movement, phenolic case, and shatterproof glass window. Accuracy shall be 1 percent of span or better. All exposed metal parts shall be stainless steel. Gage shall be Ashcroft Duraguage Figure 1279, Ametek 1981L, or equal.
Execution:	
Installation:	Install in accordance with manufacturer's instructions and the recommendations of API RP550 to the specified requirements. Root valves shall be provided at all process pressure taps except taps made for safety instruments. Gage valves shall be provided at the instrument where the instrument is not within sight of the root valve or where two or more instruments are connected to a single tap. Safety instruments shall not be connected to the same process tap as instruments used for

Instrument Identification:

PG (continued)

control, indication, or recording. Unless otherwise specified, pressure instruments shall be located as close as practical to the process tap but shall be positioned to permit observation and maintenance. Pressure gages may be supported from the process tap if this location permits observation from the floor or a permanent work platform. Pressure instruments shall be installed in such a manner that blowout discs are not obstructed.

Application/ Calibration:

Application, calibration, and set points shall be as specified in paragraph 17200-3.03.

3.03 INSTRUMENT SPECIFICATION SHEET--INSTRUSPEC

Instrument Identification:	TI
Instrument Function:	Temperature measurement
Instrument Description:	Temperature indicator
Power Supply:	N/A
Signal Input:	Process
Signal Output:	N/A
Process Connection:	1/2-inch male NPT
Product Data:	Temperature indicators shall be 4-1/2-inch gas pressure operated bourdon tube elements, 270-degree movement, phenolic case, shatterproof glass window, and 1/2-inch NPT process connection. Bulb shall be 3 inches long by 3/8-inch diameter for all ranges. Stem lengths shall be selected to place bulb in middle third of pipe. Indicator head shall be swivel mounted to the stem. Temperature indicator shall be Ashcroft Duratemp Type 600B, or equal.
Execution:	
Installation:	Temperature instruments shall be installed in accordance with the manufacturer's instructions and the recommendations of API RP550 to the specified requirements. For pipelines less than 4-inch diameter, temperature elements shall be installed at a pipeline elbow if possible. Where an elbow is not available, a wye fitting shall be installed in the pipeline for installation of the temperature element at a 45-degree angle with the flow.

SECTION 17212

TRANSMITTERS

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies requirements for transmitters. Application requirements are specified in Section 17200.

1.02 REFERENCES

This section contains a reference to the following document. Additional references are listed in Section 17000. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed document, the requirements of this section shall prevail.

Reference	Title
NEMA 250-85	Enclosures for Electrical Equipment

1.03 SUBMITTALS

Submittals shall be provided as specified in paragraph 17200-1.03.

PART 2--PRODUCTS

2.01 GENERAL

Unless otherwise specified, measuring elements and transmitters shall comply with the following requirements:

1. Output indicators complying with paragraph 17212-2.02 shall be provided with any transmitter that does not include an integral indicator. Indicators, whether integral or separate, shall be calibrated in process units, and said units shall be engraved on the indicator scale plate.

2. Transmitters shall be two-wire type with operating power derived from the signal transmission circuit.

3. Transmitter output shall be 4 to 20 milliamperes, current regulated and shall drive any load between 0 and 550 ohms with the power supply at 23 volts DC.

4. Transmitters shall meet specified performance requirements with load variations within the range of 0 to 600 with the power supply at 24 volts DC.

5. Transmitter output shall be galvanically isolated.

6. Time constant of transmitters used for flow or pressure measurement, including level transmitters used for flow measurement, shall be adjustable from 0.5 to 5.0 seconds.

7. Transmitter output shall increase with increasing measurement.

8. Transmitter enclosures shall be rated NEMA 250, Type 4, unless otherwise specified.

9. Transmitters located outdoors shall be provided with surge protectors: Rosemount Model 470A, Taylor 1020FP, or equal.

10. Where two-wire transmitter is located in an area classified as hazardous, it shall be made safe by means of an intrinsic safety barrier as specified in paragraph 17212-2.03.

11. Where four-wire transmitters are permitted, they shall be provided with a loop powered signal current isolator as specified in paragraph 17212-2.05 connected in the output signal circuit.

2.02 OUTPUT INDICATOR

Output indicator shall be 90-degree movement, 2-1/2-inch milliammeter enclosed in a NEMA 7/9 meter case. Scale shall be calibrated in process units with tic marks for milliampere input. A diode shall be provided to maintain loop continuity in case of meter movement failure or removal. Accuracy shall be within 2 percent of span.

2.03 INSTRINSIC SAFETY BARRIERS

Intrinsic safety barriers for two-wire transmitters shall be of the active, isolating, loop powered type. Barrier shall be Measurement Technology LTD. type MT3042, Stahl 9005/01-252/100/00, or equal.

2.04 INSTRUMENTATIOW SPECIFICATION SHEETS (INSTRUSPEC)

General requirements for instruments specified in this section are listed on INSTRUSPEC sheets in paragraph 17212-3.03. Application requirements are specified in the instrument index, paragraph 17200-3.03, and/or on the drawings.

2.05 SIGNAL CURRENT ISOLATOR

Isolator shall provide galvanic isolation of milliampere transmission signals from transmitters with inadequately isolated output circuits. Isolator shall be housed in a NEMA 250, type 4/7 conduit body and shall derive its operating power from the signal input circuit. Input and output signals shall be 4 to 20 milliamperes, and error shall not exceed 0.1 percent of span. Input resistance shall not exceed 550 ohms with an output load of 250 ohms. Isolator shall be Moore Industries SCX/4-20MA/4-20/MA/6.5DC/-RF(EX), or equal; engineer knows of no equal.

2.06 PRODUCT DATA

Product data shall be provided as specified in paragraph 17200-2.03.

PART 3--EXECUTION

3.01 INSTALLATION

Installation requirements are specified in paragraph 17200-3.01.

3.02 TESTING

Testing requirements are specified in Section 17200-3.02.

3.03 INSTRUSPEC SHEETS

The following INSTRUSPEC sheets are included in this section:

3.03 INSTRUMENT SPECIFICATION SHEET--INSTRUSPEC

Instrument Identification:	FM
Instrument Function:	Flow measurement
Instrument Description:	Magnetic flow transmitter
Power Supply:	120 volts AC, 60 hertz nominal
Signal Input:	Process
Signal Output:	Analog signal as specified in paragraph 17212-2.01 plus pulse frequency where specified
Process Connection:	Flange, ANSI B16.5, Class 150, raised face
Product Data:	Magnetic flow transmitter shall consist of a flow tube and separate converter complete with all necessary interconnecting cables and conduits. Transmitter shall be suitable for full-scale flow rates from 3.0 to 30 feet per second. System accuracy shall be better than 0.5 percent of flow rate or 0.1 foot per second, whichever is greater. Transmitter shall be Foxboro, Rosemount, or equal. Unless otherwise specified, flow tube shall be polyurethane lined steel with 150-pound ANSI flange connections and ASTM A276, type 316 stainless steel electrodes. Flow tubes located in lined or nonconductive pipes shall be provided with grounding spools or swages fabricated from ASTM A312, type 316 stainless steel. Grounding spools or swages inside diameter shall be 1/16 inch smaller than flow tube inside diameter. Where pipe run size is different from specified flow tube size, uniformly diverging swages with a total

Instrument Identification: FM (continued)

angle between walls not exceeding 15 degrees shall be provided. Excitation power requirements shall not exceed 100 volt-amperes. Flow tube assembly shall contain no electronic circuitry. Flow tube shall be coated with corrosion-resistant polyurethane or epoxy paint. The flow converter shall contain all electronics associated with the magnetic flow transmitter system. Calibrated span adjustment shall permit range adjustment without need for separate test equipment. Adjustable dampening shall be provided.

Where specified, in-service electrode cleaning shall be provided. Unless otherwise specified, either the boil-off or the ultrasonic system is acceptable. Where the boil-off system is used, a time clock shall provide automatic intermittent initiation of the boil-off, and a track and hold module shall be provided to hold flowmeter output for the duration of the boil-off period. Where ultrasonic cleaning is used, it shall be complete with flow tube transducers and ultrasonic generator. Ultrasonic cleaning shall operate continuously.

Execution:

Installation: Install in accordance with manufacturer's instructions and the recommendations of API RP550 to the specified requirements.

Instrument
Identification:

FM (continued)

Avoid damage to the tube liner. Spool pieces or swages shall be bolted to each end of the flow tube and the entire assembly slid into the pipe run as a unit. Flange bolts shall be tightened to tube manufacturer's specified torque. Converter shall be separately located to provide convenient access for observation and maintenance but shall be as close to the flow tube as practical.

3.03 INSTRUMENT SPECIFICATION SHEET--INSTRUSPEC

Instrument Identification:	FVA
Instrument Function:	Flow measurement
Instrument Description:	Variable area flow transmitter
Power Supply:	24 volts DC from transmission circuit as specified in paragraph 17212-2.01.
Signal Input:	Process
Signal Output:	Analog signal as specified in paragraph 17212-2.01.
Process Connection:	Flange, ANSI B16.5, Class 150, raised face, size as specified
Product Data:	Flowmeter shall be all-metal straight-through construction with magnetically coupled float follower. Accuracy shall be plus or minus 2.0 percent or better. Transmitter shall be Fischer & Porter 10A5004, Brooks 3801, or equal.
Execution:	
Installation:	Install in accordance with manufacturer's instructions and the recommendations of API RP550 to the specified requirements.

3.03 INSTRUMENT SPECIFICATION SHEET--INSTRUSPEC

Instrument Identification:	LUT
Instrument Function:	Level measurement
Instrument Description:	Ultrasonic level transmitter
Power Supply:	120 volt, 60 hertz nominal
Signal Input	N/A
Signal Output:	As specified in paragraph 17212-2.01
Process Connection:	N/A
Product Data	Transmitter shall be a noncontact, ultrasonic echo-time measuring device. It shall consist of a piezoelectric transducer element assembly and a remote transmitter unit interconnected by vendor-supplied coaxial cable. System shall utilize 1500 volt peak minimum energy level on the transducer and shall be suitable for measuring liquid surfaces from 2 to 35 feet below the transducer. Transducer shall incorporate a reference reflector to provide instantaneous sound velocity compensation. Transmitter shall utilize microprocessor circuitry to process echo times for elimination of stray echos and, where specified, to provide linearization functions. Transducer shall be provided with flange or pipe mounting accessories as required for the particular installation conditions.

Instrument Identification:	LUT (continued) Level transmitter shall be Fischer & Porter 50US3200 series, Moore Technologies SVS-100 series, or equal.
Execution:	
Installation:	Transducer shall be rigidly mounted approximately 2 feet above maximum liquid level and accurately leveled. Transmitter shall be wall or stand mounted as specified.
Calibration:	System shall be calibrated in accordance with paragraph 17200-3.02.

3.03 INSTRUMENT SPECIFICATION SHEET--INSTRUSPEC

Instrument Identification:	PGT
Instrument Function:	Pressure measurement
Instrument Description:	Gage pressure transmitter
Power Supply:	As specified in paragraph 17212-2.01
Signal Input:	N/A
Signal Output:	Analog transmission signal as specified in paragraph 17212-2.01
Process Connection:	1/2-inch female NPT flange adapter
Product Data:	Pressure transmitter shall be capacitance or resonant-wire type. Unless otherwise specified, wetted parts shall be ASTM A276, type 316 stainless steel. Span shall be adjustable over a 6:1 or greater range. Overrange capacity without affecting calibration shall be not less than 200 percent of maximum specified range. Volumetric displacement shall not exceed 0.01 cubic inches over the specified span. Fill fluid unless otherwise specified shall be silicone oil. Adjustable dampening shall be provided. External zero adjustment shall be provided. Accuracy shall be 0.25 percent of span or better for spans greater than 5 inches water column and 0.5 percent of span or better for spans less than or equal to 5 inches water column. Transmitters shall be Rosemount 1151 Series, Foxboro 820 Series, or equal. Transmitter shall be provided with the following adjustable range:

Instrument Identification: PGT (continued)

Adjustable range of transmitter, water column	Span specified in paragraph 17200-3.03, water column
0.5 to 6 inches	0.5 to 5.5 inches
5 to 30 inches	5.5 to 27.5 inches
25 to 150 inches	27.5 to 137.5 inches
125 to 750 inches	137.5 to 750 inches

Higher ranges and spans shall be provided as specified in paragraph 17200-3.03. Transmitters for spans less than or equal to 25 psig shall be provided with one 1/2-inch flanged process connection and two 1/4-inch drain/vent ports, one plugged and one provided with bleed valve. Reference diaphragm shall be provided with a weatherproof, bugproof atmospheric vent. Transmitters for spans greater than 25 psig shall be similar to the above except shall be designed for gage pressure service, and overpressure rating shall be greater than the lesser of 2000 psig and 150 percent of maximum range.

Execution:

Installation: Install in accordance with manufacturer's instructions and the recommendations of API RP550 to the specified requirements.

Root valves shall be provided at all process pressure taps. Gage valves shall be provided at the instrument where the instrument is not within sight of the root valve or where two or more instruments are connected to a single tap. Safety instruments shall not be connected to the

Instrument Identification:	PGT (continued) same process tap as instruments used for control, indication, or recording. Unless otherwise specified, pressure instruments shall be located as close as practical to the process tap but shall be positioned to permit observation and maintenance. Pressure instruments shall not be supported from process piping.
Application/ Calibration:	Application, calibration, and set points shall be as specified in paragraph 17200-3.03.

3.03 INSTRUMENT SPECIFICATION SHEET--INSTRUSPEC

Instrument Identification:	PDT
Instrument Function:	Pressure measurement
Instrument Description:	Differential pressure transmitter
Power Supply:	As specified in paragraph 17212-2.01
Signal Input:	N/A
Signal Output:	Analog transmission signal as specified in paragraph 17212-2.01
Process Connection:	Two 1/2-inch female NPT flange adapters
Product Data:	Pressure transmitter shall be capacitance or resonant-wire type. Unless otherwise specified, wetted parts shall be ASTM A276, type 316 stainless steel. Span shall be adjustable over a 6:1 or greater range. Overrange capacity without affecting calibration shall be not less than 200 percent of maximum specified range. Volumetric displacement shall not exceed 0.01 cubic inches over the specified span. Fill fluid unless otherwise specified shall be silicone oil. Adjustable dampening shall be provided. External zero adjustment shall be provided. Accuracy shall be 0.25 percent of span or better for spans greater than 5 inches water column and 0.5 percent of span or better for spans less than or equal to 5 inches water column. Transmitters shall be Rosemount 1151 Series, Foxboro 820 Series, or equal.

3.03

Transmitters shall be provided with the following adjustable range:

Adjustable range of transmitter, water column	Span specified in paragraph 17200-3.03, water column
0.5 to 6 inches	0.5 to 5.5 inches
5 to 30 inches	5.5 to 27.5 inches
25 to 150 inches	27.5 to 137.5 inches
125 to 750 inches	137.5 to 750 inches

Higher ranges and spans shall be provided as specified in paragraph 17200-3.03. Differential pressure transmitters shall be provided with a three-valve manifold as specified in paragraph 17211-2.02 D and with four 1/4-inch drain/vent ports, two plugged and two provided with bleed valves. Static pressure rating shall be 2000 psig or greater.

Execution:

Installation:

Install in accordance with manufacturer's instructions and the recommendations of API RP550 to the specified requirements.

Root valves shall be provided at all process pressure taps. Unless otherwise specified, pressure instruments shall be located as close as practical to the process tap but shall be positioned to permit observation and maintenance. Pressure instruments shall not be supported from process piping.

Application/ Calibration:

Application, calibration, and set points shall be as specified in paragraph 17200-3.03.

END OF SECTION

SECTION 17216

PROCESS SWITCHES

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies requirements for process activated switches. Application requirements are specified in Section 17200.

1.02 REFERENCES

This section contains references to the following documents. Additional references are listed in Section 17000. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
NEMA 250-85	Enclosures for Electrical Equipment
NEMA ICS 2-83	Standards for Industrial Control Devices, Controllers and Assemblies

1.03 SUBMITTALS

Submittals shall be provided as specified in paragraph 17200-1.03.

PART 2--PRODUCTS

2.01 GENERAL

Unless otherwise specified, switches shall comply with the following requirements:

1. Contact outputs used for alarm actuation shall be ordinarily closed and shall open to initiate the alarm.

2. Contact outputs used to control equipment shall be ordinarily open and shall close to start the equipment.

3. Contacts monitored by solid state equipment such as programmable controllers or annunciators shall be hermetically sealed and designed for switching currents from 20 to 100 mA at 24 volts DC.

4. Contacts monitored by electro-magnetic devices such as mechanical relays shall be rated NEMA ICS 2, designation B300.

5. Double barriers shall be provided between switch elements and process fluids such that failure of one barrier will not permit process fluids into electrical enclosures.

6. Switch electrical enclosures shall be rated NEMA 250, type 4 minimum.

7. Contacts in Class 1, Division 1 areas and monitored by solid-state circuits shall be made safe by suitable intrinsic safety barriers as specified in paragraph 17120-2.04.

2.02 INSTRUMENTATION SPECIFICATION SHEETS (INSTRUSPEC)

General requirements for instruments specified in this section are given on INSTRUSPEC sheets in paragraph 17216-3.03. Application requirements are specified in the instrument index, paragraph 17200-3.03, and/or on the drawings.

2.03 PRODUCT DATA

Product data shall be provided as specified in paragraph 17200-2.03.

PART 3--EXECUTION

3.01 INSTALLATION

Installation requirements are specified in paragraph 17200-3.01.

3.02 TESTING

Testing requirements are specified in paragraph 17200-3.02.

3.03 INSTRUSPEC SHEETS

The following INSTRUSPEC sheets are included in this section:

3.03 INSTRUMENT SPECIFICATION SHEET--INSTRUSPEC

Instrument Identification:	LCS
Instrument Function:	Level measurement
Instrument Description:	Conductance level switch
Power Supply:	120 volts AC, 60 hertz nominal
Signal Input:	N/A
Signal Output:	Contacts as specified in paragraph 17216-2.01
Process Connection:	Male NPT, 2- or 3-inch size depending on number of electrodes
Product Data:	Switch shall be of the conductance type with PVC sheathed 1/4-inch stainless steel rod electrodes for lengths up through 6 feet. For lengths greater than 6 feet, wire suspension type with stainless steel shield electrodes shall be provided. Electrode fittings shall be an epoxy coated and gasketed cast aluminum housing of suitable configuration for the application. Probes shall be B/W Controller Corporation, Charles F. Warrick Co., or equal. Induction relays shall be two winding type. Primary power supply shall be 120 volts, 60 hertz. Secondary potential shall not exceed 300 volts AC and short circuit current shall not exceed 25 milliamperes. Level switches shall be B/W Type DH, Warrick Series 1G, or equal.
Execution:	
Installation:	Install in accordance with manufacturer's instructions as specified on the drawings.

Instrument Identification:	LCS (continued)
Calibration:	In accordance with paragraph 17200-3.02 B.3.b. Switch set point and reset point shall be adjusted as specified.

3.03 INSTRUMENT SPECIFICATION SHEET--INSTRUSPEC

Instrument Identification:	LFS
Instrument Type:	Level measurement
Instrument Description:	Float Switch, Free Floating
Power Supply:	N/A
Signal Input:	Process
Signal Output:	Contact as specified in paragraph 17000-2.03
Process Connection:	N/A
Product Data:	Switch shall be free floating type suspended from a PVC coated multicore connecting cable which also contains the conductors. Float shall be conical shaped and shall be approximately 6 1/2 inches in diameter at the large end. Float shall contain mercury switches with a minimum rating of 6 amps at 115 volts. Float shall be foam-filled, hermetically sealed and PVC coated. Intermediate relays and Intrinsic Barriers shall be provided in accordance with the manufacturer's recommendations.
Execution:	
Installation:	Install in accordance with manufacturer's instructions and as shown on the drawings.
Test:	In accordance with paragraph 17000-3.02.
Application/ Calibration	Application, calibration, and set points shall be as specified in Section 18950.
Approved Manufacturers:	Kari, Enviroquip Series 2900, Ryan-Herco Series 6902, or equal.

3.03 INSTRUMENT SPECIFICATION SHEET--INSTRUSPEC

Instrument Identification:	PS
Instrument Function:	Pressure measurement
Instrument Description:	Pressure switch
Power Supply:	N/A
Signal Input:	Process
Signal Output:	As specified in paragraph 17216-2.01
Process Connection:	1/2-inch female NPT
Product Data:	Pressure switch shall consist of a pressure transducer and a precision switch. Pressure transducer shall be th diaphragm piston type with wetted materials as recommended by the switch manufacturer. Piston shall be backed by a cylinder disc to permit 10 times over-range pressure without affecting calibration. Range spring and piston shall be isolated from process fluids by the diaphragm. Switch shall be provided with two 3/4-inch conduit connections. Switch assembly housing shall be cast aluinum rated types 3, 4, and 7D per NE<A ICS6. Contractor shall select pressure transducer so that set point falls between 30 and 70 percent of maximum range. Approximate set point and, if applicable, rest point shall be indicated on calibrated scales. Repeatability and sensitivity shall be 1.0 percent of operating range or better. Unless otherwise specified, switches shall be nonadjustable deadband type. Pressure switches shall be SOR Inc. Static-O-Ring, Mercoid Series 1000, or equal.

Instrument Identification:	PS (continued)
Execution:	
Installation:	Install in accordance with manufacturer's instructions nad the recommendations of API RP550 to the specified requirements.
Application/ Calibration:	Application, calibration, and set points shall be as specified in paragraph 17200-3.03.

SECTION 17271

SIGNAL CONDITIONING MODULES

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies requirements for panel mounted signal conditioning modules.

1.02 REFERENCES

This section contains a reference to the following document. Additional references are listed in Section 17000. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed document, the requirements of this section shall prevail.

Reference	Title
EIA RS-310C-77	Racks, panels, and associated equipment

1.03 SUBMITTALS

Submittals shall be provided as specified in paragraph 17200-1.03.

PART 2--PRODUCTS

2.01 GENERAL

Unless otherwise specified, signal conditioning modules shall comply with the following requirements:

1. Analog signal inputs shall be 1 to 5 volts DC into 20M ohms.

2. Analog signal outputs shall be 1 to 5 volts DC into 20K ohms.

3. Discrete output contacts shall be SPDT rated 5 amperes at 117 volts AC and 28 volts DC.

4. Power supply be 24 volts DC plus or minus 10 percent. Power supply effect shall not exceed 0.005 percent per 1.0 percent change.

5. Electronic trips shall be arranged so that output contact opens in case of loss of signal or loss of power supply.

6. Modules shall be plug-in circuit boards.

7. Modules shall be rated for continuous operation in an ambient temperature of 0 to 80 degraes C. Ambient temperature effect shall not exceed plus or minus 0.01 percent per degree C within that range.

8. Span and zero adjustments shall be made by front accessible multi-turn potentiometers.

9. Electronic trip modules shall be provided with LED indicators for relay status.

10. Printed circuit card cages shall be suitable for 19-inch EIA RS310C rack or panel mounting as required.

11. Modules shall withstand 30 volts per meter radio frequency radiation between 200 and 500 MHz with not more than 0.25 percent calibration effect. Modules shall also be provided with traps on the terminals to shunt conducted radio frequency interference to ground.

12. Signal and power supply terminals shall be galvanically isolated from the card cage frame.

All modules specified in this section shall be the product of a a single manufacturer and shall be of matching construction to permit unlimited mixing within the card cages.

2.02 INSTRUMENTATION SPECIFICATION (INSTRUSPEC) SHEETS

General requirements for instruments specified in this section are listed on INSTRUSPEC sheets in paragraph 17271-3.03. Application requirements are specified in the instrument schedule, paragraph 17200-3.03, and/or on the drawings.

2.03 PRODUCT DATA

Product data shall be provided as specified in paragraph 17200-2.03.

PART 3--EXECUTION

3.01 INSTALLATION

Signal conditioning modules shall be installed in panels specified in Section 17110.

3.02 TESTING

Testing requirements are specified in paragraph 17200-3.02.

3.03 INSTRUSPEC SHEETS

The following INSTRUSPEC sheets are included in this section:

3.03 INSTRUMENT SPECIFICATIONS SHEET--INSTRUSPEC

Instrument Identification:	YVC
Instrument Function:	Function module
Instrument Description:	Voltage to current isolation amplifier
Power Supply:	24 volts DC
Signal Input:	Standard panel instrument voltage signal
Signal Output:	4 to 20 milliamperes into 0 to 1000 ohms, isolated
Process Connection:	N/A
Product Data:	Accuracy shall be 0.5 percent of span or better, time constant milliseconds or less, temperature drift 0.02 percent of span per degree C or less over a range of 0 to 50 degrees C. POwer supply effect shall not exceed 0.1 percent of span with power supplied provided. Module shall be Moore Industries, AGM Electronics, or equal.
Execution:	
Installation:	Mount and connect in panels specified in Section 17110 in accordance with manufacturer's instructions to the specified functional requirements.

END OF SECTION

SECTION 17274

MINIATURE CASE ELECTRONIC PANEL INSTRUMENTS

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies requirements for panel mounted electronic instruments used to provide process control and interface between the operator and the process.

1.02 REFERENCES

References are listed in Section 17000. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

1.03 SUBMITTALS

Submittals shall be provided as specified in paragraph 17200-1.03.

PART 2--PRODUCTS

2.01 GENERAL

Unless otherwise specified, panel instruments shall comply with the following requirements:

1. Analog instruments shall be miniature-case drawout type nominally 6 inches high by 3 inches deep by not more than 20 inches deep.

2. Operator, tuning, and configuration adjustments shall be accessible without disconnecting the instrument from the process.

3. Analog signal indicators shall be solid-state, LED or gas-discharge type, bar-graph displays with not less than 200 segments.

4. Analog signal inputs shall be 1 to 5 volts DC into not less than 250K ohms.

5. Analog signal outputs shall be 1 to 5 volts DC into 10 ohms except where instrument provides final output signal to field in which case output shall be 4 to 20 mA current regulated into 0 to 600 ohms.

6. Power supply shall be 24 volts DC plus or minus 10 percent.

7. Signal and power supply connections shall be galvanically isolated from the instrument case.

Panel instruments specified in this section shall be the product of a single manufacturer, and shall match and line up to form an integrated appearance and operator interface strategy.

2.02 INSTRUMENT SPECIFICATION (INSTRUSPEC) SHEETS

General requirements for instruments specified in this section are listed on INSTRUSPEC sheets in paragraph 17274-3.03. Application requirements are specified in the instrument schedule, paragraph 17200-3.03, and/or on the drawings.

2.03 PRODUCT DATA

Product data shall be provided as specified in paragraph 17200-2.03.

PART 3--EXECUTION

3.01 INSTALLATION

Operator interface instruments shall be installed on panels specified in Section 17110.

3.02 TESTING

Testing requirements are specified in paragraph 17200-3.02.

3.03 INSTRUSPEC SHEETS

The following INSTRUSPEC sheets are included in this section:

3.03 INSTRUMENT SPECIFICATION SHEET--INSTRUSPEC

Instrument Identification:	KI
Instrument Type:	Miniature-case panel instrument
Instrument Description:	30 volts DC maximum on terminals or 120 volts AC, 60 hertz nominal with cord set and plug
Signal Input:	Standard panel instrument votage signal into 250,000 ohms minimum
Signal Output:	N/A
Product Data:	Indicator shall be buffered solid state type and shall provide for one or two variables on a 4-inch vertical scale with an accuracy of 0.5 percent of span or better.
Execution:	
Installation:	Install in panels specified in Section 17110 in accordance with manufacturer's instructions to the specified functional requirements.

3.03 INSTRUMENT SPECIFICATION SHEET--INSTRUSPEC

Instrument Identification:	KRE
Instrument Type:	Miniature-case panel instrument
Instrument Description:	Recorder station
Power Supply:	30 volts DC maximum on terminals and 24 volts AC for chart drive; or 120 volts AC, 0 hertz nominal with cord set and plug for electronics
Signal Input:	Standard panel instrument voltage siginal into 250,000 ohms minimum
Signal Output:	N/A
Process Connection:	N/A
Product Data:	Recorder shall provide for one to four pens on a 4-inch-wide chart with an accuracy of 0.5 percent, repeatability of 0.2 percent, and deadband of 0.25 percent of span or better. Chart shall provide not less than 15 days recording at 0.75 inch per hour. Chart system shall permit easy inspection and return to the recorder of previously recorded data. Recorders shall display not less than 4 hours of recorded data without withdrawing either the chart or the recorder from the case.
Execution:	
Installation:	Install in panels specified in Section 17110 in accordance with manufacturer's instructions to the specified functional requirements.

END OF SECTION

SECTION 17275

MISCELLANEOUS PANEL INSTRUMENTS

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies requirements for miscellaneous panel mounted instruments used to provide process control and interface between the operator and the process.

1.02 REFERENCES

References are listed in Section 17000. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

1.03 SUBMITTALS

Submittals shall be provided as specified in paragraph 17200-1.03.

PART 2--PRODUCTS

2.01 INSTRUMENT SPECIFICATION (INSTRUSPEC) SHEETS

General requirements for instruments specified in this section are listed on INSTRUSPEC sheets in paragraph 17275-3.03. Application requirements are specified in the instrument schedule, paragraph 17200-3.03, and/or on the drawings.

2.02 PRODUCT DATA

Product data shall be provided as specified in paragraph 17200-2.03.

PART 3--EXECUTION

3.01 INSTALLATION

Instruments shall be installed on panels specified in Section 17110.

3.02 TESTING

Testing requirements are specified in paragraph 17200-3.02.

3.03 INSTRUSPEC SHEETS

The following INSTRUSPEC sheets are included in this section:

3.03 INSTRUMENT SPECIFICATION SHEET--INSTRUSPEC

Instrument Identification:	IC
Instrument Type:	Miscellaneous panel instrument
Instrument Description:	Impulse counter
Power Supply:	24 volts DC
Signal Input:	24 volt DC pulse
Signal Output:	N/A
Process Connection:	N/A
Product Data:	Impulse counter shall be solid-state, C-MOS logic, non-reset type with battery backup and 8-digit LED display. Counter shall be Veeder-Root 7991, Waugh Controls Model 428, or equal.
Execution:	
Installation:	Mount and connect in panels specified in Section 17110 in accordance with manufacturer's instructions.

3.03 INSTRUMENT SPECIFICATION SHEET--INSTRUSPEC

Instrument Identification:	ISS
Instrument Type:	Miscellaneous panel instrument
Instrument Description:	Solid state indicator
Power Supply:	24 volts DC
Signal Input:	1 to 5 volts into 40K ohms minimum
Signal Output:	N/A
Process Connection:	N/A
Product Data:	Indicator shall be a 200-segment vertical bar graph type, red LED display, approximately 4 inches in length. Resolution shall be plus or minus 0.5 percent of span, and calibrated accuracy shall be plus or minus 1.0 percent of span or better. Indicators shall be suitable for group mounting. Indicator shall be Sigma Instruments 9270, Crompton Instruments 264, or equal.
Execution:	
Installation:	Mount and connect in panels specified in Section 17110 in accordance with manufacturer's instructions.

END OF SECTION