

SECTION 11235CHEMICAL FEED PUMPING SYSTEMPART 1 - GENERAL1.1 DESCRIPTION

- A. Work Included: Furnish, install, test, and place into satisfactory operation pumping equipment and associated appurtenances for an aqueous disinfection system and an aqueous dechlorination system as well as shown on the Drawings and as specified herein, including the following:
1. Fourteen (14) chemical feed pumps.
 2. Miscellaneous related items specified within.
- B. Related Work Specified Elsewhere:
1. Additional General Equipment Requirements specified in Section 11000.
 2. Piping and tubing specified in Division 11.
 3. Instrumentation is specified in Division 13.
 4. Storage Tanks are specified in Section 11236.
 4. Chemical Feed and Sample System Tubing is specified in 15065.
 5. Valves are specified in Section 15118.
 6. Electrical work is specified in Division 16.
- C. Description of Systems:
1. Disinfection System:
The disinfection system consists of eight chemical feed pumps which withdraw liquid sodium hypochlorite from four bulk storage tanks and discharge to five locations.
 - a. Secondary effluent and bypass flows will be disinfected by pumping sodium hypochlorite into the secondary and primary chlorine contact tank influent chambers as shown on the Drawings, and mixing the sodium hypochlorite with the effluent by the use of existing submersible induction mechanical mixers. Three (3) pumps are dedicated to the secondary side and three (3) pumps are dedicated to the primary side.
 - b. Sodium Hypochlorite will be pumped and injected into two existing return activated sludge force mains located in the Activated Sludge Pump Gallery. Two (2) pumps are dedicated to this purpose.
 - c. Delivery of sodium hypochlorite for backup chlorination shall be accomplished by injecting sodium hypochlorite into a new carrier water line that has been extended into the Hypochlorite Building. This sodium hypochlorite solution will then be discharged to the backup chlorination point at the effluent meter structure via a combination of new and existing piping.
 2. Dechlorination System:
The dechlorination system consists of six chemical feed pumps which withdraw liquid sodium bisulfite from two bulk storage tanks and discharge to two locations.

- a. Delivery of sodium bisulfite shall be accomplished by pumping sodium bisulfite into an existing carrier water line that has been extended into the Bisulfite Building. This sodium bisulfite solution will then be discharged to each of the two dechlorination chambers through an existing diffuser and via a combination of new and existing piping. Three (3) pumps are dedicated to the secondary side and three (3) pumps are dedicated to the primary side.

1.2 QUALITY ASSURANCE

A. General:

1. The disinfection and dechlorination system as specified herein shall be supplied by one manufacturer who shall supply all equipment and appurtenances regardless of manufacturer and shall be responsible to the Contractor for performance of the entire system. System supplier shall have a minimum of 5 years experience design and manufacturer of disinfection systems.
2. The Specifications and Drawings direct attention to certain required features of the disinfection and dechlorination systems equipment and materials of construction, but do not purport to cover all details entering into its design. Nevertheless, the Contractor shall furnish all materials and equipment complete in all details and ready for operation for the intended purpose.
3. All equipment and accessories shall be the manufacturer's latest and proven design.
4. All parts of the equipment shall be amply proportioned for long, continuous, and uninterrupted service.
5. Suitable provisions shall be made for easy access for service and replacement of parts.

B. Acceptable Manufacturer:

1. Watson Marlow Bredel, Wilmington, MA.

1.3 SUBMITTALS TO THE ENGINEER

A. The Contractor shall submit the following for Engineer's review:

1. Complete layout drawings illustrating all construction details and dimensions including any manufacturer instructions on installation or handling.
2. Shop drawings, manufacturers' literature, maintenance data, operating instructions, and a list of maintenance materials as specified in the General Conditions and specification Sections 01340 and 11000 of the Contract Documents. (Chemical feed pumping system manufacturer shall integrate all required shop drawings into a common submittal package.)
3. Calculations as specified herein.

1.4 GUARANTEE

- ### A. The Contractor shall obtain a warranty by the manufacturer, in the name of the Owner, in strict accordance with Section 11000 and the General Conditions.

PART 2 - PRODUCTS

2.1 SCOPE OF WORK

- A. Provide fourteen (14) chemical feed pumps as specified herein.
- B. Provide variable frequency drives (VFD) that are capable of providing the high turn down ratio (100:1). VFD's and pump motors shall be fully compatible with each other. The VFD's shall be provided by the pump manufacturer to insure that the pump manufacturer has full responsibility providing a complete and fully operating system over the specified range of flow. The VFD's for the sodium bisulfite feed pumps are integrated onto the pump system. The VFD's, for the sodium hypochlorite pumping systems, are independent of the pump and shall be mounted in a single panel by others. VFD's shall be manufactured by Toshiba as specified in Division 16.
- C. Provide VFD's for the sodium hypochlorite feed pumps to the Contractor for installation, by the Systems Integrator in Division 13, into a single VFD panel. A total of eight (8) VFD's are to be provided.
- D. Provide any special tools required for changing pumping tube elements.
- E. Provide all appurtenances necessary to connect pump tubing to hard pipe.

2.2 SODIUM HYPOCHLORITE PUMPS

A. Pump Description

- 1. Pumps shall be positive displacement peristaltic type complete with retractable roller pump-head, close coupled gearbox, a high turn down (100:1) variable frequency drive (VFD) compatible motor, and flexible extruded tube elements.
- 2. Peristaltic pumping action is created by the compression of the flexible tube between the pump-head rollers and outer track. The rotation induces forward fluid displacement within the tube by the rotation of the pump rotor. The tube restitution after the roller passes creates a subsequent vacuum in the suction side drawing fluid to the pump head.
- 3. Pumps shall be dry self priming, capable of being run dry without damaging effects to pump or tube, and shall have a maximum suction lift capability of up to 30-feet of vertical water column.
- 4. Pumps, drives and tubing elements shall be able to pump the specified capacity at a maximum pressure of 30 psi with TL "Load Sure" tube elements.
- 5. Pumps shall use no check valves or diaphragms and shall require no dynamic seals in contact with the pumped fluids. Process fluid shall be contained within pump tubing and shall not directly contact any rotary or metallic components.
- 6. Flow shall be in the direction of the rotor rotation. Rotation can be reversed and shall be proportional to rotor speed.

B. Quality Assurance

- 1. Pumps to be the manufacturer's standard product.
- 2. Motor, gear reducer and pump-heads shall have a two (2) year manufacturer's warranty from date of substantial completion.
- 3. Pumps shall be manufactured under ISO 9001.

C. Sodium Hypochlorite Pump Schedule

Pump Group	Secondary Disinfection	Bypass Disinfection	RAS Disinfection
Application	Sodium Hypochlorite	Sodium Hypochlorite	Sodium Hypochlorite
Pump Series	Series 621 Close Coupled	Series 621 Close Coupled	Series 621 Close Coupled
Pump Type	Simplex Pump Heads	Simplex Pump Head	Simplex Pump Head
Speed Type	Variable Speed	Variable Speed	Variable Speed
Roller Number	2 rollers per head	2 rollers per head	2 rollers per head
Pump Model No.	621V-RE by Watson-Marlow	621V-RE by Watson-Marlow	621V-RE by Watson-Marlow
Quantity	Three (3) each	Three (3) each	Two (2) each
Tag Number(s)	HYP-1, HYP-2, HYP-3	HYP-4, HYP-5, HYP-6	RAS-HYP-1, RAS-HYP-2
Fluid	Bleach, NaOCl	Bleach, NaOCl	Bleach, NaOCl
Type/concentration	12.5% Trade Strength	12.5% Trade Strength	12.5% Trade Strength
Specific Gravity	1.21	1.21	1.21
Fluid Temperature	50 to 80° F	50 to 80° F	50 to 80° F
Indiv. Pump Capacity:			
	Max 2.75 GPM	3.13 GPM	1.0 gpm
	Min 0.0275 GPM	0.031 GPM	0.01 gpm
Gearbox RPM range	1.8 - 180 rpm	2.0 - 200 rpm	1 - 102 rpm
Pressure at Discharge	12 PSI	12 PSI	12 PSI
Suction Head	10-feet	10-feet	10-feet
Tubing Diameter ID	17 mm	17 mm	12 mm
Tubing Wall Thick	4 mm	4 mm	4 mm
Tubing Material	Marprene TL	Marprene TL	Marprene TL
Tubing Style	Load Sure TL with fittings	Load Sure TL with fittings	Load Sure TL with fittings
Tubing W. P. Rating	30 PSI	30 PSI	30 PSI
Tubing End Fittings	¾" Male Cam & Groove Fittings, Quick Disconnect	¾" Male Cam & Groove Fittings, Quick Disconnect	¾" Male Cam & Groove Fittings, Quick Disconnect
Fitting Material	Polypropylene	Polypropylene	Polypropylene
Power (VAC, Phase Frequency)	480 VAC, 3PH, 60 HZ	480 VAC, 3PH, 60 HZ	480 VAC, 3PH, 60 HZ
Motor Size	¾ HP	¾ HP	¾ HP

D. Pump Construction

1. Pump-head

- Pump-head shall consist of a fixed track with tool lockable hinged guard door.
- Pump-head door shall have two clear windows for viewing of rotation direction. When closed, pump door shall seal against the pump track for leak containment and controlled waste through the pump-head waste port in the event of a tube failure.
- Rotor assembly shall be equipped with four compression rollers which shall be retractable for tube loading and flushing cycles. Compression rollers shall be located 90 degrees apart for compression of the tube against the track four times per rotor revolution. One roller shall at all times be fully engaged with the tubing providing complete compression to prevent backflow or siphoning.

Occlusion gap shall come factory set to accommodate 4.0 mm wall thickness tube elements.

- d. The rotor assembly shall be close coupled to the output shaft of the drive gear motor by a 19 mm keyed shaft and shall be axially secured to the shaft by a through center retaining screw. Pump-head track shall be secured to the drive via two slotted screws and shall be self locating.
2. Material of Construction
 - a. Track: Aluminum, Trimate polyester powder coat, electrostatically applied and baked
 - b. Door:
 - 1) Inner Shell: Grilamid TR55
 - 2) Outer Shell: shock resistant Polyurethane
 - 3) Door Seal: Silicone
 - 4) Drain Port Adapter: Acetyl
 - c. Rotor:
 - 1) Hub & Roller Arms: Fortron 1140L4 (PPS)
 - 2) Hub Cover: Dupont Hytrel 65544
 - 3) Main Rollers: 304SS
 - 4) Main Roller Bearings: Carbon Steel (sealed)
 - 5) Guide Rollers: Nylatron
 - 6) Hardware & leaf springs: 304SS
- E. Tubing
1. Pump shall be supplied with a Load Sure tubing element with molded end fittings which shall be self locating when fitted into the pump-head.
 2. Tube element shall be in contact with the inside diameter of the track (housing) through an angle of 180 degrees and be held in place on the suction and discharge by the tubing element end fittings.
 3. The tubing shall be replaceable with no disassembly of the pump-head other than opening the cover and adjusting the rollers.
 4. Tubing Material of Construction:
 - a. Tube: Marprene II, 12 or 17 mm ID x 4.0 mm wall thickness as noted in the Pump Schedule.
 - b. TL Style Element: 73 Shore A durometer
 - c. If required for chemical compatibility, pump manufacturer shall recommend an alternate tubing material.
 5. Molded polypropylene fittings consisting of 3/4" Male Cam & Groove quick disconnects shall be factory installed to each end of the pumping tube element with corrosion resistant permanently fixed banding.
 6. Supply one tube element of the specified size per pump head. See section on spare parts for additional elements to be provided.
- F. Drive
1. Gear reducer:
 - a. Gear reducer shall be double reduction helical in line gearing with a housing constructed of SAE Class 30 cast iron.

- b. Gear reducer output shall have NEMA C-face adapter between gear reducer and motor.
 - c. Gearing shall be manufactured to AGMA Class 11 &12 requirements with an overall gearbox rating of AGMA Class II under continuous operation.
 - d. Minimum efficiency shall be 95%.
2. Motor - see Section 11000 for additional requirements.
 - a. The motor shall be a TEFC Design B, Class F insulation, 1.15 motor service factor, 4 pole, 460VAC, 60 Hz, 3 phase, specifically designed for variable frequency drive inverter duty with a high reduction ratio.
 - b. Horsepower shall be as listed in the chemical feed pump schedule
 - c. Motor shall be able to be started automatically after a power outage
 3. Mounting: The gear reducer and motor shall be mounted to epoxy coated aluminum mounting baseplate.

2.3 SODIUM BISULFITE PUMPS

A. Pump Description

1. Pumps shall be positive displacement peristaltic type complete with spring-loaded pump head, self-contained variable speed drive, and flexible extruded tube as specified.
2. Peristaltic pumping action is created by the compression of the flexible tube between the pump head rollers and track, induced forward fluid displacement within the tube by the rotation of the pump rotor, and subsequent vacuum-creating restitution of the tube.
3. Pumps shall be dry self-priming, capable of being run dry without damaging effects to pump or tube, and shall have a maximum suction lift capability of up to 30' vertical water column. Maximum pressure rating: 30 psi.
4. Pump shall not use check valves or diaphragms and shall not require dynamic seals in contact with the pumped fluid. Process fluid shall be contained within pump tubing and shall not directly contact any rotary or metallic components.
5. Flow shall be in the direction of the rotor rotation, which can be reversed and shall be proportional to rotor speed.

B. Quality Assurance

1. This specification is the basis for design of peristaltic metering pumps. All pumps, whether named as an acceptable supplier or submitted as an equal must, at a minimum, meet the following critical design requirements.
2. To maximize pump efficiency and minimize tube fatigue that will impact life, performance, and accuracy, pumps must be designed not to exceed the specified P/10 ratio (Theoretical maximum number of occlusions per 10 gallons pumped). Pumps exceeding the specified P/10 ratio, will not be considered suitable for the duty condition. The following criteria is set to maintain the P/10 of ratio for the tube size specified for this application:
 - a. Maximum two compressing rollers for two compressions per revolution.
 - b. Tube wall thickness of 2.4 mm and material specified
 - c. Large diameter spring-loaded roller set for 2.4mm wall thickness tubing

- d. Max base drive speed of 220 RPM for 2.4mm wall thickness tubing.
 - e. Track geometry of no less than 180 degrees and rotor geometry with roller 180 degrees apart.
3. P/10 ratio shall be as specified in Pump Schedule; Contractor shall provide calculations verifying P/10 ratio.
 4. Drive and pump heads shall be 24 hr continuous duty rated and have a three-year manufacturer's warranty from date of shipment.
 5. Pumps to be manufacturer's standard product.
 6. Pumps must be manufactured under ISO 9001-2000.
 7. Pumps shall be meet all applicable CE and C ETL US standards per UL610101A
- C. Sodium Bisulfite Pump Schedule

Pump Group No.	Secondary Dechlorination	Bypass Dechlorination
Application	Sodium Bisulfite	Sodium Bisulfite
Pump Series	Series 520	Series 520
Pump Type	Simplex Pump Head	Simplex Pump Head
Speed Type	Variable Speed	Variable Speed
Roller Number	2 rollers per head	2 rollers per head
Pump Model No.	520DuS/R2 by Watson-Marlow	520DuS/R2 by Watson-Marlow
Quantity	Three (3) each	Three (3) each
Tag Number(s)	DEC-1, DEC-2, DEC-3	DEC-4, DEC-5, DEC-6
Fluid	NaHSO ₃	NaHSO ₃
Type/concentration	38% Solution	38% Solution
Specific Gravity	1.35	1.35
Fluid Temperature	55 to 80° F	55 to 80° F
Indiv. Pump Capacity:		
Max	0.30 gpm	0.30 gpm
Min	0.003 gpm	0.003 gpm
Gearbox RPM range	0.1 - 220 rpm	0.1 - 220 rpm
Max Pressure at Discharge	25 psi	25 psi
Suction Head	8-feet	8-feet
Tubing Material	Marprene	Marprene
Tubing ID	6.4 mm	6.4 mm
Displacement/Revolution (gallons)	0.0017	0.0017
P/10 Ratio	11,570	11,570
Power (VAC, Phase, Freq)	120VAC, 1 PH, 60 Hz	120VAC, 1 PH, 60 Hz
Motor Size	135 VA	135 VA

D. Pump Construction

1. Pump-head

- a. Pump head shall consist of a fixed track, a hinged guard door, two spring-loaded tube clamp mechanisms, and spring-loaded roller rotor assembly.

- b. Pump tubing shall be in contact with the inside diameter of the track through an angle of 180 degrees and be held in place on the suction and discharge by a spring loaded self-adjusting clamp mechanism.
- c. At all times, one roller shall be fully engaged with the tubing providing complete compression and preventing back flow or siphoning.
- d. Tube occlusion and spring tension shall be factory set to accommodate 2.4mm wall thickness tubing and shall not require adjustment for accommodating tubing of 1.6mm to 9.6mm ID.
- e. Pump head Assembly
 - 1) Pump Track Geometry must have a minimum 96.6mm swept diameter through a minimum track angle of 180 degrees
 - 2) Provide high corrosion/impact materials as specified
 - a) Track Construction: polyphenylene sulfide
 - b) Guard Construction: hinged impact-resistant polycarbonate breakaway guard, tool un-lockable for operator safety.
 - c) Rotor Construction: polyphenylene sulfide
- f. Tube Retainer Mechanism
 - 1) Provide two spring-loaded adjustable tube retainer mechanism to secure the tubing at the entry and exit points of the pump head
- g. Rotor Assembly
 - 1) Provide rotor assembly that ensures gradual tube occlusion and compensates for tube tolerance:
 - a) Twin spring-loaded roller arms located 180 degrees apart, each fitted with stainless steel helical springs and compressing roller for occlusion of the tube twice per rotor revolution
 - 2) Compressing Rollers: 316 stainless steel with low friction stainless steel bearings and PTFE seals, minimum diameter of 18mm
 - a) Provide non-compressing guide rollers constructed of corrosion resistant Nylatron
 - 3) Clutch: Equip rotor with a central handgrip hub and manually activated clutch to disengage the rotor from the drive for manual rotor rotation during tube loading. Clutch shall automatically reengage rotor to gearbox upon one complete revolution.
 - 4) Mounting: To prevent slip, the rotor assembly shall be axially secured to the dogged output shaft of the gear motor via a slotted collet and central retaining screw.
 - 5) Pump heads requiring disassembly or special tools for tube changing are not acceptable.

E. Tubing

- 1. Pump head shall accept tubing sizes 1.6mm, 3.2mm, 4.8mm, 6.4mm, 8.0mm and 9.6mm with 2.4mm wall thickness and materials including, Marprene, Bioprene, Silicone, Sta-Pure & Chem-Sure. Pumps that require tools for adjustment or changing pump heads to accept different tubing materials or sizes are not acceptable.

2. Pump tubing shall be constructed of Marprene II, a thermoplastic elastomer with 64 Shore A durometer and minimum 2.4 mm wall thickness. If required for chemical compatibility, pump manufacturer shall recommend an alternate tubing material.
 3. Supply one 15-meter roll of specified tubing size for each different chemical service. For hydraulic stability, tubing with a wall thickness less than 2.4mm is not acceptable.
 4. Molded polypropylene fittings consisting of appropriately sized male Cam & Groove quick disconnects shall be factory installed to each end of the pumping tube element with corrosion resistant permanently fixed banding.
 5. Supply one tube element of the specified size per pump head. See section on spare parts for additional elements to be provided.
- F. Drive
1. Rating: Continuous 24 hour operation, 40°C ambient.
 2. Supply: 110-120V 50/60 Hz and 220-240V 50/60 Hz, 1-Phase field switchable. 3. Supply nine-foot length main power cord with standard 115V three-prong plug.
 4. Max drive power consumption: 135VA.
 5. Enclosure: NEMA 4X
 6. Housing: Pressure cast aluminum with Alocrom pre-treatment and exterior grade corrosion resistant polyester powder coat. By nature of the environmental conditions, unpainted housings, including 316SS, are not acceptable.
 7. Pumps must meet the following minimum requirements for operator interface functionality. Pumps not meeting this minimum functionality will not be accepted.
 - a. Backlit graphical LCD capable of up to four lines of text with up to 16 characters per line to display pump speed, running status, flow rate, and programming instructions
 - b. Keypad for start, stop, speed increment, speed decrement, forward/reverse direction, rapid prime, and programming.
 - c. Menu driven on screen programming of manual or auto control, flow and remote signal calibration, and general programming.
 - d. Programmable “Auto Restart” feature to resume pump status in the event of power outage interruption.
 - e. Programmable “Keypad Lock” to allow operator lockout of all keys except emergency start/stop.
 - f. Programmable “Maximum Speed” to allow operator to set the maximum speed of the pump within 0.1-220 rpm.
- G. Supply auto control features to meet the following minimum functionality requirements for use with the SCADA system. Pumps not meeting this minimum functionality will not be accepted.
1. Remote Control Inputs
 - a. Speed Control:
 1. Primary Analog 4-20mA or 0-10VDC speed input, with input signal trimmable and speed scaleable over any part of the drive speed range.

2. Secondary Analog 4-20mA or 0-10VDC scaling input, with input signal trimmable and programmable scaling factor.
3. Provisions for alternative remote accessory potentiometer (if supplied by others) for primary speed control or secondary speed scaling.
- b. Start/Stop Control: via 120 VAC input- Configurable command sense allowing open to equal run or open to equal stopped. Configurable to be a keypad start/stop override in Manual mode
- c. Forward/Reverse Control: via 120 VAC input
- d. Auto/Man Mode Control: via 120 VAC input
2. Status Outputs
 - a. Four relay contacts rated for a maximum current of 2A at 120V, NO or NC software configurable to indicate the following:
 1. Running/Stopped status
 2. Forward/Reverse status
 3. Auto/Manual status
 4. General Alarm status
 - b. Speed output – Analog 4-20mA or 0-10 VDC
3. Accepts RS485 data protocol
4. Termination: supply screw down terminals suitable for up to 18 AWG field wire and accessible through four glanded cable entry points on the pump
- H. Drive motor- brushless DC motor with integral gearbox and tachometer feedback.
 1. Speed Control Range of 2200:1 from 0.1 to 220 rpm +/- 0.1 rpm throughout the range.
 2. Closed loop microprocessor controlled drive with pulse width modulation at speeds above 35 rpm and synchronous mode with magnetic field rotation control below 35 rpm
 3. Circuitry complete with temperature and load compensation and protection.
- I. Mounting: Drive shall be self-supporting and shall not require anchoring.

2.4 APPURTENANCES

A. Chemical Feed Line Connecting Tubing

1. Pump manufacturer shall supply the necessary length of reinforced PVC flexible hose for connection of pump to the process lines. The PVC flexible hose shall have a polypropylene female cam & groove quick disconnect fitting factory installed at each end with the same clamping system as used for attaching the pumping tubing to the male cam and groove end. One end of the connecting tubing female cam and groove connector shall connect to the pump's male cam and groove connectors on both the suction and discharge. The connecting hose shall make a loop and the other female end shall connect to the fixed rigid PVC suction and discharge piping with a male cam and groove fitting. The male cam and groove fitting attached to the rigid piping shall be provided by the pump manufacturer so that it mates to the female end properly and installed by the chemical feed system piping contractor. Provide two hose assemblies with the

two female cam and groove connectors and two loose male connectors for each pump head.

2. All connecting hose assemblies shall have male NPT for connection to the Schedule 80 PVC piping.
- B. Pressure Relief Valves and Pulsation Dampers:
1. Provide PVC discharge pressure relief and regulating valves, isolation valves and pulsation dampeners as shown on the Drawings, and as specified hereinafter. All components shall be compatible with the chemical handled. Sodium hypochlorite system shall be provided with Viton gaskets and seals; and sodium bisulfite system shall be provided with EPDM gaskets and seals.
 2. Pulsation dampeners: Provide pulsation dampeners for the sodium hypochlorite discharge piping. Provide a 175 cubic inch Sentry II plastic dome top chargeable pulsation dampener with Viton Bladder. Inlet size 2-inch pipe to be bushed down to ¾-inch Schedule 80 pipe. Unit shall be equipped with pressure gage and gas fill valve. Model No. C911V by Blacoh Fluid Control Moreno Valley CA. Install mount unit with pressure gage mounted down and inlet mounted up so off gasses from the bleach can rise out of the dampener and vent to the high point in the discharge piping. Provide with PVC isolation gate valve.
 3. Pressure Relief and Pressure Regulating Valves: All PVC top and bottom body construction ¾-inch pipe size; adjustable release pressure from 10 to 150 PSI; Viton Diaphragm; all stainless steel fasteners. NPT connection shall be provided. Over pressure shall release through vent line back to suction side piping and vent piping from calibration column. Griffco Valve Inc. or equal

PART 3 - EXECUTION

3.1 INSTALLATION

- A. In accordance with Sections 11000 and 01800.
- B. All equipment furnished under this specification shall be suitable for installation as shown on the contract drawings. The Contractor shall be responsible for determining any restrictions that may prevent the use of any piece of equipment as well as determining the necessary clearances and headroom required to move and install all equipment to its final location.
- C. Installation shall be in strict accordance with the system Manufacturer's instructions and recommendations. Equipment shall be placed in the locations shown on the drawings.
- D. Guy wires, anchor bolts, and other hardware required for installing equipment shall be provided by the Contractor.
- E. The Contractor shall provide material and labor for any plumbing, electrical wiring, and similar incidentals that may be necessary to complete installation of the equipment specified in this section.

3.2 START-UP

- A. Contractor shall refer to Section 01800 for further information.
- B. The Contractor shall assume full responsibility for the furnishing of suitable chemical reagents to accomplish the guaranteed disinfection and dechlorination specified herein.
- C. Startup and acceptance tests shall be done to demonstrate that the equipment is capable of performing its specified functions in a satisfactory manner without mechanical defects or operational difficulties. All defects and defective equipment revealed by or noted during the test shall be corrected or replaced promptly at no additional cost to the owner.
- D. The Manufacturer shall furnish the services of a qualified factory trained representative, who has complete knowledge of the system and its components, to inspect the final installation, to supervise initial start-up and operation, and to train operating personnel in the proper operation and maintenance of the system. Manufacturer's services will be provided for a minimum of one (1) eight-hour day. More days as required to satisfactorily inspect, start-up, place system into operation and train operating personnel shall be provided at no additional cost to the Owner.
- E. The contractor shall guarantee all workmanship and materials furnished under this item as specified in the General Conditions.

3.3 SPECIAL TOOLS AND SPARE PARTS:

- A. All special tools required for normal operation and maintenance of the equipment shall be furnished with the equipment by the Manufacturer. The Operation and Maintenance Manual shall identify each such tool and where it is used.
- B. Spare parts shall be furnished in quantities as follows:
 - 1. Sodium Hypochlorite Pumps:
 - a. Chemical Pump Head Assembly and Rotor 8 sets
 - b. Load Sure TL Pumping Elements with Fittings 16
 - c. Chemical Pump Connecting Assemblies 8
 - 2. Sodium Bisulfite Pumps:
 - a. Pump Head Assembly 6
 - b. Tubing Elements with Fittings 6
- C. Spare parts shall be packed in containers which are suitable for storage and which are clearly labeled with indelible markings that indicate the part number and the name of the part contained therein.

END OF SECTION