

SECTION 13253 - PACKED TOWER TYPE CHEMICAL ODOR CONTROL SYSTEMS

City of San Diego, CWP Guidelines

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NTS: Portions of this Section, pertaining to the FRP tanks (design, fabrication, installation, testing, etc.) must be reviewed by the FRP engineer retained by the Design Consultant. See Section 06610 for selection and qualifications of the FRP engineer.

Further, Design Consultant shall combine this Section with other appropriate odor control Specifications (e.g., Section 13251 - Activated Carbon Odor Control Systems) to create a system specification with unit responsibility for the entire odor control system. The system specification shall cover all related instrumentation and controls, pumps and piping, ductwork, and other accessories.

Design Consultant may have to reorganize the tables in this Section depending upon the number of odor control systems on the project and the best method of presenting all the needed information.

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PART 1 -- GENERAL

1.1 WORK OF THIS SECTION

- A. The WORK of this Section includes providing odor control systems consisting of all piping, tankage, media, ductwork, valves, control panels, pumps, compressors, fans, instrumentation, conduit, wiring, and other appurtenances necessary for complete and operable systems.
- B. The WORK also includes coordination of design, testing and installation.
- C. The WORK also requires that one manufacturer be made responsible for furnishing the WORK of this Section, but without altering or modifying the CONTRACTOR'S responsibilities under the Contract Documents.
- D. To facilitate the interchangeability of spare parts, all similar components for the systems, such as the foul air fans, air compressors, and chemical feed pumps, shall be the products of a single manufacturer.

1.2 RELATED SECTIONS

- A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.

1. Section 06610 Glass Fiber and Resin Fabrications
2. Section 11000 Equipment General Provisions
3. Section 11175 Pumps, General

4. Section 11261 Metering Pumps
5. Section 13209 Fiberglass Reinforced Plastic Tanks
6. Section 15855 Air Handling and Moving Equipment
7. Section 15860 FRP Ductwork

1.3 SPECIFICATIONS AND STANDARDS

A. Except as otherwise indicated, the current editions of the following apply to the WORK of this Section:

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| 1. | ANSI/AWS D1.1 | Structural Welding Code-Steel |
| 2. | NBS PS 15 | Custom-Contact-Molded Reinforced Polyester Chemical-Resistant Process Equipment |
| 3. | AISC-1978 | Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings |
| 4. | ASTM A 325 | Specification for High-Strength Bolts for Structural Steel Joints |
| 5. | ASTM A 490 | Specification for Heat-Treated Steel Structural Bolts 150 ksi (1035 MPA) Tensile Strength |
| 6. | ASTM C 581 | Practice for Determining Chemical Resistance of Thermosetting Resins Used in Glass Fiber Reinforced Structures Intended for Liquid Service |
| 7. | ASTM D 638 | Test Method for Tensile Properties of Plastics |
| 8. | ASTM D 695 | Test Method for Compressive Properties of Rigid Plastics |
| 9. | ASTM D 790 | Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials |
| 10. | ASTM D 883 | Definitions of Terms Relating to Plastics |
| 11. | ASTM D 2563 | Recommended Practice for Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts |
| 12. | ASTM D 2583 | Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor |
| 13. | ASTM D 2584 | Test Method for Ignition Loss of Cured Reinforced Resins |

- 14. ASTM D 3299 Specification for Filament-Wound Glass Fiber Reinforced Thermoset Resin Chemical-Resistant Tanks
- 15. NFPA 255 Method of Test for Surface Burning Characteristics of Building Material

1.4 SHOP DRAWINGS AND SAMPLES

A. The following shall be submitted in compliance with Section 01300:

1. Shop Drawings:

- a. Shop drawings showing dimensions of the complete system, instrumentation, electrical service, duct and water and drain connections, routing and materials of chemical solution piping.
 - b. Materials and equipment list.
 - c. Structural calculations and drawings for the scrubber vessels, loads, and deflection of the vessel at the point of connection to the ductwork, wall thickness, anchor bolt size and location; ladder and platform design, and location of lifting hooks. Also, calculations showing that the vessels and other equipment shall withstand an earthquake in Seismic Zone 4 and sustained wind load of [50] pounds per square foot. All structural drawings and calculations shall be stamped and signed by a registered structural engineer experienced in the design of plastic and fiberglass structures. The CONSTRUCTION MANAGER will review the structural drawings and calculations for completeness only.
2. References: Information on at least one successfully performing odor control system of comparable size and complexity the manufacturer has supplied in the recent past, with contact names, addresses, and telephone numbers.
3. Samples: A representative sample of the vessel laminate for approval of surface finish and visual defects. The fabricated WORK shall be identical in surface finish and visual quality.

1.5 OWNER'S MANUAL

A. The following shall be included in the OWNER'S MANUAL in compliance with Section 01300:

1. **Certificates:** Certificates from the FRP ductwork supplier that:

- a. The type of resin used has been tested in accordance with ASTM C 581 and is compatible with an environment consisting of air, caustic, hydrogen sulfide gas, methane, aromatic hydrocarbon vapors, droplets of salt water, and droplets of water containing sodium hypochlorite, hydrogen peroxide, sodium hydroxide, and sulfuric acid.
- b. The type of fiberglass used has a flame spread rating of 25 or less and a smoke developed rating of 50 or less as measured in accordance with NFPA Standard No. 255.
- c. The ductwork meets the deflection requirements under the vacuum pressure and hoop loading indicated herein.

2. A certificate from the vessel manufacturer listing the name, composition, and characteristics of the resin.

1.6 FACTORY TESTING

- A. **Inspection and Testing Requirements:** The CONSTRUCTION MANAGER reserves the right to reject delivery of any pieces of equipment found, upon inspection, to have any blisters, chips, crazing, exposed glass, cracks, burned areas, dry spots, foreign matter, surface porosity, sharp discontinuity or entrapped air at the surface of the laminate. Any item which does not satisfy the tolerances indicated below shall be rejected.

FRP PRODUCT TOLERANCES

Defect	Inside Surface	Outside Surface
Blister	None	Max dimension: 1/4-in dia x 1/8 in high Max density: 1 per sq ft Min separation: 2 in apart
Chips	None	Max dimension of break: 1/4-in and thickness no greater than 10 percent of wall thickness Max density: 1 per sq ft
Crazing	None	Max length: 1/2 in Max density: 5 per sq ft Min separation: 2 in
Cracks	None	None
Exposed Glass	None	None
Scratches	None	Max length: 1 in Max depth: 0.010 in
Burned Areas	None	None
Surface Porosity	None	None
Foreign Matter	None	None
Sharp Discontinuity	None	None
Pits	Max 1/8 in, dia by 1/32 in deep Max: 10 per sq ft	Max 1/8 in dia by 1/16 in deep Max: 10 per sq ft
Dry Spot	None	2 sq in per sq ft

Entrapped Air	None at the surface 1/16 in and 10 per sq in max within laminare	1/8 in and 4 per sq in or 1/16 in and 10 per sq in
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- B. Notification of the fabrication schedule must be given to the CONSTRUCTION MANAGER at least two weeks in advance of any exterior gel coating (or equivalent) of the vessel . The CONSTRUCTION MANAGER reserves the right to be present at the fabricators facility for visual inspection of equipment to be supplied.
- C. Prior to shipment, all vessels must be smoke-tested at a pressure of one psi and held for a minimum of one hour, with no visible signs of leaks or excessive wall deflection. The CONSTRUCTION MANAGER reserves the right to be present at the fabricator's facility during testing and shall therefore be notified of test schedule at least 2 weeks in advance.

1.7 SERVICES OF MANUFACTURER

- A. **Startup Assistance:** The startup of each odor control facility shall be accomplished under the supervision of an experienced startup engineer from the manufacturer. The startup engineer shall be at the jobsite for a minimum of [5] working days to inspect the installation of each system, and direct the startup of each system. The startup engineer shall furnish a written certification that each system is correctly installed, with all indicated and required components, and that each is capable of meeting the specified performance requirements. This written certification shall be submitted to the CONSTRUCTION MANAGER prior to the startup of any system.
- B. **Performance Test:** The CONTRACTOR shall furnish an experienced manufacturer representative to perform the [3] day performance test on the project site.
- C. **Instruction of OWNER'S PERSONNEL:** The CONTRACTOR shall furnish the services of a trained, qualified representative of the equipment manufacturer for each piece of equipment for at least [2] days after units are put in proper working order, for the purpose of inspecting the installation and instructing the OWNER'S operating personnel.

1.8 QUALIFICATIONS

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NTS: In the paragraph below, define the terms "comparable size and complexity" for the equipment or system specified. Requiring experience of more than one successful project requires sound justification and prior written approval from the City Project Manager.

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- A. **Manufacturer:** Company specializing in odor control systems of the type and size indicated with at least one successfully performing system of comparable size and complexity manufactured in the recent past. System of comparable size and complexity shall have the following characteristics: [].

PART 2 -- PRODUCTS

2.1 GENERAL

- A. **Process Description:** The CONTRACTOR shall provide equipment which utilizes chemical [absorption] and [adsorption] processes for removal of odors. Foul air from the plant process facilities shall be delivered to a scrubber vessel of the countercurrent-flow packed tower type. [Sodium hypochlorite] [Sodium hydroxide] [hydrogen peroxide] shall be introduced into the scrubber vessel at indicated location(s). The equipment provided shall be designed to provide a minimum of [99] percent removal of H₂S in the foul air stream, and [] percent of odor units.
- B. Equipment and facilities indicated on the drawings are based on equipment typically provided by one manufacturer []. Any design changes necessitated by the selection of another approved manufacturer shall be the CONTRACTOR's responsibility, and all design and construction costs associated with any such changes shall be borne by the CONTRACTOR. All design changes shall be subject to review and approval by the CONSTRUCTION MANAGER.
- C. If the CONTRACTOR desires to use the system of a manufacturer other than those listed, it shall submit to the CONSTRUCTION MANAGER operational or pilot test data indicating the successful operation of the alternative odor control equipment in wastewater treatment facilities. Such data shall be submitted to the CONSTRUCTION MANAGER for review prior to the submittal of equipment shop drawings. The alternative manufacturer's system design shall be similar to that which is successfully demonstrated in other wastewater treatment facilities by pilot testing or full-scale operational data; however, in no case shall scrubber vessel detention times and construction materials be less than those specified, nor shall the capacities of the chemical feed systems or the capacities of the exhaust fans be less than specified. No alternative odor control equipment shall be provided which cannot demonstrate successful operation to the satisfaction of the CONSTRUCTION MANAGER.
- D. **Performance:** Each chemical odor control system shall be designed for the following operating conditions and criteria:

Equipment No's	-	[]	
Location	-	[]	
Number of systems	-	[]	
Air flow, cfm	-	[]	
Minimum gas contact time in packed section, sec	-	[]	
H ₂ S concentration at inlet, ppm	-	[50]
Minimum H ₂ S removal, percent	-	[99 percent]
Minimum odor unit removal, percent	-	[]	
Minimum packed bed depth, feet	-	[]	
Maximum air pressure loss, inlet to outlet, at design flow, inches w.c.	-	[]	
Packing wash	-	[acid]

2.2 SCRUBBER CONTACT CHAMBER

- A. **General:** Each scrubber vessel shall be a fabricated FRP, countercurrent flow tower, that shall include integral recirculation sump, liquid distribution header, inert polyethylene high efficiency internal packing, FRP packing support plate, mist eliminator, and all necessary fittings and appurtenances as required and indicated. It shall conform to the following set of design criteria:

Location	Equipment No.	No. Vessels Req'd.	Vessel Dimensions (ft dia x ft ht*)
[]			
[]			
[]			
[]			

*Side wall height.

- B. **Materials of Construction:** The vessels/scrubber towers shall be constructed of fiberglass. The resin shall be reinforced with an interior Type C fiberglass veil and an exterior continuous, even-tensioned fiberglass filament wound reinforcement. The scrubber towers shall be one piece construction with no cell joints. A final gel coat is required such that no glass fiber is exposed. Final gel coat shall be pigmented. The color of the gel coat shall be as selected by the CONSTRUCTION MANAGER. The fiberglass shall contain an ultraviolet absorber to protect the resin from ultraviolet degradation. The resin shall be suitable for continuous exposure to saturated hydrogen sulfide gas, [sodium hypochlorite mist], [hydrogen peroxide mist], [sodium hydroxide mist] and [sulfuric acid] at temperatures up to 120 degrees F.
- C. The minimum wall thickness of the tower shall be 1/4-inch and the skirt thickness not less than 1/2-inch. Surfaces shall be smooth with no exposed fiber, sharp projections, foreign inclusions, air bubbles, pinholes, or delaminations. The structural section of the tower shall not include the internal veil and shall have an ultimate tensile strength of not less than 30,000 pounds per square inch. The scrubber towers shall be designed with no stiffeners.
- D. **Color:** The color of fiberglass scrubbers will be selected by the CONSTRUCTION MANAGER prior to the start of fabrication. The CONTRACTOR shall submit for approval standard color selections prior to fabrication.
- E. **Structural Design:** The CONTRACTOR shall assign to the odor control system equipment supplier full responsibility for the complete structural design of each scrubber vessel tower. Each tower with inlet piping, recirculation piping, and exhaust stack, shall be freestanding and shall be designed for Seismic Zone 4 and to withstand a sustained wind load of not less than [50] pounds per square foot.
- F. **Construction Details:** The scrubber vessels shall be provided complete with all air inlets, chemical solution(s) piping, manways, flanged outlets, duct connections and stainless steel anchor bolts as indicated herein. Hold-down brackets, lifting lugs, painted lifting instructions, and anchor plates shall

be provided as recommended by the manufacturer, and approved by the CONSTRUCTION MANAGER. All scrubber vessels shall have dome-shaped covers.

- G. All pipe outlets shall be flanged and reinforced as required. Screwed outlets shall not be acceptable. The scrubber vessel shall have a 3-inch diameter full-drain nozzle for draining and all necessary flanged nozzles for recirculation lines, chemical feed, recirculation sump overflow, process monitoring and control devices, and other connections as required by the manufacturer.
- H. Duct inlets and outlets shall be flanged. Connections shall be provided on the system inlets and the exhaust stacks for mounting of hydrogen sulfide probes. Where duct inlets are near the bottom of the towers, the inlets shall be connected to a 90-degree elbow located inside the tower, facing downward.
- I. Each vessel shall have access manways and hatches for inspection and maintenance of the vessel internal components. The access manways and hatches shall include a 24-inch diameter recirculation sump access hatch and two 36-inch diameter shell manways at the top and bottom of the packing zone for maintenance, inspection, and replacement of the internal components of the scrubber vessel. The manway bolts shall be Type [316] stainless steel. All other nuts and bolts for attachment of equipment to the scrubber vessel, and anchor bolts shall be Type 316 stainless steel.
- J. Sample ports with PVC gas sample valves shall be provided every 2 feet parallel to gas flow, measuring from the entrance to the packed section. Sample ports shall project at least 6 inches into the packed section.
- K. A fiberglass access ladder with safety cage and platform, fiberglass grating, and picket type hand railing, shall be provided for access to hydrogen sulfide probes located on the exhaust stack. The access platform shall be large enough and strong enough to accommodate three 250 lb workers plus [200] lb of work and safety equipment.
- L. The stack shall terminate with a Type 316 stainless steel bird screen and rainhood.
- M. The bottom of the scrubber vessel shall be slightly sloped to the drain line.
- N. Each scrubber shall have an exhaust stack the same diameter as the influent foul air stack. The exhaust stack shall have a height of [5] feet above the top of the scrubber vessel and shall be fitted with a gas sample port [2] feet above the vessel.
- O. The following accessories shall be furnished and installed as part of the fiberglass scrubber vessel:
 - 1. FRP packing support plate, segmented for easy removal through the access manway.
 - 2. High-efficiency, polypropylene tower packing of physical and performance characteristics as recommended by the manufacturer.
 - 3. PVC distribution header constructed for ease of maintenance and removal. The distribution header shall be designed to minimize fouling due to particulates and chemical deposition.

4. High-efficiency, polypropylene mesh mist eliminator section designed to return any mist carryover to the liquid recycle section. The mist eliminator shall remove 99 percent of all particulates and liquid droplets larger than 10 microns diameter.
5. Shell-mounted manometer to indicate total pressure drop (in inches of water) across the packed-bed and mist eliminator sections of the scrubber vessel.
6. Mechanical float valve assembly for automatic addition of dilution water independent of conductivity-based dilution water addition.

2.3 CHEMICAL FEED AND DILUTION SYSTEM

- A. **General:** The chemical feed and dilution system shall take [sodium hypochlorite] and [sodium hydroxide], [] from the storage tanks and deliver these chemicals to the recirculation system of the scrubber vessel. The feed rate of [sodium hypochlorite] shall be manually controlled. The feed rate of [sodium hydroxide] shall be automatically controlled by a pH controlled system. To control the concentration of total dissolved solids in the recirculation solution in the scrubber vessel, a conductivity-controlled dilution water system shall be provided. Dilution water shall be added to the recirculation system when the conductivity increases to a predetermined, adjustable set point and the dilution water addition shall continue until the conductivity of the recirculation solution reaches a lower, predetermined adjustable set point. The dilution water shall be [plant utility water] and strainers, manual and automatic valving and check valves shall be provided where indicated and required. During the addition of dilution water, the excess volume of liquid shall overflow by gravity to the odor control sump area.

2.4 CHEMICAL METERING PUMPS

- A. **General:** Positive displacement, diaphragm type chemical metering pumps shall be provided to deliver [50 percent sodium hydroxide] and [12.5 percent sodium hypochlorite] to the scrubber vessels. All chemical metering pumps shall be suitable for 24 hours per day operation under the following Operating Conditions:

Pump I.D. No.	Location	[Sodium Hydroxide:]		[Sodium Hypochlorite:]	
		Min. Flow (gph)	No. of Pumps Required	Min. Flow (gph)	No. of Pumps Required
[]	[]	[]	[]	[]	[]
[]	[]	[]	[]	[]	[]
[]	[]	[]	[]	[]	[]

- B. **Pump Construction:** The chemical metering pumps shall be in accordance with Section 11261, with the following, additional provisions: chemical metering pumps shall have an output adjustable over a range of 200:1, from zero flow to maximum capacity while pumps are in operation. Adjustment shall be by means of two dial knobs, one to adjust stroke length over a 10:1 range, and the other to adjust stroke frequency over a range of 20:1. Pumps shall have HAND-OFF-AUTOMATIC switches. All pumps shall have a discharge pressure of [35 psig.]. Internal pressure relief shall be incorporated into the pump drive to stop pumping action at [50 psig.] Polyethylene

discharge and suction tubing shall be provided complete with compression fittings. A foot valve with an integral strainer shall be provided for the suction line and an injection check valve with [1/2-inch] NPT male connection for the injection line. The injection check valve shall incorporate a dilating discharge orifice which prohibits scaling and accumulation of crystalline deposits.

- C. **Pump Drive:** The pump shall operate on a 115-volt, 60-Hz, single-phase power supply. Controls shall be housed in an enclosure, NEMA rated in accordance with the area designations of Section 16050. The solid state electronic pulser shall be fully encapsulated. Electronics shall be housed in a chemical resistant enclosure at the control panel end of the pump, NEMA rated based on area classifications as specified in Section 16050, for maximum protection against chemical spillage.
- D. **Control:** Control of the [sodium hypochlorite] pumps' flow rate shall be manual. The pumps shall be automatically shut off if a low level is sensed in the appropriate [sodium hypochlorite] [sodium hydroxide] [] tanks. The [sodium hydroxide] pumps shall have a 3 position selector switch, HAND-OFF-AUTO, so that the pumps may be controlled ON/OFF manually [or by a 4 to 20 mA signal from the scrubber recirculation water pH monitoring system].
- E. **Pipe Connections:** Polyethylene tubing with Type 316 stainless steel or other suitable compression fittings shall be provided between the chemical tanks or drums and the suction side of the pumps.
- F. **Accessories:** Each pump shall be provided with:
 - 1. Positive anti-siphon device constructed of PVC.
 - 2. Flow meter and indicator.
 - 3. Injection assembly with an injection nozzle inserted through a 1-inch NPT corporation stop to permit complete withdrawal of injection assembly while system is under pressure.

2.5 PIPING

- A. **General:** The CONTRACTOR shall provide all piping, fittings, valves, meters and gauges as indicated and required.

2.6 AUTOMATIC pH CONTROL SYSTEM

- A. The chemical feed system shall be designed for the automatic injection of sodium hydroxide if the pH of the scrubber recirculation liquid falls below a desired set point. This set point shall be as recommended by the manufacturer.
- B. The pH of the recirculation liquid shall be continuously monitored and displayed at respective odor control local control panels. Output signals from the 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 0.10 pH. The unit shall have a PVC housing with a threaded submersion

shield with glass electrode suitable for operating temperature ranges between -30 degrees F and 140 degrees F.

- C. The analyzer shall be compatible with the probe supplied. Signal output shall be 4-20 mA-dc. Unit shall be operated on 120-V ac power. The indication shall have a range of 0 to 14 pH units. The unit shall be provided with 2 form C relays which may be independently adjusted over the entire range. The relay contacts shall be rated for 120 volts ac, 10 amps.
- D. The automatic pH control system shall be furnished with all necessary cable, and the CONTRACTOR shall install the cables from the pH sensors to the local control panels as indicated.

2.7 AUTOMATIC CONDUCTIVITY CONTROL SYSTEM

- A. The odor control system shall be designed for the automatic addition of dilution water to the scrubber recirculation system if the recirculation liquid conductivity increase beyond a desired set point. This set point shall be as recommended by the manufacturer.
- B. The conductivity of the recirculation liquid shall be measured by a shell-mounted conductivity probe. The probe shall be of the removable-type for insertion through a full-port ball valve into the recirculation liquid zone of the scrubber vessel.
- C. The conductivity of the scrubber vessel recirculation liquid shall be continuously monitored and displayed at the Odor Control Local Control Panel. Output signals from the probe shall be transmitted to the analyzer over standard signal wire.
- D. The analyzer shall be compatible with the probe supplied. Signal output shall be 4-20 mADC, and the unit shall be operated on 120 V ac power. The unit shall be provided with 2 form C relays which may be independently adjusted over the entire range. The relay contacts shall be rated for 120 ac, 10 amps.
- E. The automatic conductivity control system shall be furnished with all necessary cables, and the CONTRACTOR shall install the cables from the sensor to the Local Control Panel.

2.8 CHEMICAL TANKS

- A. **General:** The following fiberglass chemical tanks shall be furnished for containment of a [15] percent [sodium hypochlorite] [] solution in accordance with the requirements of Section 13209:

Tank No.	Location	Tank Volume (gals)	Tank Diameter (inches)	Straight Tank Height (inches)
[]	[]	[]	[]	[]
[]	[]	[]	[]	[]
[]	[]	[]	[]	[]
[]	[]	[]	[]	[]

- B. **Appurtenances:** The sodium hypochlorite tanks shall all have 2-inch PVC drains with 2-inch plug valves. The piping connections shall be flanged. The tanks shall have a domed top with a 3-inch vent, a 3-inch overflow, and a 24-inch diameter flanged manway. Each of the tanks shall have a 1-inch opening in the dome for the installation of a bubbler tube to be provided and installed by the CONTRACTOR. All other connections and appurtenances shall be as indicated.

2.9 RECIRCULATION AND MIXING PUMPS

- A. **General:** The packed-tower, countercurrent-flow scrubber vessel requires a recirculation pump for the scrubbing liquid. A sodium hydroxide mixing pump shall also be provided as indicated to allow for mixing of sodium hydroxide.
- B. The following plastic body chemical pumps shall be provided for recirculation and mixing service in accordance with the requirements of Section 11192. The pump bodies and base plates shall be of fiber reinforced plastic. The CONTRACTOR shall provide typical seal-water piping and appurtenances. The recirculation pump operating conditions are approximate and shall be verified by the odor scrubber system manufacturer.

<u>Pump No.</u>	<u>Name</u>	<u>Location</u>	<u>Service</u>	<u>Capacity & TDH</u>
[]	Recirculation Pump	[]	[]	[]
[]	Mixing Pump	[]	[]	[]

2.10 EXHAUST FANS

- A. **General:** The CONTRACTOR shall provide FRP foul air exhaust fans as indicated. Each fan shall be a Duct Axial Fan, with a V-belt drive, designed for continuous, 24-hour per day service. Each fan housing, impeller, inlet flange, and outlet flange shall be constructed of fiberglass reinforced polyester in accordance with National Bureau of Standards "Voluntary Product Standard PS 15-69" where applicable. The surface of all fiberglass reinforced polyester in contact with the odorous air shall be corrosion resistant and suitable for contact with any scrubbing solution carryover. The exterior surface of the fiberglass reinforced polyester in contact with the atmosphere shall be finished with a final gel coat which shall protect the fiberglass from ultraviolet radiation. The finished exterior shall be smooth with no exposed fiber, sharp projections, foreign inclusions, air bubbles, pin holes, or delaminations. The fan shall be statically and dynamically balanced at operating speed prior to shipment.

B. **Fan Operating Conditions:**

Service	-	Foul air - hydrogen sulfide
Elevation above sea level (ft)	-	[]
Inlet Temperature (degrees F.)	(max)	[]
	(min)	[]

Relative Humidity (percent) - []

C. Fan Design Data:

<u>Equip. I.D. No.</u>	<u>Discharge Capacity (cfm)</u>	<u>Static Pressure (in WC)</u>	<u>Min. Motor Size (hp)</u>	<u>Max. Fan Speed (rpm)</u>	<u>Max. Motor Speed (rpm)</u>
[]	[]	[]	[]	[]	[]
[]	[]	[]	[]	[]	[]
[]	[]	[]	[]	[]	[]
[]	[]	[]	[]	[]	[]

D. Materials and Construction:

- Impellers - Single piece, solid fiberglass construction. Minimum 6 blades.
- Drive shaft - Stainless steel, plastic coated, keyed at both ends. Suitable for V-belt drive.
- Drive - V-belt drive with epoxy coated steel, vented safety cover over both the motor and the V-belts.
- Bearings - Heavy-duty, self-aligning, deep row, radial-ball type shielded and mechanically sealed in cast iron housing. All bearings shall be rated for a minimum L-10 life of 100,000 hours.
- Lubrication - Grease lubricated. Stainless steel lube tubes extend from bearings to the exterior of the fan housing.
- Internal bolts - Resin-coated stainless steel.
- Drive mounting - Motor is mounted on the exterior of the fan housing.
- Connections - Flanged connections on both ends. Flanges shall be fiberglass.
- Base - Epoxy-coated steel mounting shoes both to inlet and discharge flanges.

E. **Drive:** V-belt drive with heavy duty, [explosion-proof,] electric motor, [suitable for outdoor installation,] and 480-volt, 3-phase, 60-Hz power supply, as specified in Section 16040.

F. Each fan additionally shall be provided as a complete unit with the following accessories:

1. 2 neoprene, flanged, flexible connectors
2. 1 set of spring-type, heavy duty restrained vibration isolators
3. 1 pressure gauge with valve
4. All necessary fittings, supports and controls

2.11 CONTROLS

- A. **General:** The operation of each odor control system shall be controlled from the odor control local control panel (OC-LCP). The panel equipment, operational sequences, and indication/alarm functions are described in this subsection. Each OC-LCP shall provide for both coordinated and independent operation of the water supply, chemical metering system, and exhaust fan.
- B. **Control Panel Equipment:** The panel shall contain HAND-OFF-AUTOMATIC (HOA) switches or ON/OFF switches and run indicating lights for:
- Dilution Water Solenoid Valve (OPEN-CLOSE-AUTO)
 - Exhaust Fan (HOA)
 - Sodium Hypochlorite Pumps (ON/OFF)
 - Sodium Hydroxide Pump (ON/OFF)
 - Recirculation Pump
- C. The panel shall contain System Start and System Stop pushbuttons.
- D. The control panel shall indicate system pH which will control the sodium hydroxide pump, and system conductivity, which will control the addition of dilution water.
- E. Each panel shall contain all necessary relays, contacts, timers, microswitches, terminals, latches, and programmable controllers to operate the odor control system and send and receive remote signals, as indicated.
- F. Motor starters for the fans and compressors shall be contained in nearby motor control centers as indicated. The OC-LCPs shall contain all other transformers, disconnects, circuit breakers, and motor starters necessary for the specified operation of the system.
- G. Each control panel shall be NEMA rated in accordance with the area designations of Section 16050. It shall be free standing, mounted on a stainless steel frame as shown. Each OC-LCP shall be furnished completely pre-wired with factory mounted instruments, controls, and indicators as required.
- H. The OC-LCP shall contain indication for the sodium hypochlorite storage and sodium hydroxide tank levels. Tank levels shall be measured by bubbler systems to be provided as a part of the system's controls.
- I. **Systems Operations:** In the manual operating mode, each piece of equipment shall be operated independently when the control switch is turned to the HAND (or open) position.
- J. When the control switch for each piece of equipment is in the AUTOMATIC position, the system functions in the automatic mode. In this mode, the system Start button shall be depressed to start the system in the following sequence:
1. Recirculation pump starts (and seal-water solenoid valve opens), pH controller is activated, conductivity controller is activated, chemical feed pumps start, and exhaust fan starts.

- K. When the system stop button is depressed, all pumps, exhaust fans, and chemical feed pumps stop simultaneously, with the water supply solenoid valve closing.
- L. The following equipment protection shall be provided:
 - 1. Recirculation pump high-discharge pressure shutoff.
 - 2. Recirculation system low-low water level alarm and pump shutoff.
 - 3. Fan vibration shut-off switch.
- M. In the automatic mode, recirculation pump failure, low recirculation water level, failure of the exhaust fan, or low level in the sodium hypochlorite or sodium hydroxide storage tanks shall cause a common alarm to signal at the OC-LCP. A common alarm indicating Odor Control System Failure shall be signalled and dry contacts for monitoring by the plant PLC system shall be provided. In a similar fashion, a low or high pH signal, a high conductivity signal or low levels in the chemical tanks shall cause separate alarms to be signaled and monitored as indicated above.
- N. All monitoring (level, pH, conductivity, [H₂S,] operating, and failure) signals from the odor control facilities shall be sent to the [] local control board for indication. The CONTRACTOR shall provide necessary transmitters, relays, contacts, etc., to allow for signals to be sent to these locations. All control signals shall be 4-20 mA.

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NTS: The hydrogen sulfide monitoring system, specified below, is an optional item. Where the cost for such a system is not justified, it can be deleted.

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[2.12] HYDROGEN SULFIDE MONITORING SYSTEM

- A. **General:** The CONTRACTOR shall supply and install a hydrogen sulfide (H₂S) monitoring system consisting of H₂S monitors, ambient air H₂S monitors and associated piping, conduit, wiring and appurtenances.
- B. **System Responsibility:** The CONTRACTOR shall assign to one manufacturer full responsibility for the entire H₂S monitoring system to provide all equipment indicated in this Section and factory representative services as indicated below.
- C. **H₂S Sensors:** [] H₂S sensors shall be provided. One sensor shall be provided on each scrubber vesselexhaust stack, and one sensor shall be provided on each foul air duct leading into the scrubber system. In addition, ambient air H₂S sensors shall be mounted in the following locations: [.] The ambient H₂S sensors shall be mounted between 7 and 9 feet above the floor. The sensors shall be solid-state, semi-conductor diffusion/adsorption type units. The CONTRACTOR shall furnish and install conduit and wire to the ambient H₂S sensors.
- D. The sensors shall sense from 0 to 10 ppm in less than 10 seconds with 50 ppm H₂S applied. The sensors shall be 100 percent clear in less than 3 minutes. The sensors shall detect from 0 to 100 ppm of H₂S and shall exhibit no loss of sensitivity of response time due to lack of exposure or prolonged

exposure to H₂S. The operating temperature range of the sensors shall be -30 degrees F to +150 degrees F.

- E. The sensors shall be guaranteed to operate as specified for a period of one year after successful startup of the H₂S monitoring system.
- F. **H₂S Monitors:** H₂S monitors shall be provided and installed in each odor control system local control panel. Each monitor shall have 2 channels for continuous readout of system influent and exhaust H₂S concentration in ppm. H₂S signals from each odor control facility [and the ambient H₂S monitors] shall be sent to the main control board for indication.
- G. Each monitor shall indicate H₂S concentration in a range of 0 to 100 ppm. Monitors shall be equipped with channel selector switch with channel scan mode, for monitors with two or more channels, high and low level alarms and reset buttons for each channel, and malfunction alarms and reset buttons for each channel. The H₂S monitors shall have automatic calibration with no zero or pot adjustments.
- H. The H₂S equipment supplier shall furnish all cable required between the H₂S sensors and H₂S monitors and the H₂S monitors and the odor control LCPs. The cable shall be installed by the CONTRACTOR.
- I. **H₂S Calibrator:** The CONTRACTOR shall supply one portable H₂S calibrator for calibration of the H₂S monitors. The calibrator shall have an output range of [20 to 100] ppm and shall be equipped with a 12-volt dc rechargeable battery. An electrically driven diaphragm pump shall convey the H₂S to the instrument to be calibrated.

2.13 NAMEPLATES, TOOLS AND SPARE PARTS

- A. **Spare Parts:** Each blower, fan, pump, and any other piece of equipment with moving parts shall be furnished with one year's supply of lubricants and one set of the following spare parts for each piece of equipment:
 - 1. Bearings
 - 2. Seals
 - 3. Driver bulb
 - 4. Filter elements
- B. The spare parts shall be labeled and packaged as indicated in Section 11000.

2.14 MANUFACTURERS

- A. Chemical odor control systems shall be as manufactured by the following (or equal):
 - 1. Ceilcote
 - 2. Beardsley and Piper
- B. Fiberglass resin shall be as manufactured by the following (or equal):
 - 1. Dow Chemical Co. [Derakane 411.5]
 - 2. ICI American [Altac 580]
 - 3. Ashland Chemicals [Hetron 922]

- C. Exhaust fans shall be as manufactured by the following (or equal):
 - 1. Ceilcote
 - 2. Hartzell Propeller Fan Co.

- D. Fiberglass duct work shall be as manufactured by the following (or equal):
 - 1. Justin Enterprises
 - 2. Fiber-Dyne, Inc.
 - 3. Ceilcote Co.

- E. H₂S monitoring system shall be as manufactured by the following (or equal):
 - 1. Texas Analytical Control, Inc.
 - 2. Rexnord Gas Detection Products

PART 3 -- EXECUTION

3.1 GENERAL

- A. All parts for the odor control system shall be installed in strict accordance with the manufacturer's instructions and under the guidance of the manufacturer's field representative.

- B. The equipment shall be fabricated, erected, assembled, and placed in proper operating condition in full conformity with the Drawings and Specifications, and engineering data, instructions, and recommendations of the equipment manufacturer. Each item of equipment shall be provided complete with all supports, electric drive units, shafts, sprockets, mechanical equipment, electrical work, and appurtenances ready for operation. All vessels and parts shall be amply proportioned for the stresses which may occur during operation, fabrication, and erection. Individual parts which are alike in all units shall be alike in workmanship, design, and materials, and shall be interchangeable. Guards shall be provided for all exposed moving shafts, drives, or parts as required by the applicable safety codes.

- C. Unless otherwise shown, the power supply to the equipment will be 480-volt, 60-Hz, 3-phase.

- D. **Supports:** The CONTRACTOR shall support all runs of ductwork at least every 5 feet and more frequently if required to meet the sag requirements indicated herein. Supports shall be fabricated out of galvanized steel and designed to meet the installation requirements. Attachment of the supports to fiberglass ducting with screws is unacceptable. All fiberglass vessels, fans, and major sections of ductwork, shall be provided with lifting lugs or eyes to facilitate handling and installation.

3.2 FIELD JOINTS

- A. Field joints in fiberglass ducts shall be made by wrapping with strips of reinforcement saturated with resin, the reinforcement being at least the thickness of the heaviest plastic section being joined. Extension to a sufficient distance on each side of the joint is required to make the joint at least as strong as the pieces joined. Mating edges shall be filled with resin paste to cover cut edges and fill voids. The inside surface of the joint shall be sealed with one layer of reinforcement where accessible.

3.3 STARTUP AND TESTING

- A. **General:** The CONTRACTOR shall be responsible for the successful startup and testing of each odor control facility. The CONTRACTOR shall furnish all necessary facilities, manpower, chemicals, tools, instrumentation, and laboratory testing services required during this phase of the WORK.
- B. **Chemical Dosage:** A maximum chemical dosage of 10 lb sodium hypochlorite per pound hydrogen sulfide and 3 lb sodium hydroxide per pound hydrogen sulfide shall be allowed for startup and system testing purposes. A 12.5 percent sodium hypochlorite solution shall be used.
- C. Upon completion of the installation, each piece of equipment and each system shall be tested for satisfactory operation without excessive noise, vibration, overheating, etc. All equipment must be adjusted and checked, for misalignment, clearances, supports, and adherence to safety standards.
- D. All startup and testing shall be done under the direction and supervision of the manufacturer. The CONSTRUCTION MANAGER shall be advised of the testing and startup schedule at least [2] weeks in advance.
- E. The performance of the system shall be verified by a [3]-consecutive-day, 24-hour-per-day, performance test conducted by the CONTRACTOR. All temporary power and water supply facilities, and H₂S sample collection and testing equipment shall be furnished by the CONTRACTOR during these [3] days, plus [5] days additional testing for mechanical equipment. Influent and effluent H₂S samples shall be collected and analyzed every [3] hours for [3] days. For the purpose of performance testing, the CONTRACTOR shall supply bottled H₂S to simulate design influent H₂S concentrations.
- F. The CONTRACTOR shall be required to test the odor control systems at an influent H₂S concentration of [50] ppm on each of the [3] consecutive test days, with a concentration of 15 ppm the remainder of the time.
- G. Hydrogen sulfide (H₂S) concentrations shall be measured using a wet chemical method where a known volume of air is bubbled through a controlled volume of calcium hydroxide and starch solution which absorbs H₂S. H₂S content shall then be analyzed by a titration and colorimetric determination. The CONTRACTOR shall utilize a portable H₂S analyzer to provide rapid feedback during testing. However, the final H₂S determination for evaluating system performance shall be by the above described wet chemical method. All H₂S testing shall be conducted by a laboratory mutually selected and agreed upon by the CONTRACTOR and the CONSTRUCTION MANAGER. The costs of all H₂S determinations shall be borne by the CONTRACTOR.
- H. At the conclusion of the test, the CONTRACTOR shall submit [5] copies of the complete test report to the CONSTRUCTION MANAGER, which shall include summaries of the influent and exhaust H₂S concentrations, test methods, any unusual occurrences, and any other useful information. The test report will be reviewed and approved by the CONSTRUCTION MANAGER prior to the final acceptance of any of the odor control systems.

3.4 CLEANUP

- A. After completion and testing the CONTRACTOR shall remove all debris and spilled chemicals from the site and clean the entire system to render it ready for startup.

**** END OF SECTION ****