SPECIFICATIONS

Biological Scrubber
ODOR CONTROL SYSTEM

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SPECIFICATION SECTION 15XXX (sample)
Biological Scrubbing Odor Control System

PART 1 GENERAL

1.01 DEFINITIONS

A.	FRP:	Fiber reinforced plastic
B.	PE:	Polyethylene
C.	PPL:	Polypropylene
D.	PVC	Polyvinyl chloride
E.	CPVC	Chlorinated polyvinyl chloride
F.	H_2S:	Hydrogen sulfide gas
G.	ppm:	Parts per million by volume
H.	NEMA	National Electrical Manufacturer's Association
I.	NFPA-70	The National Electrical Code
J.	UL	Underwriter's Laboratory
K.	ASTM	American Society for Testing and Materials
L.	NBS	National Bureau of Standards
M.	IEC	International Electrotechnical Commission
N.	AMCA	Air Movement and Control Association

1.02 REFERENCE STANDARDS

A. PS 15-69: National Bureau of Standards Voluntary Product Standard "Custom contact molded Reinforced Polyester Chemical Resistant Process Equipment".
B. ASTM D-883: "Definition of Terms Relating to Plastics".
C. ASTM D-2583: "Test for Indentation Hardness of Rigid Plastics by Means of Barcol Impressor".
D. ASTM D-2563: "Recommended Practice for Classifying Visual Defects in Glass Reinforced Plastic Laminate Parts".
E. ASTM D-4097-82: "Standard Specifications for Contact Molded Glass Fiber Reinforced Thermoset Resin Chemical Resistant Tanks".
F. Where design conflicts arise between the various standards, the most stringent design shall be used.

1.03 SYSTEM DESCRIPTION

The Contractor shall furnish and install the biological scrubbing odor control system (System) as indicated in the drawings and specifications herein. The system shall be designed for long-life and working conditions that include corrosive environments, corrosive atmospheres, and continuous operation. All parts subject to "normal" usage, "routine wear and tear", and standard operating conditions shall be made readily accessible for scheduled maintenance procedures. Any component that is exposed to either a corrosive environment or atmosphere will be constructed from corrosion resistant materials. Each system shall include the following:

A. Process monitoring control
B. Recirculation pump(s)
C. Fan(s)
D. Biological Scrubber vessel(s) with air inlet and outlet, access manways, media, media support, scrubbing solution, spray system, tie-down lugs, lifting lugs, and all FRP fittings as shown on the contract drawings.

There shall be ( ) Biological Scrubbing odor control systems required, as delineated below:

System ID / Name	Number of Vessels per System	Air Flow required per System (cfm)	Fan Horsepower required (HP)	Fan Static Pressure required (in. w.c.)

1.04 PROCESS DESCRIPTION

The system is used in the control and removal of odorous compounds, principally Hydrogen Sulfide (H_2S). The system shall consist of a vertical or horizontal biological oxidation section. The system configuration shall enable the gaseous phase to flow counter-currently, or co-currently, through the bacteria oxidation ecosystem consisting of a recirculation solution containing mineral nutrients and trace elements flowing over the porous rock media. The scrubbing solution and media shall serve as the ecosystem for microorganisms, and shall be continuously re-circulated without the use of chemicals for neutralization, or the need for constant adjustment after start-up.

1.05 SYSTEM RESPONSIBILITY

The system described herein shall be provided by a single Odor Control System Supplier in order to achieve single source warranty and process performance responsibility, as well as to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's services. The Odor Control System Supplier shall be responsible for furnishing the system as specified herein, for delivery to site, assistance with installation, testing and for warranty of the system design and performance.

1.06 MANUFACTURER'S QUALIFICATIONS

A. General: The Manufacturer shall be one recognized and established in the design, production and manufacturing of biological odor control systems with a minimum of five full-scale installations. These installations must be permitted by an air quality board, such as the Southern California A.Q.M.D., and have been in operation for a period of five years or more.

B. The plans and specifications reflect the Biological Scrubber system as manufactured by HEE Environmental Engineering. Any other listed or qualified Manufacturers may provide a system for this project. The bid for a system other than that shown shall include any additional structure(s), electrical, mechanical, duct changes, civil construction, equipment, and/or installation costs, as well as any other costs necessary for an installed functioning system. Additional engineering costs to review and support the bid shall be borne by the Contractor, and shall be subject to the review of the Engineer. Any increase in the footprint size shown on the plan shall be subject to the Owner's review and may be cause for rejection of that Manufacturer. If the proposed system requires any increase in power, maintenance, or labor costs, all such costs associated with the alternate system shall be stated in the aggregate for a twenty (20) year period for the purpose of total capital and operating cost evaluation.

C. The Engineer and Owner reserve the absolute right to reject any or all proposals or to waive any formality or technicality in any proposal in the interest of the Owner.

1.07 SUBMITTALS

A. The Contractor shall submit complete Shop Drawings for the System, together with all piping, ductwork, valves and control for review by the Engineer.

B. Shop Drawings: The Contractor shall submit the following information for approval before equipment is fabricated:

1. Drawings of system showing assemblies, arrangements, piping, electrical, mounting details, equipment outline dimensions, fitting size and location, motor data, operating weights of all equipment and sufficient information to allow the Engineer to check clearances, connections, and conformance with the specifications.
2. Materials of construction of all equipment.
3. Manufacturer's catalog data and operating literature. Specifications, performance data, and calibration curves for chemical recycle pumps, exhaust fan, and auxiliary components.
4. Complete instrumentation, control, logic and power wiring diagrams in sufficient detail to allow installation of the instrumentation, controls and electrical components.
5. Manuals: Furnish manufacturer's installation, operation and maintenance manuals, bulletins, and spare parts lists.

C. Design Calculations: The Contractor shall submit complete design calculations for the Ammonia Reduction System to confirm the following:

1. The system design calculations must demonstrate a minimum overall system removal efficiency at the maximum inlet design condition.

2. The system shall be capable of withstanding the imposed seismic loads specified. Certified design calculations stamped by a registered professional engineer. Calculations shall include, but not be limited to, the following:

   a. Dead loads
   b. Live loads
   c. Seismic loading per UBC Code
   d. Anchor lug attachment to the shell

PART 2 PRODUCTS

2.01 GENERAL

A. The Contract Documents indicate *specific* required features of the equipment, but do not purport to cover *all* details of design and construction.

2.02 PERFORMANCE REQUIREMENTS

Ambient Air Temperature, Deg. F:	_____
Inlet H_2S Concentration, ppm:	_____
H_2S Removal Efficiency:	Above 50 ppm - 99.0% Below 50ppm - O.5 ppm
Minimum Stack Discharge Limit, ppm:	_____
Process Air Temperature, Deg. F:	50 - 100

2.03 DESIGN REQUIREMENTS

A. The design requirements have been established to accomplish the engineer's desired margin of safety. No changes will be allowed.

Pressure Losses External to System:	_____
Scrubber Pressure Losses, maximum:	4" w.c.
Vessel(s) Diameter	_____
Wind Loading, minimum:	100 mph
Seismic Zone:	UBC Zone 4
Media Height Per Vessel maximum:	_____
Retention Time Per Vessel	_____

2.04 BIOLOGIAL SCRUBBER VESSEL(S)

A. The Biological Scrubber odor control system shall be the HEE-XXXX Model system, as supplied by HEE Environmental Engineering. Each vessel shall be designed with gas disruption ring, manways and porous rock media supports. The vessel shall be designed for continuous operation. The Odor Control System Supplier shall submit all calculations necessary to ensure proper functioning of the scrubber at the stated design conditions. The design shall include, as a minimum, engineering calculations, documented physical and mechanical properties, materials selection, and all detailed drawings required for the proper fabrication and assembly of the scrubber.

B. The design shall allow for the most severe combination of conditions, which may include any or all of the following:
1. Maximum internal and external pressure including test conditions.
2. All dead loads including the maximum operating weight of the equipment.
3. Hydrostatic loads.
4. Superimposed loads such as those due to wind and seismic forces.
5. Loads due to wetted internal components such as the media, pipe, etc.

6. Bending moments due to eccentric loads from pipe, duct, etc.
7. All live loads.
8. Snow and ice loads.
9. Buoyancy effects and effects from flooding.
10. Localized loads acting at attachments.
11. Loads applied during transportation and erection.
12. Loads imposed by personnel during erection and operation.
13. Thermal expansion and contraction.
14. All other applicable loads and forces not listed above.

C. The structural design calculations, including documentation for all physical properties used in the design, shall be sealed by a Registered Professional Engineer who is regularly engaged in the design of composite structures.

D. The Odor Control System Supplier shall provide documentation for all laminate properties used in the design. The laminate used to fabricate the scrubbers shall be similar in construction, layer sequence, resin and glass types, and cure to that used in determining the physical properties. All properties shall be adjusted as required to compensate for operating temperature.

E. Resin:
1. The Biological Scrubber vessel shall be fabricated using a corrosion resistant vinyl ester resin such as Hetron 922, Derakane 411, AOC K022 or equal. Unless otherwise specified, the same resin shall be used throughout all laminates.
2. Catalysts and promoters shall be of the type and amount recommended by the resin manufacturer for use with their resin in the required service. Positive measurement control of catalysts, promoters, and resins shall be maintained at all times.
3. No fillers, additives, or pigments shall be employed in the resin except as required for fire retardancy. A thixotropic agent for viscosity control may be used in the proportion and type recommended by the resin manufacturer. No thixotropic agent is to be used in the corrosion liner or on surfaces to be in contact with the corrosive environment.
4. When specified, antimony trioxide or antimony pentoxide will be added to the resin used in the structural wall only. The amount added shall be as recommended by the resin manufacturer to achieve the required fire retardancy rating.
5. Resin putty shall be made using the same resin as was used in the original fabrication of the parts to be joined. Resin putty shall contain a minimum 15 percent (15%) by weight of milled glass fibers. A fumed-silica additive such as Aerosil 200 or Cab-O-Sil TS 720 shall be added to increase the viscosity of the putty. The use of silica flour, grinding dust, or other fillers is not allowed.

F. Reinforcement:
1. Glass fiber reinforcement used shall be a commercial grade corrosion-resistant borosilicate glass, as manufactured by Owens-Corning, PPG, Certainteed, or equal, unless otherwise noted.
2. All glass fiber reinforcing shall have an epoxy compatible silane type surface finish and binder that is specifically recommended by the glass manufacturer for the particular resin system to be used. This surface finish should allow the maximum possible chemical bonding between the resin and glass.
3. Glass surfacing veil shall be 10-mil thick type C (chemical grade) glass, unless otherwise specified. Synthetic surface veil shall be 10 mil thick polyester surfacing veil, such as Nexus, unless otherwise specified.
4. Mat shall be Type E (electrical grade) glass with nominal fiber length of 1.25" + 0.75".
5. Continuous glass roving used in chopper guns shall be Type E chopper roving.
6. Woven roving shall be 24 oz./yd.^{2} Type E glass with a 5 x 4 plain weave.
7. Continuous roving used in filament wound construction shall be Type E glass winder roving with a yield of 200 yards or more per pound.
8. Unidirectional reinforcement shall be weft unidirectional fabric, Type E glass, 15.7 oz./yd.^{2} as manufactured by Excel, Kytex, Brunswick or equal.

G. Corrosion Barrier:

1. The inner surface of the corrosion barrier shall be resin-rich and reinforced with one layer of 10 mil thick C-veil.
2. The interior layer of the corrosion barrier shall consist of a minimum two plies of 1-1/2 oz./ft.^{2} chopped strand mat. Each ply shall be rolled separately to remove entrapped air.
3. Chopped glass applied by chopper gun is not allowed in the corrosion barrier.
4. All plies of the inner surface and interior layer are to gel completely before proceeding with the structural laminates.
5. Completed corrosion liner as described above shall contain not less than 20 percent nor more than 30 percent glass by weight. No thixotropic material shall be used in the resin for the liner or in the fabrication of any FRP components intended for internal corrosive service. Final liner shall have a minimum thickness of 100 mils.
6. All edges of surfacing veils in wet lay-up shall be lapped a minimum of one inch.

H. Filament Wound Structural Laminates:

1. The corrosion liner laminate shall be followed by structural laminates of varying construction types.
2. For filament wound structural laminates, reinforcement shall consist of continuous strand fiberglass roving applied with a minimum of interruptions until the specified minimum thickness is attained. This laminate shall contain 45 to 65 percent glass by weight.
3. Each complete cycle of filament winding shall form a closed pattern of winding bands which completely cover the surface with two bi-directional layers. Each layer shall be a maximum of one roving in thickness. Singular cycles shall not exceed a thickness of 0.05 inches.
4. Spacing of filaments within the winding band shall be sufficiently close that bridging is avoided and glass content is maintained within the specified limits. Spacing of the filaments shall be uniform across the winding band without bunching or gapping.
5. The helix angle of winding shall be as shown in the structural calculations, and as measured from the centerline of revolution of the equipment shell.
6. Tolerance on helix angle is 2 degrees.
7. If chopped glass or layers of mat are needed to insure proper bonding between the corrosion liner and filament winding, or if chopped glass, mat, or unidirectional glass within the filament winding is required to achieve the required strength requirements, they may be added at the Manufacturer's option.
8. If for any reason, winding is interrupted to the point where the outer surface is gelled or exotherm temperatures are excessive, production shall stop and the laminate shall be allowed to cure. Any prominent ridges left on the cured surface shall be ground to smooth the projections and prevent bridging. Following the grinding, a bedding layer of 3/4 oz. per sq. ft. mat or chopped glass shall be applied and thoroughly rolled to remove air. Winding with continuous strand may be resumed before this layer gels. The additional mat layer is extra material and will result in a wall thickness greater than that calculated.
9. Large Field Erected Vessels.

   Fabrication shall be per ASTM D 3299 and NBS Voluntary Product Standards PS 15-69.

   The shell shall be fabricated in multiple mod segments using the filament winding process to achieve the required diameter and height. This process shall utilize a corrosion barrier of two-ply Nexus surface veil. The corrosion barrier reinforcement shall be 100 mil chopped strand laminate, an exothermic period, followed by the filament winding procedure. During the filament winding procedure, the structural portion of the straight shell shall be applied achieving a total laminate of the required thickness. The dish top and bottom shall be fabricated using the spray-up method per NBS PS 15-69 standards. After curing both the bottom and dish top shall be cut into appropriate widths for shipping purposes. Fittings for the tank shall be fabricated using the hand lay-up method per ASTM D 3299 and NBS PS 15-69 standards and installed during field erection of components.

I. Biological Scrubbing Media Support:

1. The media support shall consist of FRP grating fully supported by a continuous FRP ring. FRP box beams shall be installed under the grating, as required, to provide additional support. The size of the grating and number and size of any required box beam shall be confirmed as noted in 2.3 "D" of this specification.
2. The FRP ring shall be of sufficient size and strength to resist the imposed loads and shall be bonded to the scrubber side wall along its full circumference. The ring shall be installed level and the top surface on which the FRP grating rests shall be relatively flat so as to prevent any point loads.
3. The FRP grating shall be either the molded or pultruded type, shall be made from premium grade vinyl ester resin and have at least 60% open area. The grating shall be supported to limit the mid-span deflection of the grating to (L/125) where (L) is equal to the span length.
   All cut edges of the grating shall be resin coated with the same resin used in the vessel's corrosion barrier.
4. The FRP box beams shall be square or rectangular in shape and shall be of sufficient size and strength to resist the imposed loads. The beam ends shall pass through the scrubber shell and bonded to both the inside and outside of the shell surface. The box beam shall be contact molded and shall have a corrosion barrier on its exterior surface identical to that of the vessel shell.
5. Field erected vessels shall have FRP supports appropriately spaced under FRP beams depending on the vessel span.

J. Internal Pipe: Internal pipe and fittings shall be Schedule 80 PVC. Joints may be flanged, threaded or cemented socket type and shall be configured to allow complete removal through the access port.

K. Spray System:

1. The scrubbing solution shall be evenly distributed over the top of the media by use of spray nozzles. The spray nozzle layout shall be designed by the Biological Scrubber vessel manufacturer. All spray nozzles shall be non-clogging type. Nozzles shall be PVC.

2. All internal spray nozzles shall be male or female thread and shall be removable from the internal header pipe. Total spray system shall be of removable design.

L. Metal Hardware and Fasteners:

1. Exterior metal hardware such as anchor lugs, lifting lugs, bolts and attachment clips shall be fabricated from type 304 stainless steel.
2. Interior fasteners shall be made from FRP, polypropylene or 316 stainless steel.

M. Gaskets: All gaskets shall be made from neoprene rubber, 3/16" minimum thickness, and have a Shore A hardness of 55 to 65. Gaskets for use with FRP flanges shall be flat, full faced, and drilled to match the drilling of the mating flanges.

2.05 MEDIA

A. The porous rock media used in the Biological Scrubber serves as part of the ecosystem for the growth of acidithiobacillus thiooxidans microorganisms. The porous rock media shall also contain the necessary iron content that in a low pH environment will create a chemistry of iron ions to support a colony of acidithiobacillus ferroxidans microorganisms. The media shall be of the type that the surface openings are not through-and-through, therefore eliminating any increase in static pressure over time due to fouling of the pore structure. The porous rock media shall be as manufactured by GLOBAL Environmental Solutions, Inc.

The media shall have a proven reliability record for biological growth with a minimum of 100,000 cubic feet installed over a five year period, with at least five separate projects, based on actual installations in a low pH sulfuric application without degradation. The media utilized shall be treated, crushed; using no aggregate larger than 3"in diameter, insuring a uniform surface area of a minimum 10,000 square feet per cubic foot of media. The media will then be screened to size and meet the following specifications:

1. UNIT WEIGHT (Jigging Method)/% Voids ASTM C29

   Dry Unit Weight (pcf) 50.8 Percentage Voids 45.2
   Saturated Surface Dry (SSD) Unit Weight (pcf) 59.1 Percentage Voids 36.3

2. SPECIFIC GRAVITY/ % Adsorption ASTM C127

   Specific Gravity (Oven Dry Basis) 1.486
   Specific Gravity SSD (Saturated Surface Dry) 1.705
   Percentage Adsorption 14.7

3. DURABILITY INDEX Cal 229
   Time line of determination form line of sediment (min) 180
   Sediment Height Reading (in) 0.1
   Durability Index 96

4. SCREENING & GRADING (ASTM C136)

Sieve Size	Percentage Passing
3”	100
2 ½”	100
2’	96.0
1 ½”	77.5
1”	16.5
¾”	2.3
½”	0
3/8”	0
No. 4	0

B. No plastic or solid organic media shall be accepted.

C. To prevent excessive damage during transit media will be shipped independent of vessel. The Contractor is required to install the media after the Biological Scrubber vessel has been set in place in accordance with the media Manufacturer’s instructions.

D. Media Warranty: The supplier of the porous rock media shall warrant the media for a period of ten (10) years. Should the media become plugged or damaged such that odor removal capacity or flow capacity is degraded, the Manufacturer shall, at no cost to the Owner, seek to remedy the problem. If the problem persists after a period of time (not to exceed six (6) months) to access the nature of the problem and attempt all manner of remedies short of media replacement, then the manufacturer shall replace the porous rock media.

   1. This warranty does not apply to problems associated with improper maintenance, negligence, misuse, abuse, or the failure to operate the system in strict accordance with the operating and maintenance instructions and operator training provided by HEE Environmental Engineering.

   2. Plugging Due to Airborne Particulates: This warranty requires the Owner to install and properly maintain the particulate filter as described in section 2.10 C.

   3. Plugging Due to Solids in Water Used for Recirculation: The porous rock media is designed to be operated with water containing no more solids than are typically found in secondary effluent. Plugging might result should the system be operated with primary effluent. If the system is to be operated with primary effluent, the Owner must provide a sample of the water to the manufacturer for solids analysis. This analysis may indicate the need for a strainer/filter. If such a filter is required, the manufacturer shall provide the filter. In this case, this warranty will require the Owner to install and properly maintain the filter.

2.06 BIOFILM SCRUBBING SOLUTION

A. The bacteria shall be of the sulfur-oxidizing type and engineered to be site specific. The liquid scrubbing solution shall be a combination of nutrients inoculated with sulfur-oxidizing bacteria. All make-up water shall be compatible for bacterial growth. A balance between the bacteria, nutrients and make-up water shall be achieved to meet the required performance criteria.

B. A separate nutrient system shall be supplied by the Odor Control System Supplier to insure adequate amount of bacterial growth. The nutrient solution shall be non-hazardous and non-toxic for shipment and storage and so stated on MSDS sheets.

C. The Biological Scrubber vessel sump shall contain at least three times the specified recirculation rate or a minimum depth of 30 inches, whichever is greater. Provisions shall be made to prevent vortexing of the recirculation solution into the pump suction.

Consideration shall be made for the minimum sump depth during "pull-down" when the media is dry and the recirculation pump is started. The overflow flange shall be provided with an internal U-trap or overflow weir. Incoming make-up and recirculation piping shall be equipped with a PVC "Y" type strainer.

2.07 PUMPS

A. The pump(s) shall be closed coupled, non-metallic, magnetically driven, sealless centrifugal, capable of flows up to 700 gpm (2650 l/min.), TDH up to 330 feet (92M), and temperatures from - 120^{o}F (-85^{o}C) to 250^{o}F (121^{o}C).

B. The pump(s) shall incorporate ductile iron casing lined with ETFE. All wetted parts shall be made with ETFE. The magnets shall be the rare earth type providing no-slip performance and eliminating the need for soft-start motors.

C. The pump(s) shall be sized by the Odor Control System Supplier to meet performance criteria and shall be of the type manufactured by ANSIMAG, or equal.

2.08 FAN AND MOTOR ASSEMBLY

A. General: Fan shall have fiberglass reinforced plastic housing and wheel, either radial or airfoil depending on volume and pressure.

B. Bearings shall be heavy duty, self-aligning grease lubricated ball type with a minimum of 100,000 hour B-10 life. FRP motor cover shall be provided. Motor shall be TEFC, with a 1.15 service factor and suitable for 3/60/230-460V. Fan shall be belt driven with adjustable drives.

C. Fan housing shall be constructed of fiberglass and reinforced with rigid bracing to increase structural integrity. Bearing support brackets shall be positioned to directly oppose belt tension forces. Fan housing shall be a curved scroll design with a 1" NPT drain connection at the bottom of the fan scroll. Housing shall be manufactured as one part in a mold.

D. Fan shall be HEE Environmental Engineering, or equal and shall be manufactured by the scrubber manufacturer to ensure compatibility.

E. The fan shall be designed for the following specifications:

Exhaust Fan Design Requirements		
Air Flow Rate, cfm		
S. P. up to scrubber Inlet, inches WC		
Total Pressure Drop, inches WC		
Motor HP		

F. The fan shall be mounted with vibration isolators on a concrete pad or equipment skid.

G. Performance: The FRP centrifugal airfoil fans shall be licensed to bear the AMCA Seal for air performance. Each fan shall be run at the factory to assure proper operation of all rotating parts, including wheel, shaft, bearings, sheaves, and belts. Motors shall be tested for amperage draw by dampering the fan from free-flow to no-flow operating.

H. The following spare parts shall be provided:

1. One (1) Set of Bearings
2. One (1) Set of Belts

I. Optional Features: The following options are not provided with the standard fan, but are provided as indicated by the specifying Engineer:

1. Class I, Division I Hazardous Area Package: TEXP (Totally Enclosed Explosion Proof), squirrel cage induction motor with 1.0 SF and the following ratings: 3 phase / 60 Hertz / 230-460 Volt, and graphite impregnation of FRP fan body.
2. Class I, Division II Hazardous Area Package: Graphite impregnation of FRP fan body. (Note: squirrel cage motors without winding T-stats are not required to be TEXP).
3. Fan Shaft of Stainless Steel: 316 Stainless steel fan shaft in lieu of standard carbon steel shaft.

2.09 INSTRUMENTATION

A. Control Panel: The panel shall be 316 stainless steel, NEMA 4X rated. The panel set-up shall be as follows:

1. The panel shall be wired to 480V/3P/60HZ power of adequate amperage to power all associated pumps, motors, valves, and controls.
2. An adequately sized main disconnect switch shall be provided within the panel.
3. A 120 VAC control power transformer rated at a minimum of 300 VA shall be provided with primary fuse and secondary circuit breaker protection.
4. A GFI safety system shall be provided on the 120 VAC circuit.
5. A 24-volt DC power supply shall be provided for instrumentation and other DC power needs.
6. AquaMetrix, Inc. flow and pH controllers shall be supplied.
7. All pilot lights shall be LED type rated for long operational life. Green will indicate that equipment is running, Red will indicate that equipment is stopped; White will indicate that all power is on, Blue will indicate a critical fault condition, and, Amber will indicate a non critical fault condition.
8. A “Power On” – White pilot light will indicate that the incoming 120 VAC power and the 24 VDC system are operating. With the light on all power supply elements are operational.
9. A sump nutrient make-up circuit will be provided that will open the make-up solenoid under one or the other of two conditions. Detection of a sump low level switch or detection of a low pH condition. The low level switch will open the make-up solenoid until the sump high level switch operates, thus bringing the sump level up to a preset condition. The pH controller will open the make-up solenoid until enough nutrients is introduced to rectify a low pH condition. The normal operation of the sump is a moderate “blow down” condition.
10. A “System OK” – Green pilot light will indicate that the system is on-line and not in a fault condition.
11. A “Process Fault” – Blue pilot light will indicate that a process fault has occurred. A process fault is defined as a pH condition above or below the pH alarm set points.
12. A “High High Sump Level” or a “Low Low Sump Level” – amber pilot light will indicate that a fault condition exists in the sump nutrient level make-up system.
13. A “Sump Fill – Green pilot light will indicate when the sump nutrient make-up solenoid is energized.
14. A “Pump Flow Fail” – Blue pilot light will indicate that a nutrient flow failure has occurred based on the set point of the flow controller.
15. A “Fan Flow Fail” – Blue pilot light will indicate that an air flow failure has occurred based on the set point of the air flow sensor.

16. A common alarm relay will summarize all of the existing alarm conditions, sound an alarm horn, and provide a dry contact to signal a remote station or computer. The green "System OK" light will be turned off and the relevant alarm light or lights will be turned on.
17. The alarm horn is activated whenever a fault signal exists on the system and will continue to sound until acknowledged by the alarm silence pushbutton. All alarm lights will remain on and the horn will remain silenced until the fault is cleared and the system OK light is turned on.
18. The "Alarm Silence" push-button serves a dual role; along with the silencing of the Horn during a process fault the push-button acts as a panel lamp test button.
19. The following hand switches shall be provided:
    a. Recycle Pump Hand/Off/Auto
    b. Exhaust Fan Hand/Off/Auto
    c. Make-up Valve Open/Closed/Auto
    d. System Local/Off/Remote
20. Adequately sized motor starters with short circuit and overload protection shall be provided within the panel for the pump and fan motors.
21. **Option I1: Nutrient System Additional Instrumentation** (for systems that are to be equipped with a nutrient system):
    a. A dilution tank make-up circuit will be provided that will open the dilution solenoid whenever the dilution tank low level switch is operated. The solenoid valve will close when the level reaches the dilution tank high level switch. Both a dilution high high level and low low level switches will also be supplied.
    b. A nutrient tank low level switch will be provided to indicate when the nutrient level is near depletion.
    c. A "High High Dilution Tank Level" or a "Low Low Dilution Tank Level" – amber pilot light will indicate that a fault condition exists in the dilution tank make-up system.
    d. A "Dilution Tank Fill" – Green pilot light will indicate when the nutrient tank solenoid is energized.
    e. A "Low Nutrient Level" – Blue pilot light will indicate when the nutrient low level switch is activated.
    f. The following hand switches shall be provided:
        1. Dilution Valve Open/Closed/Auto

2.10 SYSTEM ACCESSORIES

A. Sound Attenuation Package: The system shall be provided with a fan sound attenuation package. This package shall consist of a rigid FRP acoustical enclosure which is placed over the fan and motor assembly. This enclosure shall allow for operator access to the fan and motor assembly for maintenance. The enclosure shall contain acoustic insulation. The enclosure shall be designed to reduce sound levels by 20 dB at a distance of five (5) feet from the fan.

B. Flow Monitoring Package: Each Biological Scrubber vessel shall include a manometer sufficient to give a direct read-out of differential pressure in inches water column across the inlet and outlet air nozzles. The manometer shall be a Dwyer Series 1230 or equal.

C. Particulate Filter: A particulate filter shall be supplied. This unit shall consist of a 304L stainless steel pad for grease and particulate filtration in front of a PPL pad with 316 stainless steel grid for mist elimination, housed inside a PPL enclosure. The pads shall be removable for cleaning and the housing shall have a door, or drop-out flange, to allow removal and replacement of the filter pads. A Dwyer Series 2000 Magnehelic differential pressure gage shall be installed on the housing to indicate pressure drop through the unit. This unit shall ship loose and be ready for installation into the reactor system supply ductwork. (CAUTION! The filter housing dimensions may prohibit direct attachment to a system fan inlet connection.) The FRP housing shall be flanged and drilled per NBS PS 15-69 and come complete with gaskets, ready for installation. The Particulate Filter shall be manufactured by HEE Environmental Engineering or equal, the unit shall be manufactured by the scrubber manufacturer to ensure compatibility.

D. Flow Control Damper: A damper shall be supplied to regulate airflow through the reactor vessel. The damper shall be supplied loose and be ready for installation into the reactor system supply ductwork. The damper shall be positioned on the inlet side of the fume exhauster when assembled. The damper shall be furnished by the manufacturer of the odor control system.

E. Discharge Raincap: The Biological Scrubber vessel outlet shall be provided with an FRP exhaust stack / weather cap assembly. This assembly shall ship loose and be ready to install at each vessel outlet nozzle. The stack shall be the height indicated on the drawings. The weather cap shall be of the "hat" style. The stack shall come flanged and drilled, with gasket and bolting hardware.

F. Interconnecting Ductwork:
   1. Ductwork between the adsorber vessel and the exhaust fan shall be provided by the odor control manufacturer.
   2. Selection between rectangular or circular cross-sectional configuration shall be the choice of the manufacturer, with approval of the engineer. Ductwork assembly and design shall be compatible with the fan and vessel. Ductwork shall be manufactured in accordance with ASTM 3299 and PS 15-69.
   3. An expansion joint shall be included in the ductwork and installed at the outlet of the exhaust fan. The expansion joint shall dampen axial, lateral, and vibrational duct movement. The expansion joint shall be resistant to ultraviolet degradation and to the corrosive gases being processed. The expansion joint shall be of a slip-on design, fastened to the ductwork with stainless steel band clamps.

G. Hazardous Location Upgrade: For hazardous locations, all motor starters shall be upgraded to NEMA Type 3R, 7 & 9 bolted enclosures. All pushbuttons and pilot light shall be door and/or flange mounted and shall be NEMA Type 7 & 9. Combination motor starters shall be Allen-Bradley 513, or equal.

PART 3 EXECUTION

3.01 SYSTEM SUPPLIER'S SERVICES

A. After the Biological Scrubbing system is installed and operational the Contractor is to test and balance the entire foul air supply as well as the system to ensure that airflow through the system satisfies the operating conditions. In addition, the Contractor shall fill the Biological Scrubber vessel sump with make-up water and check that pump, fan, piping, controls, and spray system are operational.

B. The Odor Control System Supplier shall "seed" the scrubber sump with the microorganisms, and balance and adjust the ecosystem to optimize growth. The system may not be started until the Odor Control System Supplier has determined that the ecosystem is in balance.

C. When start-up occurs and untreated air is introduced measurements shall be taken at the inlet indicating the levels of H_2S present in the air stream. After 48 hours measurements will again be taken at inlet and outlet to determine the level of growth of the microorganisms. After 72 hours further measurements will be taken, and will continue to be taken every 12 hours until required performance criteria is achieved.

D. A test report shall be submitted to the Engineer for review and approval. The test report shall include the actual field test data, inlet H_2S concentration, outlet H_2S concentration, and H_2S removal rate as well as any operational notes made throughout the test duration.

E. After successful completion of the test, the Contractor is to seal any holes made in the duct or the system.

F. The Odor Control System Supplier shall provide ( ) man days of field service for operator training.

3.02 QUALITY ASSURANCE:

A. The engineer may provide and direct inspectors to inspect the equipment at the place of manufacture or upon arrival at the job site. The manufacturer shall furnish all reasonable assistance, if required by the engineer or inspector, for the proper inspection of the work. Inspection shall not relieve the manufacturer from any obligation to perform the work strictly in accordance with this specification. Work not so performed shall be replaced by the manufacturer at his own expense.

END OF SECTION

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