ODOUR CONTROL SYSTEM

1. GENERAL

1.1 Summary

.1 Furnish, install and test a biological odour abatement system (biofilter, biotrickling, bioscrubbing system or a combination) capable of handling and removing 99 percent of hydrogen sulfide and 95 percent of inlet odours. The odour control system shall include a humidification system, containment vessel, synthetic media, support panels, irrigation system, nutrient addition system, instruments, associated control system, and all appurtenances to make it operable, as indicated and as specified.

1.2 Standards

.1 Air Movement and Control Association (AMCA).

.2 American National Standards Institute (ANSI).

.3 American Society for Testing and Materials (ASTM):

.1 ASTM C582 - Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment.

.2 ASTM D648 - Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position.

.3 ASTM D3982 - Contact Molded “Fiberglass” Ducts.

.4 ASTM D4385 - Classifying Visual Defects in Thermosetting Reinforced Plastic Protruded Products.

.5 ASTM D746 - Brittleness Temperature of Plastics and Elastomers by Impact.

.6 ASTM D790 - Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

.7 ASTM D1505 - Density of Plastics by the Density-Gradient Technique.

.8 ASTM D1525 - Determination of Vicat Softening Temperature of Plastics.

.9 ASTM D1693 - Environmental Stress-Cracking of Ethylene Plastics.

.10 ASTM D1998 - Polyethylene Upright Storage Tanks.

.11 ASTM D2583 - Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.

.12 ASTM D3299 - Filament-Wound Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Tanks.

.13 ASTM D4097 - Contact-Molded Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Tanks.

.14 ASTM D4167 - Fiber-Reinforced Plastic Fans and Blowers.

.15 ASTM E84 - Surface Burning Characteristics of Building Materials.

.16 ASTM E679 - Determination of odour and Taste Thresholds by a Forced-Choice Ascending Concentration Series Method of Limits.

.17 ASTM F1473 - Notch Tensile Test to Measure the Resistance to Slow Crack Growth of Polyethylene Pipes and Resins.

.4 Deutscher Verband für Schweißen (German Welding Society) Guidelines (DVS):

.1 2207-1 - Welding of Thermoplastics.

.5 Fiberglass Reinforced Plastics Institute, Inc. (FRPI):

.1 Laminate Certification Manual.

.6 ISO:

.1 17855-1 - Plastics – Polyethylene (PE) Molding and Extrusion Materials.

.2 19069-1 - Plastics – Polypropylene (PP) Molding and Extrusion Materials.

.7 National Bureau of Standards (NBS):

.1 PS 15 - Custom Contact Molded Reinforced Chemical Resistant Process Equipment.

.8 Anti-Friction Bearing Manufacturers Association (AFBMA).

.9 Canadian General Standards Board (CGSB).

.10 Canadian Standard Association (CSA).

.11 Electrical Equipment Manufacturers Association of Canada (EEMAC).

.12 Hydraulic Institute Standards (HIS).

.13 International Society for Measurement and Control (ISA).

.14 National Electrical Manufacturers Association (NEMA).

.15 National Fire Protection Association (NFPA).

.16 Occupational Health and Safety Act (OHSA).

.17 Ontario Building Code (OBC).

.18 Sheet Metal and Air Conditioning National Contractor’s Association (SMACNA).

1.3 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Certified Shop and Working Drawings. Drawings for the vessels shall also include a complete description of the laminate construction as specified within this Section and be accompanied by a detailed post-cure procedure that will be utilized.

.3 Submit details of:

.1 Resin Type.

.2 Types and amounts of filler.

.3 Corrosion liner description.

.4 Reinforcement types for hand lay-up or chopped laminates.

.5 Gel coat and UV inhibitor.

.4 Material Certification:

.1 Provide certification from the Manufacturer that the materials of construction specified are recommended and suitable for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of three (3) years. Provide proposed materials at no additional cost to the City.

.2 Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.

1.4 Warranty

.1 The Manufacturer shall warrant that the media in the odour control system will not compact, degrade or decompose for a period of 10 years from Final Completion.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Supply products from a single manufacturer responsible for the complete biological odour control system, complete with all features and accessories in this specification.

.2 Supply products modified as necessary by the Manufacturer to provide the specified features and to meet the specified operating conditions.

.3 Acceptable Manufacturers:

.1 BIOREM Technologies.

.2 Evoqua.

.3 Cockerill Environmental.

.4 Or approved equal.

2.2 Performance Criteria

.1 The odour control system shall be a continuous operation dual system with each unit designed at 50% max flow capacity. If one unit is out of service, the second unit must be able to pass the peak flow (even if there is reduced treatment).

.2 The foul air source locations are:

.1 Existing hauled liquid waste storage tank and receiving manholes.

.2 Phosphorus release tanks.

.3 Sludge screenings bins.

.4 Waste activated sludge thickeners.

.5 Thickened sludge sumps.

.6 Intermediate centrate tanks.

.7 Screened sludge equalization tanks.

.8 Intermediate dewatering centrifuges.

.9 Dewatered sludge hoppers.

.10 Dewatered sludge chutes.

.11 Sludge receiving station.

.12 Hauled sludge equalization tanks.

.3 Foul air inlet conditions at the odour control system:

.1 Foul air temperature: 5 to 20°C.

.2 Outdoor ambient temperature: -40 to +40°C.

.4 Removal efficiencies:

.1 Provide a minimum odour removal efficiency of 95 percent during both average and peak loading conditions. Design Builder shall determine minimum, average and peak odour emission rates.

.2 Provide a minimum hydrogen sulphide reduction efficiency of 99 percent during both average and peak loading conditions. Design Builder shall determine minimum, average and peak emission rates of hydrogen sulphide.

.5 Odour Control System General Performance:

.1 Odour control system vessel including media, all internals, required water supply piping internal to vessel, pumps, control valves, instrumentation, control systems and panels are to be supplied in a complete package.

.2 The equipment is to be the Manufacturer's standard design. The design is to have been proven effective and reliable under similar operating conditions.

.3 The odour control system is to be designed to operate 24 hours per day, 7 days per week.

.4 Minimum service life of the media shall be 10 years.

2.3 Configuration, Components and Features

.1 General:

.1 The Manufacturer will be responsible for the supply of the odour control system package, complete with all features and accessories as listed in this Section.

.2 The odour control system packages will include all equipment, media, tankage, pumps, valves, piping, ductwork, instruments, controls, electrical equipment, panels, accessories and appurtenances needed to constitute a complete and fully functional system capable of withdrawing and treating the design foul air and loading; and discharging treated foul air to atmosphere.

.3 The Contractor shall install the vessel(s) in accordance with the Drawings which will be stamped by a registered professional engineer licensed to practice in the Province of Manitoba.

.4 All equipment supplied shall be suitable for continuous operation in a corrosive foul air stream generated within a wastewater treatment facility.

.5 Humidification system will be sized to raise the relative humidity of the air stream from 60 percent to 95 percent or higher.

.6 Provide alarm for negative pressure for each unit process.

.7 The odour control system is comprised of the following components:

.1 Vessel material of construction to be FRP, and to be UV and H_2S resistant.

.2 Synthetic, random packed, bioscrubbing/biotrickling filter media, or inorganic biofilter media.

.3 Interconnecting ductwork between fans, filtration vessel, and exhaust.

.4 If bioscrubbing system, water recirculation pump, complete with isolation valves, check valves, and strainers.

.5 Waterbox.

.6 If bioscrubbing/biotrickling system, nutrient addition system with nutrient solution storage vessel, metering pump and valving complete with integrated controls.

.7 Complete winterization system designed for an outdoor climate in Winnipeg, MB including nutrient tank immersion heater, space heaters, integral thermostat, and recirculation line heater.

.8 Instrumentation and fluid control valves.

.9 Safety equipment needed for operation of nutrient addition system, inclusive of an eyewash or shower if needed through specification of Material Safety Data Sheet.

.10 Sample ports required for commissioning and testing.

.11 Auxiliary equipment.

.2 Vessels:

.1 All materials and components shall be new and unused and free of defects and imperfections. Vessels shall be designed in accordance with the following requirements:

.1 The vessel is to handle H_2S fumes and sulphuric acid at a pH range of 1.0-2.0.

.2 The vessel shall be able to withstand the maximum suction pressure of -7 kPa (-28” wc) created by the odour control exhaust fans downstream of the vessels.

.3 The vessel is to be manufactured so that all parts are proportioned to have liberal strength and stiffness and to be especially adapted for the intended working conditions.

.4 Vessel is to be designed to operate under a positive pressure.

.5 Insulate the exterior of the vessel with minimum 50 mm of insulation and aluminum jacketing.

.6 For FRP construction, construct the vessel as follows:

.1 The inner shell is to be approximately 25 percent glass and 75 percent resin. Provide an internal C-glass surface veil liner for corrosion resistance.

.2 Resin (flame retardant versions only):

.1 Acceptable Products:

.1 Hetron FR922 by Ashland Chemical Co.

.2 Derakane 510C-350.

.3 Dion ver9300FR.

.4 Vipel K022-AC Series.

.5 Or approved equal.

.3 Reinforcing material is to be commercial grade glass fiber containing a coupling agent to produce a suitable bond with the resin used.

.4 All materials are to be suitable for exposure to hydrogen sulfide fumes at a concentration of up to 300 ppm and sulfuric acid at a pH of 1.0.

.5 Ultraviolet absorbers are to be added to the exterior surface for improved weather resistance.

.7 All surfaces are to be finished so as to obtain complete cure of the resin without air inhibition. The finished laminate is to be as free as commercially practicable from visual defects such as foreign inclusions, dry spots, air bubbles, pinholes and pimples. The vessels are to conform to the Manufacturer's minimum standard for Barcol hardness.

.8 Vessel rigidity to be designed to prevent collapse, implosion or any other damage to the unit from operation of the suction fan at any point along its performance curve.

.9 The inner surface is to be free of cracks and crazing with a smooth finish and with an average of not over two pits per 0.1 m^2, providing the pits are less than 3 mm diameter and not over 0.8 mm deep and are covered by sufficient resin to avoid exposure of inner surface fabric. Some waviness is permissible as long as the surface is smooth and free of pits.

.10 The vessel is to be equipped with the accessories as listed below:

.1 Provide Lifting eyebolts (minimum of 4) for use in transporting and placing the vessel.

.2 Provide hold downs (minimum of 4) each consisting of Type 316 stainless steel anchor bolts. The anchor bolts are to be used for anchor bolting to the concrete foundation.

.3 All necessary access doors, sampling ports, nozzles and other attachments. Vessel connection flanges are to be compatible with connecting piping and ductwork.

.4 The Manufacturer is to provide an access ladder, platform, and guardrail for safe access. They are to be used for person access for maintenance and inspection during operation, as well as media loading if required. A swing-gate is to be provided at the top of the ladder on the platform for fall safety.

.5 Provide at least one side entry manway for each lift and spray nozzle assembly and is to be a minimum of 60 cm (24 inches) diameter with bolted flanged covers and are rated for 10 psi minimum. Provide bolted manways with 3 mm thick full face neoprene gaskets with Type 316 stainless steel bolts. Provide manways as needed for inspection and access to internals of the vessel.

.6 All bolts and fasteners are to be Type 316 stainless steel.

.7 All gaskets are to be EPDM.

.8 Vessel flanges and attachments are to be compatible with connecting piping and ductwork.

.9 The media support is to be vinyl ester FRP grid type. Packing support plates and mid-span supports are to be suitable to support the weight of the packing and entrained recirculation solution.

.10 Provide integral sump to allow for continuous water recirculation, if required.

.11 Provide a chevron-style, mist eliminator at the top of each vessel.

.3 Bioscrubber and Biotrickling Media:

.1 The media shall be a permanent engineered media. The media shall be formulated with nutrients, buffering agents and adsorbents.

.2 The media is to not shrink or swell under varying moisture conditions. The media shall be resistant to degradation and compaction. Media shall not settle by more than 1.5% of its original depth within six (6) months after installation. The media shall not shrink or swell with carrying moisture contents.

.3 The media is to be supplied in a volume that is sufficient to treat the design airflow at the required empty bed residence time confirmed by the Manufacturer.

.4 The media shall be free debris and contaminants.

.4 Biofiltration Media:

.1 Media is to be random packed.

.2 The biofiltration media is to consist of inorganic inert hydrophilic material, uniform in shape.

.3 The media is to not shrink or swell under varying moisture conditions.

.4 The media shall have low pressure drop requirements over the life of the biofiltration filter and be designed for uniform and even air distribution.

.5 The media shall be unreactive and shall not degrade when exposed to decreased pH ranges.

.6 When media compacts, experiences significant channeling, excessive pressure drop, or other degradation (i.e., reduction in particle size/density), the manufacturer shall replace the media in accordance with the media warranty requirements.

.5 Recirculation and Spray Irrigation System:

.1 The circulation system for the bioscrubbing/biotrickling filter, and spray irrigation system for the biofilter shall consist of a spray nozzle assembly that is located above the top of each media bed layer, and centrifugal circulation pump for the circulation system. Spray nozzles to be PVC.

.2 The circulation system and spray irrigation system shall provide full and even coverage of the bioscrubbing/biotrickling filter/humidifier cross section are to ensure uniform media moisture content throughout the biofiltration system.

.3 All instruments and valves in the water supply lines, circulation lines, and spray irrigation lines to be supplied by the Manufacturer.

.4 All piping and nozzles shall be corrosion resistant.

.5 The centrifugal pump shall be CPVC or Type 316 stainless steel construction, capable of pumping the specified capacity and shall be sized for optimal performance of the odour control system.

.6 The recirculation system shall be operated for entire life of odour control system.

.7 A media irrigation system that operates intermittently shall be utilized for the biofilter system. Frequency and duration of irrigation shall be determined by the Manufacturer.

.8 Manufacturer to provide waterbox panel to house instruments and valves.

.9 Provide insulation, aluminum jacketing and heat tracing for all exterior pumps and piping to prevent freezing.

.10 The biofilter shall be fitted with a drain connection sized to handle 150% of the water flow entering the spray chamber. All drains shall be attached with p-traps to prevent air leakage and shall be corrosion resistant.

.11 An overflow drain shall be provided above the normal sump liquid level in the exterior sump to allow drainage of high liquid levels.

.6 Recirculation Pumps:

.1 Provide duty and standby recirculation pumps for each bioscrubbing system. Pumps shall be of suitable material for operation with a low pH corrosive solution.

.2 The Manufacturer shall be responsible for pump sizing and drive assembly.

.3 Select and design the equipment specified herein specifically for continuous duty pumping of recirculation water.

.4 Provide equipment that is non-overloading and that operates without noise, vibration, heating or damage when operating at the specified operating conditions.

.5 Shafts shall be machined and surface ground to ensure the interchangeability of shafts and the attached parts.

.6 Bearings shall be of sufficient size and properly spaced to transfer all radial and axial loads to the pump housing and to minimize shaft deflection.

.7 The selected pump should not use the maximum size of impeller for that series of pump.

.8 All electrical equipment shall be Class 1, Division 2, explosion proof.

.9 The Contractor shall supply and install all necessary connection wiring and cables to the control panel and associated accessories as per the Manufacturer's instructions.

.10 The pumps must be designed to operate at a continuous, full load for the liquid specified without external cooling.

.11 Provide a watertight seal between the pump and piping connections.

.12 The pump shaft shall be of adequate size and strength to transmit the full horsepower with a liberal safety factor to ensure rigid support of the impeller and to prevent vibration at operating speeds.

.13 Bearings shall be of sufficient size and properly spaced to transfer all radial and axial loads to the pump housing and to minimize shaft deflection.

.14 The impeller shall be statically and dynamically balanced, positioned rigidly and secured on the shaft with a stainless steel key and impeller lock nut or lock screw.

.7 Nutrient Addition System:

.1 For each biotrickling/bioscrubber systems, provide one nutrient addition systems.

.2 Each nutrient addition system shall contain the following:

.1 FRP nutrient feed tank sized by the Vendor to contain a one (1) month supply of nutrient solution.

.2 One (1) motorized mixer internal to the nutrient feed tank.

.3 Piping connections to the one (1) metering pump installed within the water panel for nutrient addition.

.4 Piping connections from the water panel to the bioscrubber recirculation line and irrigation line for nutrient addition.

.5 Provide two (2) year supply of bioscrubber nutrients.

.6 Ball valves for isolation.

.7 Check valve.

.8 Water supply connection.

.9 Overflow drain.

.3 All piping shall be of corrosion resistant material.

.4 Provide means of mixer and nutrient pump local controls. Contractor to provide all field wiring required, including the following control and monitoring points to the PAC panel for the nutrient pump:

.1 Remote Selected.

.2 Running.

.3 Low Flow Alarm.

.4 Leakage Alarm.

.5 General Fault.

.6 Start/Stop Command.

.7 Speed Indication.

.8 Speed Setpoint.

.8 Electric Motor:

.1 The motor shall be sized for runout conditions and shall be non-overloading throughout the entire pump range of operation without utilizing the motor service factor.

.2 The motor shall be designed for continuous duty and shall be capable of sustaining at least ten (10) evenly spaced starts per hour.

.3 The motors shall be of the squirrel cage induction shell type design, housed in an air-filled watertight chamber.

.4 The motors shall adhere to the requirements of Section 16223.

.9 Waterbox:

.1 Provide a waterbox, which houses components necessary for water transfer to the vessels, if required.

.2 Waterbox to be a minimum NEMA 4X enclosure of either FRP or Type 316 stainless steel.

.3 Waterbox is to contain valves, strainer, and plumbing required for media irrigation.

.4 Provide field connection to external water supply.

.5 Waterbox is to contain the following instrumentation and fluid control valves:

.1 One each: ball valve, y-strainer and pressure indicator on water supply line.

.2 One ball valve (N/O) for sump make-up water isolation.

.3 One ball valve (N/C) for once through recirculation water option.

.4 One flow indicator/switch, to display recirculated water flow rate, signal alarm and shut off recirculation pump in case of reduced water flow.

.5 Local magnetic flowmeters to display irrigation, sump make-up and sump blow down water flow rates.

.6 One diaphragm valve for recirculated water flow control.

.7 One PIT for recirculated water flow.

.8 One ball valve for recirculated water flow isolation.

.9 One globe valve for blow-down water flow control.

.6 Instrumentation and fluid control valves (external to waterbox):

.1 Two Anubar and differential pressure gauges to measure inlet airflow (local read).

.2 Magnehelic differential pressure gauge to measure pressure drop across media beds.

.3 One online inlet air temperature indicator.

.4 One ball valve (N/O) sump isolation valve.

.5 One Y-strainer on inlet of recirculation pump.

.6 One Ball valve (N/C) for sump drainage.

.7 One check valve on outlet of recirculation pump.

.8 Two PITs (water), one on each side of recirculation pump.

.9 Online hydrogen sulphide analyzer (minimum detection range 0.01 ppm H_2S) and transmitter.

.10 Handheld hydrogen sulphide analyzer (minimum detection range 0.01 ppm H_2S) complete with testing standards and transmitter compatible with sample ports.

.11 All instrument ranges shall be selected by the Manufacturer to match the complete long-term operational ranges of the equipment.

.12 Select instruments suitable for measuring foul air differential pressure with characteristics described in this Section.

.10 Biofilter Fans:

.1 Comply with requirements of Section 15854 – Centrifugal Foul Air Fans.

.11 Ductwork:

.1 Ductwork to be fiberglass reinforced plastic (FRP) or high-density polyethylene (HDPE).

.2 Add ultraviolet absorbers to surfacing resin to improve weather resistance.

.3 Provide supports to ensure ductwork is free from vibration when in operation.

.4 Insulation to be provided for exterior environment in accordance with Division 11 and 15.

.5 Slope ductwork to drain and provide drains.

.12 Duct Inspection Plates:

.1 Removable inspection plates, made of the same material as the duct, not less than 150 mm square or 200 mm round, at all fan inlet and discharge connections.

.2 Gasketed with an airtight seal with the parent duct.

.13 Gasketing and Sealing:

.1 Flanged nozzles: Viton or hypalon full face gaskets of 50 to 60 Shore “A” Durometer hardness.

.2 Fabricated gaskets: Machine-made or die-stamped with inside and outside edges parallel or concentric, as applicable. Make bolt holes oversized to prevent crimping of gasket when installed.

.3 Neoprene:

.1 6 mm (1/4 inch) thickness.

.2 Acceptable Product:

.1 Garlock 7986.

.14 Auxiliary Equipment:

.1 Provide a nutrient feed system to maintain optimal conditions for microbial growth. A polypropylene tank and metering pump shall be provided to deliver the adequate amount of nutrients to the system. Provide in a weather appropriate enclosure for the climate specified, or other approved arrangements by City. One (1) year supply of nutrient dry blend will be provided.

.15 Interconnecting Ductwork:

.1 Provide the ductwork between the humidifier, the odour control fans, and the reactor vessel by odour control Manufacturer.

.2 Provide the ductwork assembly and design compatible with the fan and vessels.

.3 Material: Provide in accordance with Section 15890.

.4 Provide an expansion joint in the ductwork and installed at the inlet and 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.

.1 Provide expansion joints in accordance with Sections 15090 and 15890.

.16 Flow Control Damper (Balancing):

.1 Provide an opposed multi-blade type damper 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 fan or as indicated. The damper shall be furnished by the Manufacturer of the odour control system and work successfully as part of the system to meet its intended purpose.

.1 Operating pressure shall meet its intended purpose of the odour control system with minimum 25% safety margin included.

.2 Damper Materials:

.1 FRP Body and Blade:

.1 Premium, corrosion resistant, flame retardant, vinyl ester resin. Derakane 510A or Hetron FR992.

.2 Minimum 3 mm (1/8-inch) corrosion barrier. FRP construction per ASTM D3982 and ASME/ANSI RTP-1.

.3 Paraffinated gel coat with ultraviolet inhibitor for the body.

.4 L/360 blade deflection. Provide stiffeners as required; 316 stainless steel for any metal used in stiffener construction for the blade.

.3 Shaft will be FRP or FRP encapsulated 316 stainless steel.

.1 Extend shaft full length of blade and 150 mm (6 inches) beyond frame.

.2 Mount damper with shaft close in the horizontal plane.

.3 The shaft seal will be FRP with Viton O-ring.

.4 The bearings will be made from PTFE.

.2 Damper Configuration:

.1 Flanges will be manufactured per ASTM D 3982. Flange and corrosion barrier must be integral to the body.

.2 The damper must be AMCA certified for air leakage (Class 1) and AMCA Certified for Air Performance. The damper must be AMCA certified at time of submittal.

.3 Manual Operators:

.1 Lever or Worm Gear:

.1 Diameter ≤ 500 mm (20 inches): crank levers with infinite screw down positioners (316 stainless steel for all metal components).

.2 Diameter > 500 mm (20 inches): worm gear operator (316 stainless steel for metal components in contact with process fluid).

.3 All Diameters: worm gear operator with chain wheel for dampers mounted >2 m. above finished floor or grade.

.3 Acceptable Manufacturers:

.1 Ruskin.

.2 Swartwout.

.3 Belco.

.4 Daniel Mechanical.

.5 Approved Equal.

.17 Control Panel:

.1 Mount on skid or wall-mounted.

.2 Enclosure:

.1 NEMA 4X Type 316L stainless steel for non-classified areas and NEMA 7 Cast Aluminum for classified areas.

.3 Completely wire components to terminal boards.

.4 Provide with hinged front cover and the following instruments flush mounted:

.1 LOCAL/REMOTE Switch.

.2 START-STOP pushbuttons, momentary-contact type with lock-out latch.

2.4 Equipment and System Controls

.1 Integrate all controls with plant's SCADA system.

.2 Instrumentation and controls are to be provided to ensure proper operation of the odour control units.

.3 All instruments are to be suitable for both the service conditions in the foul air being treated and outdoor installation.

.4 Provide differential pressure sensor and transmitter.

2.5 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements and the following:

.1 One (1) of each type of pressure gauge, with diaphragm seals or plain, as necessary.

.2 Two (2) spare gaskets of all types, materials and sizes.

.3 Two (2) Fan belts.

.4 Two (2) Fan shaft bearings.

.5 Two (2) Fan shaft seal.

.6 One (1) Recirculation pump.

.7 Two (2) Irrigation nozzles.

.8 Two (2) Actuators

3. EXECUTION

3.1 General

.1 Install in accordance with the Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

3.2 Field and Functional Testing

.1 After installation, perform the following full operational tests in presence of the City. Furnish all labor, materials and equipment required for such tests.

.1 Leakage Test:

.1 Factory test with water to the height of the overflow or the straight side height of the vessel, greater amount. Submit test data.

.2 The water level must be unchanged after 24 hours with no visible signs of leakage or wall deflection exceeding 1/4 percent of span.

.3 Hydrostatic test shall be witnessed by the City.

.2 H_2S testing is to be performed on site by the manufacturer's field service representative using portable H_2S sensors.

.3 Odour Sensory Testing is to be performed by an independent testing firm that specializes in such testing.

3.3 System Balancing

.1 Adjust manual and automatic control devices to balance air flows so they perform as indicated and specified.

.2 Balance air systems so each outlet is within 10 percent and each fan is within 5 percent of values indicated.

.3 Submit report to the City outlining balancing procedures used; report to include:

.1 Type of measuring devices used.

.2 Air quantities at each outlet, damper, and fan.

.3 Fan speeds.

.4 Fan suction and discharge pressures.

3.4 Performance Testing

.1 Sample foul air from the inlet and treated foul air from the discharge of the odour control system to confirm operation within the performance requirements.

.2 Test for all parameters identified in this Section.

.3 Document conformance with the performance requirements in this Section.

.4 Contract with an independent testing agency to perform the performance testing.

.5 Submit calibration reports for all instruments used as part of the performance test.

.6 If the odour control equipment does not meet the specified removal of odorous compounds as listed in this Section, submit a plan for how the equipment will be corrected to meet the specified requirements. Design Builder shall be responsible all costs associated with correcting the equipment and installation to provide a fully functional system that meets the performance requirements.

.7 Submit a performance testing report upon completion of the testing documenting the test results.

END OF SECTION

ACTIVATED CARBON VESSEL

1. GENERAL

1.1 Summary

.1 This Section covers the furnishing and installation of an activated carbon media-based odour control or odour polishing unit.

1.2 Standards

.1 American Society for Testing and Materials (ASTM):

.1 ASTM 0638 - Standard Test Method for Tensile Properties of Plastics.

.2 ASTM 0648 - Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position.

.3 ASTM 0746 - Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.

.4 ASTM 0790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

.5 ASTM C582 - Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment.

.6 ASTM D883 - Standard Terminology Relating to Plastics.

.7 ASTM D1505 - Standard Test Method for Density of Plastics by the Density-Gradient Technique.

.8 ASTM D1525 - Determination of Vicat Softening Temperature of Plastics.

.9 ASTM D1693 - Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics.

.10 ASTM D1998 - Polyethylene Upright Storage Tanks.

.11 ASTM D2583 - Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.

.12 ASTM D2584 - Standard Test Method for Ignition Loss of Cured Reinforced Resins.

.13 ASTM D3299 - Filament-Wound Glass-Fiber-Reinforced Thermoset Resin Chemical-Resistant Tanks.

.14 ASTM D4097 - Contact-Molded Glass-Fiber-Reinforced Thermoset Resin Corrosion Resistant Tanks.

.15 ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

.16 ASTM E679 - Standard Practice for Determination of Odour and Taste Thresholds by a Forced-Choice Ascending Concentration Series Method of Limits.

.17 ASTM F1473 - Standard Test Method for Notch Tensile Test to Measure the Resistance to Slow Crack Growth of Polyethylene Pipes and Resins.

.2 The American Society of Mechanical Engineers (ASME):

.1 ASME B16.5 - Pipe Flanges and Flanged Fittings.

.3 Air Movement and Control Association International (AMCA).

1.3 Submittals

.1 Provide submittals in accordance with Section 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Three 100 mL samples (each) of the proposed carbon media with a written description of its pertinent properties.

.3 Fully dimensioned layout drawings and cross-sectional details of the odour control system, including bill of materials.

.4 Static pressure calculations.

.5 Bed life calculations.

.6 AMCA certified fan performance curves and data, indicating the following: air flow rate (L/s), static pressure (Pa), brake horsepower (BHP), motor horsepower (HP), efficiency, vibration data, revolutions per minute, model, size, and sound power data.

.7 Details on the weatherproof enclosure for the fan, including dimensions and materials of construction.

.8 Required ancillary services.

.9 Details of coating systems to be applied.

.10 Base dimensions, materials, and connection details.

.11 Details of insulation provided to prevent galvanic corrosion between mating surfaces constructed of dissimilar metals.

.12 Installation instructions indicating assembly, mounting and anchorage requirements, alignment and assembly tolerances, and points of connection for ancillary services.

.13 Provide all information required for the design of structural supports for the odour control system including all live (wetted) and dead loads, special reinforcing requirements, drainage passages, floor slopes, and all other applicable requirements.

.14 Provide all information required for the design of fan bases, including horizontal and vertical loads, dynamic loads (WR2) for rotating components, size and location of anchor bolts and all clearances required.

1.4 Quality Assurance

.1 Manufacturer Qualifications:

.1 A minimum of 10 years' experience in the design, fabrication, and supply of odour control systems.

.2 Five installations of activated carbon units treating an air volumetric capacity in excess of 5,000 m^3/h per facility.

.3 At least one of the five installations must treat an air volume in excess of 20,000 m^3/h per facility.

.2 FRP Fabricator: demonstrate, through past records, their capability in successful manufacturing of filament-wound fiberglass.

.3 FRP vessel fabricator's Quality Assurance Supervisor: minimum 3 years' experience in the fabrication of fiberglass structures.

.4 HDPE Fabricator: demonstrate, through past records, their capability in successful manufacturing of HDPE vessels and piping.

.5 HDPE vessel fabricator's Quality Assurance Supervisor: minimum 3 years' experience in the fabrication of HDPE structures.

1.5 Shipment, Storage and Protection

.1 Temporary shipping braces if required are to be clearly identified for removal after assembly.

.2 Lifting lugs are to be shop installed, as required, to permit safe handling during shipping and erection with conventional hooks or slings.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Supply products from a single Manufacturer responsible for one complete activated carbon odour control system complete with all features and accessories in this specification.

.2 Supply products modified as necessary by the Manufacturer to provide the specified features and to meet the specified operating conditions.

.3 Acceptable Manufacturers:

.1 Purafil.

.2 Unisorb.

.3 Advanced Air Solutions.

.4 Evoqua.

.5 CMI.

.6 Or approved equivalent.

2.2 Performance / Design Criteria

.1 The odour control system shall be a continuous operation dual system with each unit designed at 50% max flow capacity. If one unit is out of service, the second unit must be able to pass the peak flow even if there is reduced treatment.

.2 For gas inlet conditions at the activated carbon unit, the design criteria for the following parameters shall conform to the Final Design:

.1 Flow Rate.

.2 Foul Air Temperature.

.3 Outdoor Ambient Temperature.

.4 Relative Humidity.

.5 Estimated Total System Pressure Loss.

.6 Hydrogen Sulphide Loading (maximum and average).

.7 Total Reduced Sulphur Compounds Loading.

.8 Volatile Organic Carbon Loading.

.9 Odour Units.

.3 For required removal efficiencies / outlet gas conditions, the design criteria for the following parameters shall conform to the Final Design:

.1 Hydrogen Sulphide.

.2 Total Reduced Sulphur.

.3 Volatile Organic Carbon.

.4 Odour Units.

.4 Activated Carbon Adsorption Unit General Performance:

.1 All equipment supplied is to be suitable for continuous operation in a corrosive gas stream generated from the treatment of wastewater from a municipal wastewater treatment facility.

.2 The equipment is to be the Manufacturer's standard design. The design is to have been proven effective and reliable under similar operating conditions.

.3 The system is to be in a draw through configuration with fans located downstream of the activated carbon media vessels.

.4 The carbon unit fans are to be supplied complete with electric motors and instrumentation. Fans and all associated equipment must be suitable for variable speed drives.

.5 Provide any sub-systems or components not mentioned in this specification that are required to provide a fully functional odour control system.

.6 The odour control system is to be designed to operate 24 hours per day, 7 days per week.

.7 The fan is to be driven by VFD allowing for variable speed operation during high and low flow periods.

.8 All media beds are to be designed to have a means of obtaining media samples at two (2) different locations.

.9 The equipment is to be designed to have a means of obtaining air samples.

.10 Minimum actual bed life of the activated carbon media is to be 2 years.

2.3 Configuration, Components, Features

.1 Activated Carbon Adsorption Unit Housing:

.1 Provide an absorption housing of either:

.1 Fibre-reinforced plastic (FRP).

.2 14 gauge, 316L, continuous welded stainless steel and reinforced with stainless supports; or

.3 Concrete with a liner in accordance with Section 03370.

.2 The housing vessel is to include the following if constructed of fiberglass reinforced vinyl ester resin:

.1 The inner shell is to be approximately 25 percent glass and 75 percent resin. Provide an internal C-glass surface veil liner for adequate corrosion resistance of the inner shell.

.2 Resin (flame retardant):

.1 Acceptable Products:

.1 Hetron 922FR by Ashland Chemical Co.

.2 Derakane 510C-350.

.3 Dion ver9300FR.

.4 Vipel K022-AC Series.

.5 Or approved equivalent.

.3 For HDPE construction, construct the vessel as follows:

.1 Meet or exceed all requirements of ASTM D1998, ASTM D1505, ASTM D1693, ASTM 0638, ASTM D1525, ASTM 0790, ASTM 0746, ASTM 0648, and ASTM F1473.

.2 Use rotational molding construction.

.3 Do not use an exterior girdle or individual support device; vessel and anchorage system alone must withstand all forces.

.4 Reinforcing material is to be commercial grade glass fiber containing a coupling agent to produce a suitable bond with the resin used.

.5 All materials are to be suitable for exposure to hydrogen sulphide fumes at a concentration of up to 300 ppm and sulphuric acid at a pH of 1.0.

.6 Ultraviolet absorbers are to be added to the exterior surface for improved weather resistance. Insulated tanks, where applicable, are to have a light gray pigmented exterior gelcoat layer.

.7 All surfaces are to be finished so as to obtain complete cure of the resin without air inhibition. The finished laminate is to be as free as commercially practicable from visual defects such as foreign inclusions, dry spots, air bubbles, pinholes and pimples. The vessels are to conform to the Manufacturer's minimum standard for Barcol hardness.

.8 The inner surface is to be free of cracks and crazing with a smooth finish and with an average of not over two pits per 0.1 m^2, providing the pits are less than 3 mm diameter and not over 0.8 mm deep and are covered by sufficient resin to avoid exposure of inner surface fabric. Some waviness is permissible as long as the surface is smooth and free of pits.

.9 The unit is to have gasketed access doors for filters and quick release access hatches on top for filling of media.

.10 The top of the unit is to be designed to withstand 6 kPa and all exposed corners are to be filed smooth.

.11 The base is to be epoxy coated steel and provided with lifting lugs and anchor tie downs. All dissimilar metals are to be isolated from galvanic corrosion and fastened together by mechanical fasters.

.12 All access doors and hatches are to use closed cell neoprene gasketing to prevent any air leakage.

.13 All gasket material is to be 6 mm thick by 19 mm wide closed cell neoprene foam.

.14 Service doors and all unit access are to be oriented to suit operations and maintenance requirements and the Design.

.15 Each filter, filter gauge, media bed and sample port are to be identified by a lamacoid label.

.16 The nameplate engraved with the unit nomenclature, order number and serial number are to be permanently attached to the unit.

.17 If installed outdoors, complete winterization system designed for an outdoor climate in Winnipeg, MB.

.2 Duct Work:

.1 Unit is to include all internal ducting required to make connections between system components including, but not limited to, filters, fan and scrubber.

.2 Foul air duct work is to be FRP, HDPE, or 316L SS and designed for the operating static pressure of the activated carbon unit.

.3 Media Bed Sections:

.1 The unit is to have independent, fully accessible; bulk loaded and vacuum unloaded media chambers. Each media section is to have a bulk loading access hatch on the top of the unit for replacing media.

.2 Each media section is to have a quick connect vacuum unloading port (stainless steel) near the bottom of the unit to remove media.

.3 The combined H_2S holding capacity of media chambers must meet the requirements of Final Design.

.4 The system is to be designed for even airflow distribution though all media beds.

.5 All media chambers are to ensure that bypass of contaminants can be prevented.

.4 Activated Carbon Media:

.1 Carbon media is to be designed for broad spectrum removal of odorous gases, including mercaptans, hydrocarbons, hydrogen sulphide and sulphur dioxide. The media must be capable of 99.5% removal of all odorous compounds under all operating conditions.

.2 Load all chemical media into the vessels after the vessel has been properly placed and readied for permanent operation.

.3 Provide media bed suitable for vapour phase adsorption of odours.

.4 Provide sufficient activated carbon media to fill each carbon bed.

.5 New and spent media are to be non-hazardous and suitable for disposal at a landfill.

.5 Mist and Grease Eliminator:

.1 Mist and grease filter eliminator is to be 99.9% efficient, on removal of mists of 2 µm or more. The mist and grease pad shall be manufactured of 316 stainless steel and wound fiberglass.

.2 The eliminator pressure drop is to be continuously monitored with a unit mounted differential pressure gauges and explosion proof pressure switch. All differential pressure gauges to have stainless steel tubing and stainless steel bulkhead fittings.

.3 Any preheating, cooling, or humidification necessary to temper the incoming air stream are to be provided by the equipment Manufacturer.

.4 Stainless steel particulate filter tracks with positive air seals are to be used to allow easy changing of the filters, and to ensure air does not bypass the filters.

.5 Mist/grease eliminator to be the permanent washable type, constructed from 304 stainless steel.

.6 The droplet separator to be a high-efficiency in-line agglomeration type for operation in horizontal flow.

.7 The separator to be fitted with a side-mounted hinged access door to provide access to the separator elements.

.8 The eliminator shall be installed at floor level. If installed at heights work platform will be required.

.9 Provide a P-trap auto drain with PVC ball valve, heat tracing and insulation at low point of the mist/grease eliminator housing.

.6 Fan:

.1 Comply with requirements of Section 15854 – Centrifugal Foul Air Fans.

.7 Base Frame:

.1 Fan, motor, carbon vessel, and mist eliminator to be mounted on a reinforced rigid AISI 304L or 316L stainless steel base frame.

.2 Base frame to be fitted with minimum of four anchor bolt tabs and four lifting lugs, all welded to the unitized frame.

.8 Interconnecting Ductwork:

.1 Ductwork within the odour control unit to be supplied by the odour control Manufacturer.

.2 The interconnecting ductwork to be constructed from stainless steel to ASTM A480/A480M or FRP to ASTM D-3299.

.3 Provide rubber flexible duct connections between the fan and the interconnecting ductwork. Flexible connections to be suitable for a corrosive environment. Flexible connections to be fastened to the ductwork with stainless steel clip bands.

2.4 Equipment and System Controls

.1 Integrate all controls with PCS.

.2 Instrumentation and controls are to be provided to ensure proper operation of the activated carbon adsorption units.

.3 All instruments are to be suitable for both the service conditions in the foul air being treated and outdoor installation.

.4 Provide differential pressure sensor and transmitter.

2.5 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements and the following:

.1 One (1) mist and grease pad.

.2 Two (2) Fan belts.

.3 Two (2) Fan wheel bearings.

.4 One (1) Fan shaft seal.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

3.2 System Operational Testing

.1 H_2S testing is to be performed on site by the Manufacturer's field service representative using portable H_2S sensors able to read in ppb.

.2 Testing is to be conducted in accordance with standard testing odour testing protocols/methods.

.3 Manufacturer to test the media three (3) months after the start-up to establish a burn rate.

END OF SECTION

FIBREGLASS REINFORCED PLASTIC (FRP) DUCTWORK

1. GENERAL

1.1 Summary

.1 The Section covers the supply, installation and testing of fiberglass reinforced plastic (FRP) ductwork and accessories.

1.2 Standards

.1 American Society for Testing and Materials (ASTM):

.1 ASTM D638 - Standard Test Method for Tensile Properties of Plastics.

.2 ASTM D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

.3 ASTM D2310 - Standard Classification for Machine-Made “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.

.4 ASTM D2563 - Standard Practice for Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts.

.5 ASTM D2996 - Standard Specification for Filament-Wound “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.

.6 ASTM D3982 - Standard Specification for Contact Molded “Fiberglass” (Glass Fiber Reinforced Thermosetting Resin) Ducts.

.7 ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

.2 American National Standards Institute (ANSI):

.1 ASME/ANSI B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.

1.3 Submittals

.1 Provide submittals in accordance with Section 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Certification from the resin Manufacturer that the proposed resin and catalyst system is appropriate for the specified service conditions.

.3 For Filament-Wound Laminates:

.1 Helix angle.

.2 Glass content range.

.3 Strand yield.

.4 Strand by inch in the winding band.

.5 Ply thickness.

.6 Amount of chop or unidirectional roving interspersed with winding, if any, and location within laminate.

.4 For Contact Molded Laminates:

.1 Construction type.

.2 Laminate thickness.

.3 Ply sequences.

.4 Glass content range.

.5 For All Secondary Overlays (Both Interior and Exterior):

.1 Laminate thickness.

.2 Ply sequences and widths.

.3 Construction details for all other special configurations and fabricated parts.

.6 Duct pressure, vacuum, and temperature ratings.

.7 Structural calculations sealed by a qualified professional.

.8 Flange bolt torque values.

.9 Supports:

.1 Location plan.

.2 Type and details.

.3 Materials of construction.

.4 Stamped and signed structural engineering design calculations for special supports.

.10 Expansion Joints/Flexible Connectors:

.1 Type and model.

.2 Materials of construction.

.3 Force required for expansion/contraction.

.4 Name of Manufacturer.

.11 Inspection plate locations, with fabrication and installation details.

.12 Round duct sample meeting specified design criteria, minimum 300 mm diameter. Sample is to be retained for quality comparison in field.

.13 Fabricator Qualifications: List of references substantiating experience.

.14 Installer Qualifications: Manufacturer's certification that installer is qualified for installation work.

1.4 Quality Assurance

.1 Acceptance:

.1 Repair of Rejected Equipment: No more than 5 percent of the surface area of each FRP duct component may be repaired.

.2 The fabricator's inspector (quality control manager) is to submit a complete quality control report for the job. The report is to be available within 15 days after the final parts are shipped. The fabricator is to have available after each shipment, the completed QC sheets for review upon request at any time.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Supply all products from a single Manufacturer.

.2 Acceptable Manufacturers:

.1 Spundstrand.

.2 Chemposite.

.3 Barski.

.4 Daniel Company.

.5 Or approved equivalent.

2.2 Performance / Design Criteria

.1 Design Requirements:

.1 Conform to ASTM D2996 and ASTM D2310.

.2 The design criteria for the following parameters shall conform to the Final Design:

.1 Design Pressure.

.2 Design Vacuum.

.3 Duct Manufacturer's design for round section, including duct wall thickness and stiffeners.

.4 The design criteria for ductwork with 6.35 mm laminate for the following parameters shall conform to the Final Design:

.1 Minimum Ultimate Tensile Strength (ASTM D638).

.2 Minimum Flexural Strength (ASTM D790).

.3 Minimum Flexural Modulus of Elasticity, tangent (ASTM D790).

.2 Field Conditions:

.1 Include field verification of existing conditions, space limitations, and required connections in ductwork design.

.2 Complete field verification prior to fabrication.

2.3 Configuration, Components, Features

.1 Expansion Joints/Flexible Connections:

.1 Type: W-design configuration with integral flanges suitable for service with FRP duct.

.2 Backing Rings: 9.5 mm thick, 50 mm wide, Type 316 stainless steel. ANSI B16.1, Class 25 diameter and drilling.

.3 Length: 150 mm, flange-to-flange.

.4 Extension: 13 mm.

.5 Compression: 50 mm.

.6 Lateral Offset: 25 mm.

.7 Thickness: 6.5 mm, minimum.

.8 Acceptable Products:

.1 Holz Rubber Company, Style 945.

.2 Or approved equivalent.

.2 Gaskets:

.1 Neoprene.

.2 6.35 mm thickness.

.3 Acceptable Products:

.1 Garlock 7986.

.2 Or approved equivalent.

.3 Inspection Plates:

.1 Removable inspection plates, made of the same material as the duct, not less than 150 mm square or 200 mm round, at all fan inlet and discharge connections.

.2 Gasketed with an airtight seal with the parent duct.

.4 Fabrication:

.1 System components minimum 5:1 safety factor for critical buckling due to vacuum. Limit flat panel deflection to one percent of the panel width. Do not include corrosion liner in structural calculations. Submit calculations, stamped by a qualified professional and complete fabrication details.

.2 Reinforce fittings and special sections or their shell thickness increased where combined stresses due to internal pressure and bending exceed maximum stress. Keep combined stresses below recommended maximum.

.3 Round duct safety factor: 10 to 1 for pressure and 5 to 1 for vacuum.

.4 Provide flanges where inside overlay is not possible.

.5 Overlay butt joints both inside and outside. Butt joints permitted only in duct sections that are accessible for inside overlay. Make field butt joints at locations at least 300 mm from any increasing or decreasing cross section of duct.

.6 Butt joints to be built up in successive layers and to be crevice-free in accordance with ASTM D2563. Width of the first layer to be 100 mm (minimum). Successive layers to increase uniformly to the specified minimum total width of overlay; centered on the joint. Crevices to be filled with resin, leaving a smooth inner surface.

.7 The inner surface of butt joints to be free of cracks and crazing, with a smooth finish, with an average of not more than two pits per 0.1 m^2 (pits to be less than 3 mm diameter and maximum of 0.8 mm deep) and covered with sufficient resin to prevent exposure of inner surface fabric. Minimal waviness is permissible provided surface is smooth and free of pits.

.8 Flange dimensions (except thickness) and drilling patterns for flanges that connect to equipment, expansion joints, or dampers are to correspond to ASME/ANSI B16.1, Class 25. Factory drill all flanges. Flange dimensions and drilling patterns for all duct joints are to correspond to ASTM D3982 for FRP ductwork.

.9 Provide gussets on flanged nozzles from ducts.

.10 Back Face of Flanges: Spot-faced, flat and parallel to the flange face, and of sufficient diameter to accept an SAE metal washer under the bolt head or nut.

.11 Duct and Fittings:

.1 Round: ASTM D2310.

.2 Rectangular: Contact molded to a thickness as dictated by structural calculation; reinforcing with angles or tees is permitted to meet required pressure/vacuum service.

.3 Joints: Butt wrapped unless otherwise required for the Final Design except flanged at connections to expansion joints, butterfly valves, blast gates, or mechanical equipment to facilitate disassembly.

.4 Fittings:

.1 Plain end or flanged, Manufacturer's standard sizes.

.2 Bends with a centerline radius of 1.5 times the diameter to be either smooth radius elbows formed over a removable mold or mitered elbows fabricated from straight duct with the following mitre segments:

.1 Bends up to 30 Degrees: 1 mitre/2 gore.

.2 31-Degree to 60-Degree Bend: 2 mitre/3 gore.

.3 61-Degree to 90-Degree Bend: 4 mitre/5 gore.

.5 Flanges to have a minimum thickness of 19 mm, where connecting to equipment, expansion joints, or dampers.

.6 Transitions: Glass-fiber reinforced, with wall stiffness equal to that of duct, designed using the pipe design criteria. Maximum deflection of a side to be less than 1 percent of the width of that side at the design internal pressure. Shop-installed reinforcing such as ribs or angles to be used if required to meet deflection requirements.

.7 Marking:

.1 Identify each duct component with the fabricator's name, resin, minimum thickness, and date of manufacture.

.2 Use permanent marking. Seal decals and labels into laminate exterior with resin.

.3 For piece marking used for installation, use oil-based paint for easy removal.

.8 Cure products to at least 90 percent of the minimum Barcol hardness specified by resin Manufacturer.

.5 FRP Ductwork:

.1 Resin:

.1 Premium corrosion-resistant, fire-retardant vinyl ester resin. Acceptable Products: Ashland Chemical Hetron FR 992, Dow Chemical Derakane 510-A, or approved equivalent.

.2 FRP fabrications not to exceed a flame spread index of 25 and smoke development rating of 50 when tested in accordance with ASTM E84 Tunnel Test.

.3 Structural wall resin to contain a minimum of 3 percent antimony trioxide to achieve the designed low flame spread index requirement.

.4 Special Catalyst: In accordance with the recommendations of the resin Manufacturer for the intended service.

.5 Add ultraviolet absorbers to surfacing resin to improve weather resistance.

.6 Color: Use no dyes, pigments, or colorants, except in the exterior gel coat. Exterior gel coat is to be selected from the fabricator's standard color palette.

.2 Construction Method:

.1 Inner Surface: Inner surface exposed to the exhaust environment to be a resin-rich liner between 0.254 mm and 0.508 mm thick obtained by using one layer of Nexus veil saturated with the specified resin.

.2 Interior Layer: Resin-rich interior surface of nominal 100 to 120 mils thick for the entire corrosion barrier, using chopped strand glass mat or chopped glass roving backing the veil. Use no additive in the corrosion barrier. The inner surface and interior layer to have a glass content of 27 percent plus or minus 5 percent.

.3 Structural Layer: Fabricated using either hand layup construction per ASTM D3982 or filament wound. Structural layer is not to be less than the following thicknesses:

Diameter (mm)	Thickness (mm)
15 - 450	3.2
500 - 700	4.8
750 - 2100	8

.4 Exterior Coat: Resin rich with no exposed raw fibers. For interior duct, the final coat to be a factory applied intumescent coating to achieve the designated results for low smoke development. For exterior duct, resin coat with ultraviolet (UV) inhibitor.

.3 Reinforcement:

.1 Chopped Strand Mat: Type E glass, minimum 0.5 kg/m^2, with silane finish and styrene soluble binder.

.2 Continuous Roving for Chopper Gun Spray-Up: Type E glass.

.3 Woven Roving: Type E glass, nominal 0.9 kg/m^2 (24 ounces per square yard), 4 by 5 weave, with silane type finish.

.4 Continuous Roving for Filament Winding: Type E glass with a silane type finish.

3. EXECUTION

3.1 GENERAL

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

.3 Cut, fit, and install in accordance with duct Manufacturer's recommendations.

.4 Make field joints only when ambient temperature is above 13°C and below 38°C.

.5 Provide supports to ensure ductwork to be free of vibration when in operation.

.6 Install plumb and straight. Install ductwork sloped downward at minimum 10 mm per metre for proper condensate drainage in direction of flow.

.7 Joining systems suitable for installation without the prior need for sanding.

.8 For permanent joints, the low VOC epoxy is used in conjunction with an integral wound, in-place centerline bead on the internal slip collar. For reconfigurable joints a high corrosion TPE sealing compound is used in conjunction with a PTFE centerline bead on the internal slip collar.

.9 Coupling system external sleeves are slipped over the joint seam after applying another layer of low VOC compound and locked into place.

.10 Wrap-it flange system, using Vee-Band, Yuband, Vanstone flanges, or approved equivalent, depending on diameter and application. All metal parts are stainless steel.

.11 Field Joining Materials: FRP duct Manufacturer to supply all materials needed for any required FRP duct field joining. Supply of these materials to be in accordance with the requirements of this Section. Provide material in kit form and provide one kit per joint.

.12 Field Joining: Any required field joining to be accomplished by a competent person in accordance with the requirements of this Section.

.13 Provide for expansion and contraction.

.14 Large elbows and terminal ends of ducts to be supported independently.

.15 Flexible connections as described herein to be provided between fans and ductwork, and elsewhere.

.16 Certify installation on Manufacturer's Certificate of Proper Installation.

.17 Anti-seize thread compound on all nuts and bolts.

.18 Flange bolts to be tightened to slightly compress gaskets without disturbing the flanges in order to make a good seal. A flat washer to be installed under each nut and bolt head.

.19 Maintain proper ductwork alignment and grade by use of laser beam equipment or surveying instruments. Use surveying instruments to verify laser equipment accuracy due to thermal deflection from differences between the ground temperature and the air temperature within the pipe.

.20 Cleaning: Blow ductwork clean using system fans and purge continuously for not less than 48 hours at a flow rate not less than design flow rate. If required, throttle fan on inlet side to prevent motor overload. Install temporary screen on inlet to protect fan from debris.

3.2 Functional Testing

.1 Leak Test all piping and joints with compressed air. Confirm that the piping can maintain a constant air pressure of 5 kPa for a minimum of 120 minutes. Spray soapy water on joints to confirm that no leaks are present.

END OF SECTION

AIR DISPERSION STACK

1. GENERAL

1.1 Summary

.1 This Section specifies design, fabrication, supply, and supervision of installation, testing and commissioning of dual wall air dispersion stack.

.2 Fabrication of stack shall be by the firm designing the stack. Subcontracting of the fabrication will not be acceptable.

1.2 Standards

.1 American Institute of Steel Construction (AISC): Manual of Steel Construction.

.2 National Building Code (NBC).

.3 Manitoba Building Code (MBC).

.4 American Welding Society (AWS): Structural Welding Code-Steel D1.1.

.5 American Society of Mechanical Engineers (ASME): STS-1-2000 Steel Stack Standard.

.6 Occupational Safety and Health Administration (OSHA): OSHA Safety and Health Standards (29 CFR 1910).

.7 National Fire Protection Association (NFPA): Lightning Protection Code.

.8 International Committee on Chimney Design, CICIND.

.9 American Society of Civil Engineers (ASCE): ASCE 7-93 Minimum Design Loads for Buildings and Other Structures.

.10 American Society of Testing Materials (ASTM):

.1 ASTM A36 - Specification for Structural Steel.

.2 ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

.3 ASTM A242 -Standard Specification for High-Strength Low-Alloy Structural Steel.

.4 ASTM A588 -Standard Specification for High-Strength Low Alloy Structural Steel.

.5 ASTM A-240 -Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Alloy.

1.3 Submittals

.1 Provide submittals in accordance with Section 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Design calculations defining all assumptions and stress limit criteria for approval. The design shall be based on loads, stresses and design codes and standards specified herein. The stack shall be designed for all conditions and loads to which it may be subjected from flue gas, temperature variations, corrosion, wind, vibration effects and boundary conditions.

.3 Arrangement and outline dimension Drawings for approval showing weights, anchor details, materials of construction, plate thickness, lifting lugs, foundation design loads, weld requirements, field splice details, fabrication tolerances and interface connections including the inlet. Drawings shall also include the following:

.1 Reinforcement at all openings.

.2 Brace detail.

.3 Means of vibration control.

.4 Testing requirements.

.5 Stack dimensions including diameters, section lengths and weights.

.6 Requirements for joining the sections in the field shall be fully specified and detailed.

.2 Operation and Maintenance Data: provide for incorporation in Operations Manual as specified in the Schedule 18 Technical Requirements.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Products:

.1 Warren Environment Inc, Atlanta GA USA.

.2 Or approved equivalent.

2.2 Performance / Design Criteria

.1 The stack shall be a dual wall design to minimize temperature loss in the flue gas. The outer shell will be the structural component and the inner shell will be designed to convey the flue gas. The inner shell shall also be designed to withstand its self-weight and deflection in the outer shell.

.2 Design stack for continuous and cyclic operation.

.3 Design stack to be free standing. Guy wires and support frames will not be acceptable.

.4 Provide stack with opening reinforcement and ovalling stiffeners. All openings shall be suitably reinforced to satisfy the strength, deflection and dynamic requirements of the stack design. Stiffeners shall be of the same material as the stack walls.

.5 In determining design stress levels of the stack, consider the maximum allowable stress at the design temperature.

.6 Clearly identify stack natural frequencies and associated critical wind velocity. If the value falls within an unacceptable range, then the stack must be designed with sufficient measures to ensure predictable dynamic control.

.7 Design stack to limit vibrations due to vortex shedding to less than 40 percent of the stack diameter. Vibrations shall be considered in both the first and second modes of vibration.

.8 Identify the structural damping coefficient and its basis in fact. Foundation pads will not be an acceptable means of increasing structural damping.

.9 Design the stack in accordance with ASME STS-1, Steel Stack Standard.

.10 The design criteria for the following parameters shall conform to the Final Design:

.1 Height above grade.

.2 Ambient temperature.

.3 Composition of flue gas.

.4 Flue gas flow.

.5 Shell outer diameter.

.6 Shell inner diameter.

.7 Inlet pipe diameter.

.8 Inlet pipe elevation.

.9 Seismic zone.

.10 Wind load.

.11 Outer shell material.

.12 Inner shell material.

.13 Insulation material.

.11 Stack design shall be sealed by a qualified professional.

2.3 Materials

.1 Outer shell: Minimum 304L stainless steel.

.2 Inner shell: fibre reinforced plastic with specification suitable for the contaminants within the flue gas.

.1 No carcinogenic substances will be included in the fibreglass-reinforced plastic (FRP) resin mix. Use most recently industry accepted replacement constituents.

.3 Insulation: Material and thickness to be suitable for the climatic conditions and the temperature of the flue gas. Insulation to be located in the annulus between the two shells.

.4 To prevent corrosion, do not use dissimilar metals.

.5 Pickle welds to provide a stack that has a uniform look from the exterior.

.1 As a minimum, pickle welds on the outside of the shell.

.2 As a minimum pickle discoloration on the outside of the shell caused by internal welds.

2.4 Configuration, Components and Features

.1 Accessories:

.1 Anchor bolts.

.2 Breeching opening.

.3 Access door at base.

.4 Top cap.

.5 Cone with discharge diameter to provide sufficient exit velocity to prevent formation of icicles.

.6 False bottom with drain.

.7 Tuned mass damper for vibration isolation.

.8 Lightning terminal with suitable base to allow mounting on the top of the stack. Provide sufficient lightning cables to reach the ground rods at the base of the stack.

.9 Lightning grounding lugs at base per NFPA requirements.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer’s recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

3.2 Fabrication

.1 Fabricate and assemble structural assemblies in the shop wherever possible. Fabricate in accordance with AISC Specifications, ASME STS-1-2000 Steel Stack Standard, and approved Shop Drawings.

.2 All welding procedures and welder qualifications shall be in accordance with AWS D1.1 or ASME Section IX. If requested, procedure certification reports and welder qualifications shall be submitted to the Professional of Record for review.

.3 All butt welds shall be two sided unless diameter prevents access. Welds shall be back-gouged to sound metal before welding the second side. Welding procedure certifications and welder qualification reports shall be made available to the Professional of Record if requested.

.4 Properly match mark materials for field assembly.

END OF SECTION