PART 1 - GENERAL

1.1 DESCRIPTION
A. This section specifies central piped high volume oral evacuation (HVE) system for dental operatories, including piping, valving, vacuum producers, separators, electric motors, starters, controls and installation and start-up.

1.2 RELATED WORK
A. Sealing around pipe penetrations to maintain the integrity of time rated construction: Section 07 84 00, FIRESTOPPING.
B. Sealing around pipe penetrations through the floor to prevent moisture migration, Section 07 92 00, JOINT SEALANTS.
C. Piping system identification: Section 09 91 00, PAINTING.
D. General requirements and items common to more than one Section of Division 22: Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
E. Valves (as required for water): Section 22 05 23, GENERAL-DUTY VALVES FOR PLUMBING PIPING.
F. Strainers (as required for water): Section 22 11 00, FACILITY WATER DISTRIBUTION.
G. Electric Motors: Section 22 05 12, GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT.
H. Motor Starters: Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS.
I. SECTION 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
   Requirements for commissioning, systems readiness checklist, and training.

1.3 QUALITY ASSURANCE
A. System: The minimum system demand shall be based on 3.3 L/s (7 scfm) per dental chair and at an operating pressure of 21 to 27 kPa (6 to 8 in Hg). A minimum of vacuum of 21 kPa (6 in – Hg) shall be maintained at the most distant outlet. System pressure drop shall be a maximum of 3 kPa (1 in – Hg) at the calculated demand flow.

1.4 SUBMITTALS
A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
B. Manufacturer's Literature and Data: Submit the following as one package:
1. Piping
2. Vacuum producer
3. Vacuum cleaning inlet
4. Vacuum gage
5. Separator
6. Vacuum relief valve
7. Butterfly valve
8. Directional flow valve
9. Anti-surge valve
10. Exhaust Silencer
11. Separator Drainage Pump
12. Control Panel

C. Completed System Readiness Checklist provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

1.5 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are in the text by the basic designation only.

B. American National Standards Institute (ANSI):
   A13.1- 07...............Scheme for the Identification of Piping System
   B16.3-06 ...............Malleable Iron Threaded Fittings Classes 150 and 300
   B16.22-01...............Wrought Copper and Bronze Solder-Joint Pressure Fittings
   B40.1-98................. Pressure Gauges and Gauge Attachments

C. American Society for Testing and Materials (ASTM):
   A47-99..................Ferritic Malleable Iron Castings
   A53M-07 .................Pipe, Steel, Black Hot-Dipped, Zinc-Coated Welded and Seamless
   A536-84 (2009) el.......Ductile Iron Castings
   B306- 09...............Copper Drainage Tube (DWV)
   D1785 06 ...............Poly (Vinyl Chloride) PVC Plastic Pipe Schedule 40, 80, 120
   D2564 04...............Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings
   D2466 06 ...............Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
D3310-09........................DRAIN, WASTE, AND VENT (DWV) PLASTIC FITTINGS
D. National Fire Protection Association

PART 2 - PRODUCTS

SPEC WRITER NOTE: Update material requirements to agree with applicable requirements (types, grades, classes, and other related items) specified in the reference applicable publications. Where installation requires extra strength or higher class pipe, adjust the following.

2.1 PIPING

A. Poly (Vinyl Chloride) (PVC):
   1. PVC Piping: ASTM D1785-06, Type 1 (normal impact), Grade 1 (chemical resistance), Schedule // 40 // 80 // pipe. Provide socket ASTM D2566 fittings and ASTM D2564 PVC solvent cement with PVC primer recommended by manufacturer. Provide DWV (drain-waste-vent). Use long radius fittings for turns and wye fittings for branching, as defined in Section 22 13 00, FACILITY SANITARY SEWERAGE. Minimum pipe size for parts of distributing piping in or below slab is 50 millimeter (2").

B. Galvanized Steel: Use only for discharge from vacuum producer, as per manufacturer’s instructions.
   2. Fittings:
      a. Flexible groove type, malleable iron, ASTM A47, or Ductile iron, ASTM A536.
      b. Malleable iron screwed, ANSI B16.3.

C. Cleanouts: Same size and material as pipe. Provide accessible and easily removable cleanouts as defined in Section 22 13 00, FACILITY SANITARY SEWERAGE

D. Apply piping identification per ANSI A13.1.

//2.2 DENTAL ORAL EVACUATION VACUUM PUMPS // (SELECT 2.2 OR 2.3) //

A. Provide a completely packaged, continuous duty dental vacuum // duplex // multiplex // system as shown on the drawings and specified.

B. Each vacuum producer shall be sized to produce 27 kPa (8 inches of mercury) at an airflow of 423 L/min (15 SCFM).

C. Duplex or multiplex systems shall consist of two or more separate high efficiency positive displacement oil sealed, rotary vane pumps with automatic continuous oil flow to all moving parts. Operation shall be waterfree.
D. Duplex or multiplex systems shall be powered by two separate standard NEMA frame motors with V-belt drives enclosed in a UL approved guard.

E. Provide two (2) 190 liters (50-gallons) fiberglass wet separator tanks. Tanks shall be pressure tested and certified for 61 KPa (18-inch Hg). Tanks shall be freestanding with legs. Provide tank drain with check valve.

F. Provide an electronic moisture alarm system capable of detecting liquid or foam overflows. Moisture sensors shall be located outside the wet tank.

G. 3 Phase motor control center shall be completed with motor starters, overload protection, single phasing protection and control transformers.

H. Controls shall be digital with LED status indicators for “power” and “motor on”; and solid state moisture alarm circuitry, moisture detector, wiring harness, manual start-stop switch, bypass for moisture alarm and remote on-off circuitry, and indicator for required maintenance.

I. System shall have a ten-year warranty against pump wear-out or failure.

J. System shall be UL 6060-1 Dental Vacuum System listed and a FDA Registered Medical Device.

K. Rated “Acceptable for Federal Service Use by USAF Dental Investigation Service and recommended shipboard use by the US Navy."

//2.3 VACUUM PRODUCER //

A. Duplex or multi-plex self-governing, multi-stage, centrifugal, turbine type of outboard design with bearings on both ends of the exhauster shaft, maximum speed of 3600 rpm, two self-aligning radial bearings sealed with grease fitting or with oil-cup lubrication, connected to its driving motor by flexible coupling. Vacuum produced shall be substantially constant throughout the operating range.

B. Cylindrical turbine cases, constructed of heavy-gage sheet steel with continuous welds at all seams or sections. Inlet and exhaust connections tangential to the casing and sized to allow air to move freely (within operational range) through the turbine without air restriction of any kind. Turbine shall have not less than 3.2 mm (0.125 inch) internal clearance throughout.

C. Motor and Starter:

1. Maximum 40 degree C ambient temperature rise motor, ball or roller bearing for operating with current, voltage, phase and cycle as specified in Section 22 05 12, GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT; open dripproof construction, continuous duty rated with service factor of 1.15 or greater; sufficient capacity to drive turbines without exceeding the nameplate rating of the motor.
2. Provide each motor with automatic, fully enclosed, magnetic starter of type specified in Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS.

D. Controls:

1. Power and control panel shall include fused disconnects, starters, running hour meter, start-stop button, operational lights, warning light, audible alarm, calibrated ammeter in both SCFM and amperes, current transformers and heavy duty automatic alternators.

2. Complete low voltage control function with low voltage remote control panel of single design containing an on/off switch pilot lights for water and oral evacuation supply to the dental operatories. Locate remote panel // in the office of the dental clinic. // Where indicated on drawing // Provide solenoid valve on water supply to the dental separators //

2.4 CENTRAL SEPARATOR (DUPLEX)

A. Freestanding, bottom pitched to drain at low end, hot-dipped galvanized steel or fiberglass construction with smooth interior walls, and able to withstand a constant negative pressure of 61 kPa (18 inches mercury). Provide optional 360 degree solid state auto flush assembly, with positive protection against flush operation with vacuum producer running, solid-state high-low liquid sensor and corrosion resistant effluent pump to drain the tank. Adjust one tank to sense 90 percent and the other tank to sense 100 percent of its water capacity, to allow for non-simultaneous discharge and, therefore, uninterrupted HVE function to the clinical facility. Provide a sensor operated (120 VAC) Solenoid valve to control the outgoing airstream for adjustments between five and 180 seconds. Cold water supply to the autoflush unit shall contain an in-line filter equipped with 40-mesh stainless-steel screens. Provide a vacuum switch to prevent the wash down solenoid from operating when system is under a vacuum. Provide pressure reducing valve to maintain water pressure not to exceed 345 kPa (50 PSI).

2.5 VACUUM RELIEF VALVE (PROVIDE FOR BACKWARD CURVE IMPELLER DESIGN EXHAUSTERS)

A. Mechanically operated, placed at the end of each trunkline, to automatically sense negative pressure in the system to maintain movement of liquids through the piping system to the separator when inlet branches are closed. Valve connector shall be 13mm (0.5 inch NPT). Equip with a silencer to reduce air noise to below 85 decibels.
2.6 PIPE ISOLATORS
   A. Flexible rubber, couple band, sealed clamps to isolate the turbine from the piping. Size coupling in accordance with the turbine's intake and output connections and provide steel coupling guards.

2.7 BUTTERFLY VALVE
   A. Inlet: Built-in or located near the first stage of the turbine to prevent turbine overload through the operational range.
   B. Exhaust: Flanged, wafer-style, installed at exhauster output flange for equipment isolation.

2.8 DIRECTIONAL FLOW VALVE
   A. Non-restrictive on turbine inlet to prevent back-flow of air.

2.9 ANTI-SURGE VALVE
   A. Mechanically or electrically operated valve that will operate automatically throughout the turbine's designed range. Valve shall continually sense the negative pressure within the turbine and maintain a predetermined, operational level of kPa (inches-of-mercury) draw. Equip with a silencer to reduce air noise to below 85 decibels.

2.10 EXHAUST SILENCER
   A. Open-bore expansion type to reduce air noise to below 85 decibels with interior baffling or shrouding.

2.11 REPLACEMENT PARTS
   A. Furnish a turbine bearings and coupling kit to include one set of turbine bearings and one complete motor/turbine flexible coupling, all of the same size and design as those supplied with the turbine.
   B. Provide complete installation instructions for repair kit items.

2.12 SEPARATOR DRAINAGE PUMP (OPTIONAL GRAVITY DRAIN NOT AVAILABLE)
   A. Provide high-pressure corrosion resistant inline jet pump dedicated for the separator system. Install between separator and gate or swing-type check valve normally installed at separator drain outlet. Outlet air solenoid valve between separator and turbine shall not be used. Pumps shall be controlled by liquid level sensors in the separator.

2.13 SEPARATOR DRAIN AND VENT
   A. Construct in accordance with NFPA 99c 2005 Edition, Level 3 Vacuum System Tank Drains and Tank Vents, paragraph 5.3.3.6.3.1 and 2.

2.14 VACUUM CLEANING INLET
   A. Use only in oral surgery recovery rooms. Provide recessed wall inlet valve with 1003 MOD 40mm (1-1/2 inch) male hose repair coupling with 15mm (1/2-inch) outside diameter aluminum tube stub (50mm long) (2 inches long).
2.15 VACUUM GAGE
A. In remote control panel: ANSI B40.1, 40mm (1-1/2 inch) dial with decorative ring.

SPEC WRITERS NOTE: Delete Paragraph B if no separator.

B. In piping near separator: ANSI B40.1, with metal case, 115mm (4-1/2 inch) dial.

2.16 PVC BODY BALL VALVES
A. PVC Body double-seal ball valves with replaceable neoprene or TFE seat seals. Provide valves suitable for at least 690 kPa (100 psig), cold water, non-shock working pressure. Design especially for vacuum service. Operating parts of valve shall be removable without removing from line.

PART 3 – EXECUTION

3.1 INSTALLATION
A. Place vacuum producers on insulating pads furnished with the equipment. Do not bolt or anchor equipment to the floor slab.

B. Cut pipe square, with burrs removed and install with minimum obstructions to air flow. Use DWV (drain-waste-vent) long-radius fittings for turns and wye type for branches.

C. Slope horizontal piping not less than ¼” per 10 ft (2mm per 1m) toward the separator tanks.

D. All fittings shall be DWV (drain-waste-vent) long-radius bend types for turns and wye types for branching. For small bore piping for which long-radius bends are not available, two 45-degree bends shall be substituted for 90-degree turning.

E. All risers to all HVE inlet locations shall be 40 mm (1.5 -inch) nominal pipe size. Risers shall connect to trunk lines whose nominal pipe sizes shall be determined by head loss calculations that yield a system designed for no more than 1.7 kPa (0.5 inches mercury) worse case head loss. Piping no smaller than 40 mm 1.5 inch shall be used.

F. The cross-sectional area of all trunk lines shall be graduated, increasing toward the vacuum source. The cross-sectional area at any point along the trunk line shall equate to the sum of the riser cross-sectional areas connected prior to that point. Individual trunk lines shall terminate with connection to the manifold of the separators.

SPEC WRITER NOTE: Delete the following Paragraph G, H, and I if wet-type system is specified.
G. If backward curve impeller design turbine is installed, terminate the most distant end from the separator of each trunk line with a vacuum relief valve.
H. Install separators level and anchored to the floor slab.
I. Start up shall be by factory representative.
J. Penetrations:
   1. Fire Stopping: Where pipes pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING. Completely fill and seal clearances between raceways and openings with the fire stopping material.
   2. Waterproofing: At floor penetrations, completely seal clearances around the pipe and make watertight with sealant as specified in Section 07 92 00, JOINT SEALANTS.

3.2 TEST
A. Pipe Leakage Test: Test in accordance with NFPA 99c, 2005 Edition, Paragraph 5.3.12.2.4. Exhaust complete piping system to a vacuum of not less than 27 kPa (8-inch mercury gage) after the pipe line is dried out initially. Vacuum shall not decrease by more than 1.4 kPa (0.4-inch mercury gage) in one hour. If the vacuum does not hold, repair the leaks and retest.
B. Air Volume and Vacuum Tests:
   1. Tests shall confirm that the system will meet air volume and vacuum requirements at aspirator tips and that vacuum producer(s) will produce the total capacity required as specified in paragraph 1.3. Perform tests after all oral evacuation equipment is properly installed and piping is cleaned and proved tight.
   2. Install HVE (high volume evacuator) tips into the designed number of the facility’s HVE (high volume evacuator) valves. Close all remaining HVE valves.
   3. With all UJC hoses fully closed, start the system. Fifteen minutes after start-up, measure the current draw of the motors with ammeter and record the reading of the vacuum gage. Fully open HVE valves with HVE tips in them and record the current and vacuum values again. Amperage measurements shall not exceed the motor full load amperage rating.
   4. Check entire system and insure the minimum flow stated in Paragraph 1.3 is achieved.
C. The commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the Resident Engineer and Commissioning Agent. Provide a minimum of 7 days prior to notice.

3.3 COMMISSIONING
A. Provide commissioning documentation in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS for all inspection, startup, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS and related sections for contractor responsibilities for system commissioning.

3.4 DEMONSTRATION AND TRAINING
A. Provide services of manufacturer’s technical representative for four hours to instruct VA Personnel in operation and maintenance of units.
B. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

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