This master should be used by designers working on Port of Portland construction projects and by designers working for PDX tenants (“Tenants”). Usage notes highlight a few specific editing choices, however the entire section should be evaluated and edited to fit specific project needs.

Use only for projects at PDX.

SECTION 221320 - Vacuum Grease Waste Removal System

1. General
	1. description
		1. This section describes a complete system of grease waste collection tanks, vacuum pumps, system controls, vacuum drainage valve assemblies, waste accumulators, and vacuum waste piping network.
		2. Work includes, but is not limited to:
			1. Drawings of all materials and systems including installation details and specifications representing the vacuum center, control components, and accumulators.
			2. Training of operation and maintenance staff as specified, especially techniques, materials, and configurations that are unique to vacuum waste systems as described in these contract documents.
			3. Progress inspections with compliance reports as required to ensure that the vacuum system is being properly installed.
			4. Final inspection/system, start-up, and commissioning with a full report to all responsible parties. Complete system documentation at the conclusion of start-up and commissioning.
			5. The vacuum drainage system shall consist of a vacuum center and fully networked electronic control system as described herein and shown on the drawings. Provide the vacuum center, electronic control panels, lift station interface panels, and lift stations.
		3. Provide piping network to transport the waste from the point of collection to the vacuum center.
		4. Provide control panel and all interconnecting power and control wiring and all controls devices and accessories for a complete system installed according to manufacturer’s installation requirements.
	2. Related work specified ELSEWHERE
		1. Section 220500, Common Work Results for Plumbing
		2. Section 220523, General-Duty Valves for Plumbing Piping
		3. Section 220529, Hangers and Supports for Plumbing Piping and Equipment
		4. Section 221100, Plumbing Piping
		5. Section 260519, Low-Voltage Electrical Power Conductors and Cables
	3. References
		1. ASME: American Society of Mechanical Engineers
		2. NEC: National Electric Code
		3. NEMA: National Electrical Manufactures Association
		4. REA: Rural Electrification Administration
			1. REA PE-60d: RUS Specification for Trunk Carrier Systems
	4. SUBMITTALS
		1. Equipment Submittals:
			1. For each item specified herein, submit product/material data; shop drawings; operation and maintenance data; as-constructed data; installation, startup, and testing manuals; operation and maintenance manuals; and as-constructed drawings.
			2. Submit operation and maintenance data for review on all scheduled pieces of equipment, and as required by the contract documents.
		2. Vacuum System Controls. Submit the following:
			1. Control panel physical layout and schematics.
			2. One-line schematics and system flow diagrams showing the location of all control devices. Provide points list for each controller including tag, point type, system name, object name, expanded ID, controller type, address, cable destination, terminal ID, panel, reference drawing, and cable number.
			3. Details of connections to power sources including grounding.
			4. Details of surge protection device installations.
			5. Sequences of operation.
			6. Complete diagrams of the related pneumatic and electric controls, including a written description of control sequences.
			7. User interface (UI) functional outline. Include each display screen to be provided, data to be displayed, and links to other screens.

Equipment Data: Include complete data for all materials, including field and system equipment. Data provided shall be marked to indicate which specific model or feature will be provided.

Field Installation Handbook: Show all standard devices, networks, controllers, and enclosures with configurations, cable specifications, wiring and installation methods, termination details, agency listings, and controller specifications.

Software Data: Provide complete descriptions of system, command, and applications software as specified. Include description of control sequences which are software based using detailed logic flow diagrams. Diagrams shall indicate logic used to achieve control sequence of calculation specified and show relationship between control sequence and application software packages specified.

Operation and Maintenance Manuals: Provide within 30 days after completing acceptance tests.

Hardware Manual: Describe all equipment provided, including:

General description and specifications.

Field Installation Handbook: Show all standard devices, networks, controllers and enclosures with configurations, cable specifications, wiring and installation methods, termination details, agency listings and controller specifications.

As-built system drawings and schedules.

Alignment and calibration procedures.

Software Manual: Describe all furnished software. Include the following documentation in the DDC software manual:

Sequence of operations.

Program listing of software source code and flow chart diagrams of programming objects for all major systems.

Printed listing of controller and operator workstation database files.

Software point name abbreviation list. Include name, description, controller where located, point type and point ID.

Input/output (I/O) point list. Include point name, controller location, point number, control device, range and span.

Printouts of all reports, group listings, and alarm messages.

Operator’s Manual: Provide all procedures and instructions for operation of the system, including:

Control panels and peripherals.

System startup and shutdown procedures.

Use of system, command, and applications software.

Alarm presentation.

Recovery and restart procedures.

Report generation.

System schematic graphics.

Maintenance Manual: Provide descriptions of maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

* + 1. Commissioning and Training:
			1. Submit commissioning plans, schedules, and related documentation in accordance with the contract documents.
			2. Submit pre-startup, start up and functional test plans prior to implementing.
			3. Submit pre-startup, start up and functional test with signoff after fully executed.
			4. Submit training plans.
			5. Submit training documentation.
	1. quality assurance
		1. Materials and equipment shall be new and of the same manufacturer. Work shall be of good quality, free of faults and defects.
		2. The system ties into all types of food and beverage concessionaires at the airport. It is expected that foreign materials (forks, towels, etc.) be introduced into the system without affecting system operation.
		3. Materials and Equipment:
			1. Each piece of provided equipment shall meet all detailed requirements of the drawings and specifications and shall be suitable for the installation shown.
			2. All piping and supports shall be as specified in the contract documents. Vacuum piping shall be stainless steel and waste piping shall be PVDF.
		4. Install all materials in a neat and workmanlike manner.
	2. COMMISSIONING
		1. Systems, equipment and component checkout, startup, calibration, operational, functional and final acceptance testing:
			1. General: Provide all personnel, equipment, instrumentation, and supplies necessary to commission controls.
			2. Commissioning: Commission systems, equipment, and components in accordance with the requirements of the contract documents. Demonstrate compliance of completed control system. Checkout and test all physical, operational, and functional requirements of the controls and related equipment.
			3. Callbacks: In addition to the requirements of the contract, the Port may request, at its discretion, a recheck or resetting of any equipment, device or control on two occasions within the first year of operation.
	3. TRAINING
		1. Contractor Training: Coordinate with the manufacturer for installation training. Prior to commencing any fabrication of the vacuum piping system, participate in an installation training program. The Contractor’s Project Manager and any individuals who will be directly involved with installation of the work shall attend this mandatory training session. In addition, a representative from the Contractor’s office shall attend to ensure that they are aware of the responsibilities being assumed by the Contractor, especially with respect to scheduling of site progress inspections.
		2. Port Training:
			1. General: Conduct training courses for designated personnel in operation and maintenance of system. Training shall be oriented to specific system being installed. Provide training manuals for each trainee, with two additional copies provided for archival at the work site. Manuals shall include detailed description of the subject matter for each lesson. Deliver copies of audiovisuals to the Port.
			2. Operator’s Training: The course shall be taught at the work site for a period of one training day after completion of the Contractor’s field testing. The course shall include instruction on specific hardware configuration of installed system and specific instructions for operating the installed system. Upon completion, each student shall be able to start the system, operate the system, recover the system after failure, and describe the specific hardware architecture and operation of the system. Repeat course if necessary to include all shift personnel.
1. products

The brand name exemption for Acorn Engineering expires December 31, 2019.

* 1. approved manufacturer
		1. Acorn Engineering, no substitutions.
	2. VACUUM CENTER (VC)
		1. The vacuum center shall consist of grease waste storage tanks, vacuum pumps, and a control system to automate their operation and shall fit within the space allowed as shown on the drawings.
		2. Provide all interconnecting power and control wiring per manufacturer’s recommendations. Provide all vent to outdoors, and drains connected to sanitary required. Provide connections to industrial hot water and cold water systems.
	3. vacuum pumps
		1. Liquid Ring Vacuum Pump(s):
			1. Provide self-contained, water sealed, air cooled, liquid ring pump package(s) as shown on the drawings.
			2. Oil free, self-contained, fully recirculating style, complete with a single stage, direct driven impeller, and shall include:
				1. Integral separator.
				2. Separator level indicator.
				3. Separator auto refresh system.
				4. An air-cooled heat exchanger.
				5. A built-in condenser.
				6. Anti-siphon valve.
			3. Capable of operating continuously for 8 hours without an active external water supply.
			4. Provide Asahi true union 2-inch PVC clear body strainer with socket fittings and FKM O-rings, or equal. Screens shall be 20 mesh 316 SS.
			5. Provide vacuum pump mounting stands with base plate and engineering supports.
	4. waste collection tanks
		1. Each waste collection tank shall be provided with a volume of 500 gallons.
		2. Tank construction shall be steel with 12 mils epoxy internal and 6 mils external coating, manufactured to ASME standards with ASME UA-1 manufacturing certificate submitted at completion of manufacturing and approved by the engineer of record prior to shipment.
		3. Provide each tank with an individual hot water rinse solenoid valve to facilitate cleansing of the vessels when required, and a manual isolation valve for servicing.
	5. VACUUM ACCUMULATOR (vacc)
		1. Grease waste accumulators shall be furnished by AcornVac, no substitutions, and installed by the Contractor. Each grease accumulator shall be purpose built for the application. The location for each grease accumulator is shown on the drawings. Coordinate with the manufacturer for optimal accumulator size and shape based on the actual field conditions and vacuum system requirements.
			1. Grease accumulator shall be manufactured from 304 stainless steel.
			2. Grease accumulators shall include a cold water tempering assembly to ensure that the waste entering the vacuum system does not exceed 140°F. The tempering assembly shall include a temperature transmitter for measuring the waste in the accumulator, solenoid valve and rinse spray nozzle which are to be furnished by the vacuum equipment supplier as loose components for installation by the Contractor.
			3. Measure the level in each grease accumulator electronically. This signal will provide for staging of the lift stations in each accumulator as well as developing a high water alarm. Individual setpoints for each of these control actions shall be provided and accessed at the vacuum center control panel.
			4. The air intake for each accumulator shall be provided with an activated charcoal filter of sufficient size as to allow for proper operation of the accumulator. Filter shall contain coconut shell base pelletized activated carbon for H2S absorption.
			5. Provide accumulator with an automatic overflow device which allows the waste arriving from the fixtures to flow into an indirect sewer connection until such time as the cause of the overflow is remedied.
			6. Provide each grease accumulator with a debris trap manufactured from 304 stainless steel with removable inspection port and full port ball valve. The debris trap shall allow for easy cleaning.
			7. Each grease waste accumulator shall have redundant waste extraction valves.
	6. Controls and Power Wiring:
		1. General:
			1. Provide all interconnecting power and control wiring and all controls devices and accessories for a complete system installed according to manufacturer’s installation requirements.
			2. Electric equipment and wiring shall be in accordance with Division 26.
			3. Manual or automatic control and protective or signal devices required for operation specified, and any control wiring required for controls and devices, shall be provided hereunder.
			4. Run all control wiring in conduit.
		2. Wiring:
			1. Field and Subfield Panels: Voltage in panels shall not exceed 120 volts. Where devices are wired to higher voltages, mount in suitable individual enclosures or group in separate control panel. Coordinate electrical power supply with Division 26. Provide conduit and wiring required to spare breakers in accordance with Division 26.
			2. Motor Control Centers: Ensure correct voltage of holding coils and starter wiring in pre-wired motor control centers to interface with automatic controls.
			3. Wiring for the primary peer-to-peer communications network shall be two-conductor, minimum 18-gauge foil-shielded, stranded twisted pair cable rated at 100 Vdc or more at 80ºC.
			4. Cable types shall be of a different color coding for easy identification and troubleshooting. Recommended color coding:

Analog Input Cable – Yellow

Analog Output Cable – Tan

Binary Input Cable – Orange

Binary Output Cable – Violet

24 Vac Cable – Gray

General Purpose Cable – Natural

Wiring for secondary network shall be three-conductor minimum 22-gauge telephone type wire. If LON works communications are used, provide two‑conductor cable.

Communications Links Surge Protection: Protect all communications equipment against surges induced on communications link. All cables and conductors which serve as communications links shall have surge protection circuits installed that meet the requirements of REA PE-60d.

Communications Links Overvoltage Protection: Protect communications equipment against overvoltage on communications link conductors. Cables and conductors which serve as communications links shall have overvoltage protection for voltages up to 480 VAC rms, 60 Hz installed. Instrument fuses or fusible resistors will be accepted for this application.

* + - 1. Control Panels:
				1. Provide wall-mounted control panels as required to contain all relays, terminal strips, power supplies, and other equipment in the building control system.
				2. Panels shall be UL listed, minimum NEMA 4/12 rated, minimum 14-gauge steel with stiffeners, continuous hinge doors, locking handles, single point latch. Alternately, panels may be constructed of structural plastic meeting UL and NEMA requirements.

2.7 System controls

A. Vacuum Center:

* + - 1. Provide the vacuum system with its own independent control system. The system shall consist of a vacuum center control panel and up to 12 electronic control panels to service the various waste lift stations within the facility. The required quantity of electronic control panels is shown on the drawings. Each electronic control panel shall be capable of managing up to 12 lift stations and 4 programmable valves as further outlined herein.
			2. The vacuum center panel shall consist of a UL508 approved control system designed to accommodate operation of the waste collection tanks and vacuum pumps as shown on the drawings and further described herein.
			3. NEMA 4/12 Enclosure.
			4. Main incoming power disconnect with through-door operator.
			5. Motor starter protector for each pump.
			6. Control circuit transformer with primary and secondary protection.
			7. Vacuum pressure transducer for display, control, and alarm purposes (vacuum switches are not acceptable).
			8. All pump and tank control strategies shall be implemented in a programmable logic controller (PLC).  The PLC shall include sufficient ports (including an Ethernet port for remote access and a serial Modbus port for monitoring) to allow for simultaneous communication with the local operator interface terminal (OIT) and other external devices such as the zone control panels or building management system. The Modbus port shall allow for remote monitoring of the system.
			9. Provide Manual-Off-Auto selector switches for each pump. The AUTO position for each switch shall be monitored by the PLC to determine if a pump is in service and may be automatically sequenced. Wire the Manual position of the selector switch directly to the pump start circuit to ensure that a unit can run independent of the PLC.
			10. Install a 12-inch color touch-screen OIT in the vacuum center control panel. The OIT shall include an Ethernet port that allows for direct or web based remote access of the vacuum center control panel and zone control panels. The remote access package shall simulate all features of the vacuum center control panel OIT and provide password control over the remote user accessibility. The OIT shall allow operating personnel to view, configure, and manipulate the vacuum center equipment, zone control panels, and lift stations. Organize screens to allow a simple and logical pathway to the various areas of setup and control. The functions and strategies associated with the zone control panels that reside in this OIT are described in the zone control panel section of this specification. The following describes the vacuum center functions that are to be available through the OIT.
				1. Vacuum Center – General Overview:
1. Display actual vacuum pressure in engineering units.
2. Display the status of the vacuum pumps – ON/OFF/FAILED/HOA!
3. Display the status of the storage tanks – ONLINE/DRAINING/DRAIN PENDING/ALARM/OFFLINE.
4. Display the level in the storage tanks.
5. Provide logical screen navigation buttons for other areas of the control system.
	* + - 1. Vacuum Center – Setup and Configuration:
6. Allow each vacuum pump to be Enabled/Disabled.
7. Allow each collection tank to be Enabled/Disabled.
8. Allow installed setpoints to be captured and also re-downloaded.
9. Provide logical screen navigation buttons for other areas of the control system.
	* + - 1. Rinse, Isolation and Vent Valve Control for Storage Tanks:
10. Allow the isolation valve to be enabled/disabled from operation, to be in automatic or manual mode. When in manual mode, the valve can be manually operated by pushing a button on this screen.
11. Allow the vent valve to be assigned as pneumatic or motorized operation, to be in automatic or manual mode. When in manual mode, the valve can be manually operated by pushing a button on this screen.
12. Allow the rinse valve for each storage tank to be in automatic or manual mode. When in manual mode, the valve can be manually operated by pushing a button on this screen.
	* + - 1. Vacuum Pump Control Setpoints allow mechanism for each of the following to be adjusted:
13. Pump Start Pressure – inches of Hg.
14. Pump Stop Pressure – inches of Hg.
15. Pump Start Lockout Time Delay – seconds.
16. Pump Stop Time Delay – seconds.
17. Pump Minimum Run Time – minutes.
18. Pump Minimum Off Time – minutes.
19. Pump Run Too Long Time Delay – minutes.
20. Pump Too Many Starts per Hour – count.
21. Quantity of Pumps Allowed to Run on Generator Power – count.
	* + - 1. Low Vacuum Alarm Setpoints, allow for each of the following to be adjusted:
22. Low Vacuum Pressure Alarm – inches of Hg.
23. Low Vacuum Pressure Alarm Time Delay – seconds.
24. Low Vacuum Alarm Lockout Delay – seconds.
	* + - 1. Storage Tank Control:
25. Allow the drain control method for each tank to be independently selected – Level Switch, Level Transmitter or Timed.
26. Allow manual drain cycle time to be selected for each storage tank.
	* + - 1. Storage Tank Control Setpoints, allow for each of the following to be adjusted:
27. Start Drain when Tank Level is (for use with Level Transmitter) – Percent full.
28. Stop Drain when Tank Level is (for use with Level Transmitter) – Percent full.
29. Drain Overlap Lockout Delay – seconds.
30. Drain Time (for use with Level Switch) – seconds.
31. Timed Drain Wait Interval (for use with Timed Drain) – minutes.
	* + - 1. Storage Tank Level Alarm Setpoints, allow for each of the following to be adjusted:
32. High Water Level Warning – Percent full.
33. High Water Level Warning Reset – Percent full.
34. High Water Level Warning Delay – seconds.
35. High Water Level Alarm – Percent full.
36. High Water Level Alarm Reset – Percent full.
37. High Water Level Alarm Delay – seconds.
38. High Water Level VP Shutdown – Percent full.
39. High Water Level VP Shutdown Delay – seconds.
40. High Water Level & High Water Level Difference Lockout – seconds.
41. High Water Level Alarm and Drain Lockout (for use with Level Switch only) – seconds.
42. High Water Level Difference Warning – Percent full.
43. High Water Level Difference Warning Reset – Percent full.
44. High Water Level Difference Warning Delay – seconds.
45. High Water Level Difference Alarm – Percent full.
46. High Water Level Difference Alarm Reset – Percent full.
47. High Water Level Difference Alarm Delay – seconds.
48. High Water Level Difference VP Shutdown – Percent full.
49. High Water Level Difference VP Shutdown Delay – seconds.
	* + - 1. Isolation and Vent Valve Setpoints
50. Fail to Close – seconds.
51. Fail to Open – seconds.
	* + - 1. Remote Alarm Assignments.
52. Allow each available alarm to be assigned to one of four specific remote alarm contacts.
53. Remote Alarm Contact 1: High priority alarms such as Pump Fail to Run, Low Vacuum Pressure, Hi Level VP Shutdown, and Hi Level Difference VP Shutdown.
54. Remote Alarm Contact 2: Second level priority alarms; such as Storage Tank Hi Level Alarm and Storage Hi Level Difference Alarm.
55. Remote Alarm Contact 3: Third level priority alarms; such as Pump HOA Not in Auto, Pump Run Too Long, Pump Too Many Starts, Isolocation Valve and Vent Valve Fail to Open, Isolocation Valve and Vent Valve Fail to Close, Storage Tank Hi Level Warning, and Storage Tank Hi Level Difference Warning.
56. Remote Alarm Contact 4: Fourth level priority alarms, such as Zone Comm Fail Alarm, Zone Alarm Active, and Miscellaneous General System Alarms.
	* + - 1. Alarm Manager Database - Display and History:
57. The OIT shall manage and display all system alarms in three formats:

Current History – Showing alarms that have occurred with the most recent at the top of the list.

Detail – Showing the full description of the alarm, time and date when it was activated, time and date when it was cleared.

Count – Itemizing all alarms in the system and how many occurrences of each alarm have occurred.

1. The OIT shall allow alarm details to be cleared.
	* + - 1. Miscellaneous System Statuses:
2. Display total system accumulated runtime hours.
3. Display total pump accumulated runtime hours.
4. Display individual pump accumulated runtime hours.
5. Display total amount of storage tank discharges.
6. Communication status with each zone control panel.
7. Vacuum center and zone control center installed software version.
	* + - 1. Lift Station Activation Totals:
8. Display total lift station activation count.
9. Allow the lift station activation counts for each zone control panel to be cleared.
	* + - 1. Zone Control Panel Setup:
10. Enable/Disable a complete zone control panel from communication with the vacuum center control panel.
11. Enable/Disable individual zone control panel lift stations from operation.
12. Configure the setup for each zone control panel lift (see Zone Control Panel article of this section for details of required configuration capabilities).
13. Establish the number of communication attempts before establishing a Communication Failure alarm.
	* + 1. An alarm light shall provide indication that alarms are active.
			2. The vacuum center shall incorporate an Ethernet switch to manage communication between the OIT, vacuum center PLC, and zone control panel PLC(s).
		1. Waste Collection Tanks
			1. Each waste collection tank shall always be either collecting or discharging waste products.
			2. Incorporate three drain strategies into the system for each storage tank and selectable from the OIT:
				1. A Level Switch Drain Mode in which a tank will be discharged based on the level in the tank as determined by a level switch,
				2. A Level Transmitter Drain Mode in which a tank will be discharged based on the level in the tank as determined by the setpoint ‘Start Drain when Tank Level is - Percent full,’ and
				3. A Timed Drain Mode in which the tank is drained at fixed time intervals.
			3. Logic shall be provided to prevent more than one tank in each group from entering the discharge mode simultaneously.
			4. Logic shall be provided to queue the drain sequence of each tank group in a First-In, First-Out format to ensure all tanks are discharged regardless of system demand.
			5. Logic shall be provided to separate the tank discharges in each set by an adjustable time period to allow a tank returning from the discharge mode to become fully vacuumized before an alternate tank is released for discharge.
			6. Provide each tank with a High Water Level Warning, Alarm and VP Shutdown. If the water level in the storage tanks gets up to the High Water Level VP Shutdown, the vacuum pumps will shut down and the collection tanks will vent, so that waste is prevented from being carried over into and damaging the vacuum pumps.
			7. The rinse solenoid valves for each collection tank shall operate during a discharge cycle to facilitate cleansing of the vessel, or may be operated manually from the OIT.
		2. Vacuum Pump(s):
			1. The vacuum pump(s) shall be staged on and off according to demand in the system as recorded by the vacuum pressure transmitter.
			2. An alternation strategy shall be employed which equalizes the accumulated runtime of the pumps.
			3. Provide each pump with a water management strategy which maintains the correct water level in its separator tank.
			4. The system shall monitor the status of the emergency power equipment and allow the operating personnel to determine how many pumps will operate when the system is running on emergency power.
			5. When the system is running on emergency power, pump staging shall cease and the number of pumps specified at the OIT for this condition shall run continuously.
		3. Lift Stations:
			1. Waste removal from the fixtures shown in the contract documents shall be accommodated by zone control panels, lift station interface panels, and lift stations.
			2. Each zone control panel shown on the drawings shall require a 120VAC, 3-amp power source with the following:
			3. Capability of operating up to 4 lift stations, and 4 configurable solenoid valves. NEMA 4/12 industrial enclosure.
			4. Individual power circuit breakers for the PLC and DC power supply.
			5. Clearly marked and numbered terminal strips for connection to each lift station interface panel and associated equipment.
			6. 24VDC Power Supply suitable for operation of 12 lift stations and 4 programmable valves.
			7. PLC with operational logic for 12 lift stations and 4 programmable valves.
			8. Ethernet communication module for interface with the vacuum center control panel.
			9. Communication wiring between each zone control panel and the vacuum center control panel shall be by means of Category 5e or 6 Ethernet cable.
			10. Four 12-bit analog inputs.
			11. Lift stations shall consist of a waste removal valve, mini check valve, lift station interface panel, accumulator, and a sufficient length of flexible vacuum rated tubing to interconnect the active vacuum components. The lift station interface panels and zone control panels operate together to determine when sufficient waste has been collected in an accumulator for removal. The active vacuum components shall consist of:
			12. A lift station interface panel assembly, provided for each lift station, which shall serve as the electrical and pneumatic interface between the lift station components and zone control panel. Each lift station interface panel shall consist of the following:
14. 16-gauge galvanized steel enclosure with removable cover.
15. Clearly marked terminal strip for connecting each lift station interface panel to its’ associated zone control panel.
16. Digital translator for monitoring lift station accumulator fill level status.
17. Solenoid valve to operate the lift station waste removal valve.
18. Manual override push button to cause activation of the lift independent of the digital translator.
19. Barb-to-tube connectors for connection of the lift station interface to the waste removal valve and vacuum source for the lift.
20. Wiring between each lift station interface panel and its associated zone control panel shall be by means of an 18-gauge conductor consisting of two twisted shielded pairs (4 conductors).
	* + 1. Waste Removal Valve:
21. Furnished by AcornVac, no substitutions, and installed by the Contractor as shown in the contract documents.
22. Normally closed tubular diaphragm type.
23. Provide a fully open, unobstructed passageway between the accumulator and vacuum piping network at a vacuum pressure of 8 inches Hg.
24. Provide a bubble tight seal between atmospheric pressure in the accumulator and vacuum pressure in the piping network when at rest.
25. Include an integral vacuum source port for connection to the lift station interface panel via the mini check valve.
26. Include a strain relief bracket for connection of the vacuum tubing.
	* + 1. Mini check valve to prevent migration of liquids in the vacuum source line into the solenoid valve.
		1. Zone Control Panel Control Strategies:
27. Each zone control panel shall be able to communicate with the vacuum center control panel and OIT via an Ethernet network.
	* + 1. The vacuum center shall share its vacuum pressure with each zone control panel on the network.
			2. Alarms shall be provided at the vacuum center control panel, via the OIT, to advise of any communication failure between the zone control panels and the vacuum center control panel.
28. Provide the following control strategies for each panel. These strategies shall be individually configurable for up to 12 lift stations and 4 programmable solenoid valves as further outlined below:
	* + 1. Each lift station shall be programmable to act in an accumulator mode or a toilet flush mode.
			2. Normal Lift Station Operation – Accumulator Mode:
29. When configured for Accumulator Mode, activation shall occur when the device which monitors the accumulator fill level determines that it is sufficiently full to require removal of the collected waste. When the discharge cycle is initiated, it shall open the associated waste removal valve and keep it open so long as the accumulator fill level activation signal is present or is shut-down and transfers to the failsafe mode of operation. When the activation signal is removed, the waste removal valve shall continue to be held open for an operator programmable time period.
30. An End of Day function shall be provided which forces the accumulator to discharge at a specified time of day to ensure that no debris remains in the vessel for extended periods of time.
	* + 1. Lift Activation Permissive:
31. Lift activation shall only occur if the selected permissive device and any associated setpoints are satisfied. The operator shall be able to select the permissive to be used by the lift activation logic from the vacuum center OIT as follows:

No Permissive required. Lift shall activate when commanded regardless of system vacuum pressure.

Vacuum center vacuum pressure transducer (shared via the Ethernet communication network). The operator shall be able to adjust the permissible activation pressure from the vacuum center OIT.

1. The operator shall be able to adjust the amount of time that the permissive must be present before the lift activation cycle is initiated.
2. If the vacuum center vacuum transducer is selected as the permissive source, and communications are lost between the vacuum center and zone control panel, the lift will activate as if No Permissive has been selected until communications are re-established.
	* + 1. Lift Activation Timeout:
3. The amount of time that a lift remains active once the activation signal has cleared shall be selectable between manual and automatic at the vacuum center OIT. In Manual, the timeout setpoint shall be fixed by the operator. In Automatic, the timeout setpoint shall be calculated by an optimizing algorithm which determines the most efficient value for the lift based on the active vacuum pressure in the system at the time the lift cycle commences.
4. The automatic timeout setpoint shall be calculated using four operator adjustable parameters. The optimizing algorithm shall compute a linear timeout value within the boundaries of these setpoints as follows:

Minimum pressure – establishes the minimum vacuum pressure (sourced from the vacuum center) at which the maximum timeout setpoint is used.

Maximum timeout setpoint – establishes the maximum timeout value when the vacuum pressure is at or below the minimum pressure setpoint.

Maximum pressure – establishes the maximum vacuum pressure at which the minimum timeout setpoint is used.

Minimum timeout setpoint – establishes the minimum timeout value when vacuum pressure is at or above this maximum pressure setpoint.

1. The active lift station timeout setpoint will automatically revert to the manual setpoint if communications between the affected electronic control panel and vacuum center are interrupted for any reason. The optimized setpoint shall be automatically restored when communications are restored.
	* + 1. Programmable Solenoid Valves:
2. Each zone control panel shall be capable of operating 4 independent and fully programmable solenoid valves that can be assigned to any of the 12 lift stations. Provide control strategies to allow each of these valves to act as any one of the following:

An accumulator rinse valve.

A temperature control valve.

A water supply safety valve.

* + 1. Zone Control Panel and Lift Station OIT Configurations, Adjustments, and Functions:
			1. Provide the following zone control OIT functions for each zone control panel:
			2. General zone control panel and lift station overview screen to provide:
1. Visual indication of the ON-OFF status of all lift stations enabled and configured for all zone control panels.
2. Manual activation of any lift station enabled and configured for any zone control panel.
3. Visual indication of the alarms active at the zone control panel.
4. Access to any zone control panel overview screen.
5. Visual indication of the vacuum center vacuum pressure.
	* + 1. Individual Zone Control Overview and Status Screen:
6. Selector for the zone control panel lift permissive source.
7. Access to the load factory default setpoint screen, where the default setpoints can be loaded for enabled lift stations for the zone control panel.
8. Access to the programmable valve setup screens.
9. Reset button for all active zone control panel alarms.
10. Visual indication of the zone control panel’s communication status with the vacuum center.
11. Enable/Disable selector for each of the 12 lift stations configurable for the zone control panel.
12. Visual indication of the lift station status for any lift station configured for the zone control panel.
13. Access to the zone control panel configuration screen(s).
	* + 1. Provide the following screens and functions for each lift station within a zone control panel:
			2. Lift Station Overview Screen.
14. Show activation status of the lift station.
15. Allow for manual activation of a lift station.
16. Allow for auto/manual selection of the timeout setpoint - tenths of seconds resolution.
17. Display the calculated timeout setpoint.
18. Allow for adjustment of the manual timeout setpoint.
19. Display the failsafe mode status.
20. Allow the failsafe mode to be off or, automatically or manually invoked.
21. Allow the On-Too-Long alarm feature to be enabled or disabled.
22. Display the status of the On-Too-Long alarm.
23. Allow for adjustment of the lift input time delay setpoint.
24. Display the total number of lift station activations since the system was commissioned.
25. Allow for Auto/Off selection of End of Day Drain feature.
26. Allow for End of Day Drain feature activation time adjustment.
	* + 1. Lift station setpoint configuration and adjustment screen.
27. Provide adjustment of the minimum activation pressure - tenths of inches Hg resolution.
28. Provide adjustment of the low activation pressure delay - tenths of seconds resolution.
29. Provide adjustment of the Input-On-Too-Long alarm delay - seconds resolution.
30. Provide adjustment of the Failsafe Wait Interval - minutes resolution.
31. Provide adjustment of the calculated timeout minimum pressure - tenths of inches Hg resolution.
32. Provide adjustment of the calculated maximum timeout runtime - tenths of seconds resolution.
33. Provide adjustment of the calculated maximum timeout pressure - tenths of inches Hg resolution.
34. Provide adjustment of the calculated minimum timeout runtime - tenths of second resolution.
35. Provide adjustment for the End of Day Drain feature – hours and minutes.
36. Display the active vacuum pressure being transmitted by the vacuum center.
37. Display the calculated timeout setpoint.
	* + 1. Lift station programmable solenoid valve setup (typical for each of 4 valves).
38. Allow each valve to be configured for a specific mode of operation:
39. None.
40. Rinse.
41. Temperature Control.
42. Safety Valve.
43. Once the mode assignment is complete, allow each valve to be configured for the specific mode of operation as follows:
44. Rinse.
45. Assign the lift number which the valve is to follow.  The solenoid valve shall activate any time the lift activates.
46. Allow the rinse valve to be operated for a period of time between lift activations by assigning a rinse schedule and duration.
47. Allow the rinse valve to activate every time the lift station activates, or on a specific interval of lift activations.
48. Allow rinse valve to be automatically turned off if a high level in the accumulator occurs.
49. Temperature control valve.
50. Assign the lift number which the temperature control valve is to follow.
51. Assign the analog input channel the control strategy is to use for the temperature control function.
52. Enable/Disable the associated extraction valve if the vessel temperature exceeds a programmed high temperature value.
53. Assign the temperature control strategy to be employed – heating or cooling.
54. Deactivate the valve if the vessel is experiencing a high level alarm.
55. Activate the valve based on the measured temperature.
56. Establish the heating or cooling start setpoint.
57. Establish the heating or cooling offset stop setpoint.
58. Enable/Disable activation of the heating valve when the lift activates.
59. Safety supply valve:
60. Assign the lift number which the safety supply valve is to follow.
61. Enable/Disable the feature.
62. Enable/Disable “Too Many Activations within Time Period.”
63. Establish the number of activations within a time period that initiates the “Too Many Activations” alarm.
64. Establish the time period through which the “Too Many Activations” evaluation is made.
65. Enable/Disable feature when vacuum pressure is too low.
66. Allow the safety valve to be automatically turned off if a high level in the accumulator occurs.
67. EXECUTION
	1. protection and cleaning
		1. Vacuum Valve Equipment: Protect from weather, construction debris, damage, dust, mortar splatter, direct paint or paint splatter by covering with plastic sheeting or bags. Remove covering after construction is substantially complete but before system start up.
		2. Due to the nature of the system and the possibility of equipment damage, it is very important to protect the piping system from entry of foreign material and debris during installation. Any damage caused by foreign objects or materials in the piping are excluded from warranty coverage and shall be repaired by the Contractor under the general project warranty.
		3. Fixtures and Valves: Protect from weather, construction debris, damage, dust, mortar splatter, direct paint or paint splatter by leaving factory provided protective covering and cardboard inserts in place during installation. Remove cardboard and coverings after construction is substantially complete but before system start up.
		4. All piping shall be fully flushed and completely clean and free of debris prior to installation of the vacuum components and water valves. Vacuum components and water valves supplied by the manufacturer that are damaged by debris or chemical treatment processes in the piping network will not be warranted.
	2. INSTALLATION
		1. General:
			1. Install in strict accordance with the contract documents, the vacuum equipment supplier’s installation instructions, and with local authority approval.
			2. Install all components, including power and control wiring per manufacturer’s recommendations, applicable codes, and referenced electrical specifications.
			3. Provide service clearance for all system components in accordance with manufacturer’s instructions, and as necessary to facilitate maintenance and replacement. The minimum service clearance shall be 36 inches on all sides of the vacuum center equipment. Install valves in accessible locations or provide access doors or panels in walls, partitions, floors, or ceilings as shown on the drawings and as required for a complete system.
		2. Equipment Installation:
			1. Vacuum Pumps:
				1. Provide valves and specialties as detailed on drawings and as required for a complete system.
				2. Lubricate in accordance with manufacturer’s instructions before operation.
				3. Support interconnecting piping independently to prevent stresses on piping/equipment connections.
				4. Install pumps on support stand in accordance with the manufacturer’s published installation instructions.
				5. Anchor unit to floor per manufacturer’s requirements and install vibration isolation and seismic restraints as specified.
			2. Waste Collection Tanks:
				1. Support interconnecting piping independently to prevent stresses on piping/equipment connections.
				2. Anchor unit per manufacturer’s requirements and install seismic restraints as specified.
			3. Accumulators:
				1. Provide valves and specialties as detailed on drawings and as required for a complete system.
				2. Support interconnecting piping and components independently to prevent stresses at piping/equipment connections.
				3. Anchor unit per manufacturer’s requirements and install seismic restraints as specified.
		3. Power and Controls Installation:
			1. Mounting Panels: Locate panels where shown on the drawings or near item of equipment to be controlled, but not on equipment itself.
			2. Field Panels: Locations shown on the drawings are recommended locations and do not indicate actual quantity or location. Provide number of panels required to accommodate all points and all hardware and software to accomplish specified control. Locate all panels in locations approved by the Port. Submit proposed locations for approval prior to preparing control drawings.
			3. Electrical:
				1. Provide control wiring for all control devices and control panels.
				2. Provide power wiring for all control devices and control panels. Obtain power from spare circuits in power panels.
				3. All wiring, including low voltage wiring, shall be installed in minimum 3/4-inch conduit in mechanical rooms or other locations susceptible to damage. Use Plenum rated cable in other locations.
				4. Grounding: Install instrumentation and communication grounding as necessary to preclude ground loops, noise, and surges from adversely affecting system operation.
				5. Control voltage shall be limited to a maximum of 120 volts.
				6. Where relay coil is connected to load side of motor starter to energize with motor operation, external control circuit shall be properly fused with fuse block located in respective starter enclosure.
			4. Identification: Provide engraved nameplates identifying all switches, lights and starters, and each control device where control function is not readily apparent.
		4. Pipe Installation:
			1. Size and type, as shown on drawings. Do not vary without written approval from the Port.
			2. All stainless steel pipe shall be cut clean and square and de-burred using abrasive saw method, or per manufacturer recommendation, taking care to leave no burrs on the inside of the piping.
			3. All fittings shall be approved for DWV usage.
			4. Inside surfaces of vacuum drainage piping shall be smooth and free of burrs, weld bead protrusions and abrupt changes in cross section.
			5. Taper ream all joints in which the inside diameter of the vacuum drainage pipe and fitting do not meet. Pipe/fitting interface shall produce a smooth transition.
			6. All ninety-degree change of direction in the horizontal vacuum drainage piping shall be made up of long radius bends.
			7. All 45-degree changes of direction in vacuum drainage piping shall be made with appropriate fittings bends.
			8. Vacuum drainage piping shall maintain a positive slope with a minimum 1/4 inch per foot in the direction of flow.
			9. Vacuum drainage piping shall be routed in an orderly fashion, with a minimum number of fittings, parallel and perpendicular to building lines unless otherwise indicated on drawings.
			10. Consider expansion and contraction during pipe installation to prevent excessive stress on pipe, fittings, or connected equipment.
			11. Install vacuum piping with bracing as indicated in Section 220529.
			12. Cleanouts located as follows:
				1. At intervals no greater than 70 feet.
				2. At the end of all vacuum mains, and at the end of each branch line, unless the branch line serves a single fixture that discharges into the main from above.
				3. So that no more than one 90-degree change in pipe direction occurs between cleanouts.
				4. At slope make ups.
			13. Branch to Main and Riser to Branch Connections: Made with wye pattern fittings; and shall not be rolled more than 45 degrees from vertical.
			14. Offsets:
				1. Maximum offset allowed in a vertical lift or riser (single accumulator with lift) shall be 12 inches, measured horizontally from the centerline of the pipe.
				2. Only one offset is allowed in a single vertical lift or riser and shall be made with two 1/8 bend fittings.
				3. The offset should be made as close as possible to the accumulator.
			15. Maximum lift height, as shown on the drawings.
			16. Sensor Ports: Fabricated from 1 1/2-inch pipe with an airtight cap and 1/4-inch barbed fitting, connected to the valve controller.
			17. Sensor Port Tubing:
				1. Bending Radius: Minimum 3 inches to prevent crimping. Crimps are not allowed in vacuum tubing; ensure there is no compression on sensor port tubing by any external support or clamping device or adjacent equipment across its entire length.
				2. Routing: Between the sensor port at the accumulator and on the valve controller so that there are no low areas or traps.
				3. Mini Check Valves: Install in vacuum source tubing to prevent migration of waste water into the valve controller. Check valves shall be provided by Acorn Engineering, no substitutions.
			18. Valves:
				1. Isolation Valves: Installed with stems above horizontal plane, not inverted.
				2. Check Valves: Installed horizontally and oriented so that flapper rests on seat under no-flow conditions.
			19. Consult with the Port and the manufacturer for any deviation from the submittals.
			20. Protect equipment drain lines from clogging, debris and damage for the duration of construction period by placing plugs in end of uncompleted work at the end of each work day or when work is stopped. Protect valve components from paint, construction debris, and dust, at all times.
			21. Inter-connect the equipment at the vacuum center, including waste and vacuum drainage piping and valves.
			22. Coordinate electrical work to wire remote monitoring alarms and indications from the dry sets of contacts to the Port’s building controls systems.
			23. Coordinate with the manufacturer for installation inspection and on-site start-up of the system. Verify that the vacuum drainage piping and collection system equipment have been installed as described in the contract documents and installation instructions.
	3. VACUUM WASTE SYSTEM INSTALLATION INSPECTION
		1. Coordinate with the manufacturer for the inspection of all vacuum waste system installation to ensure proper operation of the system and maintain product warranty.
		2. Schedule inspection of the piping and component installation at specific intervals of completion during the construction period. Provide up to twelve progress inspections approximately once per month; inspection schedule to be determined in consultation with the Port prior to commencement of the installation. At the completion of each inspection, a formal written report of the findings, along with all supporting documentation necessary to convey issues and discrepancies that require corrective measures shall be submitted to the Port. Provide additional, or more frequent, inspections when required. Charges for additional site and progress inspections shall be approved by the Port beforehand.
		3. All work scheduled for inspection shall be complete before inspection will take place. Any work that has been scheduled for inspection and is not complete at the time of inspection will require re-inspection, may be subject to additional costs to the Contractor, and shall be approved by the Port beforehand.
		4. The Contractor, manufacturer, and Port shall be present at the time of inspection. Correct all noted discrepancies before scheduling additional inspections. The enforcement of corrections will be the responsibility of the Contractor. The operation of the system or equipment shall not be warranted if any portion of work has not been inspected, has been inspected but has not been corrected, or has not been installed in accordance with the contract documents, shop drawings and the manufacturer’s installation guidelines and recommendations.
	4. VACUUM WASTE PIPE SYSTEM TESTING
		1. Test all vacuum piping for leaks and defects. Check the tightness of the vacuum piping during construction as sections are completed.
		2. The vacuum piping shall first be tested for leakage under positive pressure before any extraction valves, vacuum check valves, or vacuum tanks are connected to the piping. Do not subject the vacuum valves (check valves, extraction valves) to positive pressure. A minimum pressure test of 30 psig is requested unless it exceeds the manufacturer’s recommendation and at that time the manufactures recommendation shall prevail.
		3. After the positive pressure test has been passed, test the vacuum piping for leakage under negative pressure. A pressure gauge shall be installed at visible location and not indicate any loss of pressure for a period not less than one hour. The area/section/system under test will be considered suitable for use when tested under a vacuum pressure of 22 inches Hg with a leak rate equal to, or less than, 6 inches Hg per hour.
		4. After the valves, tanks, etc., have been connected, test the entire vacuum waste system for leakage under negative pressure. The leak rate for this test shall not exceed 6 Hg inches vacuum pressure Hg per hour.
		5. If the leakage rate is greater than that specified above in any of the test sequences, locate and repair all leaks and defects with new materials and retest system or portion thereof until satisfactory results are obtained. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the vacuum system tested.
	5. VACUUM WASTE SYSTEM COMMISSIONING
		1. Vacuum Center Equipment Pre-Startup Checks:
			1. Perform the following operations and checks prior to system start-up. Operations and checks shall only be completed for equipment necessary for vacuum center equipment startup for typical test area (i.e., the whole vacuum system for the facility does not have to be complete and commissioned).
				1. Remove temporary end cap protectors.
				2. Verify that vacuum piping and electrical power have been connected to the vacuum center equipment.
				3. Verify valves, controllers, vacuum tubing, and vacuum center equipment have been installed per the vacuum system equipment supplier’s installation instructions and guidelines.
				4. Repair or replace damaged or defective equipment, specialties, and accessories.
				5. Verify service clearance has been provided for all equipment as required in drawings and specifications.
				6. Verify in writing that the system is complete and ready for inspection and start up.
			2. After performing pre-startup checks and certifying that the vacuum center is ready for startup, review startup checklists, inspect visually, and sign off prior to startup.
		2. System Pre-Startup Checks:
			1. Perform the following operations and checks prior to system startup:

Remove plastic covers from controllers, extraction valves, and associated equipment.

Perform functional test on all fixtures.

Check rinse valve operation.

Check extraction valve operation.

Check bypass valve operation.

Ensure that drains and piping are free of debris and not clogged.

Perform leakage tests as described herein.

Ensure that there are no traps in sensor lines.

Ensure that vacuum tubing is not kinked, damaged, or otherwise blocked.

Ensure the valves, controllers, vacuum tubing, and vacuum central equipment have been installed per manufacturer’s recommendations.

Repair or replace damaged or defective equipment, specialties, and accessories.

Verify service clearances have been provided for all equipment as required herein.

Verify in writing that the system is complete and ready for inspection and startup.

* + - 1. After the Contractor performs pre-startup checks and certifies that the vacuum center is ready for startup, review startup checklists, inspect visually and sign off prior to startup.
		1. Startup Procedure:
			1. Sequence the startup of the vacuum center and piping system to ensure no damage to equipment or piping.
			2. Startup system and ensure operation before connecting to tenant waste piping.
		2. Functional Acceptance Testing:
			1. Simulate operation of the vacuum system with a temporary load before tie-in of vacuum system to tenants piping system.
			2. Connect one tenant’s gravity waste piping to vacuum grease waste removal system and verify proper operation before connecting remaining tenants.
			3. Connect remaining tenants according to construction schedule and verify operation as each tenant is connected.

END OF SECTION 221320