Chapter 15
Water and Waste System
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15.0 Water and Waste System

15.1 Overview

A pressurized fresh water system shall be provided on each car to supply potable water for drinking, hand washing, toilet flushing and Café car galley requirements. Storage for 200 gal of potable water shall be located in the A/F-end or B-end equipment room of coach and cab/baggage cars, and 300 gal on café/lounge cars. A re-circulating chiller shall provide chilled potable water to two dispensing stations, one on each level of all cars.

A vacuum type waste retention system shall be provided on each car. The waste tank, drain lines and associated components shall be located in the B-end equipment room. Gray water from toilet room and galley hand washing sinks shall be captured and pumped to the waste retention tank.

No waste water shall be permitted to drain to ground, including gray water from hand washing sinks. Only fresh water from the following sources shall be permitted to drain to ground:

- Condensate from Heating, Ventilation and Air Conditioning (HVAC) and chiller units
- Drain from potable water chillers
- Melt water from ice storage bins
- Carbody drains from door tracks and equipment rooms
- Fresh water from water supply system when drained manually or by freeze protection devices

All car types shall have an Accessible Toilet Room (ATR) on the lower level. Coaches and cab/baggage cars shall also have a Unisex Toilet Room (UTR) on the upper level.

The water and waste systems shall be protected from damage due to freezing through the use of heat tape, blanket heaters, automatic drain valves (water system only) and insulation.

See Chapter 14, Food Service, for galley water system requirements.

15.2 General Requirements

15.2.1 Water System Features

A potable water supply system shall be provided on each car to supply water for drinking, washing, cleaning and waste disposal. The fresh water shall be supplied from one or more storage tanks located in the A/F-end equipment room. These water tanks shall be filled from a water fill valve located on each side of the car at the A/F-end.

The basic features of the water system include:

- 200 gal fresh water storage in coach and cab/baggage cars, 300 gal in café/lounge cars (one or more tanks)
- Water fill, vent and drain system
- Pressurization system
- Distribution and piping
- Pressure regulators
- Backflow or vacuum preventers
- Sinks, faucets and drains
- Water heaters (or flash heaters)
• Water cooler and alcove
• Fresh water for toilet bowl rinse during flush
• Fresh water for waste retention tank rinse during draining
• Galley water: sinks and coffee maker

15.2.2 Waste System Features

A waste system shall provide flush toilets in each toilet room. The waste system shall be a vacuum system with sufficient capacity to collect and retain a minimum of 250 gal of passenger waste, in a single tank, for discharge at a dumping facility. Waste incineration is not permitted. The waste system shall be designed with a minimum service life of 30 years, a minimum overhaul cycle of eight years and a minimum maintenance cycle of one year. Overhauling of waste system components may be included in the maintenance cycle. Recommended waste system components included in maintenance cycle is to be approved by the Customer. The waste system and all its components shall be designed for fail-safe operation and protection of passengers, service personnel and equipment.

The waste tank shall be located in the B-end equipment room, and shall have waste discharge drain lines and valves located adjacent to the tank on each side of the car.

The waste system shall be designed to operate normally at all elevations from 200 ft below to 9200 ft above sea level, and under all environmental and operational conditions identified in PRIIA Specification 305-912.

Toilet flushing shall be inhibited due to: lack of adequate water, air pressure, vacuum or electric power; waste tank full or waste drain valve open.

The basic features of the waste system include:

• Toilet bowl with flush control
• 250 gal usable waste tank capacity
• Vacuum source and control
• Waste tank vent
• System status indicators
• Waste tank drain and rinse
• Piping

15.2.3 FDA Compliance

The Contractor shall arrange for an FDA inspection of the design and installation of the water and waste system on each car to certify that it meets all requirements. Documentation of compliance shall be included in each vehicle’s history book.

Water from hand washing faucets shall be dispensed at a temperature between 100°F and 108°F, in accordance with FDA/PHS requirements. All water heaters and flash heaters shall maintain water temperature in accordance with FDA/PHS regulations.

FDA-approved backflow preventers shall be located as necessary to prevent contamination of the fresh water system from the waste system. Backflow preventers shall be easily accessible for inspection and maintenance.

The Contractor shall thoroughly clean and sanitize the fresh water system on each vehicle prior to release from the Contractor’s facility, to remove dirt, debris, solder, adhesive, cleaning agents or other contaminants from the manufacturing process. All filters in the fresh water system shall be renewed after the sanitization process and before release of the vehicle.
15.3 Water System

15.3.1 Water Tank

Storage for 200 gal of potable water shall be provided on coach and cab/baggage cars, and 300 gal on café/lounge cars, in one or more stainless steel tanks located in the A/F-end equipment room. Water tanks shall include internal baffle plates to minimize wave action produced by train motion. Water storage tanks shall comply with the latest edition of the ASME Boiler and Pressure Vessel Code sections IX and X.

Tanks shall be equipped with a manual drain valve for use in tank sanitizing as required by the FDA. Manual drain valves shall be readily accessible within the equipment room and shall drain to ground.

15.3.2 Water Fill, Vent and Drain System

A water fill point shall be provided on each side of the car. The fill point and three-way valve shall be enclosed in a stainless steel box inset into the equipment room and equipped with a weather-tight cover. The water fill box cover shall be spring loaded to be held securely in the closed position, with a strut or latch to hold the cover in the open position during water filling. The water fill point shall be a nozzle (Equipment Hydraulique Rainville p/n H-G15-001X or equivalent) enclosed in a metal shroud (Clements National p/n MRA-H-ALST-V109 or equivalent) and be painted medium blue.

A three-way valve (NYAB p/n 705504 N-9723 or equivalent) shall be provided on each side of the car that will cut off pressurization air and vent the water tanks when placed in the FILL position. This will allow the tank to be filled via a check valve located immediately behind the fill nozzle. The three-way valve shall be enclosed behind sheet metal, serviceable from the front, with only the operating handle exposed. When venting the tanks, vented air shall blow downwards to the ground and away from maintenance personnel operating the valve.

When the valve is placed in the WATER position, the vent will be closed and air pressure applied to the water in the tanks. Valves and piping shall be sized for a maximum fill time of 15 minutes, including the time necessary to vent the tank.

Water fill point piping and valves shall be insulated and equipped with heat tape for freeze protection. All hardware used in the water fill system shall be corrosion resistant and rated for use in a wet environment.

15.3.3 Pressurization System

The water supply system shall be pressurized through the use of auxiliary air, provided from the main reservoir through a governor and regulator valve. Air pressure for water rising shall be set for 45 ± 2 psig. The system shall be designed such that water shall not flow back into the auxiliary air system under any circumstances.

A desiccant air filter shall be provided on the main reservoir air supply line to remove contaminants from water raising air (see Chapter 7).

Potable water shall be provided through a pressure reduction valve at 20 ± 2 psig for hand washing sinks in toilet rooms, potable water drinking fountains and café galley sinks.

Water for toilet bowl rinse shall be provided at 28 ± 2 psig. Waste tank rinse water shall be unregulated.
15.3.4 Distribution and Piping

Distribution piping shall be seamless stainless steel tubing in the longest possible continuous length without joints, with stainless steel fittings. Anti-water hammer air chambers shall be provided as required. Easily accessible ball cock type isolation valves shall be provided for each of the following (located upstream of pressure regulators, backflow preventers, etc):

- Main water supply (at water tanks)
- Sinks (combined hot and cold water feed at faucet)
- Water chiller
- Toilet flush (one for each toilet)
- Waste tank rinse
- Galley sinks and coffee maker
- Water heaters

Easily accessible manual drain valves shall be provided to allow draining water from the car as well as to service equipment.

Engraved color coded laminated plastic tags, attached to piping, will be provided to identify all water and air pressure regulators, water and waste cutout cocks, and drain cocks.

15.3.5 Pressure Regulators

Pressure regulators, complete with integral gauge shall be supplied to maintain the water pressures identified herein. Regulators shall be adjustable and have a locking ring or other locking device to prevent unintended changes to pressure settings.

15.3.6 Backflow Preventers/Vacuum Breakers

The potable water system shall be isolated from toilet flush water and toilet waste tank rinse water through the use of FDA-approved backflow preventers or vacuum breakers. Backflow preventers/vacuum breakers shall be located for easy access and replacement.

15.3.7 Sink, Faucet and Drain

Each toilet room shall be equipped with a sink, faucet and drain. All sinks shall be stainless steel. All gray water discharge from the sinks shall be captured and sent to the waste tank. Minimum drain line internal diameter shall be 1.5 in. Drain water may not be used as flush water for toilets.

Sink faucets shall utilize an automatic start-stop feature, such as infrared or proximity sensor, that will permit hands-free use of the faucet. The sensor may be mounted in the counter surface or the faucet. Faucets shall be regulated to have a flow rate of no more than 0.5 gpm, in order to maintain FDA-compliant water temperature.

15.3.8 Water Heaters

Each restroom shall be equipped with a standard one-gallon, 120VAC, 1250 W (minimum), vertical unit. Hot water temperature in the tank shall be maintained in accordance with PHS recommendations, and shall be mixed with cold water at the toilet room faucet to maintain hand washing water temperature between 100°F and 108°F at a flow rate of 0.5 gpm, in accordance with FDA/PHS regulations. The water heaters shall include the following features: immersion heater, factory installed thermostatic control and low water protection. The tank relief valve shall be set at 75 psig. The water feed piping to the heater shall be from the bottom to allow gravity draining from the local freeze protection valve. The water heater shall be easily
accessibile and removable without disturbing any other equipment. Water heaters shall conform to ASME Boiler and Pressure Vessel Code sections IX and X.

For galley water heater, refer to Chapter 14.

15.3.8.1 Instant-Flow Water Heaters (Flash Heaters)

An in-line instant-flow water heater (flash heater) may be provided as an alternate to a standard water heater. The flash heater shall meet temperature requirements of the water heater, and must be able to increase water temperature from an ambient temperature of no more than 50°F to the FDA required 100°F to 108°F at a flow rate of no less than 0.5 gpm. The flash heaters shall be flow activated and shall operate at 120VAC. Flash heaters shall be easily accessible for replacement or maintenance.

15.3.9 Water Cooler and Alcove

Each drinking water station shall consist of a stainless steel alcove equipped with a chilled water dispenser and drain. The drain shall be .50 in. copper piping and shall drain to ground under the car. A kazoo shall be installed on the end of the drain under the car.

Water coolers shall be capable of producing at least 10 gal of chilled water per hour to spigots at designated locations on the upper and lower levels of all cars. The water cooler shall be capable of chilling water from 80°F to 50°F within 10 minutes. The chilled water shall be recirculated to provide chilled water on demand.

Water coolers shall operate from 120VAC and shall use a non-ozone-depleting refrigerant meeting 40CFR Part 82. The water cooler shall have an FDA-approved particulate and bacteria filter on the supply line to the spigot.

Water shall be dispensed at a rate no greater than 0.5 gpm, or by gravity, to minimize spraying.

15.3.10 Toilet Flush Water

Toilet flush water shall be provided to the toilet bowl assembly through a cutout cock, pressure regulator and backflow preventer.

15.3.11 Waste Tank Rinse Water

Waste tank rinse water shall be provided to the waste tank through a cutout cock and backflow preventer. Waste tank rinse water shall be at the same pressure as the water raising system.

15.3.12 Galley Water

Potable water shall be provided to the galley of the café/lounge cars for hand washing, food preparation and coffee makers. See Chapter 14 for details.

15.4 Waste System

A waste system shall be provided on each car. The system shall have a useful waste storage capacity of at least 250 gal. The waste system shall be comprised of vacuum toilets, constant-vacuum waste transfer system, a central waste collection tank, two external waste valve stations, indicator panels and associated piping and controls.

Safety, reliability and ease of servicing and maintenance shall be major design considerations. The system shall be designed and tested to operate at all elevations from 200 ft below to 9200 ft above sea level, in accordance with PRIIA Specification 305-912.
Pump motors shall operate from 480VAC, 3-phase, 60 Hz head end power. All controls, solenoid valves, relays and circuitry, and antifreeze protection shall operate from 120VAC, 60 Hz. All transducers and indicator devices shall operate from 74VDC.

The equipment shall be designed for a minimum service life of 30 years, a minimum overhaul cycle of eight years and a minimum maintenance and level sensor calibration cycle of no less than one year.

The system shall consist of the assemblies listed below:

- Vacuum toilet
- Waste collection tank
- Waste valve stations
- Waste system indicator panels

The system shall have no adjustments and automatically recover from loss of power, air or water pressure when restored. The system shall have a manual reset pushbutton provided on the status panel to reset the system after a lockout, such as resulting from a toilet with a failed open vacuum flush valve. Cycling the 74VDC circuit breaker shall also reset the system.

Gray water from hand washing sinks shall be collected and stored in the waste tank. Gray water may be transferred from sinks to waste tank by the use of pumps or vacuum draw. Gray water shall not drain to ground.

### 15.4.1 Operation

A flush cycle shall be initiated by operating a flush actuating pushbutton located adjacent to the raised toilet lid in the UTR. The ATR will have two flush pushbuttons, one located on each side of the toilet, per ADA requirements. The flush function at all other toilets in the car will be disabled during the flush cycle. The vacuum blower shall automatically come on at the beginning of the cycle. Pressurized rinse water shall be sprayed into the toilet bowl before waste is evacuated. Toilet operation shall be disabled when: there is inadequate water, vacuum, air pressure or 480VAC; the waste tank is full; or when the waste tank drain line is open.

The waste shall be drawn, by vacuum, from each toilet in the car and transported through a 2 in. diameter waste line to a holding tank for discharge at a collection facility. The holding tank shall be continuously under vacuum, regulated by blower operation and maintained by an air-tight check valve between the tank and vacuum blower.

Indicators shall show the volume of waste collected in the retention tank and system status. The vacuum blower and toilet flushing shall be disabled whenever waste volume collected exceeds usable tank capacity.

A waste discharge valve shall be located on each side of the car near the B-end truck to drain the waste collection tank. Waste may be drained from the retention tank by gravity or vacuum assistance from the servicing facility. When the waste discharge valve is opened: vacuum blower operation will be disabled; the waste retention tank will be vented; the interior of the retention tank will be rinsed with wayside water; and wastes will be drained from the retention tank to the servicing facility. Draining the waste tank shall not require more than one person. Servicing time for draining the tank shall not exceed five minutes. The waste tank must be able to be drained without requiring 480VAC power or air pressure to be present on the car. An external rinse water hookup shall be provided if rinse water is required for draining.
15.4.2 **Toilet Bowl with Flush Control**

Each toilet room of each car shall be equipped with a toilet stand and shroud.

The toilet assembly shall be a self-contained, free standing unit consisting of a bowl with spray ring, rinse valve, drain valve, electronic flush control module, isolation valve, and supporting frame. The assembly shall be mounted on a stainless steel pan, to contain flooding should the outlet become blocked.

A flush pushbutton shall be provided to initiate the flush cycle. Pressurized rinse water shall be sprayed into the toilet bowl before waste is evacuated. Force required to activate the flush pushbutton shall be within ADA requirements.

Pressurized rinse water, 7 oz to 8 oz per flush, shall be sprayed into the toilet bowl before waste is evacuated. It shall be provided from the car water system via a dedicated local cutout cock, backflow preventer and pressure regulator.

Compressed air from the main reservoir shall be provided via a cutout cock and pressure regulator to operate the toilet flush valve.

The toilet assembly shall be mounted so as to be easily accessible and removable for service and maintenance. The shroud shall be secured with captive fasteners so as to be easily removed and installed. Likewise, valves shall be easily accessible, without tools, for operation from inside the car.

15.4.2.1 **Toilet Bowl**

The toilet bowl shall be stainless steel with a non-stick coating (such as Teflon), applied inside to prevent waste matter and mineral deposits from adhering. Bowl surfaces shall curve in a continuous fashion and shall be free of recesses and inaccessible areas. The sides of the bowl shall be steep and sloped toward the vacuum vent inlet to allow waste to accumulate for evacuation. To prevent blockage of the sewage system, the outlet of the bowl shall be a maximum 1.75 in. in diameter and shall be the most restrictive point in the piping system. The bowl and spray ring shall be easily and completely cleaned with ordinary cleansing agents and tools.

15.4.2.2 **Overflow Pan**

A pan shall form part of the interior bathroom assembly. The floor pan of the modules shall be FRP with a stainless steel overflow pan under the toilet bowl. The purpose is to prevent fluids from wicking beneath the toilet room flooring, both for hygiene and also to prevent degradation of the subflooring materials. This overflow pan shall be watertight and have raised edges of at least 2 in. in height. The pan's exposed edges shall be folded for safety and to provide stiffness. The floor pan shall be installed over, and attached to, the subfloor of the car. Attachment points shall be on the sides, rather than the bottom surface, and be watertight.

A drain tube shall penetrate the floor of the pan to allow spilled fluids to drain to ground. The drain shall be flush with the bottom of the pan, and shall extend through to the underside of the car. It shall be sealed to make the joint waterproof and shall also be sealed with an appropriate material to prevent flame propagation from underfloor flame sources. A split rubber hose (kazoo) shall be attached to the bottom end of the drain tube to prevent dust and debris from being blown up the tube.

15.4.2.3 **Flush Valve**

The flush valve shall be either pneumatically operated (60-120 psig), or vacuum operated (3-12 in. of Hg), and be a self-contained unit which provides a zero-leakage seal at the bowl outlet after operation. Operation shall be initiated through a solenoid valve. The flush valve shall
seal within 0.1 seconds from a full open position. The zero-leakage seal shall be maintained under 15 in. Hg of vacuum. The valve shall be constructed entirely of stainless steel with the exception of seals and actuator. All surfaces that are subject to wear shall be designed to be self-lubricating with no maintenance required. Seals shall be easily replaced with standard tools.

The flush valve shall pass a Customer approved proof-of-design test, which shall be included in the vehicle’s proof-of-design test plan, with a minimum of 300,000 cycles of operation. See Chapter 19.

15.4.2.4 Rinse Valve

The rinse valve shall control rinse water flow into the bowl. The valve shall be designed to maximize water pressure for water flow and orifice size when activated and provide a positive zero-leak seal when closed.

15.4.2.5 Electronic Flush Control

The electronic flush control unit shall control all toilet operations and activate the blower when the flush cycle is initiated. All electrical connections between the car and toilet assembly shall be made through a multi-pin connector. The electronic module shall plug into a card socket. The flush cycle shall be initiated at each toilet by a flush pushbutton. The flush cycle shall be delayed whenever another flush cycle on another toilet on the car is in progress. The control unit will provide the following timing functions:

- Blower ON signal from flush initiation;
- 1.0-1.5 second RINSE activated 0.5-0.7 seconds from flush initiation; and
- 3.0-3.5 second DRAIN activated 1.0-1.5 seconds from flush initiation.

15.4.2.6 Flush Pushbutton

At least one clearly labeled flush pushbutton shall be provided in the UTR, and two flush buttons in the ATR to initiate the flush cycle.

15.4.2.7 Cut Out Valve

A rinse water and air cut out valve shall be provided for each toilet assembly. Cut out valves shall be easily accessible, without tools, for operation en route from inside the car. Pipe flanges and couplers shall be provided to allow easy and quick removal of the toilet assembly by maintenance personnel.

15.4.2.8 Vacuum Isolation Valve

A slide type waste line vacuum isolation valve shall be provided on the toilet assembly with actuator handle accessible from the front of the toilet at floor level.

15.4.3 Waste Tank and Vacuum System

The waste tank assembly shall be designed as a self-contained unit suitable for mounting in an equipment room. The assembly shall consist of the retention tank, vacuum blower, level measuring system, tank drainage, freeze protection, electronic controls and debris shields.

Pump motors shall operate from 480VAC, 3-phase, 60 Hz HEP. All controls, solenoid valves, relays and circuitry, and antifreeze protection shall operate from 120VAC, 60 Hz. All transducers and indicator devices shall operate from 74VDC.
15.4.3.1 Retention Tank

The Waste Collection Tank assembly shall be a self-contained pallet-type unit intended for mounting in the car equipment room. The assembly shall consist of the retention tank, vacuum blower, check valve, vacuum relief valves, level indicators, level-measuring system, rinse valve, freeze protection and electrical control panel. Equipment location in the equipment room shall allow the unit to be easily serviced in place for most repairs, including replacing the vacuum blower. Design shall have the vacuum blower and associated check valve located on the exposed side to the tank when it is mounted in the equipment room, to allow these components to be easily serviced. In addition, it shall be easy to remove the unit from the car for preventative maintenance and overhaul. This includes not having to move or remove any equipment not directly related to the waste system.

Usable retention tank capacity shall be a minimum 250 gal.

The waste holding tank will be made of carbon steel. The interior and exterior surfaces will be coated with a corrosion resistant epoxy powder finish. This coating shall provide a tank life in excess of 30 years.

Self-cleaning sight glasses at the FULL, 2/3 and EMPTY levels shall be provided as a visual check of the waste level. A removable clean-out cover large enough to permit the interior of the tank to be cleaned and inspected shall be provided. A water separator located inside the tank shall prevent water and waste from being ingested into the vacuum blower. A 28 ± 2 psig rinse shall automatically apply fresh rinse water at a rate of 3 to 6 gpm to the sides of the tank during the drain cycle. The rinse valve shall be mechanically opened by the tank discharge actuator.

15.4.3.2 Central Control Panel

The control system for the overall waste system shall be incorporated onto the waste tank unit, enclosed in a weather-tight electrical cabinet. The central control panel shall consist of vacuum blower control and protection functions, level measuring, status panel interface, vacuum switches, transformer, AC and DC circuit breakers, tank draining functions and safety switch. All conduit connections to the control box shall be liquid-tight and shall use waterproof fittings and hardware. All electrical connections between the car and tank assembly shall be made through multi-pin connectors. The electronic module shall plug into a card socket.

15.4.3.3 Vacuum Blower and Control

The waste collection system shall be a constant vacuum type, with the vacuum obtained from an electrically operated blower operating on 480VAC. The vacuum blower will come on at the beginning of the flush cycle and will cycle on as needed to maintain the required vacuum.

The vacuum blower shall be capable of producing a differential pressure of at least 12 in. of Hg and a flow rate of at least 200 Standard Cubic Feet per Minute (SCFM). Tank vacuum shall be maintained at 6-10 in. of Hg through operation of the blower and an air-tight check valve between the tank and blower. The vacuum blower shall cycle on when the system differential pressure falls below 6 in. of Hg and cycle OFF when the differential pressure rises above 10 in. of Hg. A 19 to 21 second time-out function shall prevent continuous vacuum blower operation at high altitudes. Any toilet FLUSH signal shall start the blower and restart the time-out function. The blower shall remain off whenever the tank is full, or during the tank drain cycle.

15.4.3.4 Tank Level Measuring System

A load-cell tank level measuring system shall be provided to monitor the level of waste inside the retention tank. An input shall be provided to the status panel inside the car to indicate when the tank is empty, 2/3 full, and full. An input shall be provided to the vacuum blower
control whenever the tank is full, which then sets the toilet room light to OUT OF SERVICE and displays TANK FULL on the system status panel.

The sensors, measurement system and TANK EMPTY indicator lights shall operate from the car 74VDC power source and shall draw no more than 1 amp of current at nominal voltage. For the level measuring system, the tank shall be considered "empty" when it contains less than 5 gal of waste.

**15.4.4 Waste Tank Draining and Rinsing**

Tank drainage shall be through a 4 in. stainless steel or epoxy-coated malleable-iron discharge line. A 4 in. inside diameter full port ball-type waste discharge valve, fitted with an Andrews quick disconnect fitting for interface with the servicing facility shall be provided on each side of the car. Tank drainage shall be controlled by a manually operated drain valve. When operated, the drain valve shall: vent the tank, open the tank rinse valve, deactivate the vacuum blower and drain the tank.

A waterproof waste valve station, enclosing the discharge valve and associated items shall be provided beneath the car on each side of the B-end. All sheet metal and related hardware shall be 304 stainless steel to inhibit corrosion. Heat tape shall be applied to the valve and piping with the use of aluminum heat transfer tape, and the surrounding space well insulated with a durable waterproof, thermal insulation. The valve operating handle shall be robust, painted yellow and oriented so as to shield it from damage caused by debris impact. The valve closed position is with the handle oriented vertically, pointing downward. To open the valve, the handle shall be rotated 90 degrees towards the side of the car (away from the center of the car). To close the valve, the handle shall be rotated 90 degrees downward. Waste may be drained from the retention tank by gravity or vacuum assistance from the servicing facility. When the waste discharge valve is opened: vacuum blower operation will be disabled; the waste retention tank will be vented; the interior of the retention tank will be rinsed with on-board water; and waste will be drained from the retention tank to the servicing facility. It may be possible to drain the tank without requiring 480VAC power or compressed air on the car.

Time to drain a full tank using a gravity system shall not exceed five minutes. The tank shall be considered empty when less than five gallons of waste remains in the tank. Accumulated deposits shall not exceed 2% of tank volume over one year.

**15.4.5 Vent**

The vent from the waste tank blower shall be routed up to the roof level, terminating at a louvered vent placed immediately below the roof line and on the opposite side from the HVAC fresh air intake to prevent ingestion of waste exhaust vapors by the HVAC system. The vent line shall run to a carbon filter located in an accessible box allowing for easy filter replacement. A moisture drain shall be installed at the bottom of any vertical runs to permit the draining of accumulated water.

**15.4.6 Sink drains**

Gray water from hand washing sinks in toilet rooms and galleys shall be captured and transferred to the waste tank for storage and discharge at maintenance facilities. Gray water shall not drain to ground. Gray water may be transferred from sinks to waste tank by pumps or vacuum draw. Level sensing and water transfer equipment must be capable of maintaining function while coated with soap scum. Sink tanks, pumps, vacuum valves and manual drains shall be located in an easily accessible position for maintainability.
15.4.7 Piping

Water and air piping to the waste system shall be seamless stainless steel tubing in the longest possible continuous length without joints, with stainless steel fittings. The waste line between toilets and the waste tank shall be 2-in. (i.d.) non-metallic pipe that conforms to PRIIA Specification 305-911. There shall be no sharp bends or moisture traps in the pipe routing.

All fresh water and waste piping shall have accessible drain ports for draining of the system manually to prevent water freezing in the pipes. There shall be no low points in the water supply or waste system that cannot be drained. Waste piping must not be drained to the ground. The waste system must be dry flushed to produce an empty piping situation. Waste in the retention tank must then be dumped using the normal procedure.

15.4.8 Indicators

The status of the waste system shall be monitored continuously and displayed on indicator panels as described below. The power source for the indicator panels shall be 74VDC so that the system status is displayed when there is no HEP.

A TANK EMPTY light (black front with green letters) shall be installed on the waste tank assembly adjacent to each of the drain valves. The indicator shall be visible by maintenance personnel so they will know when the tank is empty so that the discharge line may be disconnected.

15.4.8.1 Status Panel

A status panel shall be installed inside the electric locker, and on the waste tank control box in the equipment room, to provide a visual indication of system status. The panel shall be black front with letter color specified below. A PUSH TO TEST button shall be provided to test the lights and reset the system.

The following indications shall be provided:

<table>
<thead>
<tr>
<th>Label</th>
<th>Indicator</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOILET SYSTEM</td>
<td>WHITE</td>
<td>System Identifier (Goes on together with any indicator below.)</td>
</tr>
<tr>
<td>POWER OFF</td>
<td>RED</td>
<td>HEP OFF to the waste system.</td>
</tr>
<tr>
<td>LOW AIR</td>
<td>RED</td>
<td>Less than 60 psig of air pressure.</td>
</tr>
<tr>
<td>LOW WATER</td>
<td>YELLOW</td>
<td>Less than 15 psig of water pressure.</td>
</tr>
<tr>
<td>LOW VACUUM</td>
<td>RED</td>
<td>Differential vacuum pressure is less than 3 inches of Hg, except when flush valve is open for toilet flush cycle.</td>
</tr>
<tr>
<td>FAULT</td>
<td>RED</td>
<td>Waste system failure detected.</td>
</tr>
<tr>
<td>TANK FULL</td>
<td>RED</td>
<td>Retention tank is full.</td>
</tr>
<tr>
<td>2/3 FULL</td>
<td>YELLOW</td>
<td>Retention tank is 2/3 full.</td>
</tr>
<tr>
<td>TANK EMPTY</td>
<td>GREEN</td>
<td>Retention tank is empty.</td>
</tr>
</tbody>
</table>

The white TOILET SYSTEM indicator lights shall be lit when any other indicator is on. Low vacuum function shall be disabled when the flush valve is open for the flush cycle.

A yellow LED indicator light shall be included on the system status panel on the electrical locker wall in the vestibule. This indicator shall be on continuously when the system is powered and operating normally, flashing when the system has a fault, and off when the system is not powered. See Chapter 11 for details.

An LED TOILET OUT OF SERVICE indicator shall be provided outside each restroom to indicate to passengers that the restroom is out of service when the toilet system is not functioning. See Chapter 9 for details.
15.5 Freeze Protection

The water and waste system shall be freeze-protected to enable the car to be left off power indefinitely in subfreezing temperatures with no damage resulting to any component of the system under any condition.

Freeze protection consists of three separate functions:

- Thermal insulation
- Protective heat, which keeps various equipment warm in cold weather
- Automatic drain valves, which drain water from car piping and tanks should a prolonged loss of heat occur

The water and waste tank enclosures shall be thermally insulated to allow the protective heat to keep the tanks from freezing at ambient temperatures down to −40°F. The installations shall be designed to remain waterproof and retain the insulation quality for the life of the equipment.

Protective heat shall be installed on fresh water and waste storage equipment and piping within the equipment room to maintain temperatures above freezing during these low ambient conditions.

15.5.1 Blanket Heaters

Blanket heaters, operating on 120VAC, may be employed for heating the water and waste tanks. Attached directly to the bottom of the respective tank, each of these heaters shall include two integral thermostats, one to activate the heat when the tank temperature falls below approximately 40°F and opening at approximately 55°F, and a second, providing a high limit function.

15.5.2 Heat Tape

Self-limiting heat tape, 120VAC, nominally 8 W per foot, shall be applied in areas subject to freezing temperatures, such as:

- Water piping
- Waste piping
- Water-fill housings
- Waste drain piping and valves

The heat tape shall be installed in a way to permit pipes and fittings to be disassembled for maintenance and repairs without removing the entire protective system.

The freeze protection thermostat will activate the heat tapes via a freeze protection contactor when the ambient outside temperature falls below 40°F.

15.5.3 Automatic Drain Valves

Air-sensing automatic drain valves with heater shall be used to protect the fresh water system from freezing should a loss of power and heat occurs. These valves include a heater on the sensing element to rapidly warm the element when HEP is applied to the car to allow the valve to close quickly after a power outage in cold weather. This allows a car to be watered shortly after power is applied rather than waiting for the piping to be warmed by the car heating system.

These valves shall be located at low points throughout the water system piping to allow all car water to drain automatically should the car lose power and the ambient air temperature fall below 38°F at the valve. No water shall be trapped in low points of the system. Vacuum relief valves are also required to allow the draining to occur. Potable and non-potable water shall
use separate valves. Fresh water shall only be drained from the car when ambient outside temperatures are below 38°F and the car has no HEP or layover power.

The waste system shall not use automatic drain valves. All waste water shall be retained on the car under freezing conditions.

* End of Chapter 15 *