

2.25 WASTE MANAGEMENT SYSTEM (WMS)

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Description

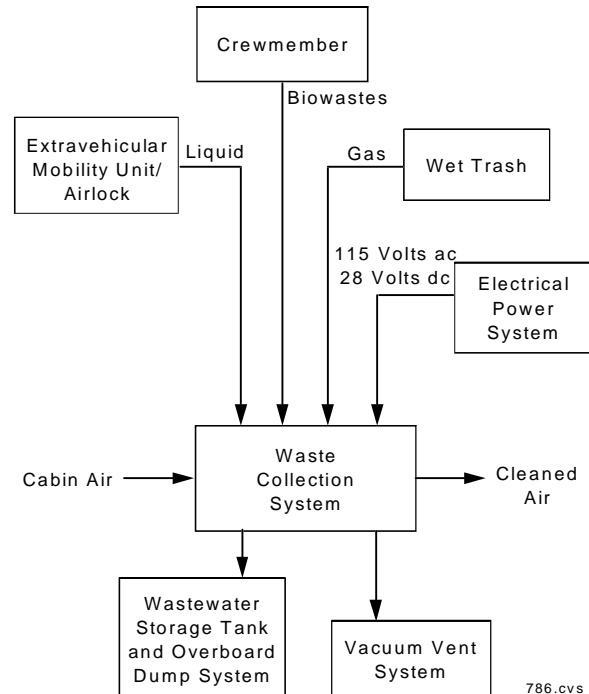
The waste management system is an integrated, multifunctional system used primarily to collect and process crew biological wastes. The WMS is located in the middeck of the orbiter crew compartment in a 29-inch-wide area immediately aft of the crew ingress and egress side hatch.

The system collects, stores, and dries fecal wastes and associated paper tissues. It processes urine and transfers it to the wastewater tank and processes EMU condensate water from the airlock and transfers it to the wastewater tank if an EVA is required on a mission. The system also provides an interface for venting trash container gases overboard and dumping atmospheric revitalization wastewater overboard in a contingency situation, and it transfers atmospheric revitalization system wastewater to the wastewater tank.

A waste management compartment door and two privacy curtains attached to the inside of the door provide privacy. One curtain is attached to the top of the door and interfaces with the edge of the interdeck access, and the other is attached to the door and interfaces with the galley, if installed. The door also serves as an ingress platform during prelaunch (vertical) operations since the flight crew must enter the flight deck over the waste management compartment. The door has a friction hinge and must be open to gain access to the waste management compartment.

The WMS consists of a commode, urinal, fan separators, odor and bacteria filter, vacuum vent quick disconnect, and controls. The commode is 27 by 27 by 29 inches, and it is used like a standard toilet. The commode contains a single multilayer hydrophobic porous bag liner

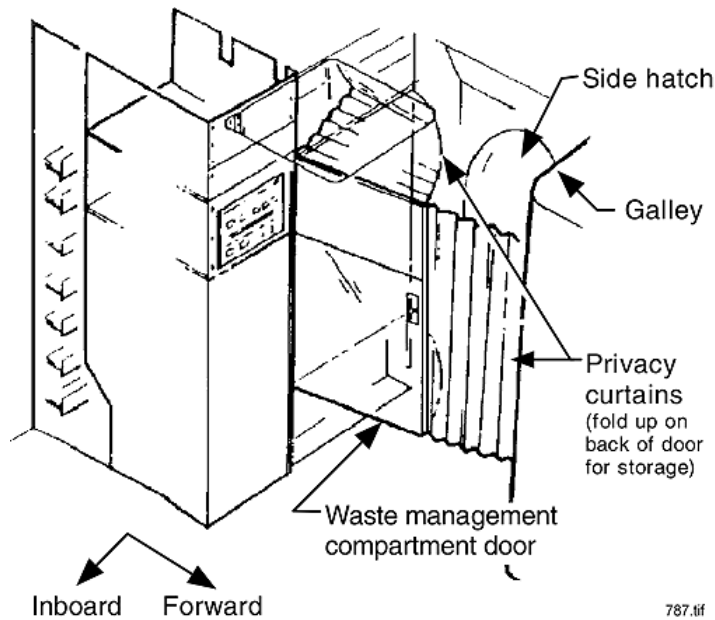
for collecting and storing solid waste. When the commode is in use, it is pressurized, and transport air flow is provided by the fan separator. When the commode is not in use, it is depressurized for solid waste drying and deactivation.



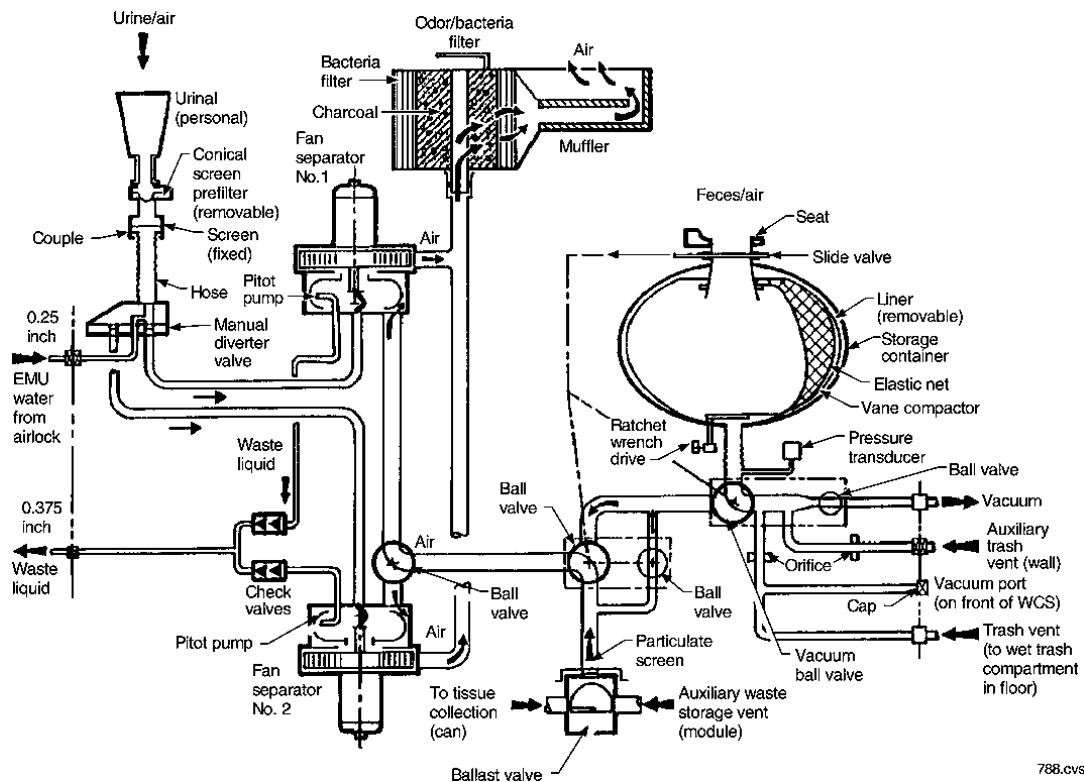
Waste Management System

The urinal is essentially a funnel attached to a hose and provides the capability to collect and transport liquid waste to the wastewater tank. The fan separator provides transport air flow for the liquid. The fan separators separate the waste liquid from the air flow. The liquid is drawn off to the wastewater tank, and the air returns to the crew cabin through the odor and bacteria filter. The filter removes odors and bacteria from the air that returns to the cabin. The vacuum quick disconnect is used to vent liquid directly overboard from equipment connected to the quick disconnect through the vacuum line.

The urinal assembly is a flexible hose with attachable funnels that can accommodate both men and women. The assembly can be used in a standing position, or it can be attached to the commode by a pivoting mounting bracket for use in a sitting position.



Waste Management System Privacy Curtains

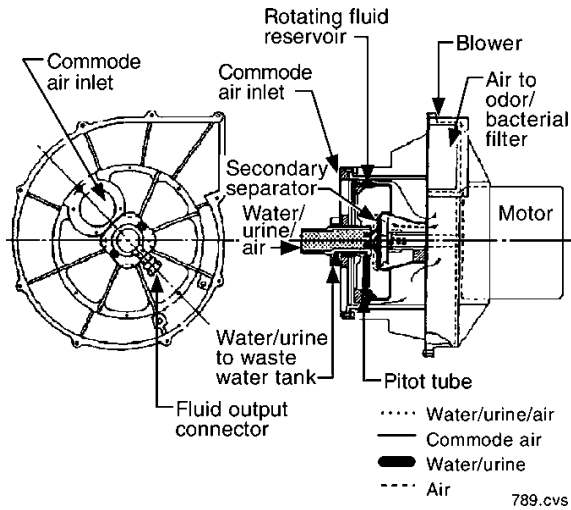


Waste Management System

All waste management system gases are ducted from the fan separator into the odor and bacteria filter and then mixed with cabin air. The filter can be removed for in-flight replacement.

Various restraints and adjustments enable the crew to achieve the proper body positioning to urinate or defecate in a zero-gravity environment. Two foot restraints are provided.

A toe bar is located at the commode base and is used for standing urination. It consists of two flexible cylindrical pads on a shaft that can be adjusted to various heights by releasing two locking levers that are turned 90° counterclockwise. The crewmember is restrained by slipping his or her feet under the toe bar restraint.



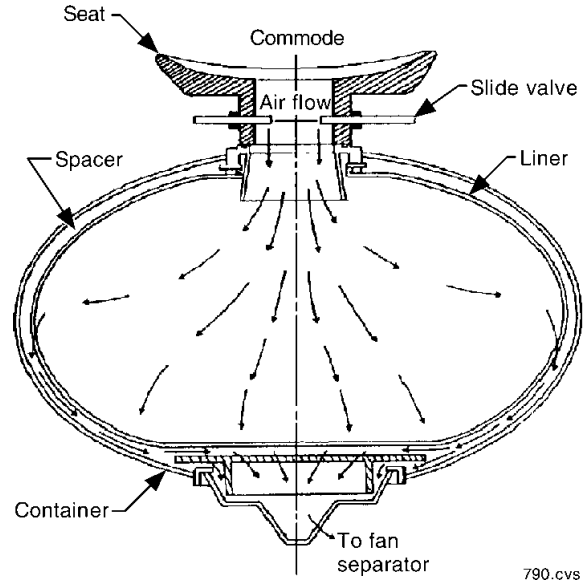
Waste Management System Fan Separator

A footrest restrains the feet of a crewmember sitting on the commode. The footrest consists of an adjustable platform with detachable Velcro straps for securing the feet. The Velcro straps are wrapped crosswise over each foot and secured around the back. The footrest can be adjusted to various angles and heights. Two locking handles pulled outward adjust the angle; two other locking levers adjust the height of the footrest.

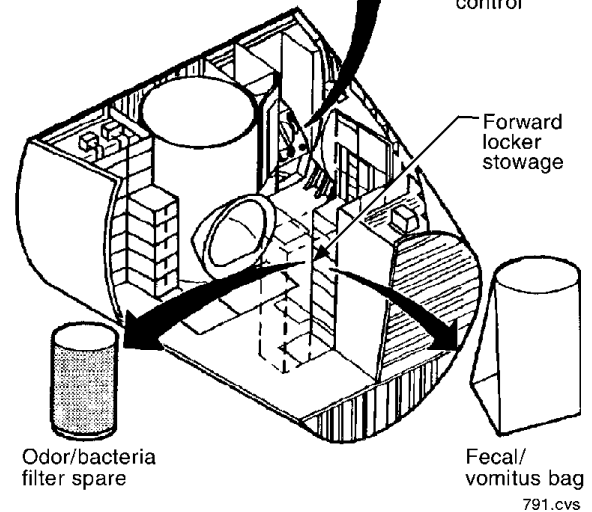
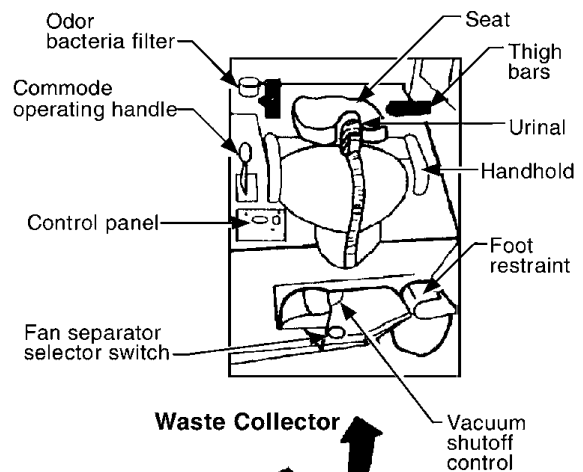
One body restraint is provided for use when crewmembers are seated on the commode. This restraint is a thigh bar that the crewmember lifts up out of the detent position, rotates over the thigh, and releases. The thigh bar exerts a preloaded force of approximately 10 pounds on each thigh.

Handholds are used for positioning or stabilizing the crewmember and form an integral part of the top cover of the waste management collection system assembly.

Stowage space in the WMS compartment is stocked with dry wipes, tissues, and wet washes. Rubber grommets in the compartment allow crewmembers to restrain their towels and washcloths.



Waste Management System Container Liner



Waste Management System - Middeck

Operations

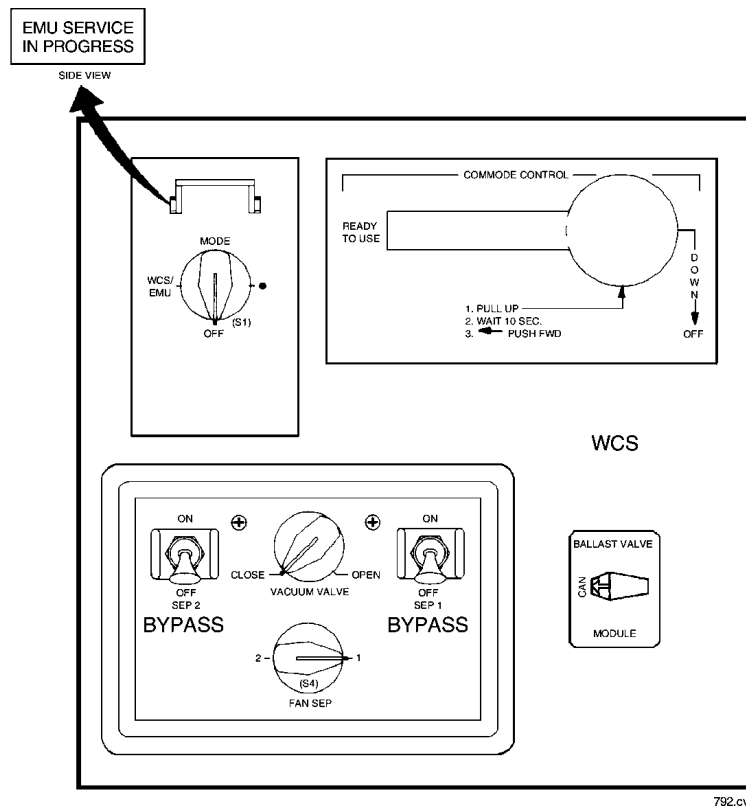
The controls on the waste management system are the VACUUM VALVE, FAN SEP select switch, MODE switch, fan separator bypass switches, and COMMODE CONTROL handle. The system uses dc power to control the fan separators and ac power for fan separator operations. The MODE switch and the COMMODE CONTROL handle are mechanically interlocked to prevent undesirable system configurations. The remaining controls operate independently. The fan separator bypass switches allow the crewmember to manually override a fan separator limit switch failure.

For launch and entry, the VACUUM VALVE switch is set to CLOSE. During on-orbit operations when the WMS is not in use, the vacuum valve is set to OPEN. This exposes the commode (overboard) via the vacuum vent system, and any solid wastes in the commode are dried. This also allows venting of the auxiliary wet trash and the volume F wet trash compartment. The hydrophobic bag liner in the

commode allows gas from the commode to vent overboard, but does not allow the passage of free liquid.

In the urine collection mode, the VACUUM VALVE remains in OPEN. The FAN SEP switch is positioned to 1 or 2. When the switch is positioned to 1, main bus A dc power is supplied to the MODE switch; when it is positioned to 2, main bus B dc power is supplied to the MODE switch. The MODE switch positioned to WCS/EMU energizes a relay for a fan separator (dependent on FAN SEP position). The active fan separator pulls cabin air flow through the urinal at a minimum of 10 cubic feet per minute and cabin air through the coffee can at 30 cubic feet per minute.

The coffee can air mixes with the urine transport air flow in the fan separator. Liquid check valves at the wastewater outlet from each fan separator prevent backflow through the non-operating separator during separator operation and prevent backflow to the urinal and air outlet when the separators are off. The liquid



Waste Management System Controls

and air mixture from the urinal line enters the fan separator axially and is carried to a rotating chamber. The mixture first contacts a rotating impact separator that throws the liquid to the outer walls of the rotating fluid reservoir. This centrifugal force causes the liquid to separate and draws it into a stationary pitot tube in a reservoir and directs the liquid through the dual check valves and into the wastewater tank. Air is drawn out of the rotating chamber and passes through the odor and bacteria filter, where it mixes with cabin air and re-enters the crew cabin.

There are two types of fan separators that can be manifested: low torque and high torque. The high torque fan separator processes liquid at a higher rpm and is therefore less likely to flood. Fan separator manifest is mission dependent.

In the EMU water drain mode, a guard is rotated over the *MODE* switch to preclude deactivation during the EMU and airlock water collection mode. A protective screen cap is installed on the urinal because it cannot be used during the EMU dump because of possible separator flooding. The WCS commode is still available for use during this mode. EMU condensate water is drained only if an EVA is required on a mission. The EMU wastewater is dumped through wastewater valves in the airlock. Other than these requirements, EMU dump is the same as the urine collection mode.

In the urine and feces collection mode, the *COMMODE CONTROL* handle is pulled up, and the commode is pressurized with cabin air through the debris screen and flow restrictor in approximately 20 seconds. (Note that if the *MODE* switch is positioned to OFF, the handle cannot be pulled up because of a mechanical interlock.) The *COMMODE CONTROL* handle is positioned to *PUSH FWD* after 20 seconds (it cannot be pushed forward until after 20 seconds because of the delta pressure across the sliding gate valve, and it cannot be pushed forward unless the *MODE* switch is positioned all the way to the *WCS/EMU* position). When the *COMMODE CONTROL* handle is pushed forward, the sliding gate valve on the commode is opened.

The WMS is used like a normal toilet. The commode seat is made of a contoured,

compliant, semisoft material that provides proper positioning and is sealed to minimize air leakage. Feces enter the commode through the 4-inch-diameter seat opening and are drawn in by cabin air flowing through holes under the seat at 30 cubic feet per minute. Fecal matter and tissues are deposited on the porous bag liner, and the air is drawn through the hydrophobic material to the fan separator. The hydrophobic liner material prevents free liquid and bacteria from leaving the collector. One or two tissues (only) could be placed in the commode. All others are deposited in a WCS canister bag and then placed in the WCS auxiliary wet trash compartment. It is recommended that no tissues be placed in the commode, since they tend to block airflow and cause more bulk in the commode. Urine is processed as in the urine collection mode. The *DOWN/OFF* position of the *COMMODE CONTROL* handle closes the sliding gate valve and depressurizes the commode for deactivation and solid waste drying. If the handle were left partially up, it would cause loss of cabin air through the vacuum vent.

NOTE

The *COMMODE CONTROL* handle must be completely down (in *DOWN/OFF* position) upon completion of WMS usage, or loss of cabin air through the vacuum vent valve will occur.

After usage, the WMS should be cleaned with wet wipes, if required, to maintain an odorless and sanitary environment. The seat can be lifted for cleaning, and the WMS should be cleaned once a day with a biocidal cleanser. The urinal should also be cleaned and flushed with water once a day.

Alternate Fan Separator Operations

If fan separator 1 is inoperative or fails to achieve proper operational speed (which can be verified by a reduced noise level or lack of air flow), the *FAN SEP* switch is positioned from 1 to 2, and fan separator 2 will operate in the same manner as 1.

The lever-locked *FAN SEP 1 BYPASS* and *FAN SEP 2 BYPASS* switches permit the crew to manually override a fan separator limit switch

failure in either the *FAN SEP* or *MODE* switches. When either switch is positioned to *ON*, dc power is applied to the corresponding relay, energizing it and providing ac power to activate the corresponding fan separator. Both *BYPASS* switches should not be *ON* at the same time. Before the *SEP 1* or *2 BYPASS* switch is activated, the *FAN SEP* select switch should be positioned in the corresponding fan separator position to preset the fan separator inlet valve, and the *MODE* switch should be positioned to *WCS/EMU* to preset the urine collection valve.

Vacuum Vent System

The vacuum vent system provides a pathway for removal of hydrogen (off-gassed by the fuel cells), for nominal depressurization of the airlock for EVAs, and for drying solid waste material in the commode when the commode is not in use.

The vacuum vent line T's off from the WCS line at the WCS three-way ball valve. When the WCS is off, the commode is exposed to vacuum through this vent line. A manual valve that is downstream of the commode serves to isolate the WCS from the vacuum vent system, if required. One situation in particular where this would be necessary would be if the WCS failed and created a cabin leak. The vacuum vent isolation valve is located downstream of the vacuum valve. It is controlled by the *WASTE H₂O VACUUM VENT ISOL VLV CONTROL* switch on panel ML31C. This switch receives electrical power from the *VACUUM VENT ISOL VLV BUS SELECT* switch on panel ML31C when the switch is positioned to *MNA* or *MNB*.

When the *WASTE H₂O VACUUM VENT ISOL VLV CONTROL* switch is positioned to *OPEN*, the vacuum vent isolation valve is opened, allowing the vacuum vent line to be open to vacuum. A talkback indicator above to the switch indicates *OP* when the valve is open, barberpole when the valve is in transit, and *CL* when the valve is closed. The *OFF* position closes the valve.

Even if the vacuum vent isolation valve could not be opened, vacuum vent functions would not be lost. A small hole in the valve plate allows proper venting overboard in such a contingency.

Alternate Vacuum Venting

Between the WCS ball valve and the vacuum vent valve is a vacuum vent quick disconnect (QD). For a failure of the vacuum vent system, vacuum venting can be regained by connecting a transfer hose from this QD to the contingency wastewater crossite QD, which allows venting through the wastewater dump line.

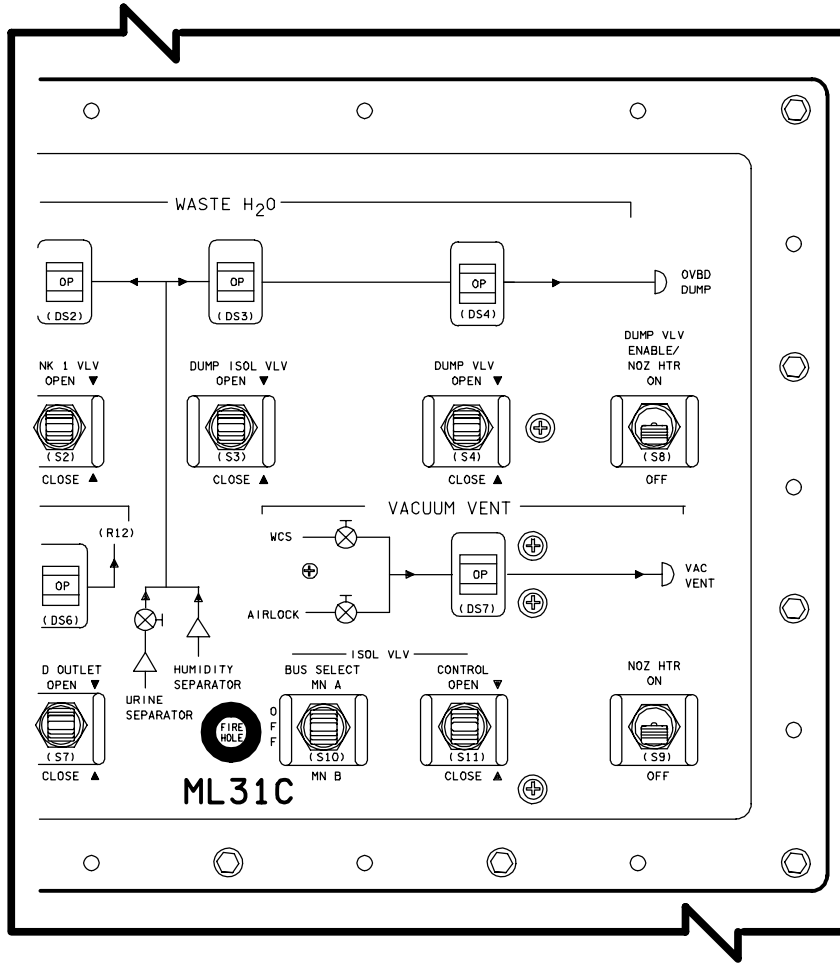
Heaters

Thermostatically controlled heaters are installed on the vacuum vent line. Electrical power for the A and B heaters is supplied on the *H₂O LINE HTR A* and *B* circuit breakers on panel ML86B. (These circuit breakers also supply electrical power to supply water dump line A and B heaters and wastewater line A and B heaters.)

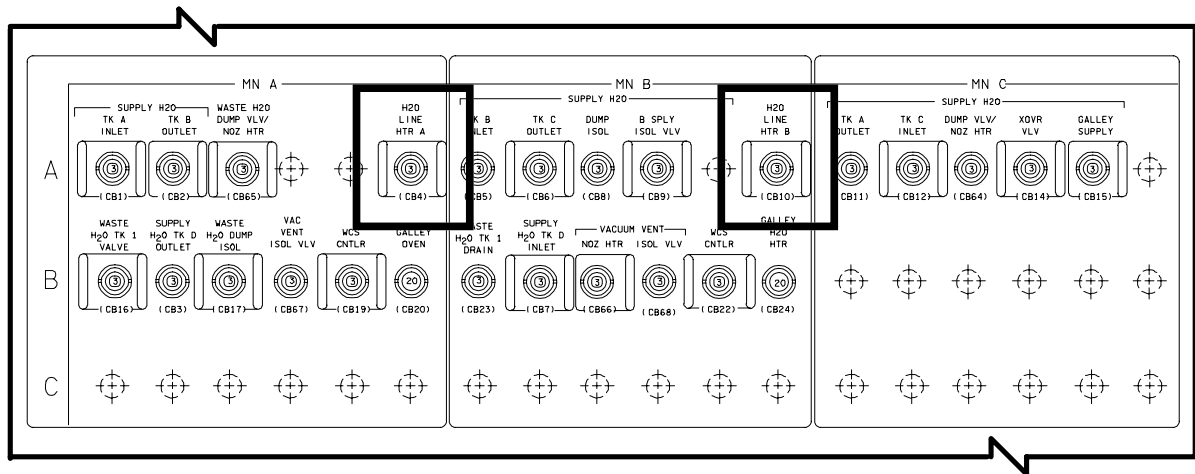
Heaters are also installed on the vacuum vent nozzle and are controlled by the *WASTE H₂O VACUUM VENT NOZ HTR* switch on panel ML31C. Electrical power is supplied to the vacuum vent nozzle heaters when the switch is positioned to *ON*. The *OFF* position removes electrical power from the vacuum vent nozzle heaters.

Alternative Waste Collection

For a non-operational WCS, contingency waste collection devices are available. Fecal collection is accomplished by using an Apollo fecal bag. Apollo fecal bags can be stowed inside the WCS commode or in the wet trash (volume F) compartment. For men, the urine collection device (UCD) is used for urine collection. A UCD consists of a collection bag, a restraint assembly, and a roll-on cuff. For women, urine collection is accomplished via the maximum absorption garment (MAG). The MAG is a modified version of an adult diaper.



VACUUM VENT Switches and Talkback on Panel ML31C



H₂O LINE HTR A and B Circuit Breakers on Panel ML86B