NOTE: AFGS-87267 has been redesignated as a handbook, and is to be used for guidance purposes only. This document is no longer to be cited as a requirement. For administrative expediency, the only physical change from AFGS-87267 is this cover page. However, this document is no longer to be cited as a requirement. If cited as a requirement, contractors may disregard the requirements of this document and interpret its contents only as guidance.

INCH-POUND

MIL-HDBK-87267
14 February 1997
SUPERSEDING
AFGS-87267
NOTICE 1
14 February 1997

DEPARTMENT OF DEFENSE
HANDBOOK

SUSTENANCE AND WASTE MANAGEMENT SYSTEMS, AIRBORNE

THIS HANDBOOK IS FOR GUIDANCE ONLY
DO NOT CITE THIS DOCUMENT AS A REQUIREMENT

AMSC N/A FSC 15GP

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: ASC/ENES, Wright-Patterson AFB, OH 45433-6503, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document, or by letter.

AIR FORCE GUIDE SPECIFICATION

SUSTENANCE AND WASTE MANAGEMENT SYSTEMS, AIRBORNE

This specification is approved for use by the Department of the Air Force, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 General. This specification establishes the development requirements and verifications for airborne sustenance and waste management systems for the support of aircrew and passengers.

1.2 Purpose. This specification can only be used to develop a statement of work, prime item development specification, or other documents to be used for procurement purposes when supplemental information relating to performance requirements of airborne sustenance and waste management systems has been entered as required.

1.3 Use. By completing the blanks in the basic specification and by deleting inappropriate sections from it, the project engineer tailors it to meet particular operational needs of the United States Air Force, as required by a specific design or development effort.

1.4. Responsible engineering office (REO). The responsible engineering office for this specification is the Crew Systems Branch, Crew and Escape Equipment Integration Section, ASC/ENECE, Wright-Patterson AFB OH 45433-6503, DSN 785-7325 or Commercial (513) 255-2165.

2. APPLICABLE DOCUMENTS

2.1 Government documents

2.1.1 Specifications, standards, handbooks, and regulations. The following specifications, standards, handbooks, and regulations form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the *Department of Defense Index of Specifications and Standards* (*DoDISS*) and supplement thereto, cited in the solicitation (see 6.2).

(When this document is used in an acquisition, Government specifications, standards, handbooks, and regulations called out in the tailored specification should be listed below.)

SPECIFICATIONS

Federal

Military

MIL-H-21303	Hot Cups, Liquid, Electric
MIL-F-87168	Fire and Explosion Hazard Protection Systems, Aircraft
AFGS-87226	Oxygen Systems, Aircraft, General Specification
AFGS-87235	Emergency Escape, Aircraft
AFGS-87240	Lighting Equipment, Airborne, Interior and Exterior

STANDARDS

Federal

Military

MIL-STD-12	Abbreviations for use on Drawings, and in Specifications, Standards and Technical Documents
AFOSH STD 161-9	Exposure to Radiofrequency Radiation
MIL-STD-210	Climatic Information to Determine Design and Test Requirements for Military Systems and Equipment
MIL-STD-454	Electronic Equipment, Standard General Requirements for
MIL-STD-461	Electromagnetic Emission and Susceptibility Requirements
MIL-STD-462	Electromagnetic Interference Characteristics, Measurement of
MIL-STD-783	Legends for use in Aircraft Stations and on Airborne Equipment
MIL-STD-810	Environmental Test Methods and Engineering Guidelines
MIL-STD-882	System Safety Program
MIL-STD-1472	Human Engineering Design Criteria for Military Systems, Equipment, and Facilities
MIL-STD-1568	Materials and Processes for Corrosion Prevention and Control
MIL-STD-1587	Materials and Processes Selection
MIL-STD-1789	Sound Pressure Levels in Aircraft
MIL-STD-1800	Human Engineering Performance Requirements for Systems
MIL-STD-1807	Crash Survivability of Aircraft Personnel
MIL-STD-1818	Electromagnetic Effects Requirements for Systems

HANDBOOKS

REGULATIONS

FAR Part 25	Airworthiness Standards: Transport Category Aircraft
AFR 146-15	Flight Food Service Management
AFR 161-35	Hazardous Noise Exposure
AFR 161-44	Management of the Drinking Water Surveillance Program

(Unless otherwise indicated, copies of Federal and military specifications, standards, handbooks, and regulations are available from the Department of Defense Single Stock Point, Standardization Document Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia PA 19111-5094.)

2.1.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this specification to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

(When this document is used in an acquisition, other Government documents, drawings, and publications called out in the tailored specification should be listed here.)

71 USC 1280	The Clean Air Act
DOD Directive 6050.9	

(Copies of specifications, standards, handbooks, drawings, publications, and other Government documents required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

2.2 **Non-Government publications.** The following document(s) form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the *DoDISS* cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the *DoDISS* are the issues of the documents cited in the solicitation (see 6.2).

(When this document is used in an acquisition, non-Government documents, drawings, and publications called out in the tailored specification should be listed here.)

The Montreal Protocol

(Non-Government standards and other publications are normally available from the organizations which prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 **Order of precedence.** In the event of a conflict between the text of this specification and the references cited herein, the text of this specification takes precedence. Nothing in this specification, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 **System description.** The Airborne Sustenance and Waste Management Systems (ASWMS) shall provide support for personnel in aircraft. The ASWMS is not intended to support ground, nautical, or space operations, equipment, or systems. The ASWMS shall support _____ aircrew members, _____ passengers, and _____ other personnel in the _____ aircraft. The ASWMS shall provide a source of _____ (liquid and/or solid) food service and means of _____ (liquid and/or solid) human, medical, and refuse waste removal and _____ other waste control, while in flight. The ASWMS shall provide the above services for a flight duration of _____ hours and an onboard duration of _____ hours, including _____ meal services, _____ (with or without) reservicing. The ASWMS _____ (shall/shall not) provide the following sustenance and waste management services while the air vehicle is on the ground _____ (with/without) direct support from the _____ support equipment. The ASWMS shall be usable by crewmembers wearing _____ personal equipment and passengers wearing _____. The ASWMS shall consist of the following functional subsystems:

a. Sustenance management systems. The sustenance management systems consist of the equipment and systems required to store, prepare, serve, ingest, clean up, and sanitize after sustenance, nourishment, and refreshment for crewmembers and passengers. Requirements for this subsystem are discussed in 3.2.1.

b. Waste management systems. The waste management systems consist of the equipment and systems necessary for the hygienic and sanitary control, storage, and removal of waste material. This includes _____ (human liquid and/or solid waste, medical waste, sustenance preparation, and service waste and/or hazardous waste material). Requirements for this subsystem are discussed in 3.2.2.

c. Sustenance or waste management spaces and compartments. These spaces and compartments are described and discussed in 3.2.3.

d. Potable water systems. The potable water systems consist of all equipment necessary to store, treat, sanitize, and serve potable (or drinking) water to crewmembers or passengers. Requirements for this subsystem are discussed in 3.2.4.

3.1.1 Sanitation and hygiene. The ASWMS shall meet the sanitation and/or hygiene requirements of _____.

3.2 Performance requirements. The ASWMS shall meet the following performance requirements under the conditions listed herein.

3.2.1 Sustenance management systems. The ASWMS shall contain the equipment necessary for the completion of the sustenance preparations; for the storage of the sustenance, serving equipment, and utensils; for the cleanup and disposal of sustenance service, ingestion, preparation, and/or storage equipment; and for _____. During storage, preparation, and/or ingestion of sustenance in flight, the ASWMS and/or its associated equipment shall not interfere with any normal or emergency crew operations.

3.2.1.1 Sustenance

3.2.1.1.1 Solid sustenance. The ASWMS system shall permit and facilitate the loading, storage, preparation, cleanup, and sanitization for _____ (meals, flight feeding; meals, ready-to-eat (MRE); meals, cooked frozen; cold weather rations; sandwich meals; bite-sized meals; high protein, low-residue meals; snack meals; and/or therapeutic flight meals) as defined in *AFR 146-15* and/or in _____ (Mil-Spec-number or other specification or standard). The ASWMS shall be capable of storing, preparing, serving, and cleaning up after these meals. Food containers shall be _____. The ASWMS shall provide readily accessible storage for the following condiments: _____. These condiments shall be in individual serving packets and shall be readily available for the final preparation of the sustenance prior to eating or drinking.

3.2.1.1.2 Liquid sustenance

3.2.1.1.2.1 Water. The ASWMS shall be capable of storing and dispensing _____ gallons of potable water to the _____ (galley, lavatory, drinking fountain, etc.) at flow rates of _____ gallons per minute. There _____ (shall/shall not) be requirements for additives to the potable water to maintain its quality while stored in the ASWMS for _____ hours at _____ degrees F. The potable water shall be delivered to the _____ (galley and/or lavatory) basin(s) at a temperature(s) of _____ degrees F for the hot water faucet and _____ degrees F for the cold water faucet. Potable water shall also be delivered to the drinking fountain/dispenser at _____ degrees F. (See 3.2.4 for potable water system requirements.)

3.2.1.1.2.2 Other liquids. Personnel transport aircraft or special purpose aircraft (i.e., those designed primarily for the transport of Distinguished Visitors) shall provide for the preparation and dispensing of _____ beverages (other than water and coffee).

3.2.1.2 **Sustenance preparation**

3.2.1.2.1 **Preflight and postflight.** Preflight and postflight preparation procedures shall not require more than _____ aircrew members at the _____ level more than _____ seconds to perform. These procedures shall require no extra tools and equipment beyond those stored within the ASWMS.

3.2.1.2.2 **Inflight preparation.** Inflight preparation, serving, cleanup, and sanitization procedures shall require no more than _____ aircrew members at the _____ level more than _____ minutes to prepare and serve meals for the number of personnel specified above. Sustenance for crewmembers who cannot leave their crewstation (such as pilots of single seat aircraft) shall require removal from the storage container and no further preparation for ingestion. For these cases, the inflight preparations shall not require more than one hand nor the undivided attention of the crewmember.

3.2.1.3 **Sustenance equipment.** The ASWMS shall be designed to contain the equipment necessary to support all aircrew members' and passengers' sustenance needs throughout all normal and emergency operations, as required by the aircraft's design mission. The ASWMS shall contain _____ (list of equipment from the following subparagraphs, such as refrigerators, ovens, coffeemakers, etc.). Wherever possible, the space provided for this equipment shall be constructed to permit similar equipment from other sources or vendors to replace the original devices. A minimum of _____ (number) units from _____ (the same or different) vendors shall be specified for and operate with the ASWMS. The equipment shall be removable (including power disconnection) from the ASWMS for cleaning, repair, and/or replacement by a single crewmember, without the removal of major subassemblies, _____ (without special tools or devices/with standard hand tools), and without removal of the contents. However, routine cleaning, sanitization, and maintenance activities should be performed without equipment removal and without special tools or devices. The connector for the equipment power supply to the ASWMS shall be in accordance with 3.6.1.6.1 and shall be readily accessible. Warnings and operating instructions _____ (shall/shall not) be prominently displayed on all equipment. Doors for this equipment shall have stays to prevent damage to the hinges or to adjacent equipment and structures. Heat generating equipment, such as ovens, coffeemakers, or refrigerators, shall have sufficient ventilation to prevent their operation from affecting the performance of adjacent structures or equipment or the temperature of passenger and crewmember spaces. Adjustment or reading of controls, displays, or placards shall not require the opening of or removal of contents from behind doors or within drawers.

3.2.1.3.1 **Miscellaneous equipment**

3.2.1.3.1.1 **Utensils, serving equipment, and tableware.** The ASWMS shall be designed to store _____ (number) of _____ (type and capacity) of utensils, serving tools, and tableware and to facilitate the _____ (preparation, buildup, service, cleanup, and sanitization) of meals requiring this equipment.

3.2.1.3.1.2 **Trays.** The ASWMS shall store _____ (number) of _____ (type) trays for use when serving meals. The ASWMS shall facilitate inflight meal cleanup and preparation using these trays. Shelves, countertops, or other surfaces used to hold trays during meal buildup, cleanup, or equipment sanitization shall hold _____ trays without limiting access to heating or storage spaces or to trash and refuse containers. Trays shall be capable of withstanding high temperature and high pressure cleaning with cleaning agents in ground kitchen automatic dishwashers and of withstanding chemicals used to sanitize their surfaces after use. Trays shall be designed to facilitate a rapid wipedown between uses.

3.2.1.3.2 **Refrigeration equipment.** The ASWMS shall contain refrigeration equipment for _____ cubic feet of chilled food storage, _____ cubic feet of frozen food storage, _____ quarts of chilled water per hour, _____ cubic feet of wet ice storage, and _____ (other refrigeration). Each storage compartment shall be plainly labelled. The refrigeration equipment shall be able to achieve and maintain _____ degrees F internal temperature in the chillers and _____ degrees F in the freezer within _____ minutes after being heat soaked for _____ minutes at _____ degrees F and maintained at an exterior environment of _____ degrees F. Any door gaskets shall not take a permanent set, shall provide an adequate seal, shall be removable for cleaning and replacement, and shall not inadvertently loosen or disconnect during the equipment use. Storage equipment doors shall be adjustable to maximize the door seal effectiveness. The refrigeration equipment shall utilize non-packing, non-hygroscopic insulation and shall be designed to prevent exterior condensation. The refrigeration storage equipment shall incorporate a temperature indicator and a separate means of adjustable temperature control for each compartment (chiller and/or freezer). Each individual item of refrigeration equipment shall require no more than _____ amperes power at _____ Volts _____ (direct current or Hertz) for a total of no more than _____ amperes for all refrigeration equipment. Insert racks in the equipment shall be able to fit the interior space and withstand the thermal environments of both the oven and the refrigeration equipment. The equipment shall contain devices to prevent damage in the event of an explosive decompression.

3.2.1.3.2.1 **Dry ice refrigeration.** The dry ice refrigeration equipment shall have a separate compartment for the dry ice. This compartment shall be accessible for cleaning and dry ice replacement by a single aircrew member without the removal of major subassemblies, without special tools or devices, _____ (with/without) removal of the contents, and _____ (with/without) removal of the refrigeration equipment from the ASWMS. This compartment shall hold enough dry ice to ensure the refrigeration equipment maintains its temperature as required by 3.2.1.3.2. The dry ice compartment _____ (shall/shall not) vent to the habitable spaces of the aircraft. There shall be an electromechanical means of ensuring forced air circulation within the chiller and freezer compartments.

3.2.1.3.2.2 **Vapor cycle refrigeration.** Vapor cycle refrigeration units, which utilize a liquid refrigerant that is vaporized to generate the chilled and/or frozen interior environments and reject the cycle heat to ambient air in a condenser, shall not exhaust the heated air from the condenser directly toward the food preparation area, passengers, or the condenser or insulated surfaces of other refrigeration equipment. The refrigerant used by these devices shall be _____. All vapor cycle refrigeration equipment shall comply with *71 USC 1280* (*The Clean Air Act*), *DOD Directive 6050.9*, and *The Montreal Protocol* for the release of chlorofluorocarbons and hydrochlorofluorocarbons to the atmosphere. The vapor circuit of the system shall be protected against a rapid overpressurization in accordance with _____. The vapor circuit shall withstand a burst pressure of _____ times the operating maximum pressure without failure or leakage and a proof pressure of _____ times the operating maximum pressure without material deformation or yielding.

3.2.1.3.2.3 **Thermoelectric refrigeration.** Those refrigeration units which utilize thermoelectric refrigeration devices shall have two electromechanical systems to force air circulation within the chiller and freezer compartments and over the heat sink to the aircraft interior. Both circulation paths shall have filters installed to ensure the air impinging upon the thermoelectric modules and heat sinks is clean to _____. These filters shall be easily removable by a single crewmember without disassembly of major components of the ASWMS, without special tools or devices, and within _____ seconds. These filters shall be commercially available. The heated air from the exterior heat sink shall not be exhausted directly toward the food preparation area, passengers, or heat sink or insulated surfaces of other refrigeration equipment.

3.2.1.3.2.4 **Drink station.** A chilled water drink station(s) shall be located at the _____. This unit shall chill the potable water to no more than _____ degrees F. The refrigeration equipment shall meet the requirements of 3.2.1.3.2.1, 3.2.1.3.2.2, or 3.2.1.3.2.3. If a galley or lavatory is part of the ASWMS, the potable water and waste water storage _____ (shall/shall not) be provided from that unit's tanks. The drink station shall be usable _____ (with and/or without) drinking cups, as defined by _____. A cold cup dispenser and waste receptacle _____ (shall/shall not) be mounted immediately next to the drink station. The drink station shall have a means of catching and containing water drips, misses, or spills from the water outlet. All waste and potable water plumbing shall meet the requirements of 3.2.2.2 or 3.2.4.

3.2.1.3.3 **Heating equipment.** The ASWMS shall contain heating equipment for the preparation of sustenance. Each item of heating equipment shall incorporate an off/on switch, a power indicator, and a separate means of adjustable temperature control or timer for each compartment, when applicable. There shall be an additional indicator to show when power is being applied to the heating equipment through the temperature controller or timer. The equipment shall not use a flame as the heat source. Each individual item of heating equipment shall require no more than _____ amperes power at _____ Volts _____ (direct current or Hertz) for a total of no more than _____ amperes for all heating equipment. Outside surface temperatures on all surfaces directly accessible to the user and all surfaces directly handled by the user during any operation shall not exceed the requirements in 3.5.4.

3.2.1.3.3.1 **Ovens.** The ovens shall be able to achieve and maintain _____ degrees F internal sustenance temperature within _____ minutes. The ASWMS shall heat _____ (cubic feet of oven space or number of meals as previously defined). Door gaskets shall not take a permanent set, shall provide an adequate seal, shall be removable for cleaning and replacement, and shall not inadvertently loosen or disconnect during the equipment use. Oven doors shall be adjustable to maximize the door seal effectiveness. The insulation used for the ovens shall not permit the formation of areas of localized high heat transfer. Oven heating compartments shall contain drip guards. They shall also contain devices to prevent damage in the event of an explosive decompression. All interior components (drip guards, lights, heating elements, fans, brackets, etc.) shall be easily removable by a single person without tools or special equipment and shall be cleanable with soap and water.

3.2.1.3.3.1.1 **Conventional ovens.** This section includes the requirements for all types of convection, conduction, forced air, steam, and/or radiant heat ovens. If internal fans are used, they shall operate continuously whenever power is supplied to the unit, whether or not the heating elements are powered. Ovens shall have a temperature indicator for each compartment. Oven heating elements shall be removable for cleaning and replacement and shall be shielded to prevent inadvertent contact by the user.

3.2.1.3.3.1.2 **Microwave ovens.** Radiation external to the oven shall be no greater than the levels allowed by Attachment 3 of *AFOSH Standard 161-9* throughout the item's design life. Microwave ovens shall contain interlocks which meet the same reference to ensure no radiation can be generated with the door fully or partially open or insecurely latched. The microwave energy source shall be protected for up to _____ minutes from damage due to excessive reflected microwave radiation created by no load operating conditions. In addition to a timer, the microwave ovens shall have an adjustable power control from _____ to _____ Watts. Microwave ovens shall have uniform distribution of the microwave energy throughout the cooking compartment. A forced air system with a replaceable filter shall be incorporated to exhaust water vapors from the cooking compartment. The compartment shall be lighted whenever the oven is operating or the door is open. An operating instructions and warning placard shall be conspicuously placed on or near the oven.

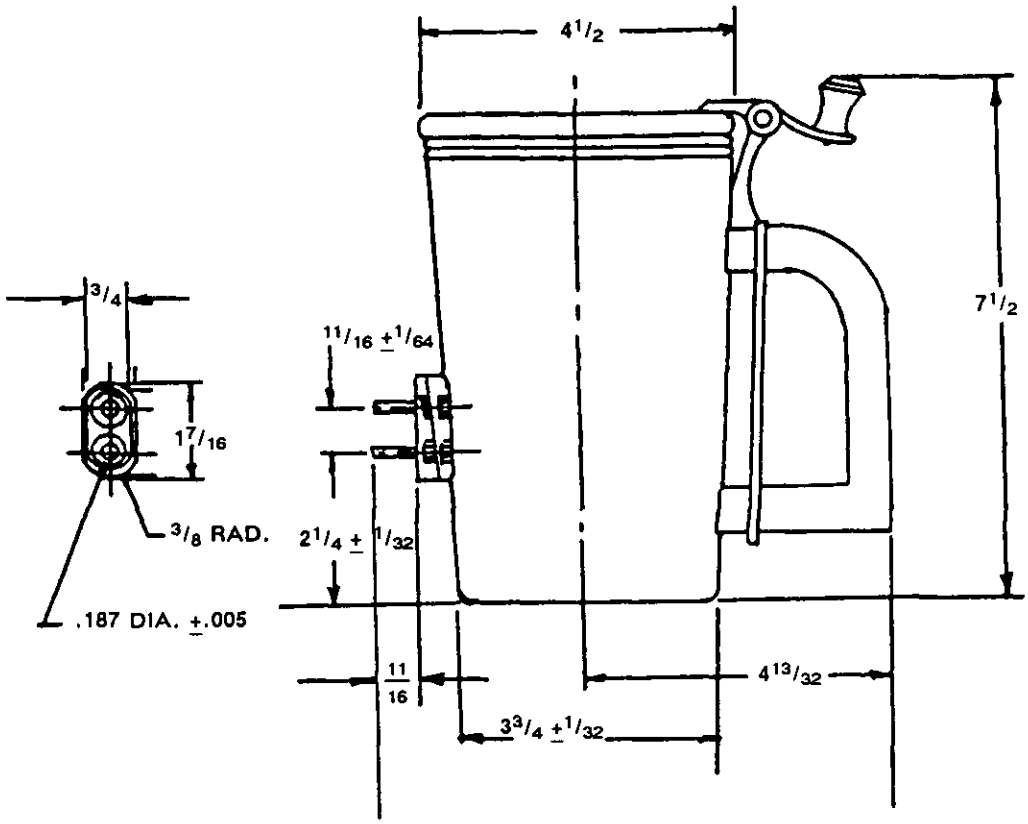
3.2.1.3.3.2 **Liquids heaters.** Liquids heaters shall be designed to prevent liquids from entering the electrical and electronic elements. They shall have a power switch and a timer to turn them off after a set time period. Heaters for liquids with sealed compartments shall be designed to prevent damage in the event of an explosive decompression. The liquids heaters shall be fully drainable by gravity. Where appropriate for the type of liquids anticipated, cathodic protection may be utilized.

3.2.1.3.3.2.1 **Coffeemaker.** The ASWMS shall be able to provide _____ cups of coffee within _____ minutes, beginning with water at the lowest operating temperature, with minimal operator interaction. The coffeemaker shall be able to make coffee from either bulk coffee with a filter or from prepackaged coffee bags. An indicator shall show when the brewing cycle is complete. After brewing, the coffee shall be maintained at _____ degrees F. The coffeemaker shall contain provisions to hold the coffee pot in position throughout all aircraft normal and emergency maneuvers without spilling coffee. The coffeemaker shall not be damaged by operation with the coffee pot absent or empty and shall not damage an empty or near empty coffee pot. The coffee pot shall be designed for easy cleaning, pouring, and handling without burn hazard to the using personnel. The pot shall not break if dropped _____ feet onto a _____ surface and shall hold _____ cups of coffee.

3.2.1.3.3.2.2 **Water heater.** Heaters for liquids shall be capable of providing water at _____ degrees F at flow rates of _____ gallons per minute. This temperature and flow of water shall be available after _____ minutes of heating after prior cold soaking for _____ minutes at _____ degrees F and while maintained at an exterior environment of _____ degrees F. Heating elements shall be removable for cleaning and replacement. The interior of the water heater shall be easily cleaned and sanitized. Water heaters shall either prevent operation if the unit is empty or shall not be damaged from operation when empty. In the event of cabin depressurization, the water heater tank pressure shall be contained without damage to the system or hazard to personnel, or vented to the exterior of the aircraft until the tank and cabin pressure differential reach a safe level.

3.2.1.3.3.2.3 **Hot cups.** Hot cups shall be constructed of an unbreakable material and shall have an insulated handle, a pour spout, and a guard to protect the user's hand from heat on the exterior surface. Hot cups shall be Type _____ (I or II), as defined by *MIL-H-21303* and figure 1. The hot cups shall be able to hold _____ fluid ounces of water. When mounted into the appropriate bracket, the hot cup shall be able to heat water to _____ degrees F within _____ minutes and maintain the contents at _____ degrees F. The hot cup shall be protected from damage from operating for _____ minutes without any water or liquid content. The hot cup shall have a lid or cover designed to return condensate or splash to the interior with positive retention. The hot cup material shall be suitable for water, coffee, chocolate, and soups. Hot cup brackets shall be in accordance with *MIL-B-7525* or _____ and shall contain a power connector, a retaining device, and a timer. The bracket shall be able to hold and provide power for _____ (one or four) hot cups. An indicator light shall be provided on the bracket for each hot cup. The power connector shall be integral to the bracket and hot cup and shall require no operation to connect other than placing the hot cup into the bracket.

3.2.1.3.3.3 **Other heating equipment.** The _____ (device name, such as ranges, hot plates, hot shelves, skillets, griddles, serving counters, etc.) shall be able to achieve and maintain _____ degrees F surface temperature within _____ minutes after being cold soaked for _____ minutes at _____ degrees F and maintained at an exterior environment of _____ degrees F. Any doors, heating elements, drip guards, decompression relief, power switches, timers, or other devices shall meet the requirements of the similar devices in the analogous oven or liquids heater performance requirements above.



Dimensions in inches: This figure is not restrictive except for those dimensions shown with tolerances.

FIGURE 1. Dimensional details of the Type II food warming cup.

3.2.1.3.4 **Sustenance stowage equipment.** Storage shelves and drawers shall be designed to be compatible with the containers used for the sustenance designated in 3.2.1.1. Adequate non-refrigerated storage shall be available for the condiments, dinnerware, and utensils needed to prepare, serve, and ingest that sustenance. Drawers shall not be located above the eye level of the smallest sized user, as defined by the anthropometric requirements of 3.5.3. Drawers shall have no transverse or vertical movement, deformation, or jamming during opening and closing. Drawers shall have stops to prevent inadvertent pulling of the drawer out of the ASWMS structure. All drawers and shelves shall be removable without tools, cleanable with standard agents, and adjustable without tools. Shelves shall be enclosed with doors to prevent the loss of the stored sustenance or equipment throughout all mission maneuvers. Stowage shall be provided on the ASWMS for all detachable or temporary ASWMS components, such as refrigerator or oven inserts, ASWMS stowage environmental protection cover, and/or ASWMS servicing hoses. Components used for the preparation or handling of sustenance shall not be stored adjacent to components used by the ASWMS for any kind of waste handling. Drawers in refrigerated spaces shall have holes to allow air circulation.

3.2.1.3.5 **Preparation area/equipment.** The ASWMS shall contain tables, counters, platforms, or other work surfaces for the preparation of _____ meals at one time. This area or equipment may be fixed and/or temporary. If temporary, it can be assembled or prepared within _____ minutes by a single aircrew member without tools. The equipment shall be rigidly secured and shall have a positive locking mechanism when in both the using and stowed positions or configurations. Stops shall be employed to limit any opening to the intended position or configuration. This equipment shall be designed to support the weight of _____. The surface of this area or equipment shall be within _____ degrees of level when the aircraft is in normal, level flight. Any slope shall be away from the user and toward a basin, a waste receptacle, or a refuse opening. When the preparation area contains a refuse opening, it shall have a hinged, spring-loaded, inward-opening cover with a drip collar. The opening shall be _____ inches in diameter or on the diagonal across two corners (if rectangular). The preparation area shall have _____ (number) utility outlet(s) rated at _____ amperes at _____ Volts _____ (direct current or alternating current) and with an integral, self-testing circuit breaker set at the rated amperage. The utility outlet shall be positioned to minimize hazards due to accidental spills during all operations at the work surfaces.

3.2.2 **Waste management systems.** The ASWMS shall hygienically dispose of waste generated by the crewmembers and passengers as described in the following paragraphs. All waste disposal equipment, devices, components, or systems shall be easily disassembled, removed, cleaned, and sanitized by skill level _____ personnel.

3.2.2.1 **Human waste.** Facilities and/or equipment shall be provided for human feces and urine collection, holding, and disposal.

3.2.2.1.1 **Human waste collection.** Equipment shall be provided for the collection of _____ (types) human waste. Whenever more than one device (toilet or urinal) for the collection of human waste is located in the same space or compartment, modesty shields and/or splash shields shall be used to separate each service area. The collection equipment shall be designed to prevent waste spillage during accelerations of _____, or as defined in 3.2.6.11. Each unit shall be equipped with a flush valve or button. All collection equipment shall be able to be brush cleaned and sanitized and shall be free of recesses. The use of anti-cling interior surfaces shall be considered.

3.2.2.1.1.1 **Fecal relief equipment.** Toilets shall be of the _____ type and shall be self-cleaning after each use. The seat, seat cover, or bench shall be removable and shall be retained in both the full up or full down positions with all anticipated aircraft attitudes and accelerations. It shall be possible to use the toilet and flush it after each use with no waiting period required in excess of _____ minutes. The toilets shall require no more than _____ Volts _____ (alternating current/direct current) electrical power at _____ Hertz and _____ (amperes or Watts).

3.2.2.1.1.2 **Urination relief equipment.** Provisions shall be included for the crew to use _____ (pilot relief bags, "piddle packs", crew relief horns, urinals, or other equipment) to relieve themselves of urine. "Piddle packs" shall be stowed in the _____ before use and in the _____ after use. Crew relief horns shall drain to _____ (overboard, human waste tank, or liquid waste tank). The entire interior surfaces of urinals shall be rinsed with each flush. Urinal drains shall be non-clogging and screened to prevent the introduction of improper trash (e.g., cups, paper towels, etc.). Any overboard drainage system shall have a shutoff valve operable from the user location, be designed to shut when not held open, and have no adverse effect on the cabin pressurization system or schedule..

3.2.2.1.1.3 **Human waste holding tank(s).** The ASWMS toilets and/or urinals _____ (shall/shall not) have a holding tank(s) separate and independent from the liquid waste system tanks. This tank(s) _____ (shall/shall not) be integral with the toilets and _____ (shall/shall not) be removable for emptying, cleaning, sanitization, and servicing. If removable, a carrying handle adequate to support the weight of the _____ (empty/filled) tank shall be included. All interior seams shall be smooth. There shall be a positive retention device for the tank when in position. The tanks shall have a level indicator that shall be located to maximize its accuracy and shall be fully cleanable. This indicator shall provide sufficient warning to preclude system shutdown due to a full waste holding tank. Connections to any chemical treatment charging line shall be above the highest anticipated liquid waste level. A check valve shall be used in the servicing line, hose, or valve.

3.2.2.1.2 **System cleaning/sanitization/disinfection.** The ASWMS human waste systems shall be able to be cleaned, sanitized, and disinfected with commercially available agents during ground servicing operations.

3.2.2.1.3 **Ventilation.** The ASWMS human waste system spaces or compartments shall be ventilated to the aircraft _____ (interior/exterior). Ventilation ports shall be located away from all normal aircraft entrances and air intake ports.

3.2.2.2 **Liquid waste.** The ASWMS shall have a liquid waste handling system that _____ (is/is not) an integral part of the _____ (galley or lavatory) system. The liquid waste system shall be completely drained by gravity when not in use, with no pockets of liquid remaining. The liquid waste system shall be designed, located, insulated, and/or constructed to prevent freezing of the contained liquid or damage to the ASWMS due to freezing at the extremes of the air vehicle's flight environment, and for _____ minutes after the aircraft has been secured from flight in the coldest air vehicle operating ambient conditions. The liquid waste handling system shall be able to withstand an internal pressure/vacuum of _____ psig during servicing without bursting, collapsing, or other deformation. Liquid galley wastes, as collected from the galley basin, shall be separated from human wastes. The system shall be able to handle waste matter from a garbage disposal.

3.2.2.2.1 Liquid waste tank(s). Liquid waste tank(s) shall be easily removable, cleaned, and sanitized, and shall have surge suppression. The tank capacity shall be _____. The tank opening for cleaning shall require no tools to operate, shall be _____ inches in diameter minimally, and shall utilize captive fasteners. If a non-round opening shape is used, it shall be sufficient size to contain a circle of the above diameter. The tanks shall have a non-spill vent with surge preventors that shall exhaust outside all passenger compartments. A carrying handle(s) adequate to support the weight of the _____ (empty/filled) tank shall be included. All interior seams shall be smooth. There shall be a positive retention device for the tank when in position. The tanks shall have a fully cleanable level indicator located to maximize its accuracy. Connections to any chemical treatment charging line shall be above the highest anticipated liquid waste level. A check valve shall be used in the servicing line, hose, or valve.

3.2.2.2.2 Liquid waste plumbing. The waste plumbing and connections shall be designed to prevent leaks under all operating and maintenance conditions, completely drain by gravity (with the exception of traps under the basins) to the waste tank, and shall not be connectable to the potable water system (with the exception of the cross-connect spool). Plumbing shall be easily disassembled for cleaning and shall drain to the liquid waste tanks by gravity when vented to the ambient air with an aircraft cruise attitude of _____ degrees pitch and a taxi attitude of _____ degrees pitch. Interior surfaces of the waste system plumbing shall be smooth and shall have a bend radius of no less than _____ inches.

3.2.2.2.3 Inflight dumping. Overboard dumping of the system or portions of the system while in flight shall be selectable and controllable by the aircrew from the _____ aircrew station. Dumping outlets shall be located to ensure no human waste will strike or collect on any exterior surface of the aircraft. Overboard dumping outlets shall be designed to prevent the outlet from freezing and the loss of cabin pressurization throughout the draining operation.

3.2.2.2.4 Liquid waste drains. There shall be a check valve and a trap in all equipment and basin drains to prevent the introduction of liquid waste and its noxious odors into crewmember or passenger spaces. All drains shall have a screen to prevent the loss of personal items (e.g., rings, pins, medals, buttons, etc.) and prevent clogging of the drain lines by inadvertent or improper disposal of waste material. Basins shall have a means of plugging the primary drain to collect water. Each basin shall have a secondary drain to prevent the water from overflowing the basin in the event the main drain should become plugged. The minimum inside diameter for basins and sinks shall be no less than _____ inches and for other devices shall be no less than _____ inches. The operation of any drain shall have no adverse effect on the cabin pressurization system or schedule.

3.2.2.3 Medical waste. The ASWMS shall facilitate the control, handling, and storage of medical waste generated by _____. The ASWMS shall process _____ medical waste. The ASWMS shall facilitate removal of the waste from the patient's bedside.

3.2.2.3.1 Medical waste stowage. The ASWMS shall provide controlled storage for all forms of medical waste as described in 3.2.2.3. All medical waste containers shall have self-closing covers, be sealed, use leakproof plastic bags, and be appropriately marked as containing a biohazard. All medical wastes shall be separated into _____ (sharps, pathological, medicinal, blood, body fluids, etc.).

3.2.2.3.2 Patient human waste. The ASWMS shall support the collection, disposal, and/or stowage of patient urine, feces, and vomitus.

3.2.2.3.3 **Medical/nursing considerations/implications.** The ASWMS shall contain _____ equipment to support the medical doctors', nurses', and technicians' needs. The ASWMS shall safely store samples of patient excrement, tissues, and fluids, or samples saved for later testing or analysis.

3.2.2.4 **Foreign waste.** During international flights, the collection, handling, separation, and stowage of animal or vegetable meal residue that remains after the completion of meal services shall be supported by the ASWMS.

3.2.2.5 **General refuse**

3.2.2.5.1 **Refuse sources and quantities.** The system shall be able to store a minimum of _____ cubic feet of trash from the _____.

3.2.2.5.2 **Refuse stowage and removal.** Refuse containers shall be conveniently placed in the _____ (galley(s), lavatories, passenger compartment, aircrew lounge, etc.) compartments and shall be _____ cubic feet in size, or shall hold _____ cubic feet of dry refuse. Openings to trash receptacles shall accept standard disposable refuse, waste, equipment, and items without disassembly, reconfiguration, folding, or content spillage. Refuse containers shall be designed to be easily emptied without content spillage during this process. All receptacles shall utilize standard commercial or military plastic bag liners and shall be easily assembled, mounted, disassembled, cleaned, and sanitized. Although primarily intended for dry waste, the containers must be watertight to prevent the spill of inadvertently disposed liquids. Refuse containers shall include self-closing covers; shall prevent the spread of obnoxious, irritating, or unpleasant odors from the anticipated refuse to the occupied space; and shall prevent the spread of wastepaper fires beyond the container interior. The door to the container shall be embossed with the words, "No Smoking" and the international symbol for this expression, with the letters and figure filled with high contrast, durable paint.

3.2.2.5.3 ***Refuse compactors.*** The ASWMS _____ (shall/shall not) contain a refuse or trash compactor able to reduce _____ cubic feet of general refuse to _____ cubic feet. The compactor _____ (shall/shall not) be able to crush _____ (bottles/cans/etc.) of _____ (size or description). The compactor shall have a safety interlock to prevent operation with the door open and shall crush the trash into a leakproof, readily available military and/or commercial container. The trash compactors shall individually require no more than _____ amperes power at _____ Volts _____ (direct current or Hertz) for a total of no more than _____ amperes for all compactors.

3.2.2.6 ***Hazardous waste (excluding medical).*** The ASWMS shall contain, control, and store wastes from hazardous cargo and/or aircraft hazardous material. These wastes shall include threats to aircraft equipment, structure, personnel, operations, and/or _____. The ASWMS shall include _____ equipment to control, clean, sanitize, and stow hazardous wastes. The ASWMS shall permit rapid and complete removal, disposal, and decontamination of hazardous waste handling equipment.

3.2.3 **Sustenance or waste management spaces and compartments.** Each compartment shall be grounded through a separate pin in the electrical connector. Grounding resistance shall not exceed _____ ohms. Compartments must be designed to fit within the envelope and the design constraints of the air vehicle system. Compartments intended for temporary loading within cargo compartments shall meet the requirements of 3.6.1.5. Equipment unrelated to the ASWMS but mounted on or in the ASWMS compartments shall be included in all load calculations and tests. Structures, hand holds, equipment, or projections of the ASWMS which may be grasped by personnel for assistance due to sudden or unexpected aircraft motion shall be capable of withstanding _____ pounds applied in any direction. Service panels and doors shall be designed for easy opening by maintainers yet shall discourage opening by passengers or other unauthorized personnel. Compartments shall be designed to prevent damage in the event of a rapid decompression.

3.2.3.1 **Oxygen.** The ASWMS spaces or compartments shall be designed and constructed so the using aircrew members have immediate access to _____ oxygen equipment. The equipment shall be positioned to permit immediate use by all standing and seated occupants within _____ minutes.

3.2.3.2 **Counter(s).** A one piece, impact resistant counter with a _____ inch raised edge and _____ inch splash shield on the wall shall be provided. If a basin is provided in the compartment, it shall be set into the countertop.

3.2.3.3 **Door(s).** Compartment doors shall have louvers for ventilation. Lavatory doors shall have an interior lock which shall have an exterior, backlighted occupied notice. These locks shall have provisions for exterior emergency unlocking. There shall be visual indication on the interior of the door if the lock is not securely latched. Door openings shall be well rounded and shall have no sharp corners or edges. When open, doors shall not block the crew and/or passenger access to passageways, egress routes, or other critical equipment. Door knobs or handles which are twisted to actuate shall open the door when turned in either direction.

3.2.3.4 **Smoke detector.** A smoke detector shall be mounted in the _____ spaces or compartments. It shall be mounted _____ and shall provide alarm indication at the _____ crewstation. The detector system installation shall be consistent with the requirements of *MIL-F-87168*.

3.2.3.5 **Floor seal.** The _____ (galley, lavatory, or other compartment or space where sustenance is prepared or waste is handled, removed, managed, or controlled) shall have a sealed floor that will hold _____ gallons of liquid with the aircraft in normal cruise flight attitude, without leaks or spills to adjacent compartments, floor spaces, structural cavities, bilges, or other areas.

3.2.3.6 **Galley-unique requirements.** The galley shall be designed to facilitate monitoring of the passengers by crewmembers who are using the galley equipment. A fire extinguisher shall be provided either as a built-in unit or a portable unit located in ready access to crewmembers operating the galley. Fire extinguishers provided for galley compartment protection shall be particularly effective for grease and electrical fires. Fire extinguisher installation shall be consistent with the requirements of *MIL-F-87168*. Sustenance preparation, storage, and serving equipment shall meet the requirements of 3.2.1.3.

3.2.3.6.1 **Galley fixtures.** The galleys shall be equipped with a wastepaper bin (able to hold used disposable cups, sustenance containers, and sustenance preparation remains); paper cup dispenser; hand grips (near the sustenance preparation area); vent fan (which is user selectable); and dispensers for paper towels, airsickness bags, and soap. Each lavatory shall have _____ (number) _____ amperes, 115V, 60 Hz utility outlet(s) with integral, self-testing breaker(s). The ventilation system shall remove _____ cubic feet of air per minute with all ventilation ducting in place and shall vent to _____ (the aircraft cabin or exterior).

3.2.3.6.2 **Galley basin(s).** The galley shall have _____ (number) basin(s) or sink(s) which shall have _____ (hot and/or cold) potable water faucets, spring loaded to shut when released. The water shall fall into the sinks in all flight attitudes from _____ degrees pitch to _____ degrees pitch. The basin opening shall be _____ inches in diameter (or _____ inches diagonally, if rectangular) to permit the cleaning and sanitization of trays, coffee pots, and other sustenance equipment. Basins and sinks shall hold _____ cubic inches when the drain is plugged and the aircraft is in a _____ degrees pitch attitude. See 3.2.2.2 for liquid waste system requirements.

3.2.3.6.3 **Galley annunciator panel.** A galley annunciator panel shall contain a receiving station for the lavatory annunciator call switch and a passenger warning sign with the message, "Return to Seat". The emergency call receiver shall have an acknowledgment switch that shall remove the signal and be accessible while seated on the galley seats. The message shall be illuminated manually by the crew from the _____ (crew position) and automatically upon _____ (emergency conditions). The galley annunciator panel shall provide the additional functions of _____.

3.2.3.6.4 **Self-service equipment.** The ASWMS shall contain _____ (type of self-service equipment, such as drink dispensers, cup dispensers, snack trays, etc.). An operating instructions and warning placard shall be posted immediately adjacent to the equipment in a position that permits the user to read the directions while performing the tasks.

3.2.3.6.5 **Service and waste carts.** The ASWMS shall contain _____ (number) service carts (also known as service trolleys) for the distribution of _____ (food and/or beverages) to the crew, passengers, patients, and other personnel and for the collection of post-meal debris. Carts shall be able to hold _____ (number) _____ (serving trays, beverages, or other sustenance). Carts shall be able to withstand periodic high temperature and pressure cleaning and sanitization with standard military and commercial agents in ground kitchen facilities. Cart stowage restraints shall be able to hold a fully loaded service cart. Each cart shall have a braking system that operates from a "dead man" switch on the handle or a foot pedal. The service cart's wheel loads shall not exceed _____ pounds per wheel and the diameters shall be no less than _____ inches.

3.2.3.6.6 **Galley seats.** The ASWMS shall contain _____ (number) galley seat(s). The seat(s) shall be located adjacent to any emergency, communications, or oxygen equipment, controls, or indicators. The seat(s) shall be positioned to permit the occupant a full view of all passengers and reduce the impact of crash conditions or equipment failure. Furthermore, the seat(s) and its attachment load path to the primary aircraft structure shall meet the crash survivability requirements of *MIL-STD-1807* and the design requirements for non-ejection seats of _____ (specification or standard) without any failure that would cause injury to the seat's occupant or to other passengers or crewmembers. The seats shall have sufficient strength, rigidity, and durability to withstand the accelerations (inertia loads) specified herein without permanent deformations, loss of rigidity, or loss of structural functioning for the design usage of _____.

3.2.3.7 **Lavatory-unique requirements.** Each lavatory shall have sufficient room to permit an occupant to _____. The lavatory shall contain _____ (toilets and/or urinals) as specified in 3.2.2.1.1.1 or 3.2.2.1.1.2.

3.2.3.7.1 **Lavatory fixtures.** The lavatories shall be equipped with _____. Each lavatory shall have a _____ amperes, 115V, 60 Hz utility outlet with ground fault circuit interrupts and an integral, self-testing breaker. The ventilation fan shall remove _____ cubic feet of air per minute with all ventilation ducting in place and shall vent to _____ (the aircraft cabin or exterior).

3.2.3.7.2 **Lavatory basins.** Lavatory basins shall have an indentation on the basin's upper surface to hold bar soap. The lavatory basin shall have _____ (hot and/or cold) potable water faucets which are spring loaded to shut when released. The basin opening shall be _____ inches in diameter (or _____ inches diagonally, if rectangular). There shall be a soap dispenser adjacent to the basin. See 3.2.2.2 for liquid waste system requirements.

3.2.3.7.3 Lavatory annunciator panel. An annunciator panel containing a call switch and a passenger warning sign with the message, "Return to Seat" shall be installed. The message shall be illuminated manually by the crew from the _____ (crew position) and automatically upon _____ (emergency conditions). An emergency call button shall be wired to the _____ (crew position) to alert the _____ (aircrew and/or medical technician) and shall be accessible from the toilet seat. The galley annunciator panel shall provide the additional functions of _____.

3.2.3.7.4 Shaving. Each lavatory shall include provisions for shaving, including razor blade disposal. This blade disposal shall accept the wide variety of disposable razors and blades available on the commercial market.

3.2.4 Potable water system. The ASWMS shall have a potable water system that _____ (is/is not) an integral part of the _____ (galley, lavatory, and/or aircraft systems). It shall transfer potable water from the storage container to the point of service. The system shall be entirely made of non-corrosive material that shall impart no taste or odors nor release any chemicals to the water. The potable water system shall be completely drained by gravity when not in use, with no remaining pockets of water. The potable water system shall be designed and constructed to prevent _____ (freezing of the contained water or damage to the ASWMS due to freezing) during all extremes of the air vehicle systems' flight environment. The potable water system shall be able to withstand a pressure of _____ psig during system filling. The system shall withstand, without damage or deformation, an ultimate pressure of _____ psig. Ground service connections for the potable water system shall be in accordance with 3.6.1.6.3. All potable water tanks, lines, inlets, and hoses shall be labelled, "Drinking Water Only".

3.2.4.1 Potable water plumbing. Potable water shall be supplied to the locations specified in 3.2.1.1.2.1 at the minimum flow rates specified therein. The system shall use semi-permanent, non-leaking quick disconnects which are easily disassembled for cleaning and are not connectable to the waste system plumbing connectors. At a single point, the potable water system shall connect to the waste water system for gravity drainage and overfill protection. This single subsystem cross connector shall be a normally disconnected spool (with associated valves and check valves) to reduce the probability of backflow from the waste system to the potable water system. If more than one potable water supply tank is used in the ASWMS design, then the system shall be designed to permit the switching of tanks while in flight. The potable water system shall be routed to avoid water spills from leaks or condensation. The potable water supply to passenger usable services shall be designed to permit crewmembers to secure the flow to these devices. A potable water emergency shutoff valve, with a placard describing its purpose and direction of operation to close, shall be located at _____. The potable water system shall have a relief valve set to prevent pressures from exceeding _____ psig at any point in the system. Additional relief valves shall be located at the supply to the _____ (equipment) and set to relieve at _____ psig.

3.2.4.2 **Potable water tanks.** The potable water system shall have a tank(s) to contain _____ gallons of potable water. Potable water tanks shall contain baffles or other provisions to prevent surging of the contents, yet shall be easily accessible for cleaning and sanitization. The tank opening for cleaning shall require no tools to operate, shall be _____ inches in diameter minimally, and shall utilize captive fasteners. If a non-round opening shape is used, it shall be a size sufficient to contain a circle of the above diameter. The tanks shall have a non-spill vent with surge preventors and shall be removable. A carrying handle(s) adequate to support the weight of the tank when full shall be included. The tank shall be insulated to eliminate or reduce condensation. All interior seams shall be smooth. There shall be a positive retention device for the tank when in position. The use of multiple tanks is acceptable. The tanks shall have a fully cleanable level indicator that shall be located to maximize its accuracy. A check valve shall be used in the fill line, hose, or valve. If a lavatory uses the same source as the galley, drinking fountain, and/or coffeemaker, then the amount available for the lavatory shall be controllable by the crewmembers. Potable water tanks shall be designed to permit manual filling by the air or ground crew when ground support equipment is not available.

3.2.4.3 **Potable water pressurization system.** The potable water system shall provide _____ psi pressure or more at all faucets or outlets. Pressure shall be generated by _____ (pneumatic source, compressor, or pump). The potable water pump shall require no more than _____ amperes power at _____ Volts _____ (direct current or Hertz).

3.2.4.4 **Potable water treatment.** The ASWMS shall be designed to treat non-potable water to remove _____, thereby making it palatable and fit for human consumption. It shall maintain already potable water in a usable condition. The ASWMS potable water system shall meet the non-treatment requirements of *AFR 161-44*.

3.2.5 **Construction**

3.2.5.1 **Materials, processes, and parts.** Materials, processes, and parts shall be selected in consonance with *MIL-STD-1587*, *MIL-STD-1568*, and the requirements listed in the following subparagraphs.

3.2.5.1.1 **Materials and processes.** The materials used for the ASWMS shall be commensurate with the operational and maintenance capability of the system and the life cycle exposure. The ASWMS shall contain no hazardous materials nor require any hazardous processes. It shall require no process or material prohibited by federal, state, or local law. As amplified by 3.2.5.1.1.1, materials nutritious to fungus shall be avoided wherever possible and shall be treated whenever they must be used. Any honeycomb- or sandwich-type panels used shall have all edges, cutouts, or holes sealed to protect the core material and prevent the entrance of moisture or foreign material. All selected materials shall not be adversely degraded due to exposure to aircraft fluids, disinfectants, cleaning or sanitization agents, or pressurized cleaning processes. The following removable modules, equipment devices, or parts shall be able to withstand periodic high temperature and pressure cleaning and sanitization with cleaning agents in ground kitchen facilities: _____.

3.2.5.1.1.1 **Materials in contact with food and/or water.** All materials used where they may contact sustenance shall not contain or pass any odor or flavor nor hazardous or toxic chemicals (such as lead or cadmium) to any food, water, or other drink. There shall be no material used in contact with food or water that will support chemical reactions with any sustenance, support the growth of fungus, or attract insects. All material used in contact with food or water shall not etch, pit, crack, or have any other structural, visual, or performance deterioration. Chemical softeners shall not be used in the bending or forming of thermoplastic materials. All potable water line materials shall be suitable for use with super chlorinated water. All materials will be selected to maximize or ensure easy cleaning and sanitization. No hygroscopic material shall be used. Flexible lines shall not be convoluted, but shall have stainless steel fittings.

3.2.5.1.1.2 **Materials in contact with human or liquid wastes.** No aluminum or porous materials shall be used in direct contact with human waste. All materials for handling wastes shall be acidproof and shall have corners with a minimum radius of _____ inch. Flexible lines shall not be convoluted.

3.2.5.1.1.3 **Flammable materials.** Combustible materials shall meet the requirements of *FAR Part 25.853* and *FAR Part 25.1359*. All materials shall be selected to minimize the density and toxicity of the smoke produced when burned. All materials used shall be burn resistant and/or self-extinguishing as required by *FAR Part 25*. Textile materials, such as draperies, curtains, coated fabrics, and insulation, shall have a maximum after flame time of _____ seconds, a maximum burn length of _____ inches, and a maximum flame time of drippings of _____ seconds when tested in accordance with Part I of *FAR Part 25.853(b)*, Appendix F.

3.2.5.1.1.4 **Corrosion control.** The ASWMS shall withstand the natural and induced environments of 3.2.6 and of the sustenance and wastes of 3.2.1.1 and 3.2.2.1 for the design life cycles without producing corrosion products which are unsanitary, unhygienic, difficult to clean, uneconomical to repair, difficult to inspect, or unacceptable due to low residual strength or poor aesthetics.

3.2.5.1.1.5 **Surfaces.** All surfaces shall be designed to be easily and completely cleaned and sanitized with a damp cloth, soap, and water. During normal use for the lifetime of the ASWMS in the environments of 3.2.6, all surfaces shall be scuff, chip, crack, scale, dent, and scratch resistant; shall be free of cracks, crevices, and other recesses; and shall not erode. Floors and walkways shall be covered with a non-skid surface with a non-skid lifetime of _____ in the environments of 3.2.6 and for the service life of 3.3. Surfaces exposed to view shall be covered as appropriate to render them _____. Surfaces not exposed to view or inaccessible for maintenance and cleaning shall be painted or treated for positive prevention of hidden corrosion. All equipment, structures, and surfaces at floor level shall be protected from damage by the users' boots and shoes by a kickplate.

3.2.5.1.2 **Parts.** With the exception of the water basin drains, traps for food particles, liquids, or condensate shall be eliminated. Modular component construction shall be utilized wherever feasible. The removal of parts, components, equipment, modules, or combinations of the foregoing shall not adversely affect the performance of all remaining unrelated portions of the ASWMS. Standard military or commercial parts shall be used, wherever practicable and whenever they meet the performance requirements, in the following order of precedence: _____.

3.2.5.1.2.1 **Radii.** All external edges formed by the meeting of two planes shall be rounded with a radius of no less than _____ inch. Internal corners formed by two planes shall also be rounded with a radius of no less than _____ inch. All external corners or protrusions formed by the meeting of three or more planes shall be rounded with a radius of no less than _____ inch. Internal corners formed by three or more planes shall also be rounded with a radius of no less than _____ inch.

3.2.5.1.2.2 **Retention and latches.** All doors, drawers, compartments, removable components, modules, carts, insert equipment, folding and/or extending components, and/or bins shall have latches to prevent inadvertent opening or closing. This requirement shall be met throughout all (normal and/or emergency) aircraft motions, vibrations, shocks, and accelerations, with the device loaded to the maximum design limit. These latches shall be positive acting in both the opened and closed positions and shall operate without tools. There shall be a _____ (tactile, aural, or visual) indication of the latch holding the item in both positions. Latches or other retention devices shall be used for the _____ (item name) to hold it in the _____ (open/closed/extended/etc.) position. When the size of an object, its anticipated path of travel, its location, or other circumstance of its design permit it to be a possible and immediate hazard to personnel, secondary latches or retention shall also be used.

3.2.5.1.2.3 **Joints.** All joints shall be smooth, even, and sealed to prevent entrapment or entrance of liquids, foodstuffs, or vermin. The surface color of joints shall blend with the adjoining surfaces. The surface of joints shall not be tacky or adhere to normal dirt and dust and shall be easily cleanable. The bottom edge of galleys and lavatories shall be sealed to prevent the entrance and accumulation of dirt, liquids, foodstuffs, or vermin under the unit.

3.2.5.1.2.4 **Removable panels, doors, drawers, and work surfaces.** All panels, doors, drawers, and work surfaces shall be flush to the adjoining surfaces when stowed or closed. They shall be retained in both the open and closed (or in use and stored) positions, shall be designed for misuse (e.g., personnel standing on drawers), and shall operate smoothly without binding when filled to their design load.

3.2.5.2 **Spill control.** Work surfaces and equipment shall be designed to capture accidental spills, condensation, overflows, or seal leakages. Overflow tubes and drip pans shall be used.

3.2.5.3 **Lighting.** All work surfaces and control panels shall have adequate illumination without glare. Lighting shall be designed for rapid replacement of lamps without tools and with retention of all fasteners and parts. Lighting fixtures shall be designed with a protective cover and shall not form shadows over work surfaces when user is in place. Fluorescent lighting ballast, if used, shall have built-in thermal protection. Lighting shall be as required by *AFGS-87240*.

3.2.5.3.1 **Light fixture, emergency.** The lavatory and all enclosed spaces shall have a ceiling-mounted emergency light that shall produce a minimum illumination of _____ footcandles on the floor and the door handle. The light shall automatically operate upon the following conditions: _____.

3.2.5.3.2 **Light fixture, normal.** Normal white lighting of a minimum illuminance of _____ footcandles shall be provided in the _____. The light switch for the normal light shall be _____ (a two-position hand switch, a variable intensity control, or an integrable part of the door lock system). If a part of the door lock system, it shall be wired to turn on when the door is locked. In either case, it shall be a two-pole switch. The normal lighting _____ (shall/shall not) be compatible with night vision systems, as described by _____.

3.2.5.4 **Electrical distribution.** Electrical power systems shall be designed in accordance with requirement _____ of *MIL-STD-454*, shall be fully compatible with the aircraft electrical power system, and shall safely support the simultaneous maximum power operation of all equipment. The electrical power provided shall be as described in 3.6.1.3 and the electrical connections to the air vehicle shall be as described in 3.6.1.6.1. Insulation resistance shall be greater than _____ megaohms for the environmental conditions of section _____. The ASWMS assemblies shall be able to withstand, without damage or breakdown, a minimum of _____ applications, _____ minutes in duration, of _____ Volts _____ (alternating current/direct current) at _____ Hertz between parallel connected terminals and the case with a leakage of no more than _____ milliamperes. All non-conductive finishes shall be removed from both contact surfaces of materials in the electrical or ground path to ensure the continuity of the electrical bonding. Electrical equipment (such as motors, terminals, lights, etc.) shall be isolated and/or protected from lint, moisture, aerosol spray, soap, cleaning and sanitation agents, and other hazard sources. See 3.6.1.1 for electromagnetic and electrical interference requirements, 3.6.1.3 for electrical power requirements, and 3.6.1.6.1 for electrical connectors interface requirements.

3.2.5.4.1 Electrical control panels. A control panel for all ASWMS equipment shall be located near the systems it powers. It shall be located away from steam, condensate, and liquids. It shall contain all power switches, warning lights, indicators, resetable circuit breakers, and timers. It shall also contain a master circuit breaker for all equipment controlled from this panel. The ASWMS compartments' light switches and utility outlet circuit breakers shall also be contained herein. All controls shall be prominently marked to indicate the purpose of the control, the range of controls, and the device powered or controlled. As a goal, there shall be a single master control panel. If not readily visible to any occupants, a placard shall be used to indicate the location of the hidden control panel(s).

3.2.5.4.2 Electrical utility outlets. A placard shall be mounted near each outlet that identifies its specific usage, voltage, and current capability. Galley preparation areas and lavatory utility outlets shall each have an integral, self-testing circuit breaker set at the outlet's rated amperage. All 60 Hz, 120V AC electrical outlets shall be three-prong grounded outlets with ground fault isolation. Utility outlets shall be positioned to minimize hazards due to accidental spills during all normal and emergency operations at the work site. Outlets at the _____ shall provide _____ Hertz power at _____ Volts AC and _____ amperes current.

3.2.5.4.3 Electrical power wiring. All wiring shall be identified in accordance with _____. Wire sizes shall be selected in accordance with _____. All electrical equipment shall be designed to prevent the entrance of moisture, soap, or cleaning and sanitization agents. A placard shall be included in all compartments and major assemblies to show and identify all internal wiring and terminals. Wiring to connectors mounted on the aircraft structures shall contain sufficient length to ensure there are no loads imparted to the connector. Wiring bundles shall be constructed to prevent the crewmembers or passengers from stepping on them or using them as hand holds.

3.2.5.5 Noise effects on personnel. The ASWMS shall not produce hazardous noise levels (as defined in *AFR 161-35* and *MIL-STD-1789*) or noise levels which result in the degradation of operator performance. The ASWMS shall not produce any drumming or rattling of components, equipment, or parts. Worst-case ASWMS noise and ambient aircraft noise shall be considered in an integrated fashion in accordance with the requirements of *AFR 161-35*, *MIL-STD-1789*, or _____.

3.2.5.6 Structural integrity. All structural elements of the ASWMS shall have sufficient strength, rigidity, and durability to resist the accelerations (inertia loads) defined herein without permanent deformations, loss of rigidity, or loss of proper structural functioning for the specified usage of _____. In addition, all elements of the ASWMS and all load paths to the primary aircraft structure shall have sufficient strength and stiffness to withstand the crash loads specified herein without failure so injury to crewmembers or passengers is prevented. All elements of the ASWMS shall be designed so their installation does not create unintentional load paths which would cause these elements to react or transmit primary structural loads, and does not degrade the structural integrity of primary structural members to which they are attached.

3.2.6 Environmental requirements. The ASWMS shall be designed to withstand, without degradation, exposure to the natural and induced environments of an equipment life cycle. The equipment life cycle shall be _____. In addition, the ASWMS shall be designed to operate as specified herein while exposed to the life cycle environments of _____. The guidance contained in *MIL-STD-210* and *MIL-STD-810* shall be utilized in this effort.

3.2.6.1 Environmental stress screening (ESS). The ASWMS shall be designed to withstand, without degradation, exposure to the combination of ESS environmental stresses and the environments of an equipment life cycle. The equipment shall be exposed to _____ ESS cycles defined as follows: _____.

3.2.6.2 **Low pressure (altitude).** The ASWMS shall be designed to withstand, without degradation, exposure to the following low pressure environments of an equipment life cycle: _____. The ASWMS shall be designed to operate as specified herein during exposure to the following low pressure environments of an equipment life cycle: _____. The ASWMS shall withstand, without failure, an explosive decompression of _____.

3.2.6.3 **Temperature.** The ASWMS shall be designed to withstand, without degradation, exposure to the following temperature environments of an equipment life cycle: _____. The ASWMS shall be designed to operate as specified herein while exposed to the following temperature environments of an equipment life cycle: _____.

3.2.6.4 **Solar radiation.** The ASWMS shall be designed to withstand, without degradation, exposure to the following solar radiation environments of an equipment life cycle: _____. The ASWMS shall be designed to operate as specified herein while exposed to the following solar radiation environments of an equipment life cycle: _____.

3.2.6.5 **Rain.** The ASWMS shall be designed to withstand, without degradation, exposure to the following rain environments of an equipment life cycle: _____. The ASWMS shall be designed to operate as specified herein while exposed to the following rain environments of an equipment life cycle: _____.

3.2.6.6 **Humidity.** The ASWMS shall be designed to withstand, without degradation, exposure to the following humidity environments of an equipment life cycle: _____. The ASWMS shall be designed to operate as specified herein while exposed to the following humidity environments of an equipment life cycle: _____.

3.2.6.7 **Fungus.** The ASWMS shall be designed to withstand, without degradation, exposure to the following fungus environments of an equipment life cycle: _____. The ASWMS shall be designed to operate as specified herein while exposed to the following fungus environments of an equipment life cycle: _____.

3.2.6.8 **Salt fog.** The ASWMS shall be designed to withstand, without degradation, exposure to the following salt fog environments of an equipment life cycle: _____. The ASWMS shall be designed to operate as specified herein while exposed to the following salt fog environments of an equipment life cycle: _____.

3.2.6.9 **Sand and dust.** The ASWMS shall be designed to withstand, without degradation, exposure to the following sand and dust environments of an equipment life cycle: _____. The ASWMS shall be designed to operate as specified herein while exposed to the following sand and dust environments of an equipment life cycle: _____.

3.2.6.10 **Explosive atmosphere.** The ASWMS shall safely operate during exposure to a _____ explosive atmosphere environment during an equipment life cycle. The ASWMS shall _____ (contain/prevent) ignition during operation in this environment.

3.2.6.11 **Acceleration.** The ASWMS shall be designed to withstand, without degradation, exposure to the following acceleration environments of an equipment life cycle: _____. The ASWMS shall be designed to operate as specified herein while exposed to the following acceleration environments of an equipment life cycle: _____.

3.2.6.12 Vibration. The ASWMS shall be designed to withstand, without degradation, exposure to the following vibration environments of an equipment life cycle: _____. The ASWMS shall be designed to operate as specified herein while exposed to the following vibration environments of an equipment life cycle: _____. During this exposure, all ASWMS equipment, components, or parts designed to latch or be retained shall not release, fail, or jam. The ASWMS shall meet this requirement in all configurations and all positions of doors, panels, shelves, or _____ equipment.

3.2.6.13 Acoustic noise exposure. The ASWMS shall be designed to withstand, without degradation, exposure to the following acoustic noise environments of an equipment life cycle: _____. The ASWMS shall be designed to operate as specified herein while exposed to the following acoustic noise environments of an equipment life cycle: _____.

3.2.6.14 Shock. The ASWMS shall be designed to withstand, without degradation, exposure to the following shock environments of an equipment life cycle: _____. The ASWMS shall be designed to operate as specified herein while exposed to the following shock environments of an equipment life cycle: _____.

3.2.6.15 Gunfire. The ASWMS shall be designed to withstand, without degradation, exposure to the following gunfire environments of an equipment life cycle: _____. The ASWMS shall be designed to operate as specified herein while exposed to the following gunfire environments of an equipment life cycle: _____.

3.2.6.16 Other environments. The ASWMS shall be designed to withstand, without degradation, exposure to the following other environments, not specified above, of an equipment life cycle: _____. The ASWMS shall be designed to operate as specified herein while exposed to the following other environments, not specified above, of an equipment life cycle: _____.

3.3 Product integrity. The ASWMS life shall be established to the requirements of the applicable integrity programs for the operating functions incorporated into the hardware, as tailored to the aircraft system installed. The following performance parameters are incorporated: _____. The following integrity program requirements shall be applied: _____.

3.4 Safety. The ASWMS and its associated equipment shall be analyzed for safety hazards in accordance with paragraph _____ of *MIL-STD-882*. The ASWMS shall incorporate hand holds in locations where a crewmember or passenger is required to stand to operate equipment (such as galleys or urinals). This is to provide personnel with a means of catching themselves if unexpected or unanticipated turbulence should suddenly cause the aircraft to move beneath them. The following areas shall be designated as fire containment areas: _____. These areas shall be constructed of fire resistant material; shall minimize openings for ventilation, entry, or other use; shall employ either self-closing openings or placards to advise that the opening must be kept closed when not in use; and shall minimize the use of wiring, hoses, or other equipment within that space.

3.5 Human engineering. Human engineering requirements shall be applied in accordance with the criteria set forth in *MIL-STD-1800*, *MIL-STD-1472*, *AFGS-87240*, and the following subparagraphs. The requirements in these documents include, but may not be limited to, the design of controls and displays, lighting, anthropometric considerations, personal comfort and safety, and ease of maintenance.

3.5.1 **Labels and placards.** Controls and modes shall be labelled to ensure correct identification, utilization, actuation, and/or manipulation. Legends and abbreviations shall conform to *MIL-STD-783* and *MIL-STD-12*, respectively. Placards shall be indelibly printed on a permanently mounted, rigid material. Placards shall be located conspicuously and in a manner that clearly references the affected equipment. Placard placement shall facilitate the use of the placard while operating the equipment in the described manner. Placard surfaces, adhesives, and layers shall not deteriorate due to normal cleaning with soap, detergent, or bleach solutions. They shall also not deteriorate due to the use of solvents used to prepare surfaces for placard application or adhesives used to mount the placards. Placards shall not deteriorate or loosen from their mount due to the application and rapid removal of masking tape. Mounted placard edges shall be sealed for sanitation.

3.5.2 **Component lifting.** Equipment designed to be installed or lifted by a single aircrew member shall weigh no more than _____ pounds when in the condition or configuration the operation is to take place. Equipment designed to be installed or lifted by two aircrew members shall weigh no more than _____ pounds when in the designed condition or configuration.

3.5.3 **Anthropometry.** All equipment designed for use or operation by USAF aircrew members shall accommodate, at a minimum, the central _____ percent of the USAF _____ (male and/or female) aircrew population. All equipment designed to be used by passengers shall accommodate the central _____ percent of the _____ population, as described by the _____ database.

3.5.4 **Touch temperature.** The surface temperatures of any component of the ASWMS subject to routine touch shall not exceed the limits specified in table I. The surface temperatures of any component of the ASWMS subject to inadvertent touch shall not exceed the limits specified on figure 2.

3.5.5 **Training.** The ASWMS design shall accommodate any training use derived from applicable training requirements analyses or specified in the system requirements document.

TABLE I. Maximum surface temperatures.

Component	°F	°C
Metallic rotary knobs	120	49
Metallic control panels, toggle and lever-lock switches	130	54
Glass surfaces	138	59
Plastic rotary knobs	147	64
Plastic surfaces and pushbuttons	156	69

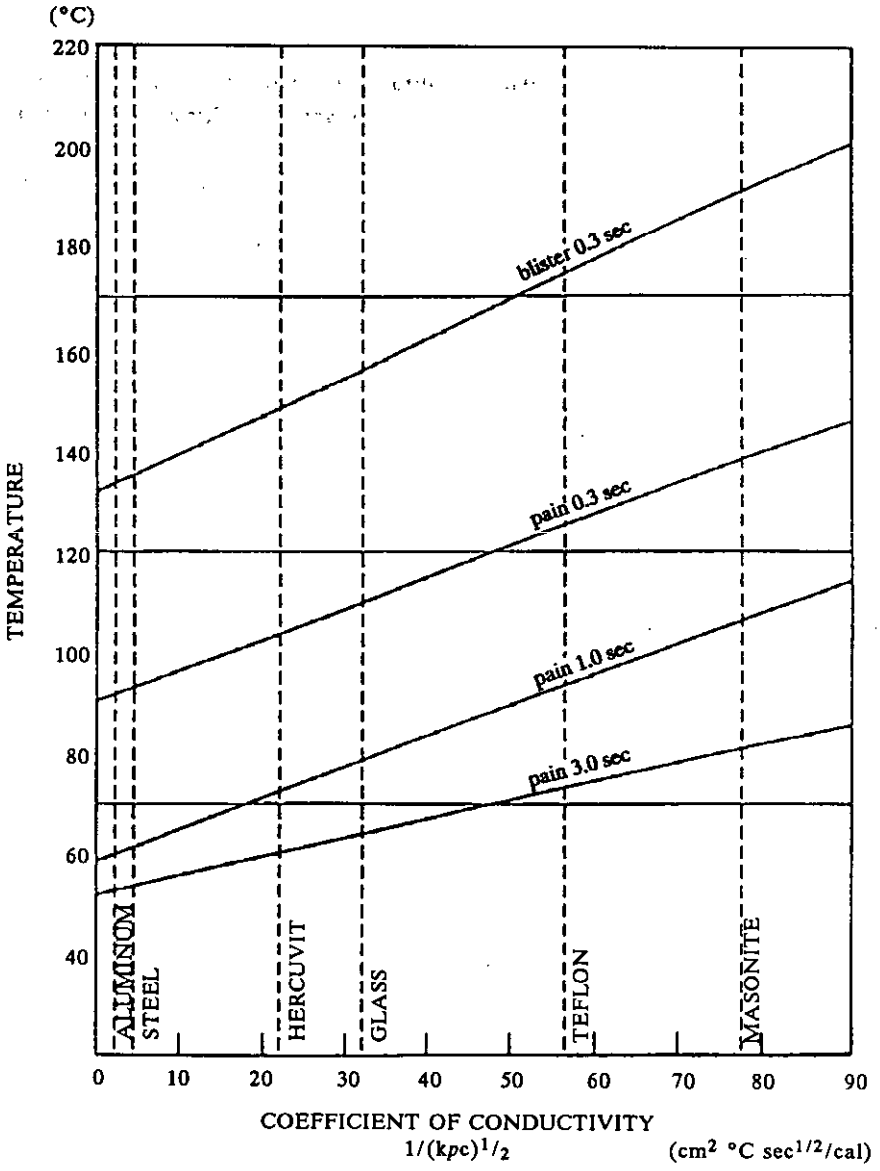


FIGURE 2. Inadvertent touch temperature limits as a function of coefficient of conductivity and contact time.

3.6 Interface requirements

3.6.1 Aircraft interfaces

3.6.1.1 Electromagnetic effects (EME). The ASWMS shall be designed to achieve electromagnetic compatibility with all subsystems and equipments within the system and with the electromagnetic environment. The ASWMS shall meet the electromagnetic effects requirements for systems as specified in *MIL-STD-1818*. Specifically, the requirements for the ASWMS are as follow: _____.

3.6.1.2 Electrostatic discharge (ESD). No part, component, or element of the ASWMS shall inadvertently actuate when subjected to a _____ Volt electrostatic discharge. After the discharge is applied, the system shall function as required.

3.6.1.3 Electrical power requirements. The electrical power system shall provide electrical power to the terminals of the power utilization equipment having the characteristics in accordance with _____. The ASWMS shall require _____ Volts, at _____ frequency, _____ phase, _____ (Y or Delta) connected and _____ amperes for all systems and components. All loads shall be balanced and grounded.

3.6.1.4 Weight and moment effects. The maximum weight of the ASWMS in its _____ (fully loaded or empty and unloaded) configuration shall not exceed _____ pounds. This weight includes all detachable or removable equipment, components, parts, modules, etc.

3.6.1.5 Loading restrictions. There _____ (shall/shall not) be partial assembly of the ASWMS after loading onboard the aircraft. All removable units shall load through existing hatches or cargo doors without alteration or disassembly of the door. Forklift tines entries shall be _____ wide, _____ high, and _____ long. The ASWMS shall accommodate loading operations with a forklift travelling at the maximum speed of _____ miles per hour. The ASWMS shall accommodate the aircraft rail-roller system as defined by _____. The ASWMS shall have winch and hoisting cable attachments able to support the mass of the ASWMS distributed between all points with a _____ factor of safety without distortion of the ASWMS or its equipment. The cable attachments shall be accessible with any environmental protection cover in place. The ASWMS' wheels should have a load of no more than _____ pounds per wheel, diameter of no less than _____ inches, and width no less than _____ inches. Attachments for the ASWMS to the air vehicle shall meet the load requirements of 3.2.3 multiplied by _____ for the forward direction, _____ for the aft direction, _____ for the _____ direction, _____ for the downward direction, and _____ for both lateral directions.

3.6.1.6 Connectors. The potable water hoses and connectors shall not be physically connectable to the liquid waste hoses or connectors. All hoses or electrical lines shall be flexible and shall not induce loads on the connectors, the ASWMS, or the aircraft structure. The ASWMS shall store all hoses and connectors for connection of the ASWMS to the aircraft or support service systems. All liquid lines shall have a valve in the line between the connector and the system. The connectors to liquid handling subsystems shall be protected by a leakproof cap when not in use.

3.6.1.6.1 Electrical connectors. The ASWMS units which are removable from the aircraft shall mate with a _____ (nomenclature or specification number) _____ (male/female) electrical connector. The connector shall be located at _____ (location) and shall have _____ feet cord length. The ASWMS shall include stowage for the cord. When connected, the power cord shall not obstruct any passage around equipment. Connectors shall be operable by a single hand without tools.

3.6.1.6.2 **Ventilation connections.** Connections for exterior vents (tank and space ventilation) shall be in accordance with _____ (specification paragraph number). The ventilation inlet and outlet flanges shall be able to withstand, without permanent deformation or failure, a force of _____ pounds axial thrust in the _____ (inward/outward) direction and a moment of _____ pound-inches about the axial centerline.

3.6.1.6.3 **Ground servicing connectors.** Potable water service connections shall not be located in the same box, area, or space and shall not be downstream from any liquid or human waste service connections or overboard dump outlets. Both the waste and potable water systems shall have a valve in the line between the connector and the system. This valve shall be accessible and/or operable from the service connection location. The condition of this valve, opened or closed, shall be easily and directly observable from the service connection operating location. If the connections and valves are located behind a panel or door, the location and purpose of these devices shall be durably and legibly marked on the exterior of the access. Operating instructions, including valve positions for filling, draining, tank selection, or other operation, shall be posted in a position where it can be read while operating this equipment.

3.6.1.6.3.1 **Liquid waste service connections.** Liquid waste servicing connectors shall be quick disconnects in accordance with _____ (specification number) and shall meet the requirements of 3.2.2.1 and 3.2.2.2. The hose length shall be _____ inches and the hose diameter shall be _____ inches for the waste liquids hoses. Connection to liquid waste ground services shall be at a single location, shall require no more than one skill level _____ groundcrew member, shall add disinfectant to the waste tank, and shall not require a ladder for connection or operation when the ground crewmember is standing on the _____ (ground or service truck/cart). After service, provisions shall be available to rinse and disinfect the hose and the connection without removal. Backflow out of the toilets, urinals, basins, or other equipment connected to the liquid waste plumbing shall be prevented during the rinse or chemical addition. See 3.2.2.2.3 for inflight, overboard dumping requirements.

3.6.1.6.3.2 **Potable water service connection.** Potable water servicing connectors shall be quick disconnects in accordance with _____ (specification number), shall meet the requirements of 3.2.1.1.2.1 and section 3.2.4, shall be easily accessible with the ASWMS installed, and shall not require tools. Operating instructions shall include a caution not to allow the filling pressure to exceed _____ psig. The hose length shall be _____ inches and the hose diameter shall be _____ inches for the potable water hoses. The potable water overflow outlet shall be observable from the location of the servicing connector. The potable water tank filling hose and connections shall be plainly labelled for potable water use only and shall not be connectable to the aircraft liquid or human waste service connectors.

3.6.1.7 **Structural interface.** For removable ASWMS equipment, attachments to the aircraft structure shall be made with quick and captive disconnects, with rigid connections in all directions to the existing aircraft mounting points, and with no requirement for special tools. The equipment design shall preclude the possibility of incorrect installation. There shall be no chatter at the connections to the aircraft. Any portion of the ASWMS that requires removal for access to other aircraft components or to structural attachments shall also incorporate captive fasteners and shall require a single hand tool common with the ASWMS unit installation. The ASWMS and its equipment shall be positioned so it does not obstruct passenger access to seats.

3.6.1.8 **Clearances, exits, hatches, and compartment access.** The ASWMS and its equipment, in any configuration, shall not block access to emergency and normal hatches and compartments. The ASWMS doors, drawers, and extending, sliding, or folding surfaces shall not block or interfere with the access to or operation of other aircraft equipment in any position (open, closed, unfolded, etc.).

3.6.1.9 Environmental control system interface. The smoke or odors generated by the operation of the ASWMS galley- or lavatory-type equipment shall ventilate to the _____ (exterior/interior) of the aircraft or shall be dissipated by the aircraft ventilation system without adverse impact on the cabin pressurization system. This ventilation shall be user controllable, _____ (shall/shall not) have a filter, and shall be without adverse impact to the cabin pressurization system. If necessary, this system shall allow a crewmember to disable it immediately.

3.6.1.10 Escape system interface. *The ASWMS, in any configuration, shall not impede egress from the* aircraft under emergency conditions.

3.6.2 Other interfaces

3.6.2.1 Ground service carts. The ASWMS shall be compatible with the _____ (type designations) ground service carts for the support of toilets, potable water filling, power, disassembly for cleaning, sanitization, or repair.

3.6.2.2 Ground stowage. The removable portion of the ASWMS _____ (shall/shall not) be contained on no more than a single pallet. The stored dimensions of the ASWMS shall be no more than _____ feet high, _____ feet wide, and _____ feet long. If a weather cover is used, it shall be easily removable by one person, shall be stowable within the ASWMS, and shall not tear or puncture from normal use. The ASWMS shall have rigid covers over all preparation and storage equipment or areas.

3.6.2.3 Insulated food transporters. The ASWMS shall include a covered and insulated food transporter to carry the sustenance from the inflight kitchen to the aircraft while the food is maintained in its frozen or chilled condition. The transporter shall contain _____ (cubic feet of volume or number of meals). When unloaded, it shall be storable in the ASWMS equipment. It shall be damage resistant, weigh no more than _____ when loaded, have two carrying handles, and maintain the temperature of the sustenance within _____ degrees F for _____ minutes at an environmental temperature of _____ degrees F.

4. VERIFICATIONS

4.1 System description verification. The ability of the ASWMS to support the required number and types of personnel for the duration of the design mission shall be verified by _____.

4.1.1 Sanitation and hygiene verification. The ASWMS sanitary provisions shall be verified by _____.

4.2 Verification of performance requirements. Unless otherwise noted, verification of the performance requirements shall be conducted at the standard conditions of _____ degrees F, _____ percent humidity, and _____ inWg barometric pressure. The maximum deviations from the specified test conditions are: _____ degrees F, _____ percent altitude, _____ percent humidity, _____ G's acceleration, _____ percent of the vibration frequency (or ± .50 Hz when below 25 Hz), _____ percent vibration amplitude, _____ voltage, _____ amperage, and _____ ohms. All numerical data shall be recorded at the level of accuracy and resolution of the measurement equipment utilized.

4.2.1 Verification of sustenance management systems. The ability of the ASWMS equipment to be used by the crewmember(s) and/or passenger(s) to meet the aircraft system's design requirements without impact to the normal and emergency operations of the air vehicle shall be verified by _____.

4.2.1.1 **Verification of solid sustenance**

4.2.1.1.1 **Verification of content and quantity.** The ability of the ASWMS system to store, prepare, cleanup, and sanitize for the meals specified in 3.2.1.1.1 shall be verified by _____. The ability of the ASWMS to store and finalize the preparation of food in containers shall be by _____. The ability of the ASWMS to store and facilitate the final application of the required condiments shall be verified by _____.

4.2.1.1.2 **Verification of liquid sustenance**

4.2.1.1.2.1 **Verification of water.** The ability of the ASWMS to store/dispense the required quantity of water for the specified length of time and under the described conditions shall be verified as described in section 4.2.4. The potable water temperature shall be measured at each of its delivery points and shall be as specified above. Each faucet shall be open for no more than _____ minutes prior to this measurement. Cold water temperatures shall be taken with the ASWMS in an environment of _____ degrees F and hot water temperatures with the ASWMS in an environment of _____ degrees F.

4.2.1.1.2.2 **Verification of other liquids.** The ability of the ASWMS to store and dispense liquids and beverages other than water or coffee shall be verified by _____.

4.2.1.2 **Verification of sustenance preparation**

4.2.1.2.1 **Verification of preflight and postflight.** Preflight and postflight preparation procedures shall be verified by _____. Time to complete the tasks will begin when _____ and end when _____.

4.2.1.2.2 **Verification of inflight preparation.** Verification of the preparations required while in flight shall be _____.

4.2.1.3 **Verification of sustenance equipment.** The ASWMS equipment shall be verified by _____. Containment of the required equipment and an ability to interface with a variety of similar equipment shall be verified by _____. The equipment removal (including power connection/disconnection) shall be verified by _____.

4.2.1.3.1 **Verification of miscellaneous equipment**

4.2.1.3.1.1 **Verification of utensils, serving equipment, and tableware.** The ability of the ASWMS to integrate with the _____ eating utensils shall be verified by _____.

4.2.1.3.1.2 **Verification of trays.** The ability of the ASWMS to store, prepare, cleanup, and sanitize the number and type of trays required for serving meals should be verified by _____. Verification of the access to all necessary spaces shall be an integrable part of this verification.

4.2.1.3.2 **Verification of refrigeration equipment.** The refrigerated, chilled, and frozen storage spaces in the ASWMS shall verified by _____. The existence of compartment labels shall be verified by _____. The ability of the refrigeration equipment to achieve and maintain the required temperatures in the specified times shall be verified by _____. The performance of the refrigeration equipment's temperature indicators and temperature controls (for each compartment) shall be verified by _____. The power requirement shall be verified by _____.

4.2.1.3.2.1 **Verification of dry ice refrigeration.** Verification of those refrigeration units which utilize dry ice for refrigeration shall be conducted in accordance with 4.2.1.3.2. Access to the dry ice compartment shall be verified by _____.

4.2.1.3.2.2 **Verification of vapor cycle refrigeration.** Verification of those refrigeration units which utilize vapor cycle electromechanical refrigeration devices shall be conducted in accordance with 4.2.1.3.3.1. Verification of the heated exhaust and the refrigerant and plumbing equipment shall be performed by _____.

4.2.1.3.2.3 **Verification of thermoelectric refrigeration.** Verification of those refrigeration units which utilize thermoelectric refrigeration devices shall be conducted in accordance with 4.2.1.3.2. In addition, the forced air circulation within the chiller and freezer compartments and over the heat sink shall be verified by _____ and replacement of the filters shall be verified by _____. The filter type and availability and the heat flow direction from the exterior heat sink shall be verified by _____.

4.2.1.3.2.4 **Verification of drink station.** The location of the drink station(s), the availability of drinking cups and trash receptacles, the source of the water, and the waste water storage shall be verified by _____. The temperature of the chilled water shall be verified in accordance with 4.2.1.1.2.1. The refrigeration equipment shall be verified as required in 4.2.1.3.2.1, 4.2.1.3.2.2, or 4.2.1.3.2.3. The waste and potable water plumbing shall be verified by the requirements of 4.2.2.2 or 4.2.4.

4.2.1.3.3 **Verification of heating equipment.** The ability of the ASWMS heating equipment to prepare sustenance for use shall be verified as follows. The ASWMS heating equipment's off/on switch, indicators, and adjustable temperature controls or timers shall be verified by _____. The voltage, frequency, and power requirements of each item of heating equipment shall be verified by _____. Exterior surface temperatures shall be verified by procedures set forth in 4.5.4.

4.2.1.3.3.1 **Verification of ovens.** The capacity of the ovens and their ability to reach the required temperatures in the specified time shall be verified by _____. The ovens shall be cold soaked for _____ minutes at _____ degrees F and maintained at an exterior environment of _____ degrees F. During this verification, the oven should be loaded with the type of meals specified in 3.2.1.1 as necessary to meet the aircraft's mission requirements. The performance of the door seal gaskets, door adjustments, insulation, drip guards, and decompression relief devices shall be verified by _____.

4.2.1.3.3.1.1 ***Verification of conventional ovens.*** The operation and performance of internal fans, temperature indicators, heating elements, and shields shall be verified by _____.

4.2.1.3.3.1.2 **Verification of microwave ovens.** Radiation external to the oven shall be verified by direct measurement on a unit operating at the highest power level at several, evenly spaced time intervals throughout a time period representative of its design life. This test should include _____ cycles of oven door opening and closing at the highest closing force level and _____ cycles of cleaning procedures. The protection of the microwave energy source from damage due to excessive reflected microwave radiation shall be verified by _____. The performance of the door interlock(s) shall be verified by _____ to verify they operate to remove power to the radiation generation system before the door begins to open. The adjustable power control shall be verified by _____. The air circulation and replacement shall be verified by _____. The operation of the cooking compartment light and the acceptability of the warning placard shall be verified by _____. The satisfactory distribution of the microwave energy shall be verified by _____.

4.2.1.3.3.2 **Verification of liquids heaters.** The operation of the liquids heaters shall be performed by _____. The performance of the pressure relief devices shall be verified by _____. The complete drainage by gravity shall be verified by _____.

4.2.1.3.3.2.1 Verification of coffeemaker. The capacity of the coffeemaker shall be verified by _____. The holding temperature of the coffee shall be verified by _____. The other operations of the coffeemaker shall be verified by _____.

4.2.1.3.3.2.2 Verification of water heater. The temperature, times, and flows of the water heater shall be verified by _____. The ability of the user to clean and sanitize the water heater and replace the heating elements shall be verified by _____.

4.2.1.3.3.2.3 Verification of hot cups. The ability of the hot cups to attain the required temperature should be verified by _____ with the ASWMS cold soaked to _____ degrees F and the environment maintained at _____ degrees F. All operations with the hot cup shall be verified by _____.

4.2.1.3.3.3 Verification of other heating equipment. Heating devices shall be able to achieve and maintain the required temperature after being cold soaked for _____ minutes at _____ degrees F and maintained at an exterior environment of _____ degrees F. The operation of components shall be verified as required for similar devices in the analogous heating equipment verification requirements above.

4.2.1.3.4 Verification of sustenance stowage equipment. The compatibility of the stowage shelves and drawers with the required sustenance, equipment, and components shall be verified by _____. The adequacy of the shelf doors and equipment retention devices shall be verified by _____.

4.2.1.3.5 Verification of preparation area/equipment. The size, location, and weight capacity of the ASWMS work surfaces shall be verified by _____. The set up, assembly time, and retention of the surfaces (both stored and in use configurations) shall be verified by _____. The slope of the surfaces shall be verified by _____ level when the aircraft is in normal, level flight. The operation of the refuse opening, refuse container, and utility outlet shall be verified by _____.

4.2.2 Verification of waste management systems. The hygienic disposal of waste generated by the crewmembers and passengers shall be verified as described in the following paragraphs. The easy disassembly, removal, cleaning, and sanitization of all waste disposal equipment, devices, components, or systems shall be verified by _____.

4.2.2.1 Verification of human waste. The performance of facilities and equipment for the collection, holding, and disposal of human feces and urine shall be performed by _____.

4.2.2.1.1 Verification of human waste collection. The performance of modesty shields and/or splash shields shall be verified by _____. The ability of the collection equipment to prevent spilling waste with the given acceleration shall be verified by _____. The operation of each flush valve or button, the capability to perform brush cleaning and sanitization, the anti-cling surface, and the lack of recesses shall be verified by _____.

4.2.2.1.1.1 Verification of fecal relief equipment. The operation of the toilets shall be verified by _____.

4.2.2.1.1.2 Verification of urination relief equipment. Urination equipment shall be verified by _____.

4.2.2.1.1.3 Verification of human waste holding tank(s). The ability of the holding tanks to maintain, process, and/or remove the waste shall be verified by _____. Tanks integral to the toilet shall be verified in concert with the verification of toilet operation.

4.2.2.1.2 **Verification of system cleaning/disinfection.** The ability of the ASWMS human waste systems to be cleaned, sanitized, and disinfected with commercially available agents shall be verified by _____.

4.2.2.1.3 **Verification of ventilation.** The ability of the ASWMS human waste system spaces or compartments to be ventilated to the aircraft exterior shall be verified by _____.

4.2.2.2 **Verification of liquid waste.** The separation or integration of the liquid waste system from other ASWMS subsystems shall be verified by _____. The design, location, insulation, and/or construction to prevent freezing and permit drainage by gravity of the liquid waste contents shall be verified at temperatures of 3.2.6.3 or _____ when held for _____ minutes. The ability of the liquid waste handling system to withstand the required internal pressure/vacuum due to servicing shall be verified by _____.

4.2.2.2.1 **Verification of liquid waste tank(s).** The construction, retention, removal, cleaning, sanitization, venting, and surge suppression of liquid waste tank(s) shall be verified by _____. The tank capacity and the size and operation of the tank opening shall be verified by _____. The adequacy of the carrying handle(s); the operation of the level indicator including its accuracy, location, and cleanability; the functioning of connections to any chemical treatment charging line; and the servicing line check valve shall be verified by _____.

4.2.2.2.2 **Verification of waste plumbing.** The ability of the waste plumbing and connections to prevent leaks, to drain completely by gravity (with the exception of basin traps) to the waste tank, and to be non-connectable to the potable water system (with the exception of the cross-connect spool) shall be verified by _____. Ease of disassembly and cleaning of all plumbing shall be verified by _____. Interior surfaces and bend radius of the waste system plumbing shall be verified by _____.

4.2.2.2.3 **Verification of inflight dumping.** Location and design of the overboard dumping outlets shall be verified by _____. The ability of the ASWMS to dump liquid wastes while in flight without the outlet freezing, without waste accumulating on exterior aircraft surfaces, and without the loss of cabin pressurization shall be verified by _____.

4.2.2.2.4 **Verification of liquid waste drains.** The operation of the check valve and trap in all liquid waste drains shall be verified by _____. The inclusion of a screen, the functioning of a drain plug, and the presence of a secondary drain shall be verified by _____. The size of the drains shall be verified by _____. The effect of drains on the pressurization system shall be verified by _____.

4.2.2.3 **Verification of medical waste.** The ability of the ASWMS to handle, control, store, process, and remove medical waste shall be verified by _____.

4.2.2.3.1 **Verification of medical waste stowage.** The ability of the ASWMS to control storage of waste medical sharps and biohazard material and to maintain medical wastes in the appropriate separate containers shall be verified by _____.

4.2.2.3.2 **Verification of patient human waste.** The ability of the ASWMS to support the collection and stowage of patient urine, feces, and vomitus shall be verified by _____.

4.2.2.3.3 **Verification of medical/nursing considerations/implications.** The ability of the ASWMS to support the medical doctors', nurses', and technicians' needs shall be verified by _____.

4.2.2.4 **Verification of foreign waste.** The collection, stowage, and transfer of foreign wastes from the ASWMS shall be verified by _____.

4.2.2.5 Verification of general refuse

4.2.2.5.1 Verification of refuse sources and quantities. The ability of the ASWMS to store the required quantities of trash from all sources shall be verified by _____.

4.2.2.5.2 Verification of refuse stowage and removal. The adequacy of the refuse containers' placement and operation shall be verified by _____. The ability of the dry waste containers to prevent the spread of wastepaper fires beyond the container interior shall be verified by _____.

4.2.2.5.3 Verification of refuse compactors. The performance of the refuse compaction equipment shall be verified by _____.

4.2.2.6 Verification of hazardous waste (excluding medical). The ability of the ASWMS to contain, control, store, clean, remove, dispose, and decontaminate hazardous waste material shall be verified by _____.

4.2.3 Verification of sustenance or waste management spaces and compartments. The floor pan, fit into the air vehicle, service doors and panels, and possible hand holds shall be verified by _____. Electrical grounding of the compartment and rapid decompression performance shall be verified by _____. Loading of compartments into the air vehicle's cargo compartments shall be verified as required by 4.6.1.5.

4.2.3.1 Verification of oxygen. The verification of the ASWMS oxygen systems' performance shall be _____.

4.2.3.2 Verification of counter(s). The size, design, and construction of counters in the compartment shall be verified by _____.

4.2.3.3 Verification of door(s). The adequacy of vent louvers and interior locks (including exterior backlighted occupied notice, exterior emergency unlocking, and visual indication that the door is securely latched) shall be verified by _____.

4.2.3.4 Verification of smoke detector. The mounting and operation of the smoke detector shall be verified by _____.

4.2.3.5 Verification of floor seal. The ability of the floor seals in all galley, lavatory, or other compartment or space where sustenance is prepared or waste is handled, removed, managed, or controlled shall be verified by _____.

4.2.3.6 Verification of galley-unique requirements. The ability of crewmembers to use the galley equipment while monitoring passengers shall be verified by _____. The adequacy of galley compartment fire extinguishers shall be verified by _____.

4.2.3.6.1 Verification of galley fixtures. The adequacy of the galley's wastepaper bin, cup dispenser, hand grips, vent fan, and dispensers shall be verified by _____. The adequacy and placement of electrical utility outlets and the ability of the ventilation system to remove the required smoke, vapors, and odors and to vent to the correct location shall be verified by _____.

4.2.3.6.2 Verification of galley basins. The galley basins' operation, water supply, drainage, and maintenance shall be verified by _____.

4.2.3.6.3 Verification of galley annunciator panel. The ability of the galley annunciator panel to receive a signal from the lavatory annunciator call switch and a signal warning crewmembers to return to their seats shall be verified by _____.

4.2.3.6.4 Verification of self-service equipment. The self-service equipment shall be verified by _____.

4.2.3.6.5 Verification of service and waste carts. The service carts' performance shall be verified by _____.

4.2.3.6.6 Verification of galley seats. The design, number, and location of the galley seat(s) shall be verified by _____. The ability of the seats to function as required shall be verified as described in *MIL-STD-1807* design requirements of _____. This verification shall be a dynamic test of the seat, ASWMS supporting structure, the aircraft supporting structure, and all connectors. Verification of the strength, stiffness, and durability of the galley attendant seats to withstand flight loads for the defined usage shall be by _____.

4.2.3.7 Verification of lavatory-unique requirements. The ability of the lavatory occupant to perform the required tasks and operate the installed equipment shall be verified by _____.

4.2.3.7.1 Verification of lavatory fixtures. The functional adequacy of the installed fixtures shall be verified by _____. The design, number, and placement of lavatory electrical outlets and the ability of the ventilation system to remove the odors and dispose of them to the proper location shall be verified by _____.

4.2.3.7.2 Verification of lavatory basins. The lavatory basins' operation, water supply, drainage, and maintenance shall be verified by _____.

4.2.3.7.3 Verification of lavatory annunciator panel. The operation of the lavatory annunciator panel and its ability to call crewmembers as required and warn passengers when it is necessary to return to their seat shall be verified by _____.

4.2.3.7.4 Verification of shaving. The ability of the lavatory to support shaving, including razor blade disposal, shall be verified by _____.

4.2.4 Verification of potable water system. The ability of the users to completely drain the system, both tanks and plumbing, by gravity shall be verified by _____. The ability of the system to maintain the operating pressure and withstand the filling pressure shall be verified by _____.

4.2.4.1 Verification of potable water plumbing. The distribution of the potable water shall be verified as described in 4.2.1.1.2.1. The connectors' operation (including the cross connection spool) shall be verified by _____. This verification shall include an attempt to interconnect the potable and liquid waste systems at all connectors. The system material and routing shall be verified by _____. Switching between supply tanks, aircraft potable water connectors interconnection, and emergency shutoff shall be verified by _____. The pressure relief valve(s) should be verified by a _____.

4.2.4.2 Verification of potable water tanks. The adequacy of the surge preventors, cleaning accesses and openings, carrying handles, retention, fill line check valve, and supply control shall be verified by _____. The performance of the insulation and interior corners shall be verified by _____.

4.2.4.3 Verification of potable water pressurization system. _____.

4.2.4.4 Verification of potable water treatment. The ability of the ASWMS potable water system to meet the requirements of *AFR 161-44* shall be verified by _____.

4.2.5 Verification of construction

4.2.5.1 Verification of materials, processes, and parts

4.2.5.1.1 Verification of materials and processes. The ability of the ASWMS materials to meet the operational and maintenance requirements of the system shall be verified by _____. The acceptability of the structural properties shall be verified by _____. The ability of required removable modules, equipment devices, or parts to withstand periodic high temperature and pressure cleaning with cleaning and sanitization agents shall be verified by _____. The absence of hazardous materials and processes; of processes or materials prohibited by federal, state, or local laws; of materials nutritious to fungus; and of materials which may be degraded due to exposure to aircraft fluids, disinfectants, cleaning or sanitization agents, or pressurized cleaning processes shall be verified by _____. The sealing of all edges, cutouts, or holes in honeycomb- or sandwich-type panels shall be verified by _____.

4.2.5.1.1.1 Verification of materials in contact with food and/or water. The absence of materials in contact with any food, water, or other drink that may contain or pass any odor, flavor, or hazardous or toxic chemicals; that will support chemical reactions due to this contact; that will support the growth of fungus; that attracts insects; that may etch, pit, crack, or have any other structural, visual, or performance deterioration due to this contact; or that is hygroscopic shall be verified by _____. The compatibility of potable water line materials with super chlorinated water shall be verified by _____.

4.2.5.1.1.2 Verification of materials in contact with human or liquid wastes. The absence of aluminum or porous materials, the use of acidproof materials, the radius of corners, and the flexible lines (including the lack of convolutions) shall be verified by _____.

4.2.5.1.1.3 Verification of flammable materials. The density and toxicity of the smoke produced when the material is burned shall be verified by _____. The burn resistance and/or self-extinguishing capability of the materials shall be verified by _____. The flame time, burn length, and dripping flame time of textile materials shall be verified by _____.

4.2.5.1.1.4 Verification of corrosion control. The ability of the ASWMS to control corrosion in the environments of 3.2.4 or due to contact with waste or sustenance material shall be verified by _____.

4.2.5.1.1.5 Verification of surfaces. The cleanability; scuff, chip, dent, and scratch resistance; non-skid capability; and non-susceptibility to cracking, chipping, scaling, or eroding due to age or extremes of environmental conditions of all surfaces shall be verified by _____. The presence and effectivity of kickplates shall be verified by _____.

4.2.5.1.2 Verification of parts. The ability to use commercial components to replace failed or obsolete parts, the use of modularity in the design, the ability of the remainder of the ASWMS to function with parts or modules removed, and the use of standard parts shall be verified by _____.

4.2.5.1.2.1 Verification of radii. The use of radii on all corners and edges shall be verified by _____.

4.2.5.1.2.2 **Verification of retention and latches.** The adequacy of the retention devices and systems design shall be verified by _____.

4.2.5.1.2.3 **Verification of joints.** The joints' construction and performance shall be verified by _____.

4.2.5.1.2.4 **Verification of removable panels, doors, drawers, and work surfaces.** The construction and performance of panels, doors, drawers, and work surfaces shall be verified by _____.

4.2.5.2 **Verification of spill control.** The ability of work surfaces and equipment to capture accidental spills, condensation, overflows, or to seal leakages shall be verified by _____.

4.2.5.3 **Verification of lighting.** The lighting at all work surfaces and control panels shall be verified by _____. The replacement of lighting shall be verified by _____. The ability to provide this light without shadows shall be verified by _____. Thermal protection for fluorescent lighting ballast shall be verified by _____.

4.2.5.3.1 **Verification of lighting, emergency.** The illumination magnitude at the required positions and the automatic operation shall be verified by _____.

4.2.5.3.2 **Verification of light fixture, normal.** The illuminance, location, and control of normal lighting shall be verified by _____.

4.2.5.4 **Verification of electrical distribution.** The capacity of the electrical power system and its compatibility with the aircraft electrical power system shall be verified by _____. The design of the electrical connections to the air vehicle shall be verified as described in 4.6.1.6.1. The insulation resistance shall be verified by measuring the resistance when exposed to _____ Volts DC for _____ minutes between all mutually isolated circuits. The ability of the ASWMS assemblies to withstand high voltages as required shall be verified by _____. The electrical grounding of the ASWMS shall be verified by _____. Protection of electrical equipment from sources of hazard shall be verified by _____.

4.2.5.4.1 **Verification of electrical control panels.** The location, function, controls, and indicators of the control panel for the ASWMS equipment shall be verified by _____.

4.2.5.4.2 **Verification of electrical utility outlets.** The placard at each outlet and the location and design of all electrical outlets shall be verified by _____. The operation of the self-testing circuit breaker at each utility outlet shall be verified by _____.

4.2.5.4.3 **Verification of electrical power wiring.** The wiring type, size, insulation, and bundles; the routing placard in each compartment and on major assemblies; and the length of the wiring to the aircraft connections shall be verified by _____.

4.2.5.5 **Verification of noise effects on personnel.** Verification of acoustical noise levels shall be in accordance with the requirements of *MIL-STD-1789* or _____.

4.2.5.6 **Verification of structural integrity.** The structural integrity of the _____ secondary aircraft structure elements of the ASWMS shall be verified by _____. The structural integrity of the remaining elements shall be verified by _____.

4.2.6 Verification of environmental requirements. Verification that the ASWMS will withstand without degradation and will operate during exposure to the environments of an equipment life cycle shall be accomplished by a combination of environmental measurement, analysis, and test. Analyses and/or tests shall be conducted to account for simultaneous application of environmental stresses (e.g., simultaneous application of vibration, temperature, and humidity). Test methods shall be tailored with regard to equipment size and configuration as well as environmental exposure. Wherever analysis data are not available to define environments adequately, direct measurement of the environment(s) must be accomplished.

4.2.6.1 Verification of environmental stress screening (ESS). The ASWMS environmental analysis and test process shall include ESS environmental stresses. Further, exposure to maximum ESS stress level(s) and duration(s) shall be the initial element of all environmental verification tests.

4.2.6.2 Verification of low pressure (altitude). Verification that the ASWMS will withstand without degradation and operate during exposure to the low pressure environments of an equipment life cycle shall be accomplished by _____. Verification shall be accomplished as follows: _____.

4.2.6.3 Verification of temperature. Verification that the ASWMS will withstand without degradation and operate during exposure to the temperature environments of an equipment life cycle shall be accomplished by _____. Verification shall be accomplished as follows: _____.

4.2.6.4 Verification of solar radiation. Verification that the ASWMS will withstand without degradation and operate during exposure to the solar radiation environments of an equipment life cycle shall be accomplished by _____. Verification shall be accomplished as follows: _____.

4.2.6.5 Verification of rain. Verification that the ASWMS will withstand without degradation and operate during exposure to the rain environments of an equipment life cycle shall be accomplished by _____. Verification shall be accomplished as follows: _____.

4.2.6.6 Verification of humidity. Verification that the ASWMS will withstand without degradation and operate during exposure to the humidity environments of an equipment life cycle shall be accomplished by _____. Verification shall be accomplished as follows: _____.

4.2.6.7 Verification of fungus. Verification that the ASWMS will withstand without degradation and operate during exposure to the fungus environments of an equipment life cycle shall be accomplished by _____. Verification shall be accomplished as follows: _____.

4.2.6.8 Verification of salt fog. Verification that the ASWMS will withstand without degradation and operate during exposure to the salt fog environments of an equipment life cycle shall be accomplished by _____. Verification shall be accomplished as follows: _____.

4.2.6.9 Verification of sand and dust. Verification that the ASWMS will withstand without degradation and operate during exposure to the sand and dust environments of an equipment life cycle shall be accomplished by _____. Verification shall be accomplished as follows: _____.

4.2.6.10 Verification of explosive atmosphere. Verification that the ASWMS will withstand without degradation and operate during exposure to the explosive atmosphere environments of an equipment life cycle shall be accomplished by _____. Verification shall be accomplished as follows: _____.

4.2.6.11 Verification of acceleration. Verification that the ASWMS will withstand without degradation and operate during exposure to the acceleration environments of an equipment life cycle shall be accomplished by _____. Verification shall be accomplished as follows: _____.

4.2.6.12 Verification of vibration. Verification that the ASWMS will withstand without degradation and operate during exposure to the vibration environments of an equipment life cycle shall be accomplished by _____. Verification shall be accomplished as follows: _____.

4.2.6.13 Verification of acoustic noise exposure. Verification that the ASWMS will withstand without degradation and operate during exposure to the acoustic noise environments of an equipment life cycle shall be accomplished by _____. Verification shall be accomplished as follows: _____.

4.2.6.14 Verification of shock. Verification that the ASWMS will withstand without degradation and operate during exposure to the shock environments of an equipment life cycle shall be accomplished by _____. Verification shall be accomplished as follows: _____.

4.2.6.15 Verification of gunfire. Verification that the ASWMS will withstand without degradation and operate during exposure to the gunfire environments of an equipment life cycle shall be accomplished by _____. Verification shall be accomplished as follows: _____.

4.2.6.16 Verification of other environments. Verification that the ASWMS will withstand without degradation and operate during exposure to the other environments of an equipment life cycle shall be accomplished by _____. Verification shall be accomplished as follows: _____.

4.3 Verification of product integrity. The ASWMS shall be verified to the integrity program requirements tailored by 3.3, and incorporated into the system specification.

4.4 Verification of safety. The compliance with *MIL-STD-882* shall be verified by _____. Incorporation of hand holds shall be verified by _____. Design and construction of fire containment areas shall be verified by _____.

4.5 Verification of human engineering. _____.

4.5.1 Verification of labels and placards. _____.

4.5.2 Verification of component lifting. _____.

4.5.3 Verification of anthropometry. _____.

4.5.4 Verification of touch temperature. The touch temperature of all exposed surfaces shall be verified by test. Temperature measurements shall be taken after assurance that the component under test is fully functional and the maximum surface temperature has been achieved during normal operation and under normal conditions.

4.5.5 Verification of training. Incorporation of required operation and maintenance training features shall be initially verified by analysis of system design and finally through functional and physical configuration audits. Incorporation of training use in reliability and duty-cycle calculation shall be verified through the reliability program. If a training system is being acquired under the contract, testing of the training features of the onboard ASWMS equipment will be as specified in the training system specification.

4.6 Verification of interface requirements

4.6.1 Verification of aircraft interfaces

4.6.1.1 Verification of electromagnetic effects (EME). The electromagnetic effects design requirements for the ASWMS shall be verified in accordance with the methods for verification contained in *MIL-STD-1818*, Section 5.

4.6.1.2 Verification of electrostatic discharge (ESD). The ASWMS shall be subjected to a _____ picofarad capacitor charged to the required voltage and discharged through a _____ ohm resistor connected in series between the sensor contacts. The contact points shall then be reversed, changing polarity, and the test repeated. The ASWMS shall meet its requirements after this exposure.

4.6.1.3 Verification of electrical power requirements. Compliance of the ASWMS with the requirements of 3.6.1.3 shall be verified by analyses and tests as follow: _____.

4.6.1.4 Verification of weight and moment effects. The maximum weight of the ASWMS shall be verified by _____.

4.6.1.5 Verification of loading restrictions. The verification of any partial assembly of the ASWMS after loading onboard the aircraft, loading of removable units through existing hatches or cargo doors, and hoisting and/or forklift operations shall be by _____. The winch operations and the rolling of the ASWMS on the aircraft rail-roller system and on paved aircraft taxiways shall be verified by _____. Attachments for the ASWMS to the air vehicle shall be verified by _____.

4.6.1.6 Verification of connectors. The presence and operation of a valve in all liquid lines between the connector and the system and of a leakproof cap on the connector shall be verified by _____. The inability to connect potable water hoses and connectors to the liquid waste hoses or connectors; the flexibility and loads induced by all hoses or electrical lines; and the storage of all hoses and connectors for connection of the ASWMS to the aircraft or support service systems shall be verified by _____.

4.6.1.6.1 Verification of electrical connectors. The capacity, location, size, and type of the electrical connectors to the ASWMS shall be verified by _____. The length of the electrical cord and its stowage, the connecting operation, and the non-obstruction of passageways and equipment by the connected cord shall be verified by _____.

4.6.1.6.2 Verification of ventilation connections. Connections for all exterior vents and the forces and moments these connections can withstand shall be verified by _____.

4.6.1.6.3 Verification of ground servicing connectors. Verification that potable water service connections are not located in the same box, area, or space and are not downstream from any liquid or human waste service connections or overboard dump outlets shall be by _____. The adequacy of all operating instructions shall be verified by _____. The performance of the servicing valve, connector, and cap should be by _____.

4.6.1.6.3.1 Verification of liquid waste service connections. Liquid waste servicing quick disconnects, hose length, connection to ground services, drainage of all liquids and solids, disinfectant addition, rinse, and other operation shall be verified by _____.

4.6.1.6.3.2 Verification of potable water service connection. Potable water servicing quick disconnects, hose length, operating instructions, and overflow outlets shall be verified by _____. Inability to connect the potable water system to the waste handling system, hoses, and connectors shall be verified by _____.

4.6.1.7 Verification of structural interface. The removal and replacement of removable ASWMS equipment and the mounting of removable ASWMS units to the aircraft shall be verified by _____.

4.6.1.8 Verification of clearances, exits, hatches, and compartment access. Access to emergency and normal hatches or compartments with doors, drawers, and extending, sliding, or folding surfaces in any position (open, closed, unfolded, etc.) shall be verified by _____.

4.6.1.9 Verification of environmental control system interface. The ASWMS area ventilation shall be verified by _____.

4.6.1.10 Verification of escape system interface. The ASWMS shall be integrated with the escape system so egress from the aircraft under emergency conditions is not impeded.

4.6.2 Verification of other interfaces

4.6.2.1 Verification of ground service carts. The compatibility of the ASWMS with the required ground service carts for the support of toilets, potable water filling, power, disassembly for cleaning, sanitization, or repair shall be verified by _____.

4.6.2.2 Verification of ground stowage. The storage capability, including the use of a weather cover, shall be verified by _____.

4.6.2.3 Verification of insulated food transporters. The design, construction, function, operation, and storage of any food transporter shall be verified by _____.

5. PACKAGING

5.1 Packaging requirements. All deliverable items shall be prepared for shipment as directed by the acquisition activity.

6. NOTES (This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. The ASWMS being procured under this effort is intended for use onboard the _____ (list aircraft) in the _____ (list compartments) for use by _____ (list the particular crewmembers or passengers). This system is intended to provide for the management of _____ (list the types of sustenance or waste).

6.2 Acquisition requirements. Acquisition documents must specify the following:

a. Title, number, and date of the specification.

b. Issue of the *DoDISS* to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1 and 2.2).

6.3 Consideration of data requirements. The following data requirements should be considered when this specification is applied on a contract. The applicable Data Item Descriptions (DID's) should be reviewed in conjunction with the specific acquisition to ensure that only essential data are requested/provided and that the DID's are tailored to reflect the requirements of the specific acquisition. To ensure correct contractual application of the data requirements, a Contract Data Requirements List (DD Form 1423) must be prepared to obtain the data, except where *DOD FAR Supplement 27.475-1* exempts the requirement for a DD Form 1423.

Reference Paragraph	DID Number	DID Title	Suggested Tailoring

(Enter the appropriate DID's for the particular ASWMS under development. Include all the listed information, including Reference Paragraph Number, DID Number, DID Title, and Suggested Tailoring.)

The above DID's were those cleared as of the date of this specification. The current issue of *DOD 5010.12-L, Acquisition Management Systems and Data Requirements Control List (AMSDL)*, must be researched to ensure that only current, cleared DID's are cited on the DD Form 1423.

6.4 Definitions. For the purpose of this specification, the following definitions apply.

AC	alternating current
AFGS	Air Force Guide Specification
AFOSH	Air Force Occupational Safety and Health
AFR	Air Force Regulation
AGARD	Advisory Group for Aerospace Research and Development
AGC	Automatic Gain Control
AIR	Aerospace Information Report
AM	amplitude modulated
amps	short form of amperes—a unit of measure for electrical current
AMS	Aerospace Material Specification
AMSDL	Acquisition Management Systems and Data Requirements Control List
ARP	Aerospace Recommended Practise
AS	Aerospace Specification
ASTM	American Society for Testing and Materials
ASWMS	Airborne Sustenance And Waste Management Systems
CFR	Code of Federal Regulations
cm^3	cubic centimeter
dB	decibel
dB(A)	A-weighted scale of decibels of noise, as defined in *MIL-STD-1789*
DC	direct current
DoDISS	*Department of Defense Index of Specifications and Standards*
dry ice	frozen carbon dioxide—CO_2 (-69.9°F)
DVs	Distinguished Visitors
EMC	electromagnetic compatibility
EMI	electromagnetic interference
EPS	electrical power system

ESD	electrostatic discharge
ESS	Environmental Stress Screening
F	Fahrenheit--a unit of measure for temperature
FAR	Federal Aviation Regulation
G	gravity—a unit of acceleration measurement equivalent to 32 feet per second per second
Hz	Hertz—a unit of measure for frequency, equal to one cycle per second
ILS	Instrument Landing System
inWg	unit of pressure measurement where inWg = (0.03613) · psig
mΩ	megohm
mA	milliampere
microwave	electromagnetic radiation at frequencies above 1000 MHz
ms	millisecond
ODC	ozone depleting chemical
ODP	ozone depletion potential
OSHA	Occupational Safety and Health Administration
psi	pounds per square inch
psia	pounds per square inch absolute
psid	pounds per square inch difference
psig	pounds per square inch referenced to sea level altitude
REO	Responsible Engineering Office
RF	radio frequency
SAE	Society of Automotive Engineers
SPL	sound pressure level
TDE	Total Daily Exposure—a measure of noise severity
TSRA	Training System Requirements Analysis
USDA	United States Department of Agriculture
USPHS	US Public Health Service
Volts	unit of measure for electrical potential energy
Watts	unit of measure for electrical power—for direct current it is equal to the current in amperes times the voltage.
wet ice	frozen water—H_2O (32.2°F)

6.5 Subject term (key word) listing

aircraft
feces
food
galley
heating
lavatory
medical waste
microwave
refrigeration
refuse
urine
water

6.6 Responsible engineering office (REO). The office responsible for development and technical maintenance of this specification is ASC/ENECE, Wright-Patterson AFB OH 45433-6503. Requests for additional information or assistance on this specification can be obtained from ASC/ENECE, Wright-Patterson AFB OH 45433-6503, DSN 785-7325, Commercial (513) 255-2165. Any information obtained relating to Government contracts must be obtained through contracting officers.

Custodian:
Air Force - 11

Preparing activity:
Air Force - 11

(Project 15GP-F105)

APPENDIX

SUSTENANCE AND WASTE MANAGEMENT SYSTEMS, AIRBORNE

HANDBOOK FOR

10. SCOPE

10.1 General. This appendix provides rationale, guidance, lessons learned, and instructions to tailor Sections 3 and 4 of the basic specification (*AFGS-87267*) for a specific application.

10.2 Purpose. The purpose of this appendix is to provide information to assist the Government procuring activity or contractor in the use of *AFGS-87267*.

10.3 Use. By completing the blanks in the basic specification and by deleting inappropriate sections from it, the project engineer tailors it to meet particular operational needs of the USAF, as required by a specific design or development effort. This appendix is designed to assist the project engineer in accomplishing this task. Specific guidance for the completion of individual blanks is contained in those sub-paragraphs of the requirement or verification guidance with the same letter as the blank.

10.4 Format

10.4.1 Requirement/verification identity. Section 30 of this appendix parallels Sections 3 and 4 of the basic specification; paragraph titles and numbering are in the same sequence. Section 30 provides each requirement (Section 3) and associated verification (Section 4) as stated in the basic specification. Both the requirement and verification have sections for rationale, guidance, and lessons learned.

10.4.2 Requirement/verification package. Section 30 of this appendix has been so arranged that the requirement and associated verification is a complete package to permit addition to, or deletion from, the criteria as a single operation. A requirement is not specified without an associated verification.

10.5 Responsible engineering office (REO). The responsible engineering office for this appendix is the Crew Systems Branch, Crew and Escape Equipment Integration Section, ASC/ENECE, Wright-Patterson AFB OH 45433-6503, DSN 785-7325 or Commercial (513) 255-2165.

20. APPLICABLE DOCUMENTS

20.1 References. The documents referenced in this appendix are not intended to be applied contractually. Their primary purpose is to provide background information for the Government or contractor engineers responsible for developing the most appropriate performance values (filling in the blanks) for the requirements contained in the specification proper. Material from these documents should be included in the developed specification whenever practical; otherwise, the document may be listed, but the specific paragraphs to be followed must be specified.

20.2 Avoidance of tiering. Should it be determined that the references contained in this appendix are necessary for a Request for Proposal or a contract, excessive tiering shall be avoided by calling out only those portions of the reference which have direct applicability. It is a goal of the Department of Defense that the practice of referencing documents in their entirety be eliminated in order to reduce the tiering effect.

20.3 Government documents

20.3.1 Specifications, standards, handbooks, and regulations. The following specifications, standards, handbooks, and regulations form a part of this specification, to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the *Department of Defense Index of Specifications and Standards* (*DODISS*), and changes and supplements thereto, as cited in the solicitation (see 6.2). Unless otherwise indicated, copies of federal and military specifications, standards, handbooks, and regulations are available from the Standardization Documents Order Desk, Bldg 4D, 700 Robbins Avenue, Philadelphia PA 19111-5094.

SPECIFICATIONS

Federal

L-T-48	Tableware, Plastic
PPP-I-350	Individual Servings of Subsistence, Packaging of
A-A-697	Paper, Toilet
S-O-1425	Ovens, Microwave, Electric
A-A-2577	Cup, Disposable; Lid, Disposable Cup
A-A-2595	Cup, Disposable; Lid, Disposable Cup
A-A-50465	Oven, Microwave, Electric (600-900 Watt)
A-A-50466	Oven, Microwave, Electric (1800-2199 Watt)
A-A-52061	Dispenser, Cups, Cup Lids, and Drinking Straws

Military

MIL-S-2668	Seat, Passenger, Aft Facing, Transport Aircraft
MIL-W-5088	Wiring, Aerospace Vehicle
MIL-O-6438	(Cancelled) Oven, Food Warming, Electrically Heated, Type B-4
MIL-U-6632	Urinals, Stationary, Aircraft
MIL-E-7016	Electric Load and Power Source Capability, Aircraft, Analysis of
MIL-B-7525	Bracket, Hot Cups, Liquid, Electric
MIL-B-8571	Bag, Storage, Drinking Water
MIL-D-11309	Disinfectant, Food Service
MIL-M-13966	Meal, Precooked, Frozen

MIL-H-21303	Hot Cups, Liquid, Electric
MS 21391	Coupling End, 1 inch, Drinking Water Service, Aircraft, Standard Dimensions
MIL-S-25073	Seats, Aircraft
MIL-T-25186	Toilets, Aircraft, Chemical
MIL-J-25718	Jug, Insulated, Type CNU-2/C
MIL-G-25608	(Cancelled) Galley, Aircraft, Design of
MIL-L-26208	Lavatory Servicing Cart, Aircraft
MIL-C-26482	Connector, Electrical, (Circular, Miniature, Quick-Disconnect, Environment Resisting), Receptacles and Plugs, General Spec for
MIL-T-38010	Tank Pumping Unit, Aircraft Lavatory Servicing, Truck
MIL-B-38157	(Cancelled) Buffet-Lavatory Unit, Type A/B-37 S-1, Air Transportable
MIL-O-38205	Ovens, Food Warming, Electric, HDU-2/B and HDU-23/B
MIL-E-38453	(Cancelled) Environmental Control, Environmental Protection, and Engine Bleed Air Systems, Aircraft, General Specifications for
MIL-L-38779	Lavatories and Accessories, Aircraft
MIL-F-43231	Food Packet, Survival, General Purpose
MIL-B-43444	Bag, Plastic,Contaminated Waste Disposal
MIL-M-44343	Meal Module, Tray Pack, 18 Soldier, Assembly of
MIL-C-44352	Condiments, Plastic Collapsible Tube Pack
MIL-S-58095	Seat Systems, Crash Resistant, Non-Ejection, Aircrew, General Specification for
MIL-T-83018	Truck, Tank A/S32A
MIL-G-83063	(Cancelled) Galley, Aircraft, General Requirement for
MIL-B-83665	Bag, Pilot Relief (Male)
MIL-O-83993	Ovens, Food Warming, Electrical (12 Meal)
MIL-F-87168	Fire and Explosion Hazard Protection Systems, Aircraft, General Specification for
AFGS-87221	Aircraft Structural Integrity Requirements
AFGS-87226	Oxygen Systems, Aircraft, General Specification
AFGS-87234	Personal Protective Equipment, Aircrew
AFGS-87235	Emergency Escape, Aircraft
AFGS-87240	Lighting Equipment, Airborne, Interior and Exterior
MIL-A-87244	Requirements for the Integrity of Avionics/Electronics
AFGS-87249	Mechanical Equipment & Subsystems, Requirements for the Integrity of (MECSIP)

STANDARDS

Federal

OSHA 1910.1000

Military

MIL-STD-12	Abbreviations for use on Drawings, and in Specifications, Standards and Technical Documents
AFOSH STD 127-300	Food Service Operations
AFOSH STD 161-9	Exposure to Radiofrequency Radiation
MIL-STD-210	Climatic Information to Determine Design and Test Requirements for Military Systems and Equipment
MIL-STD-454	Electronic Equipment, Standard General Requirements for

MIL-STD-704	Aircraft Electrical Power Characteristics
MIL-STD-781	Reliability
MIL-STD-783	Legends for use in Aircraft Stations and on Airborne Equipment
MIL-STD-810	Environmental Test Methods and Engineering Guidelines
MIL-STD-882	System Safety Program
MIL-STD-909	Sanitation Standards for Food Storage Facilities
MIL-STD-1472	Human Engineering Design Criteria for Military Systems, Equipment, and Facilities
MIL-STD-1530	Aircraft Structural Integrity Program (ASIP)
MIL-STD-1568	Materials and Processes for Corrosion Prevention and Control
MIL-STD-1587	Materials and Processes Selection
MIL-STD-1686	Electrostatic Discharge Control Program for the Protection of Electrical and Electronic Parts, Assemblies and Equipment
MIL-STD-1776	Aircrew Station and Passenger Accommodation
MIL-STD-1789	Sound Pressure Levels in Aircraft
MIL-STD-1800	Human Engineering Performance Requirements for Systems
MIL-STD-1803	Software Development Integrity Program (SDIP)
MIL-STD-1807	Crash Survivability of Aircraft Personnel
MIL-STD-1818	Electromagnetic Effects Requirements for Systems

HANDBOOKS

AFSC DH 1-2	General Design Factors
AFSC DH 1-3	Human Factors Engineering
AFSC DH 2-2	Crew Stations and Passenger Accommodations
AFSC DH 2-8	Life Support
USPHS Handbook 308	Handbook on Sanitation of Airlines
MIL-HDBK-237	Electromagnetic Compatibility Management Guide for Platforms, Systems, and Equipment
MIL-HDBK-263	Electrostatic Discharge Control Handbook for the Protection of Electrical and Electronic Parts, Assemblies and Equipment

REGULATIONS

TO 13A20-4-1	Buffet Lavatory Unit Type A/B 37S-1
9 CFR Part 308	Sanitation
14 CFR Part 23-25	Airworthiness Standards
14 CFR Part 121	Certification and Operations: Domestic, Flag and Supplemental Air Carriers and Commercial Operators of Large Aircraft
AFR 19-15	Reduction in the Use of Chlorofluorocarbons, Halons, and Other Substances that Deplete Stratospheric Ozone
21 CFR Part 1250	Interstate Conveyance Sanitation
FAR Part 25	Airworthiness Standards: Transport Category Aircraft
29 CFR Part 1910.1000	Occupational Safety and Health Regulations
40 CFR Part 25	Federal Aviation Administration
40 CFR Part 141	Primary Drinking Water Regulations
40 CFR Part 259	Standards for the Tracking and Handling of Medical Waste
42 CFR Part 300f	The Safe Water Act
49 CFR Part 172	Hazardous Materials Tables, Packaging and Labels
71 USC 1280	Clean Air Act
USDA List	Proprietary Substances and Nonfood Compounds Authorized for Use under USDA Inspection and Grading Programs

AFR 71-4/TM 38-250/ NAVSUP PUB 505/ MCO P4030.19E/DLAM 4145.3 Joint Regulation	Preparation of Hazardous Material for Military Air Shipment
FAR Part 121	Certification and Operations: Domestic, Flag and Supplemental Air Carriers and Commercial Operators of Large Aircraft
AFR 146-7	Food Service Management
AFR 146-15	Flight Food Service Management
AFR 161-26	Control of Foodborne Illnesses
AFR 161-34	Public Facility Sanitation
AFR 161-35	Hazardous Noise Exposure
AFR 161-44	Management of the Drinking Water Surveillance Program

20.3.2 ***Other Government documents, drawings, and publications.*** The following other Government documents, drawings, and publications form a part of this specification to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation. Copies of other Government documents, drawings, or publications required in connection with this acquisition should be obtained from the contracting activity or the contracting officer.

71 USC 1280	The Clean Air Act
AFWAL-TR-81-4186	Bilge Inhibitors
CALSPAN-ND-5296-M-1	Characterization Studies of Wastewater Generated from Military Installations
DOD Directive 6050.9	
FAA TR AC-213-7	Microwave Oven Radiations
NATICK/TR-90/013	Cold Water Cleaning and Sanitizing of Kitchenware in the Field
NATICK/TR-91/033L	Flight Feeding Concepts for the Navy
PB-218 418	The Public Health Acceptability of In-Flight Waste Disposal
SAM-TR-65-37	Disease Transmission by Aircraft

20.4 **Non-Government publications.** The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted are those listed in the issue of the *DODISS* cited in the solicitation. Unless otherwise specified, the issues of those documents not listed in the *DODISS* are the issues cited in the solicitation. Non-Government publications are normally available from the organizations that prepare or distribute the documents. These documents may also be available in or through libraries or other informational services.

The Montreal Protocol

AGARD-CP-169	Aeromedical Implications of Recent Experience with Communicable Disease

(Advisory Group for Aerospace Research and Development proceedings are available from AGARD, North Atlantic Treaty Organization, 7 rue Ancelle, 92200 Neuilly sur Seine, France.)

ASCC AIR STD 25/16	Replenishment Connections for Potable (Drinking) Water
ASCC AIR STD 61/39	Maximum Permissible Temperatures of Materials for Contact with Bare Skin

(Air Standardization Coordinating Committee standards are available from ASCC, c/o HQ USAF/XOXX(ISO), Washington DC 20330-5058.)

Aviation Space and Environmental Medicine; Oct 1976; Dr. A.S.R. Peffers; "Food Sanitation and Air Safety"
(Aerospace Medical Association reprints are available from ASMA, 320 S. Henry Street, Alexandria VA 22314.)

ASTM E145-68	Gravity Convection and Forced-Ventilation Ovens
ASTM F446-85	Grab Bars and Accessories Installed in the Bathing Area
ASTM F1317-90	Calibration of Microwave Ovens

(American Society for Testing & Materials documents are available from ASTM, 1916 Race Street, Philadelphia PA 19103-1187.)

ISBN 0-87765-315-1 Fire Protection Handbook
(This handbook is available from the National Fire Protection Agency, Battery March Park, Quincy MA 02269.)

ISO 450 Aircraft Connection for Water of Drinking Quality
(International Organization for Standardization documents are available from International Organization for Standardization, 3 rue de Varembe, 1211 Geneve Switzerland.)

MITRE Corp. "Pollution Prevention and the Acquisition of Aircraft Weapon Systems" WP-92W000003
(This document is available through ASC/EME, Major Elves, Wright-Patterson AFB OH 45433-6503.)

NSF 1	Soda Fountain and Luncheonette Equipment
NSF 2	Food Service Equipment
NSF 4	Commercial Cooking and Hot Food Storage Equipment
NSF 5	Hot Water Generating and Heat Recovery Equipment
NSF 6	Dispensing Freezers
NSF 7	Food Service Refrigerators and Storage Freezers
NSF 8	Commercial Powered Food Preparation Equipment
NSF 12	Automatic Ice Making Equipment
NSF 13	Refuse Compactors and Compactor Systems
NSF 14	Plastics Piping Components and Related Materials
NSF 18	Manual Food and Beverage Dispensing Equipment
NSF 21	Thermoplastic Refuse Containers
NSF 30	Cabinetry and Laboratory Furniture for Hospitals
NSF 35	Laminated Plastics for Surfacing Food Service Equipment
NSF 36	Dinnerware
NSF 40	Individual Aerobic Wastewater Treatment Plants
NSF 41	Wastewater Recycle/Reuse and Water Conservation Devices
NSF 42	Drinking Water Treatment Unit - Aesthetic Effects
NSF 49	Class II (Laminar Flow) Biohazard Cabinetry
NSF 51	Plastic Materials and Components Used in Food Equipment
NSF 52	Supplemental Flooring
NSF 53	Drinking Water Treatment Units - Health Effects
NSF 55	Ultraviolet Microbiological Water Treatment Systems
NSF 58	Reverse Osmosis Drinking Water Treatment Systems
NSF 59	Food Carts
NSF 60	Drinking Water Treatment Chemicals - Health Effects
NSF 61	Drinking Water System Components - Health Effects
NSF 62	Drinking Water Distillation Systems

NSF Criteria C-2	Special Equipment and/or Devices (Food Service Equipment)
NSF Criteria C-9	Evaluation of Special Processes, Components, or Devices Used in Treating Wastewater

(National Sanitation Foundation standards are available from NSF, 3475 Plymouth Road, PO Box 1468, Ann Arbor MI 48106.)

SAE ARP 695	Galley Installations
SAE ARP 712	Galley Lighting
SAE ARP 731	General Requirements for Application of Vapor Cycle Refrigeration Systems for Aircraft
SAE AIR 1168/3	Aerothermodynamic Systems Engineering and Design
SAE ARP 1315	Lavatory Installation
SAE AS 1426	Standard Galley System Specification
SAE AMS 1450	Disinsectant (Insecticide), Aircraft
SAE ARP 1972	Recommended Measurement Practices and Procedures for EMC Testing
SAE ARP 4001	Lavatory Smoke Detectors
SAE ARP 4171	Safety Considerations of Food and Beverage Service Carts
SAE ARP 4242	

(Society of Automotive Engineers documents are available from SAE International, 400 Commonwealth Drive, Warrendale PA 15096.)

UL 923	Microwave Cooking Appliances

(Underwriters Laboratories standards are available from Underwriters Laboratory Inc., 333 Pfingston Road, Northbrook IL 60062.)

20.5 **Order of precedence.** In the event of a conflict between the text of this specification and the references cited herein, the text of this specification shall take precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained and described in the solicitation.

30. REQUIREMENTS AND VERIFICATIONS

3.1 **System description.** The Airborne Sustenance and Waste Management Systems (ASWMS) shall provide support for personnel in aircraft. The ASWMS is not intended to support ground, nautical, or space operations, equipment, or systems. The ASWMS shall support ___(a)___ aircrew members, ___(a)___ passengers, and ___(b)___ other personnel in the ___(c)___ aircraft. The ASWMS shall provide a source of ___(d)___ (liquid and/or solid) food service and means of ___(e)___ (liquid and/or solid) human, medical, and refuse waste removal and ___(f)___ other waste control, while in flight. The ASWMS shall provide the above services for a flight duration of ___(g)___ hours and an onboard duration of ___(h)___ hours, including ___(i)___ meal services, ___(j)___ (with or without) reservicing. The ASWMS ___(k)___ (shall/shall not) provide the following sustenance and waste management services while the air vehicle is on the ground ___(k)___ (with/without) direct support from the ___(k)___ support equipment. The ASWMS shall be usable by crewmembers wearing ___(l)___ personal equipment and passengers wearing ___(l)___. The ASWMS shall consist of the following functional subsystems:

a. Sustenance management systems. The sustenance management systems consist of the equipment and systems required to store, prepare, serve, ingest, clean up, and sanitize after sustenance, nourishment, and refreshment for crewmembers and passengers. Requirements for this subsystem are discussed in 3.2.1.

b. Waste management systems. The waste management systems consist of the equipment and systems necessary for the hygienic and sanitary control, storage, and removal of waste material. This includes ___(e)___ (human liquid and/or solid waste, medical waste, sustenance preparation, and service waste and/or hazardous waste material). Requirements for this subsystem are discussed in 3.2.2.

c. Sustenance or waste management spaces and compartments. These spaces and compartments are described and discussed in 3.2.3.

d. Potable water systems. The potable water systems consist of all equipment necessary to store, treat, sanitize, and serve potable (or drinking) water to crewmembers or passengers. Requirements for this subsystem are discussed in 3.2.4.

REQUIREMENT RATIONALE (3.1)

The ASWMS must be able to provide sufficient sustenance and waste management for manned aircraft to perform their designed missions without interruption or disruption due to unmet biological needs of the crewmembers or passengers. This requires adequate liquid for drinking, food for eating, and facilities for the elimination of urine and, whenever possible and/or supportable, feces. Furthermore, the ASWMS should be designed for the support of additional missions by the aircrew, aircraft, and/or passengers. This system accomplishes all this by providing sufficient sustenance and waste management to permit all attached personnel to perform all required flight and postflight missions immediately, such as parachuting into non-secure areas, search and rescue, rapid aircraft turnaround, etc.

REQUIREMENT GUIDANCE

The ASWMS is a design consideration for all types of aircraft: tactical, strategic, transport, medical, and/or special purpose. Although a major consideration for large, multicrew and/or passenger aircraft, this requirement is not limited to these systems. Sustenance and waste management is a basic design issue for even the smallest manned platform. Ferry flights, extended missions, air refuelling, and rapid ground turnaround all require some level of involvement from an ASWMS.

The ASWMS need not, and should not in all cases, be a fully equipped galley and/or lavatory. Rather, the system should contain just those elements necessary to support the missions of the particular air vehicle for which it is being developed. For example, the B-1 sustenance provisions consist of

a hot cup, a hot and a cold water jug (both with catch basins), a storage drawer (for meals and miscellaneous items), a drinking cup dispenser, and various controls, indicators, and timers. Extensive tailoring of the requirements of the ASWMS basic specification would be needed, and should be accomplished for use in an aircraft with missions similar to the B-1. For example, the section on ovens would not be used in a specification for the sustenance management systems of an aircraft like the B-1. Even greater tailoring would be needed for a fighter or attack air vehicle.

Commercial ASWMS equipment, which range from individual items of equipment (such as coffeemakers, trash compactors, toilets, etc.) to complete galley or lavatory systems, are readily available and should be considered for use wherever their performance meets the needs of the overall system. Considerable developmental cost savings can be realized by their use. Commercial ASWMS items and systems are designed, constructed, and verified to meet *Federal Aviation Regulation (FAR) Part 25, Airworthiness Standards: Transport Category Aircraft*, and *Part 121, Certification and Operations: Domestic, Flag and Supplemental Air Carriers and Commercial Operators of Large Aircraft*. Most of these devices are built to meet the *Society of Automotive Engineers Aerospace Standard (SAE AS) 1426, Standard Galley System Specification*; the *Society of Automotive Engineers Aerospace Recommended Practice (SAE ARP) 695, Galley Installation*; *SAE ARP 1315, Lavatory Installation*; and others). The primary source of detailed technical information is the individual manufacturer's design and compliance test data.

a. The number of personnel to be supported should be added here. The aircraft crewmembers should include all crew positions—pilot, navigator, defensive or offensive weapons operators, electronics systems operators, mission specialists, medical technicians, loadmasters, etc. The passengers should include all non-crew personnel carried during any design mission such as air transport, parachutists, patients, Distinguished Visitors (DVs), students, etc.

b. Other personnel should include those who will be on the aircraft during a design mission, but are not included in the first two categories. These categories should be deleted if there are no passengers and/or other personnel.

c. This blank should be completed with the type designation of the aircraft on which the ASWMS will be used. This vehicle will greatly influence the design and operation of the ASWMS.

1. Fighter or attack aircraft. Fighter and attack aircraft crewmembers are limited in their ability to move and must maintain control of their air vehicle at all times. Limited space within the cockpit prevents the integration of extensive suites of ASWMS equipment. The dynamic flight environment requires specific attention to the equipment performance during high accelerations. Close-fitting personal equipment further restrict the design and use of the ASWMS equipment. However, due to the nature of the vehicle and the fighter/attack aircraft missions, it is vital that the aircrew members be able to maintain high performance levels. This entails the ingestion of appropriate quantities of sustenance and elimination of urine as produced. To ignore these design considerations is to create situations where the crewmember and aircraft will be unnecessarily placed at risk when the crewmember attempts to use the ASWMS-type devices to perform necessary human functions, or when he attempts to operate while restraining himself from performing those human functions.

2. Bomber aircraft. Although the crewmembers in these aircraft may be free to leave their workstations during some phases of their mission, this is not always possible or desirable. In most cases, the aircraft is capable of integrating a significant amount of ASWMS equipment. This may be necessary for those aircraft with extended mission durations.

3. Transport aircraft. The crewmembers in these aircraft are not as severely limited in their ability to move or leave the operator's position. Consequently, some form of galley and lavatory are frequently appropriate. Aircraft designed to transport a significant number of passengers require a proportional increase in the size, complexity, and numbers of ASWMS equipment. This must be considered even when the transport of passengers is a low-level priority mission for the supported air vehicle. In these cases, the requirement may be met through the use of removable or temporary facilities. The design of aircraft used to transport DVs must ensure all aspects of the ASWMS' design meet the aesthetic needs of the personnel the system is intended to carry.

4. Specialized mission aircraft. Frequently, these are modified versions of the aircraft listed above or of civilian air vehicles. When this modification is performed, all aspects of the design missions of the supported aircraft must be considered during the ASWMS requirements development.

d. "Rules-of-thumb" previously used for the determination of the need for sustenance were that: 1) aircraft with onboard durations over 3 hr or aeromedical aircraft should provide liquid sustenance and 2) aircraft with onboard durations over 6 hr, transport and special mission aircraft with onboard durations over 16 hr, and aeromedical aircraft should provide solid sustenance.

e. "Rules-of-thumb" previously used for the determination of the need for waste management systems were that: 1) aircraft with onboard durations over 2 hr should have a human liquid waste (urine) management system and 2) aircraft with flight durations greater than 6 hr or with passengers or other personnel aboard during mission flights greater than 2 hr should have a human solid waste (feces) management system. Depending upon the personnel and the missions, air vehicles may also require the capability to manage vomitus, menstruate, and/or medical waste from human occupants.

f. Other waste generated while in flight should be controlled in a safe manner that facilitates removal when servicing is possible. This waste may include medical waste, sustenance preparation and service waste, and/or hazardous waste material.

g. The flight duration is the longest anticipated time in the air for all normal, emergency, contingency, and secondary missions.

h. The onboard duration is the longest possible time the crewmembers, passengers, and/or other personnel may be on board without the ability to exit the aircraft to ingest necessary drink or food or to relieve themselves. This should include anticipated times due to personnel, equipment, and cargo loading; flight delays for operations or weather; taxiing; runway clearance; mechanical delays; flight holds for DVs or Very Important Persons (VIPs); etc. The onboard duration includes the time in the air (the flight duration).

i. The number of meal services and the amount of potable water required are related to the onboard duration but may also be limited due to other extenuating factors, such as environmental conditions. For example, a design mission in a hot or dry climate may require more water than one in cooler climates. When multiple meals are necessary, they should not all be a full dinner but should be combinations of sandwich meals and dinners.

j. Depending upon the aircraft missions, reservicing of the ASWMS may be possible at some points in the design mission. If so, any restrictions on the reservicing should be stated.

k. Depending upon the design mission, the personnel involved, and the equipment available, the ASWMS may need to support the aircrew and passengers' sustenance and waste management needs for an extended

period of time while on the ground. Again depending upon these factors, the ASWMS may need to do this while the aircraft is not able to supply power for galley equipment. Additionally, lavatory waste tanks may require emptying due to any ground use. This may require rapid servicing immediately prior to flight.

l. Crewmembers should be able to use the ASWMS while wearing the most restrictive combination of personal equipment required for any air vehicle design mission. Unless the aircraft is designed for a specific passenger that wears a particular set of equipment/garments, the ASWMS should be safe for use by all passengers wearing common "street" clothing such as dresses, business suits, etc.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.1 System description verification. The ability of the ASWMS to support the required number and types of personnel for the duration of the design mission shall be verified by _____.

VERIFICATION RATIONALE (4.1)

Verifications must be performed to ensure the ASWMS will support the required number and type of personnel under the flight conditions imposed by the aircraft system's design missions.

Many of the performance verifications will require a carefully prepared and executed test program. However, the majority of the verifications for this system require a system-level demonstration program.

VERIFICATION GUIDANCE

This verification should be performed by a combination of analyses, inspections, and demonstration. However, the final proof of the system's ability to meet this requirement must consist of a full systems-level demonstration.

The human subjects used in this demonstration should be representative of the age, size, anthropometry, strength, and educational level of the personnel who will use the ASWMS in the operational fleet. Active duty USAF and/or USAF Reserve personnel may provide the most representative sample, if available.

It is also important that the durations, preparations, and supplies used in this evaluation are representative of those that will be used operationally. Many of the performances cannot be fully observed unless the demonstration is conducted in the airframe for which the ASWMS is being developed and the sustenance with which the system is designed to interface is used. In some cases, it may be necessary that the aircraft be engaged in the type of flight profiles it will be performing during the actual design missions.

Verification in a simulator is not recommended for many requirements, due to the need to evaluate the ASWMS' performance in the flight environment, including all anticipated maneuvers and unanticipated buffeting, turbulence, and other motions. However, it is understood that other constraints may require some verification be performed by simulation or mockup. If so, all interfaces with the ASWMS should be the same quality and quantity as those in the aircraft. Also, all constraints imposed by the aircraft (i.e., accesses and connectors) should be duplicated.

VERIFICATION LESSONS LEARNED

In the past, when mock-ups of galleys were used to simulate a particular function for verification of its performance, they were subsequently found to be a valuable asset for the training of future equipment maintainers and operators.

An example of how mockup evaluation should be carefully monitored was given by the B-1 sustenance provisions verification. During these demonstrations, difficulty testing the system's operation with the blackout curtain deployed was experienced due to the lighting being non-representative of that found in the actual aircraft. These verifications had to be deferred for test on the actual aircraft.

3.1.1 **Sanitation and hygiene.** The ASWMS shall meet the sanitation and/or hygiene requirements of _____.

REQUIREMENT RATIONALE (3.1.1)

The ASWMS must follow some established sanitation guidance to ensure the health and welfare of all ASWMS users, crewmembers, and passengers. The ASWMS must meet specific sanitation regulations to operate within certain geographic and political boundaries.

REQUIREMENT GUIDANCE

Poor design of equipment for sanitation or hygiene can have severe consequences in the operation of air vehicles. Dr. A.S.R. Peffers, in an article in the October 1976 issue of *Aviation, Space and Environmental Medicine*, listed the following six negative influences that poor food and waste handling equipment and methods may have on the operation of commercial air vehicles. Each of the following has a similar impact upon the successful completion of a mission by a military aircraft.

a. Due to the rapid onset of some types of food poisoning, crewmembers may be suddenly incapacitated with little, if any, warning.

b. Other types of food borne illnesses may create subtle, unobserved, and unrealized incapacitations which may affect crewmember performance during critical phases of flight.

c. Unhygienic disposal of food and waste products attracts birds to the aircraft servicing areas and they may strike critical air vehicle components or be ingested by the engines.

d. The same unhygienic disposal also attracts rats, which not only carry other pests, parasites, and diseases, but also may damage electrical power and control systems by gnawing through electrical insulation.

e. An acute outbreak of food poisoning among passengers may cause the air vehicle to divert to alternate airfields to which the crew may not be accustomed, which may not have as high a standard of landing aids, or which may severely impact the mission completion.

f. Wherever open food or waste is kept, flies may be attracted and may contaminate food intended for flight or for airfield canteens where both crew and passengers may eat.

For more details on the transmission of diseases by, in, and on aircraft, *SAM-TR-65-37* provides a thorough description of the consequences of food, water, waste, and human borne pathogens in aircraft and *AGARD CP-169* provides additional information on the transport of communicable diseases. There have been serious, major illnesses, such as typhoid, smallpox, and dysentery, which have affected the operations of both military and commercial aircraft. Diseases have been transferred within the air vehicle through the drinking water, food, cargo materials, crew, and passengers.

One or more of the sanitation guidelines listed below should be referenced, in accordance with the system's design missions:

a. United States Public Health Service, "*Handbook of Sanitation of Airlines, Handbook 308*", 1964, and applicable Supplements.

b. *Occupational Safety and Health Administration Standard 1910.1000.*

c. *Air Force Occupational Safety and Health Standards 161-3, 161-4, 161-5,* and *161-8.*

d. National Sanitation Foundation (NSF) Standards or Criteria. The NSF establishes performance and verification standards for a wide variety of equipment, devices, or systems which must be maintained in a sanitary condition to prevent the spread of disease or the ingestion of hazardous chemicals. Also, the foundation maintains a listing of equipment which has been tested and determined to meet their requirements. The designer should contact the foundation to determine the specific standards applicable to his design. These standards are listed in 20.4.

e. Code of Federal Regulations

1. *Federal Aviation Administration, 40 CFR Part 25*

2. *Standards for the Tracking and Handling of Medical Waste: 40 CFR Part 259*: defines medical wastes and handling and transport requirements for medical waste.

3. *Sanitation: 9 CFR Part 308*: establishes minimum sanitation requirements for facilities inspected by the Food Safety and Inspection Service (USDA)

4. *Interstate Conveyance Sanitation: 21 CFR Part 1250*: defines terms and establishes sanitation requirements for land and air interstate transport food service systems

5. *Hazardous materials tables, packaging and labels: 49 CFR Part 172*: defines hazardous materials and handling requirements

6. *Primary Drinking Water Regulations: 40 CFR Part 141*: defines the Environmental Protection Agency requirements for potable water.

f. *42 U.S.C. 300f Section 1412(b)(3)(A): The Safe Water Act*: provides Maximum Contaminant Levels and Maximum Contaminant Level Goals for known and anticipated drinking water contaminants.

g. *International Standards for Drinking Water*, World Health Organization

h. *NATICK/TR-90/013: Cold Water Cleaning and Sanitizing of Kitchenware in the Field*: provides information on adequate sanitization procedures for use when hot water is not available.

Although written primarily for food warehouse facilities, *MIL-STD-909* provides valuable guidance for the design of all food handling and stowage facilities. Of particular interest is an explanation of the Sanitation Compliance Rating (SCR) system for food storage facilities. This system contains several items which can be met only by early inclusion into the air vehicle design.

It should also be noted that sanitation requirements will affect the design of other ASWMS elements indirectly related to sanitation. A high level of precedence for sanitation and hygiene requirements must be established in the contractual requirements. Tradeoffs between the use of various design elements may hinge upon this requirement. For example, if no hot water is available, then additional sinks for soaking and rinsing and additional potable water tank volume for extra wash water may be required. The design impact of these additions may be greater than that of a small water heater for use during sanitation operations.

When sanitizing chemicals are intended for use with the ASWMS, they should be selected from those included in the *List of Proprietary Substances and Nonfood Compounds Authorized for Use under USDA Inspection and Grading Programs*. *Military Standard 909* recommends that when they are used, a test kit or other approved and accurate method of ascertaining the correct solution concentration is used should be readily available. The ASWMS designer should facilitate this by ensuring the designated storage is adequate for the test equipment and the proper test methods for the designed equipment is specified.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.1.1 Sanitation and hygiene verification. The ASWMS sanitary provisions shall be verified by _____.

VERIFICATION GUIDANCE (4.1.1)

In those cases where laws regulate the sanitary performance of the ASWMS equipment, the performance verification of the ASWMS is frequently also regulated.

The Underwriters Laboratory (UL) and NSF standards discussed above in the Requirement Guidance also contain extensive and detailed information on the appropriate verification requirements for each sanitation or hygiene requirement. Acceptable evidence of compliance with these standards is usually the use of the UL or NSF symbol on the device, listing of the equipment in the UL or NSF directories, or a certified test report from an independent testing facility.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2 **Performance requirements.** The ASWMS shall meet the following performance requirements under the conditions listed herein.

REQUIREMENT RATIONALE (3.2)

The ASWMS has design performances for which it is being procured. These are defined in the following requirements.

REQUIREMENT GUIDANCE

Examples of previous performance requirements are provided throughout the Requirement Guidance sections of this document. The data and information thus furnished are not intended for direct use without extensive tailoring. Each design mission in each aircraft and each location within an aircraft will demand an individually written performance requirement. All aspects of the intended life cycle use must be considered to ensure an adequate requirement.

See each of the following individual requirements for specific guidance.

REQUIREMENT LESSONS LEARNED

See each of the following individual requirements for specific lessons learned.

4.2 **Verification of performance requirements.** Unless otherwise noted, verification of the performance requirements shall be conducted at the standard conditions of _____ degrees F, _____ percent humidity, and _____ inWg barometric pressure. The maximum deviations from the specified test conditions are: _____ degrees F, _____ percent altitude, _____ percent humidity, _____ G's acceleration, _____ percent of the vibration frequency (or ±.50 Hz when below 25 Hz), _____ percent vibration amplitude, _____ voltage, _____ amperage, and _____ ohms. All numerical data shall be recorded at the level of accuracy and resolution of the measurement equipment utilized.

VERIFICATION RATIONALE (4.2)

The conditions under which the various verifications are conducted can affect the performance of the equipment. Rather than repeat the standard verification environment, it should be described here. Exceptions to these conditions for specific verifications should be described for each test, inspection, analysis, or demonstration.

VERIFICATION GUIDANCE

Details on the verifications required to certify equipment for domestic aeronautical use are contained in *14 CFR Parts 23 through 25.*

Wherever the environment of the verification impacts the equipment's performance, the environment must be set as identical or similar to the actual operational environment. However, when not limited by this constraint, standard laboratory, manufacturing facility, or office conditions may be used.

Examples of previous verification requirements are provided in the Verification Guidance sections throughout this document. The data and information thus furnished are not to be utilized directly without extensive tailoring. Each application, each location, and each aircraft will demand a verification be written to ensure the particular performance in the life cycle uses and environments is included.

Due to the proliferation of digital instrumentation, it has become too common for test conductors to record their data in significant figures beyond the accuracy and/or resolution of the test equipment. This provides misleading and false information to those who must analyze the data and determine the acceptability of the performance.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.1 Sustenance management systems. The ASWMS shall contain the equipment necessary for the completion of the sustenance preparations; for the storage of the sustenance, serving equipment, and utensils; for the cleanup and disposal of sustenance service, ingestion, preparation, and/or storage equipment; and for _____. During storage, preparation, and/or ingestion of sustenance in flight, the ASWMS and/or its associated equipment shall not interfere with any normal or emergency crew operations.

REQUIREMENT RATIONALE (3.2.1)

The ASWMS must have the equipment necessary to provide sustenance as required herein. Additional requirements may be imposed, based upon the particular aircraft system and its design mission.

The sole purpose for designing, building, and maintaining an aircraft is to meet a particular operational need. The ASWMS must be designed to assist the aircraft in meeting its design objectives. It cannot be permitted to impose restrictions on the aircraft operations.

REQUIREMENT GUIDANCE

Additional functions for the ASWMS which are required by the aircraft's design missions, operations, or constraints (such as support of DVs or emergency missions) should be added to this requirement.

The amount of equipment and the performance capabilities achievable are constrained by the air vehicle's size, capabilities, and other performance requirements. Single- and dual-place aircraft are frequently limited to prepared snack-type food and beverages of limited quantity. Smaller multi-place aircraft may have limited preparation capabilities based on the available space and the number of crewmembers. Passenger and larger multi-place aircraft may have a single or several full galleys for the preparation of complete meals for the crew, the passengers, and DVs. The C-20 has a full galley for the service of passengers as well as a "Crew Refreshment Center" that consists of a coffeemaker, a cup dispenser, and a condiment drawer.

The onboard durations, personnel complement, and mission concept requirements must be included to determine the required ASWMS capabilities. In situations where multiple missions are possible (such as cargo and passenger transport), designing for the worst case conditions or utilizing loadable and removable (palletized) systems may be appropriate. Those aircraft designed for heavy loads or intensive use of power for mission equipment may be limited in the power available for sustenance preparation. Alert aircraft may need specially prepared food and beverages which are stabilized to keep for long periods of time without refrigeration to ensure full mission capability at all times. The ASWMS developed for the B-1B, a multi-place aircraft that stands alert duties, stores 40 Meals, Ready to Eat (MRE), has a 2-gal insulated jug for water, and has a hot cup for heating liquids.

Military aircraft should utilize, wherever they meet the performance requirements of the air vehicle, commercial galleys for the service of passengers. Those aircraft specifically designed for the transport of high-level government personnel or DVs frequently require highly specialized galley facilities to prepare gourmet meals and snacks from raw and basic ingredients.

Detailed guidance on the design of aircraft galleys and galley equipment is provided in *SAE AS 1426*.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.1 Verification of sustenance management systems. The ability of the ASWMS equipment to be used by the crewmember(s) and/or passenger(s) to meet the aircraft system's design requirements without impact to the normal and emergency operations of the air vehicle shall be verified by _____.

VERIFICATION RATIONALE (4.2.1)

Verifications must be performed to ensure the operation of the ASWMS will meet the aircraft system's requirements and will not interfere with the aircrew member's operational procedures during any phase, normal and emergency, of the aircraft's design mission.

VERIFICATION GUIDANCE

Analyses and/or demonstrations should be used for this verification. Analyses are used to determine the probable impact of the ASWMS design. However, a demonstration is required to ensure the equipment operation will not interfere with the aircraft flight control and the mission accomplishment.

The demonstration portion of this verification should be performed as an integral part of the full system demonstration of 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.1.1 **Sustenance**

3.2.1.1.1 **Solid sustenance.** The ASWMS system shall permit and facilitate the loading, storage, preparation, cleanup, and sanitization for ___(a)___ (meals, flight feeding; meals, ready-to-eat (MRE); meals, cooked frozen; cold weather rations; sandwich meals; bite-sized meals; high protein, low-residue meals; snack meals; and/or therapeutic flight meals) as defined in *AFR 146-15* and/or in ___(a)___ (Mil-Spec-number or other specification or standard). The ASWMS shall be capable of storing, preparing, serving, and cleaning up after these meals. Food containers shall be ___(b)___. The ASWMS shall provide readily accessible storage for the following condiments: ___(c)___. These condiments shall be in individual serving packets and shall be readily available for the final preparation of the sustenance prior to eating or drinking.

REQUIREMENT RATIONALE (3.2.1.1.1)

The ASWMS equipment must be able to support fully the standard USAF meal service as well as any food service developed specifically for the particular aircraft and its design mission.

The food containers may impact the design of the ASWMS. Many types of flight meals are prepackaged in a serving container. If so, they will need to be stored and preparations for ingestion will need to be made while the food is in that container. Finally, after the meal has been eaten, the container requires storage as waste or for sanitization for later reuse.

An acceptable taste for particular food items is an important factor in the maintenance of a healthy food intake. It is also a highly individualized parameter that varies greatly from person to person. Condiments are frequently used to alter the flavor and texture of sustenance to meet personal preferences. Therefore, the ASWMS must facilitate the use of condiments.

REQUIREMENT GUIDANCE

All aspects of sustenance support are affected by the type of sustenance that must be used and therefore must be considered in the ASWMS design. These aspects include meal loading, storage, preparation, cleanup, and sanitation.

Meal loading may require backing up a truck to the aircraft door and manually loading the meals, carrying a specially developed insulated food container to the aircraft, setting a flight kitchen prepared meal into a preselected location until it is needed, or loading a cargo pallet of meals for large meal service requirements.

Sustenance storage requires adequate space for the particular sustenance. Based upon the sustenance type, it may require maintenance at ambient or refrigerated temperatures. Size requirements will be based on the number of personnel supported and the type of meals. Special care may be needed for patient or DV needs.

Meal preparation may be as simple as opening a box lunch or as complicated as preparing a gourmet meal for DVs. The aircraft mission, the personnel type and quantity, and the flight durations all affect this aspect of sustenance support.

Cleanup and sanitation are not necessarily the same but are both necessary design considerations. Cleanup in a fighter-type aircraft may simply involve setting the box lunch remains into a position where they will not interfere with flight operations. At the other extreme, cleanup of a large meal service may include the washing of trays, countertops, and utensils, as well as the disposal of

the meal remnants. Sanitation of serving and preparation equipment to prevent the inadvertent transfer of micro-organisms from one individual to another must also take place when this equipment may be used by more than one person. Sanitation requires the use of chemicals, high temperature, or other techniques (scrubbing, high pressure, etc.) to remove or destroy any micro-organisms which could be passed from one to another.

a. Not all the meals described in Chapter 3 of *AFR 146-15* will be used with every aircraft system. However, those selected should be specified to ensure compatibility with the ASWMS equipment.

Some meals used with ASWMS systems have been described by military specification. For example, *MIL-F-43231* describes survival food packets, *MIL-M-44343* describes the 18-soldier standard and arctic meal module, and *MIL-M-13966* (cancelled) was used to describe frozen, precooked meals. If any of these meals are contemplated for use with the particular aircraft system, they should be specified in this requirement. Furthermore, any other meals not specified elsewhere in this document but required for the support of the aircrew under the aircraft's peculiar design missions should be described in detail. Selection of the components of these meals should be in accordance with Chapters 1, 3, and 4 of *AFR 146-15*. Whenever they meet these requirements, the use of commercially available frozen, freeze dried, microwaveable, canned, or processed meals should be supported. Finally, ASWMS equipment developed for air vehicles intended for the transport of DVs will need to be able to support the complicated processes involved in the preparation of a wide variety of gourmet meals from the basic ingredients.

Frequently, box lunches prepared by the airbase's flight kitchen are used when preparation or storage facilities are limited. The meal must be consumed within 5 hr of its preparation if refrigeration of these lunches is not available.

The C-135 required the galley to support the storage and refrigeration of 135 *MIL-M-13966* precooked, frozen meals and to facilitate the service of these meals within a 2-hr period.

b. *Federal Specification PPP-I-350* describes the size and construction of several civilian and military food containers.

c. Examples of the types of condiments which could be made available are salt, pepper, ketchup, tabasco sauce, mustard, mayonnaise, relish, honey, sugar, artificial sweetener, syrup, butter, jam, jelly, coffee creamer, and salad dressing. Bulk-packaged condiments may be more readily available in some locations than individual serving packets. However, their use increases the opportunity for spills and cleanup tasks, limits the use of condiments at stations away from the galley, increases the number of preflight and postflight tasks, and requires a more complex storage compartment design. *Federal Specification PPP-I-350* describes the packaging of condiments for civilian and military use. Direction for the construction and filling of condiment plastic tube packs is provided in *MIL-C-44352*.

REQUIREMENT LESSONS LEARNED

Experienced aircrew members have repeatedly emphasized the need for adequate storage space.

4.2.1.1 Verification of solid sustenance

4.2.1.1.1 Verification of content and quantity. The ability of the ASWMS system to store, prepare, cleanup, and sanitize for the meals specified in 3.2.1.1.1 shall be verified by _____. The ability of the ASWMS to store and finalize the preparation of food in containers shall be by _____. The ability of the ASWMS to store and facilitate the final application of the required condiments shall be verified by _____.

VERIFICATION GUIDANCE (4.2.1.1.1)

Analysis, inspection, and demonstrations are the preferred methods to verify this requirement. Analyses and inspections may be used to evaluate the compatibility of the ASWMS with each item of the specified meals. However, a demonstration is required to show full compatibility of the ASWMS system with the meals required for support of the design aircrew members under the constraints of the design mission.

The demonstration part of this verification should be performed as a portion of the full system demonstration of 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.1.1.2 Liquid sustenance

3.2.1.1.2.1 Water. The ASWMS shall be capable of storing and dispensing ___(a)___ gallons of potable water to the ___(b)___ (galley, lavatory, drinking fountain, etc.) at flow rates of ___(c)___ gallons per minute. There ___(d)___ (shall/shall not) be requirements for additives to the potable water to maintain its quality while stored in the ASWMS for ___(d)___ hours at ___(d)___ degrees F. The potable water shall be delivered to the ___(e)___ (galley and/or lavatory) basin(s) at a temperature(s) of ___(e)___ degrees F for the hot water faucet and ___(e)___ degrees F for the cold water faucet. Potable water shall also be delivered to the drinking fountain/dispenser at ___(f)___ degrees F. (See 3.2.4 for potable water system requirements.)

REQUIREMENT RATIONALE (3.2.1.1.2.1)

The aircraft crewmembers may need an adequate supply of drinking water, depending upon the mission length. This water must be maintained in a usable condition for a minimum of the entire onboard duration.

REQUIREMENT GUIDANCE

a. Aircraft with flight missions over 3 hr in duration should provide 1 qt of potable drinking water for each crewmember and passenger. For missions in excess of 16 hr, 1 pt additional drinking water should be provided for each 8 hr of flight. These are minimum amounts for personnel in a sedentary state. Personnel going into or coming from hot, low humidity, windy environments; personnel performing active tasks; and personnel under high levels of stress all require additional levels of liquid sustenance. If multiple sorties or missions are possible, it may be advantageous to select the potable water quantity based on more than a single mission. The amount may vary considerably based on environment, task, and stress factors.

Additionally, adequate water must be available for washing hands and face, preparing meals and beverages, and cleaning up after the meal, as required by the aircraft and its missions. Potable water should not be used to flush or clean toilets or urinals. If potable water is not used for the lavatory sink (or any other location on the air vehicle), then a placard that states the water is "Unsafe to Drink" should be prominently posted at that outlet.

For every 8 hr of flight, an aeromedical aircraft should carry 2 qt of water for each patient and a minimum reserve supply of 1 pt of water per patient.

b. The water needs to be distributed as required by the aircraft and ASWMS design and the aircraft mission. Distribution may be needed for the galley (sink, hot cup dispenser, cold water dispenser, coffeemaker, etc.), the lavatory (sink), and other aircraft or ASWMS locations.

c. The desired flow rates should be stated for each faucet and should be based upon the time required to conduct the necessary functions of that delivery site.

d. The time and temperatures that the water needs to be stored at should be based upon the anticipated temperatures in the ASWMS for the design missions, including ground operations time and temperatures. Water treatment should be as described in 3.2.4.4.

e. The galley or lavatory sinks may contain hot and/or cold water faucets as necessary to meet the aircraft mission requirements. Cold water for sinks should be at or below the cabin temperature. Hot water should be 120 to 140°F. Higher temperatures should not be permitted due to the possibility of scalding or burning a user.

f. Cold water for drinking should be 65 to 70°F. Aeromedical aircraft should provide a cold water outlet (maximum 70°F) near the nursing station.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.1.1.2 Verification of liquid sustenance

4.2.1.1.2.1 Verification of water. The ability of the ASWMS to store/dispense the required quantity of water for the specified length of time and under the described conditions shall be verified as described in section 4.2.4. The potable water temperature shall be measured at each of its delivery points and shall be as specified above. Each faucet shall be open for no more than ___(a)___ minutes prior to this measurement. Cold water temperatures shall be taken with the ASWMS in an environment of ___(b)___ degrees F and hot water temperatures with the ASWMS in an environment of ___(b)___ degrees F.

VERIFICATION GUIDANCE (4.2.1.1.2.1)

a. This verification should be performed as a test. The amount of potable water carried by the ASWMS and its delivery to the specified sites should be obtained by direct measurement of the tank quantity and the flow rates at the various stations. The quality of the water before and after storage in the ASWMS for the required period of time at the specified environmental conditions should be obtained by standard water chemistry procedures, such as described in *AFR 161-44, Management of the Drinking Water Surveillance Program*. Water chemistry samples should be taken at each delivery site.

b. The temperature of the potable water should be tested at each delivery site. The time of flow before the temperature measurement should be based upon the flow rate and the volume of tubing from the heater/cooler (if any) or storage tank to the faucet outlet. A small amount of additional time may be added to account for the heating and/or cooling of the water supply lines.

Hot water temperatures should be taken at the lowest operational environmental temperature and the cold water at the highest operational environmental temperature (see 3.2.6.3 for environmental temperatures).

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.1.1.2.2 Other liquids. Personnel transport aircraft or special purpose aircraft (i.e., those designed primarily for the transport of Distinguished Visitors) shall provide for the preparation and dispensing of _____ beverages (other than water and coffee).

REQUIREMENT RATIONALE (3.2.1.1.2.2)

The USAF has developed and operated a wide variety of aircraft to fulfill a multitude of different missions. Although not normally included in the ASWMS design, stowage and service of liquids other than water may be needed to meet the needs of a particular aircraft's design requirements.

REQUIREMENT GUIDANCE

Some of the liquid sustenance the ASWMS may be required to support could include: soda pop, milk, tea (hot or cold), and electrolyte restorer (e.g., Hi-C®, Gatoraide®, Crystal Lite®, etc.). Many of these beverages may need to be maintained or served at high or low temperatures (i.e., hot tea or cold soda pop).

The equipment must be designed to permit complete, sanitary cleaning of all parts.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.1.1.2.2 Verification of other liquids. The ability of the ASWMS to store and dispense liquids and beverages other than water or coffee shall be verified by _____.

VERIFICATION GUIDANCE (4.2.1.1.2.2)

This verification must be tailored to meet the specific requirements of the particular liquid services provided. The verification must account for the propensity of liquids to solidify, form deposits or sludge, and clog and plug equipment. Conditions which contribute to these or any other negative performances of the liquids must be included in this verification.

The ability of the equipment to be cleaned after storage and/or use with the specified liquids must also be demonstrated.

This verification should be conducted as a demonstration, under operating conditions, and if the ASWMS is to store any liquids, under storage conditions.

The demonstration portion of this verification should be performed as a part of the full system demonstration of 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.1.2 **Sustenance preparation**

3.2.1.2.1 **Preflight and postflight.** Preflight and postflight preparation procedures shall not require more than _____ aircrew members at the _____ level more than _____ seconds to perform. These procedures shall require no extra tools and equipment beyond those stored within the ASWMS.

REQUIREMENT RATIONALE (3.2.1.2.1)

The preflight and postflight procedures required for most aircraft missions are complex and taxing and must be carefully limited.

REQUIREMENT GUIDANCE

The existing procedures necessary to prepare the aircraft and its associated equipment for flight and to secure them after flight are inheritly demanding. Additional work to prepare the ASWMS for flight, for use, and for postflight stowage is unacceptable and must be minimized where it cannot be eliminated.

It is possible that various skill levels will be required to preflight and postflight the ASWMS. For example, a supervisory-level and two basic-level aircrew members could be needed to install an environmental cover. In this event, the last part of the first sentence of this requirement should be repeated as needed.

If the requirement exists for preparation of sustenance while on the ground, and if the additional requirement is laid that this be performed with the aircraft engines and power systems secured, then the ground powered generator must be sized appropriately.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.1.2 ***Verification of sustenance preparation***

4.2.1.2.1 **Verification of preflight and postflight.** Preflight and postflight preparation procedures shall be verified by _____. Time to complete the tasks will begin when _____ and end when _____.

VERIFICATION GUIDANCE (4.2.1.2.1)

The demonstration of this verification should be performed as a portion of the full system demonstration of 4.1. The events which trigger the initiation and end of the procedure must be clearly specified to ensure the duration measurement is properly made.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.1.2.2 Inflight preparation. Inflight preparation, serving, cleanup, and sanitization procedures shall require no more than _____ aircrew members at the _____ level more than _____ minutes to prepare and serve meals for the number of personnel specified above. Sustenance for crewmembers who cannot leave their crewstation (such as pilots of single seat aircraft) shall require removal from the storage container and no further preparation for ingestion. For these cases, the inflight preparations shall not require more than one hand nor the undivided attention of the crewmember.

REQUIREMENT RATIONALE (3.2.1.2.2)

The inflight preparation procedures required for most aircraft missions are complex and taxing. Additions to these procedures must be carefully limited.

REQUIREMENT GUIDANCE

The existing procedures necessary to fly an aircraft, operate its systems and equipment, and successfully complete its assigned mission are already demanding. Additional work during flight is unacceptable and must be minimized where it cannot be eliminated.

Aircrew members who must make their preparations to eat at their crewstations while they perform their mission cannot be required by the ASWMS to devote more than 2 to 3 sec of attention at a single period to the preparation of their food (e.g., opening containers, unwrapping, inserting warming units or straws, etc.).

Food should not be kept unrefrigerated for longer than a cumulative time of 4 hr prior to consumption. This includes transport of the food to the ASWMS, unrefrigerated stowage, preflight preparation, and inflight preparation.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.1.2.2 Verification of inflight preparation. Verification of the preparations required while in flight shall be _____.

VERIFICATION GUIDANCE (4.2.1.2.2)

The demonstration of this verification should be performed as a portion of the full system demonstration of 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.1.3 Sustenance equipment. The ASWMS shall be designed to contain the equipment necessary to support all aircrew members' and passengers' sustenance needs throughout all normal and emergency operations, as required by the aircraft's design mission. The ASWMS shall contain ____(a)____ (list of equipment from the following subparagraphs, such as refrigerators, ovens, coffeemakers, etc.). Wherever possible, the space provided for this equipment shall be constructed to permit similar equipment from other sources or vendors to replace the original devices. A minimum of ____(b)____ (number) units from ____(b)____ (the same or different) vendors shall be specified for and operate with the ASWMS. The equipment shall be removable (including power disconnection) from the ASWMS for cleaning, repair, and/or replacement by a single crewmember, without the removal of major subassemblies, ____(c)____ (without special tools or devices/with standard hand tools), and without removal of the contents. However, routine cleaning, sanitization, and maintenance activities should be performed without equipment removal and without special tools or devices. The connector for the equipment power supply to the ASWMS shall be in accordance with 3.6.1.6.1 and shall be readily accessible. Warnings and operating instructions ____(d)____ (shall/shall not) be prominently displayed on all equipment. Doors for this equipment shall have stays to prevent damage to the hinges or to adjacent equipment and structures. Heat generating equipment, such as ovens, coffeemakers, or refrigerators, shall have sufficient ventilation to prevent their operation from affecting the performance of adjacent structures or equipment or the temperature of passenger and crewmember spaces. Adjustment or reading of controls, displays, or placards shall not require the opening of or removal of contents from behind doors or within drawers.

REQUIREMENT RATIONALE (3.2.1.3)

This requirement is needed to ensure all equipment, including those items not detailed below, meets the needs of the aircraft and its missions. The ASWMS may require the use of several types of specialized equipment.

REQUIREMENT GUIDANCE

In the past, several military specifications have been utilized to define the requirements for aircraft galleys. These include *MIL-G-25608*, *MIL-B-38157*, and *MIL-G-83063*. These specifications have been cancelled but are readily available through microfiche services and are valuable sources of information on the past technical requirements for the development of aircraft galleys.

The requirements of this section should be deleted if no sustenance support equipment is used for the particular aircraft. However, those parts which define the performance of individual equipment used in any portion of the air vehicle should be retained.

Commercial galley items may frequently be used on or in aircraft galleys, provided they meet the requirements detailed herein. Environmental, safety, and other performance requirements cannot be waived to permit the use of a commercial item in conditions or in a manner for which it was not designed and cannot perform.

Much of the equipment required for the preparation or storage of sustenance generates heat when in operation. Heat is created by refrigeration equipment from heat sinks and heating equipment from its functional source. The heat so developed must not be allowed to have an adverse impact on the operation of other equipment or the crew and/or passenger comfort.

If utensils, tableware, trays, or other serving devices are to be used in more than one meal or one meal sitting, then the ASWMS should support the complete sanitation of these items. However, if there is no need for more than one use of these items per flight, then their sanitization may be conducted at ground facilities.

An innovative means of food storage and preparation has been developed by the USAF and tested by the U.S. Army in long-range U.S. Navy aircraft. The Food Service Unit (*NATICK/TR-91/033L*) maintains specially prepared meals at refrigerated temperatures and then heats the hot portion to the desirable temperature before serving. Thus, one unit serves as both refrigerator and oven. Use of developments such as these should be strongly encouraged.

The C-135 galley, in addition to potable water and waste handling systems, was equipped with one dry ice refrigerator, one wall-mounted can opener, one 12- to 15-cup coffeemaker, one 6- to 8-oz cup dispenser, two 12-meal conventional ovens, two hot cups with mounted brackets, storage for coffee and accessories, and an operating and maintenance manual.

a. The equipment to be included in the particular ASWMS design should be listed here. This may include refrigeration units, ovens, water coolers or heaters, coffeemakers, etc.

The space provided for each item should be, wherever possible, modular in design to permit use with a variety of equipment styles and types. The number of alternative items should be selected to maximize its future replacement at the end of its service life. If multiple sources for the equipment exist, several different vendors should be specified or the requirements should be generic to permit the use of devices produced by different manufacturers.

b. Removal of the equipment should be a simple activity that requires the minimum amount of disassembly, personnel, tools, and equipment. The electrical connector should be positioned or designed so connection/disconnection can be made without reaching behind the unit or into a tight, cramped, and/or deep space to connect or disconnect the unit. This can be accomplished by using connectors which automatically connect as the equipment is moved into place (and disconnect as it is moved out of position) or by positioning the connector where it can easily be reached (in the front of the unit or directly behind an access panel).

c. Equipment should be removable from the ASWMS structure. If possible, it is best to design the equipment so no tools are necessary for this operation. If not, then only standard hand tools should be permitted for the removal operation.

d. Sustenance preparation and storage equipment is used by a wide number of personnel with varied backgrounds and educations. If hazardous conditions exist (such as high voltages, hot spots, unprotected rotating machinery, etc.), then the appropriate warning sign should be provided. If the equipment may be used by crewmembers who have not been specifically trained in its operation, then operating instructions may reduce the incidence of personnel injury or equipment failure due to improper or hazardous procedures. However, to accomplish this, the instructions must be printed with a process that ensures their readability after repeated environmental exposures, many cycles of operation, and inadvertent food and liquid spills. Also, the instructions must be posted in a manner that permits the user to reference them during equipment use. For example, instructions should not be posted behind the coffee pot when the pot is in place on the coffeemaker, or on the front of an oven door that swings out of view.

e. Detailed information on the design and development of aircraft sustenance support equipment is provided in *SAE AS 1426*.

f. The following *National Sanitation Foundation (NSF) Standards* contain extensive guidance on the design of particular forms of sustenance preparation and storage equipment:

NSF 1	*Soda Fountain and Luncheonette Equipment*
NSF 2	*Food Service Equipment*
NSF 4	*Commercial Cooking and Hot Food Storage Equipment*
NSF 8	*Commercial Powered Food Preparation Equipment*
NSF 12	*Automatic Ice Making Equipment*
NSF 18	*Manual Food and Beverage Dispensing Equipment*
NSF Criteria C-2	*Special Equipment and/or Devices (Food Service Equipment).*

REQUIREMENT LESSONS LEARNED

A primordial galley was designed to utilize a single type of specially sized refrigerator and oven. When replacement units became necessary, new units were unavailable. After the old units were no longer repairable or serviceable, development of replacements was expensive.

Although the use of commercial items in the design of military aeronautical equipment should be permitted and encouraged, specific items should not be required or recommended. The specification for the C-20 galley (for the support of DVs) required the use of a particular commercial hot water heater. However, the contractor's previous experience with these units proved them unsuitable for aeronautical use. The device contained a tank of heated water that was open to the cabin atmosphere at all times, which would cause the cabin to fill with steam with any loss in cabin pressurization. Other problems were also found, such as excessive corrosion and a constant dripping during the heating cycle.

The fans in an oven were not designed for easy cleaning or replacement. Due to the nature of the air moved about in ovens, it was a frequent and difficult task to clean these fans. Replacement onto the shaft was also difficult because tools and careful adjustment were required to prevent the fan from striking the oven walls.

4.2.1.3 Verification of sustenance equipment. The ASWMS equipment shall be verified by _____. Containment of the required equipment and an ability to interface with a variety of similar equipment shall be verified by _____. The equipment removal (including power connection/disconnection) shall be verified by _____.

VERIFICATION GUIDANCE (4.2.1.3)

This verification may be conducted by test, demonstration, inspection, analysis, or a combination of these methods, based upon the particular item involved. However, all aspects of the item's performance must be included.

Representative samples or specifically constructed simulations of the different units available should be used to demonstrate this requirement. Inspections and analyses which use the final ASWMS product and drawings of the alternative units could also be used. However, the latter method may not reveal all limitations inherent in the unit's use with the ASWMS.

The equipment cleaning and removal should be verified by demonstrations.

The demonstration portion of this verification should be performed as a part of the full system demonstration of 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.1.3.1 Miscellaneous equipment

3.2.1.3.1.1 Utensils, serving equipment, and tableware. The ASWMS shall be designed to store _____ (number) of _____ (type and capacity) of utensils, serving tools, and tableware and to facilitate the _____ (preparation, buildup, service, cleanup, and sanitization) of meals requiring this equipment.

REQUIREMENT RATIONALE (3.2.1.3.1.1)

The ASWMS must be able to store eating utensils and tableware in a manner that permits ready access during meal preparation. The ASWMS must interface with the tableware needed to serve meals.

REQUIREMENT GUIDANCE

Utensils are usually included in dining packets, as designed in accordance with *Federal Specification L-D-350*. Type I packets contents, as listed in the reference, include: a fork, knife, and spoon; a napkin; salt, pepper, and sugar packets; a can opener; two toothpicks; two chewing gum tablets; a wet towelette; and a drinking straw. Type II packets omit the can opener, gum, toothpicks, towelette, and straw. Type III packets omit the can opener, gum, and sugar. These packets are wrapped in a protective covering to maintain their sanitary condition. Since unused items become an unnecessary stowage and waste burden, the packets with the minimally required contents, usually Type II, should be used.

The fork, knife, and spoon should be in accordance with *Federal Specification L-F-560*. The C-135 required storage and access for 135 napkin and utensil sets that measured 3.75 × 2.75 × .50 in.

Serving equipment includes coffee pots, ladles, or other devices necessary to prepare or serve the sustenance.

Tableware includes any dishes, bowls, cups, glasses, or other food-holding device. This may also include covers or lids to maintain the serving temperature of the sustenance. Plastic tableware suitable for aircraft use is described in *Federal Specification L-T-48*.

This requirement may be repeated as necessary for each type of utensil, serving equipment, or tableware required for the ASWMS. The ASWMS for aircraft systems which include DVs or dignitaries may require duplicate requirements—one for the DVs and one for crewmembers and support personnel (staff, secretaries, etc.). A method is needed to account for tableware and utensils of significant value and to prevent pilferage of these items when the air vehicle is intended for simultaneous transport of DVs and other passengers (such as staff, members of the press, etc.)

The number of each item of tableware needed should be based upon the number of aircrew and passengers to be supported, with approximately 5 percent extra items for special occasions. The capacity of each item should be based upon the anticipated serving sizes.

Tableware should include non-skid bottoms and should be compatible with trays and anticipated food. *Federal Specification L-T-48* describes standard plastic tableware.

The use of disposable equipment should be carefully weighed. The use of disposable utensils, plates, bowls, trays, cups, and other devices permits rapid cleanup after the meal and eliminates the need for sanitation of used equipment before it is used again. However, it also increases the need for storage space for the disposable devices before the meals and for the large amount of trash generated after the meal. Typically, unless trash compactors are available, the volume of trash after the meal will be significantly larger than the stored material before the meal.

The C-20 executive transport aircraft specified storage space for twenty 12-in. plates, thirty bowls, thirty saucers, twelve 8-oz juice glasses, twelve 12-oz drinking glasses, forty sets of utensils, twenty-five cloth napkins, and twenty-five miniature salt/pepper sets, as well as three large mixing bowls and twelve serving trays. This did not include silverware and china for the executive service.

National Sanitation Foundation Standard 36, Dinnerware, contains extensive guidance on the design and selection of dinnerware.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.1.3.1 Verification of miscellaneous equipment

4.2.1.3.1.1 Verification of utensils, serving equipment, and tableware. The ability of the ASWMS to integrate with the _____ eating utensils shall be verified by _____.

VERIFICATION GUIDANCE (4.2.1.3.1.1)

Demonstration is the preferred method of verification, although an analysis may be used for some portions. An inspection is not recommended, since the ability of the ASWMS user to access the utensils and tableware storage during the meal buildup, cleanup, and sanitization cannot be adequately evaluated with this method.

The demonstration portion of this verification should be performed as a part of the full system demonstration of 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.1.3.1.2 Trays. The ASWMS shall store _____ (number) of _____ (type) trays for use when serving meals. The ASWMS shall facilitate inflight meal cleanup and preparation using these trays. Shelves, countertops, or other surfaces used to hold trays during meal buildup, cleanup, or equipment sanitization shall hold _____ trays without limiting access to heating or storage spaces or to trash and refuse containers. Trays shall be capable of withstanding high temperature and high pressure cleaning with cleaning agents in ground kitchen automatic dishwashers and of withstanding chemicals used to sanitize their surfaces after use. Trays shall be designed to facilitate a rapid wipedown between uses.

REQUIREMENT RATIONALE (3.2.1.3.1.2)

The ASWMS must maintain the trays for use with the inflight meals and must not interfere with the buildup, cleanup, and sanitization for the meals.

REQUIREMENT GUIDANCE

The number of trays needed should be based upon the total number of crewmembers and passengers, with a few additional for the use of the ASWMS users. To serve 135 meals within 2 hr, the C-135 required 70 trays, sized 11.75 × 15.75 in. These trays were intended to integrate with seat tray tables sized 10 × 17 in. The trays were the nesting type and included recesses for: one precooked frozen meal, one accessory packet, one dessert cup, two beverage cups, one salad cup, and two salad cups. The tray was also required to provide space for a roll or slice of bread, milk carton, and butter patty.

The trays used with the ASWMS should be the nesting style, so each tray holds the one above (or next to it) and the one below (or on the other side) firmly in place. The ASWMS should accommodate trays with inserts or depressions set into them to hold the food and utensils in place during aircraft movement. However, trays without inserts should also be accommodated. Trays should also have turned-up edge lips to help contain spills.

The ASWMS should be designed to hold as many trays as possible to facilitate the buildup of multiple meals. The surface should reduce the possibility of the trays slipping or moving due to aircraft motion or turbulence. To permit the user to gather the items to be placed on the tray for buildup, full access is needed to the tray storage, refrigerators, ovens, sink, coffeemaker, utensils, and condiments. During the cleanup and sanitization after the meal, access is needed to the tray storage, sink, utensil storage, and trash containers. Throughout all operations, full access must be maintained to the ASWMS power panel and all ASWMS controls and indicators. During flights with longer durations, trays must be designed to facilitate their reuse after a rapid wipe down to permit service of more than one meal.

Trays for use with the ASWMS should be in accordance with *MIL-T-43819* or as required to meet the operational needs of the user. The tray should be able to hold cups, bowls, plates, and utensils as needed for the meals specified in 3.2.1.1. Furthermore, the tray should sized to fit both the passenger and crewmember seats. The tray should be designed to withstand steam and scalding water without warping or delaminating, to not chip when dropped from 40 in., and with rounded edges and internal corners to prevent or reduce user injury.

Figure 3 describes the tray used for the C-5A troop galley.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

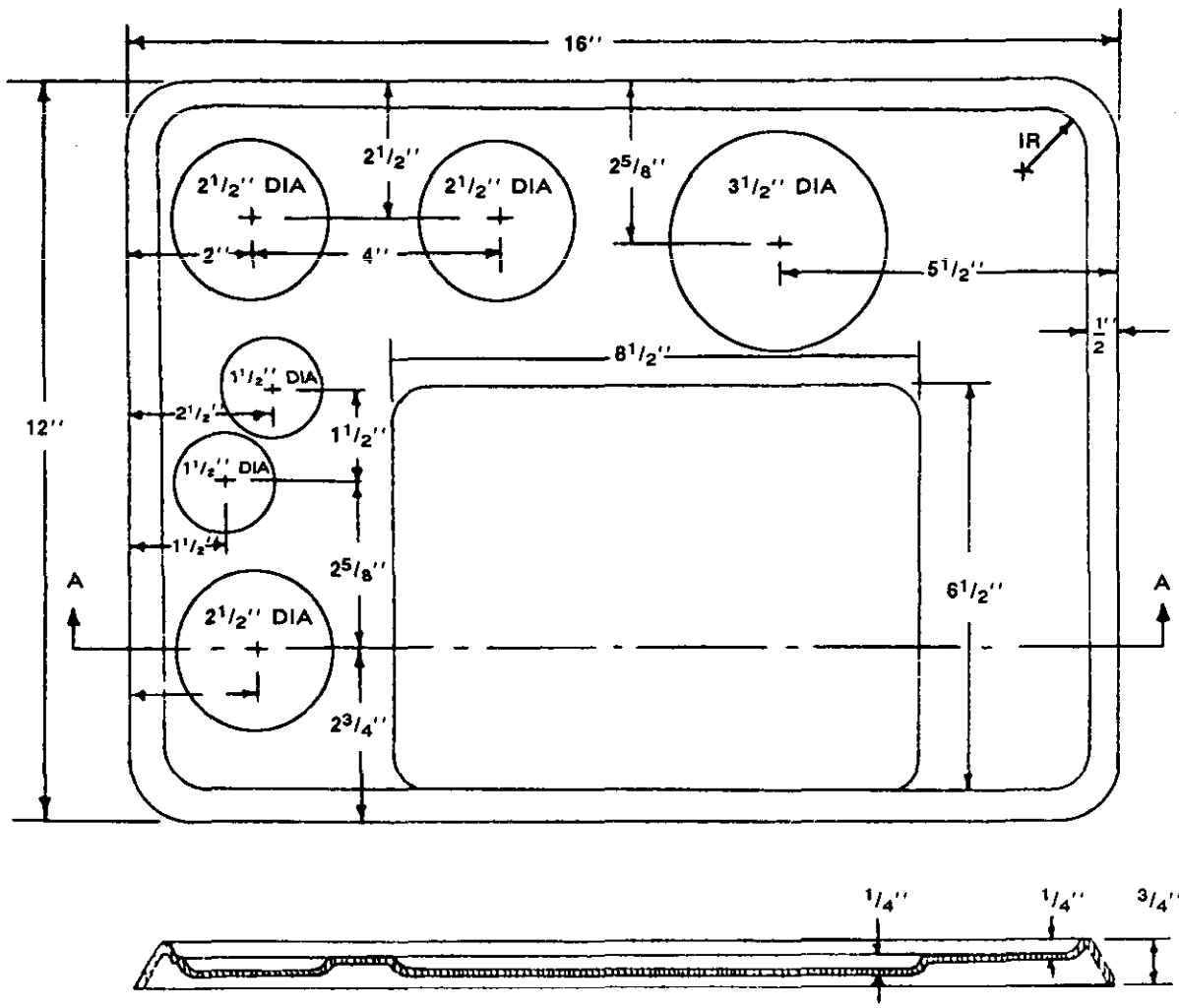
4.2.1.3.1.2 Verification of trays. The ability of the ASWMS to store, prepare, cleanup, and sanitize the number and type of trays required for serving meals should be verified by _____. Verification of the access to all necessary spaces shall be an integrable part of this verification.

VERIFICATION GUIDANCE (4.2.1.3.1.2)

This verification should be performed as a demonstration. The demonstration should be performed as a part of the full system demonstration of 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).



SECTION A-A

FIGURE 3. Typical food service tray.

3.2.1.3.2 Refrigeration equipment. The ASWMS shall contain refrigeration equipment for ___(a)___ cubic feet of chilled food storage, ___(a)___ cubic feet of frozen food storage, ___(a)___ quarts of chilled water per hour, ___(a)___ cubic feet of wet ice storage, and ___(a)___ (other refrigeration). Each storage compartment shall be plainly labelled. The refrigeration equipment shall be able to achieve and maintain ___(b)___ degrees F internal temperature in the chillers and ___(b)___ degrees F in the freezer within ___(c)___ minutes after being heat soaked for ___(c)___ minutes at ___(c)___ degrees F and maintained at an exterior environment of ___(c)___ degrees F. Any door gaskets shall not take a permanent set, shall provide an adequate seal, shall be removable for cleaning and replacement, and shall not inadvertently loosen or disconnect during the equipment use. Storage equipment doors shall be adjustable to maximize the door seal effectiveness. The refrigeration equipment shall utilize non-packing, non-hygroscopic insulation and shall be designed to prevent exterior condensation. The refrigeration storage equipment shall incorporate a temperature indicator and a separate means of adjustable temperature control for each compartment (chiller and/or freezer). Each individual item of refrigeration equipment shall require no more than ___(d)___ amperes power at ___(d)___ Volts ___(d)___ (direct current or Hertz) for a total of no more than ___(d)___ amperes for all refrigeration equipment. Insert racks in the equipment shall be able to fit the interior space and withstand the thermal environments of both the oven and the refrigeration equipment. The equipment shall contain devices to prevent damage in the event of an explosive decompression.

REQUIREMENT RATIONALE (3.2.1.3.2)

Refrigeration storage may be necessary to maintain the sustenance in an edible condition or to prepare the food into a palatable state for extended flights. This equipment must, to ensure the safety of the items so maintained, efficiently maintain this temperature without creating additional health hazards due to unsanitary or unclean conditions. Chilled water may also be needed to support the requirements of crewmembers and passengers in hostile environments.

REQUIREMENT GUIDANCE

The *Society of Automotive Engineering Aerospace Information Report (SAE AIR) 1168/3, Aerothermodynamic Systems Engineering and Design*, presents detailed information on the design of several different types of refrigeration systems for aircraft.

National Sanitation Foundation Standard 6, Dispensing Freezers, and *NSF 7, Food Service Refrigerators and Storage Freezers*, contain extensive guidance on the design of particular forms of refrigeration equipment.

a. The refrigeration space capacity should be based upon the space needed to store chilled sustenance and frozen foods to support the number of people listed in 3.1 for the mission length of time also listed, utilizing the sustenance specified in 3.2.1.1. Separate freezer and chiller sections may or may not be necessary for the particular use, depending upon the type of meals served and the anticipated duration of the mission. The chilled water capacity should be based upon the chilled water requirements for the number of people listed in 3.1 and for the mission length of time listed.

b. In accordance with *AFR 161-26*, chilled food should be maintained at 35 to 40°F and frozen food should be maintained at 0°F or below. The thermodynamic capacity of refrigeration equipment should be based upon the heat transfer anticipated due to the environmental conditions (highest exterior temperature and lowest internal temperature) and operational considerations (door openings and closings, time the door is open, etc.). This capacity should not be specified in terms of cooling power (number of BTUs) since the power requirements of the cooling system are affected by many other design factors (such as the type and thickness of insulation, the effectiveness of the door seal, the accessibility of the items within the refrigeration, etc.).

The C-135 galley refrigerators were required to maintain -10 to -5°F in the freezer and 40 to 45°F in the chiller compartments for 14 hr with an external ambient temperature of 140°F for the first 2 hr and 90°F for the remaining 12 hr. (Note that this unit was developed prior to the change in the *AFR 161-26* requirement for cold food storage to 35 to 40°F.)

c. The temperature of the heat soak period should be at or slightly above that specified in 3.2.6.3 for the storage of the ASWMS on or off the aircraft system. The time required to achieve the operating temperatures should be based upon an estimate of the time from applying power to the ASWMS (or adding dry ice) to the time the sustenance is to be placed into the refrigerated space. Refrigeration units are required by *21 CFR Part 1250.34* to contain a temperature indicator located in the warmest portion of the unit.

d. The ASWMS refrigeration equipment power requirements should be based upon an equitable distribution of all power available for ancillary, non-critical systems. To maintain design simplicity, promote commonality, and prevent incorrect power connections, the voltage and frequency should be the same for all ASWMS equipment. However, if the need is clearly and factually demonstrated, other voltages and frequencies may be used.

The following subsections present the requirements and guidance for vapor cycle, dry ice, and thermoelectric refrigeration. Other types of refrigeration equipment are possible (e.g., cryogenic). If such units are possible or anticipated, their requirements should be selected from these subsections with additions as needed to describe the specific technical requirements for the particular type of refrigeration.

REQUIREMENT LESSONS LEARNED

Originally, *AFR 161-26* required a maximum refrigeration temperature of 40 to 45°F. However, several people died in a civilian incident after eating cheese kept at this temperature. It was discovered that the Listeria bacteria, commonly found in cheese, cannot only withstand but also grow when kept at this temperature. The regulation was changed to a maximum of 35 to 40°F. There have been no incidents with food maintained at the new level. Extensive tests have also verified the effectiveness of the lower temperature.

During a preliminary design review for a new refrigeration system for an air transportable galley/lavatory, it was discovered that the sensor for the temperature indicator (mounted on the door) was highly susceptible to accidental breakage, yet was unprotected.

After several years of operation, the cause of frequent over-temperature conditions in a aircraft galley refrigerator was discovered. The heat sink of this unit had inadequate ventilation that caused the temperature in this space to rise to a high level. This significantly decreased the efficiency of the unit to operating levels below that required to maintain the needed interior temperature. The addition of ventilation ports around this heat sink eliminated this problem.

The E-3A AWACS carries a crew of 20 and has mission durations of 10 hr or more. To reduce cost, it was directed that the E-3A would use an existing GFE refrigerator/freezer unit from the C-5. However, since this unit would not fit through the doors on the E-3, it was cut in half and then reassembled using quick disconnects in the cooling lines. Leaks were frequently found in the cooling lines or connectors during operations and fouled compressors. At one time, 95 percent of the E-3 fleet had inoperative refrigerator/freezer units. The Tactical Air Command identified this as the "Number One Problem" in the command. Their effort was to reduce up-front costs, build in reliability, and reduce maintainability problems which impacted Life Cycle Costs and operational effectiveness.

4.2.1.3.2 Verification of refrigeration equipment. The refrigerated, chilled, and frozen storage spaces in the ASWMS shall verified by ___(a)___. The existence of compartment labels shall be verified by ___(b)___. The ability of the refrigeration equipment to achieve and maintain the required temperatures in the specified times shall be verified by ___(c)___. The performance of the refrigeration equipment's temperature indicators and temperature controls (for each compartment) shall be verified by ___(d)___. The power requirement shall be verified by ___(e)___.

VERIFICATION GUIDANCE (4.2.1.3.2)

a. The refrigerated, chilled, and frozen storage spaces and chilled water capacities should be verified by direct measurement in the final article. During this verification, the temperature profile throughout the chiller and/or freezer storage compartment(s) should be measured at various points, the number and locations to be based upon the size, shape, and loaded configuration. Either the actual articles to be kept chilled or frozen, or simulations of the same dimensions and thermal capacitance, should be placed as they will be used in the refrigeration compartments. The temperature of the chilled water should be measured at the water outlet at the maximum flow rate of the system.

b. The existence of compartment labels should be verified by inspection of the final assembly but may be verified by inspection of the drawings.

c. The ability of the refrigeration equipment to achieve and maintain the required temperatures in the specified times should be verified by tests. The time required for a heat soak prior to this test should be determined from the unit's size and shape and with *MIL-STD-810* guidance.

d. The performance of the refrigerated storage equipment's temperature indicators and temperature controls (for each compartment) should be verified by tests. The temperature within the compartments should be adjusted, using the controls, throughout the full range of control. After the temperature has stabilized at each setting, the interior temperature profile and indicator readings should be recorded. This should be performed at each end of the temperature adjustment range and at several, evenly spaced adjustments in between.

e. The power requirement should be verified by tests, using the maximum power conditions (such as the highest exterior temperature with the lowest interior temperature) for the specific unit.

f. The operability, maintainability, and performance of the door gaskets, door adjustability, insulation, insert racks, decompression devices, and equipment cleaning and removal should be verified by tests or demonstrations. The demonstration portion of this verification should be performed as a part of the full system demonstration of 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.1.3.2.1 Dry ice refrigeration. The dry ice refrigeration equipment shall have a separate compartment for the dry ice. This compartment shall be accessible for cleaning and dry ice replacement by a single aircrew member without the removal of major subassemblies, without special tools or devices, _____ (with/without) removal of the contents, and _____ (with/without) removal of the refrigeration equipment from the ASWMS. This compartment shall hold enough dry ice to ensure the refrigeration equipment maintains its temperature as required by 3.2.1.3.2. The dry ice compartment _____ (shall/shall not) vent to the habitable spaces of the aircraft. There shall be an electromechanical means of ensuring forced air circulation within the chiller and freezer compartments.

REQUIREMENT RATIONALE (3.2.1.3.2.1)

The refrigeration devices which utilize dry ice to generate and maintain the cooler internal temperatures have specific design constraints which should be imposed.

REQUIREMENT GUIDANCE

When used as the cooling medium for refrigeration units, dry ice requires a separate compartment that can be replenished as the carbon dioxide heats and turns from a solid to a gas. This compartment's access should not require the unit to be removed from the ASWMS or the unit to be emptied, if at all possible. However, due to the limited space available, this requirement may need to be relaxed. In this event, the requirement should not be completely eliminated, although reduced, and the maximum time that the contents may left exposed to ambient conditions should be specified. (For example, partial content removal may be necessary to provide access to the dry ice compartment. If so, the food should not remain outside the freezer long enough to begin thawing [dependent upon the maximum ambient temperature] nor remain outside the chiller for more than a cumulative time of 4 hr [including ASWMS loading and meal preparation]).

A separate dry ice compartment and an internal forced air circulation device may be necessary to maintain an even temperature throughout the chiller and freezer sections. This is important to ensure all food items are kept below their maximum storage temperature and, for those items susceptible, above their minimum storage temperature.

Dry ice is frozen carbon dioxide at -109.3°F. It will destroy human tissue on contact and is hazardous to breathe in concentrations over 0.5 percent. Concentrations of 9 percent are fatal in 5 to 10 min. Because it is heavier than air, personnel should not be permitted to lie on or near the floor when dry ice is in use. Also, dry ice should not be used on upper decks when personnel are stationed on lower decks.

If the dry ice compartment is allowed to vent to the crewmember or passenger spaces of an aircraft, then a major concern is that the interior volume does not reach hazardous concentrations of carbon dioxide. For pressurized aircraft, the following formula describes the safe maximum weight of dry ice (W) in pounds, based upon the aircraft interior volume (V) and the rate of air exchanges (x) per hour. Care must be taken with this equation to ensure the units used for the aircraft volume (V) and the air exchange rate (x) match. That is, if the volume is in cubic feet, then the exchange rate should be in cubic feet per hour. Similarly, cubic meters and cubic meters per hour could be used.

$$W = 0.01455 \cdot V \cdot x$$

Paragraph 11-9 and figures 11-2, 11-3, and 11-4 of the joint *Air Force/Army/Navy/Marine Corps Regulation* published as *AFR 71-4/TM 38-250/ NAVSUP PUB 505/MCO P4030.19E/DLAM 4145.3* provides additional guidance on the acceptable loading of dry ice. Included are such factors as tabulated maximum loadings of dry ice for specific aircraft and conditions which may reduce the acceptable loading.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.1.3.2.1 Verification of dry ice refrigeration. Verification of those refrigeration units which utilize dry ice for refrigeration shall be conducted in accordance with 4.2.1.3.2. Access to the dry ice compartment shall be verified by _____.

VERIFICATION GUIDANCE (4.2.1.3.2.1)

Verification of the cleaning, maintenance, and dry ice replacement requirements should be performed as a part of the full system demonstration of 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.1.3.2.2 Vapor cycle refrigeration. Vapor cycle refrigeration units, which utilize a liquid refrigerant that is vaporized to generate the chilled and/or frozen interior environments and reject the cycle heat to ambient air in a condenser, shall not exhaust the heated air from the condenser directly toward the food preparation area, passengers, or the condenser or insulated surfaces of other refrigeration equipment. The refrigerant used by these devices shall be ____(a)____. All vapor cycle refrigeration equipment shall comply with *71 USC 1280 (The Clean Air Act)*, *DOD Directive 6050.9*, and *The Montreal Protocol* for the release of chlorofluorocarbons and hydrochlorofluoro-carbons to the atmosphere. The vapor circuit of the system shall be protected against a rapid overpressurization in accordance with ____(b)____. The vapor circuit shall withstand a burst pressure of ____(c)____ times the operating maximum pressure without failure or leakage and a proof pressure of ____(c)____ times the operating maximum pressure without material deformation or yielding.

REQUIREMENT RATIONALE (3.2.1.3.2.2)

The refrigeration devices which utilize electromechanical devices to generate and maintain the cooler internal temperatures have specific design constraints which need to be imposed.

REQUIREMENT GUIDANCE

The air exhausted from refrigeration radiators is often heated to an uncomfortable level. This can be extremely uncomfortable to the operators and passengers. Also, this can significantly decrease the thermodynamic effectiveness of other refrigeration equipment if directed against them.

The *SAE ARP 731* provides detailed guidance on the design of vapor cycle refrigeration systems and should be consulted for specific refrigeration requirements. Guidance on the design of airborne vapor cycle refrigeration systems is also contained in *MIL-E-38453*.

Note that if this type of refrigeration is selected, then a vapor recovery unit may be required as an article of organizational-level support equipment to permit even simple repairs to this equipment.

a. Refrigerants selected must be non-hazardous to the environment or to the aircraft systems. International and federal regulations require a complete phaseout of refrigerants that contain chlorofluorocarbons (CFCs) by 1 January 2000. The Department of Defense currently requires new systems to use refrigerants with an Ozone Depletion Potential (ODP) of approximately zero. As stated in *AFR 19-15*, it is USAF policy to eliminate the dependence on Ozone Layer Depleting Substances (OLDS), to eliminate non-critical use of OLDS, to eliminate the release of OLDS, and to comply with *DOD Directive 6050.9*.

However, many of the current substitutes for CFC refrigerants may have other performance characteristics which may make them unacceptable for a particular use. Some may have an anaesthetic effect on crewmembers if leaks should allow the concentration to be large enough. Others may act as an aggressive solvent or may not mix with necessary refrigerant lubrication. The ASWMS developer must work closely with the refrigeration equipment designer to ensure the proper refrigerant/equipment combination is selected.

Note that a USAF-wide ban on the purchase of ozone depleting chemicals (ODCs) is planned to commence on 1 October 1993 and U.S. production of ODCs will cease by 31 December 1995. Although some waivers will be allowed, they will apply only to critical functions where suitable substitutes are not available. Further, drastically decreased worldwide production of ODCs will make procurement difficult and expensive. The *Clean Air Act, 71 USC 1280*, defines the ozone depletion potential, lists this potential for common refrigerants, describes the phaseout dates for production of these substances, and discusses exceptions to the limitations (including caps on these exceptions) for aviation safety, medical devices, and national security. Reference *DoD Directive 6050.9*. All USAF users should further reference *AFR 19-15* and the USAF and Air Force Materiel Command policy letters on the use of ODCs.

b. The C-17 galley specification requires that the vapor cycle refrigeration system meet the overpressurization requirements of *American National Standard, codes UG-125(c), (f) & (h); UG-127; UG-133; UG-134(a) & (e)(1); UG-135 (a) & (b)*; and *UNF-125*.

c. Burst pressure is normally set at four times the anticipated maximum operating pressure, while the proof pressure is normally two times this pressure.

REQUIREMENT LESSONS LEARNED

In an aircraft air conditioning system, rigid tubing connecting a refrigeration compressor, oil cooler, and other components developed cracks due to vibration induced fatigue. Vibration isolation or vibration absorbing tubing were not used in the design. Environmental stress screening was not performed (*AFLC/AML Lessons Learned Program #11403*).

4.2.1.3.2.2 Verification of vapor cycle refrigeration. Verification of those refrigeration units which utilize vapor cycle electromechanical refrigeration devices shall be conducted in accordance with 4.2.1.3.3.1. Verification of the heated exhaust and the refrigerant and plumbing equipment shall be performed by _____.

VERIFICATION GUIDANCE (4.2.1.3.2.2)

Verification of the heated exhaust, refrigerant, and cooling system plumbing may be conducted by inspection of the drawings and analysis of the selected material and heat transfer direction and amount.

Burst pressure, proof pressure, and overpressure performance should be verified by a test. The overpressure protection should be disabled for the proof and burst pressure tests.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.1.3.2.3 Thermoelectric refrigeration. Those refrigeration units which utilize thermoelectric refrigeration devices shall have two electromechanical systems to force air circulation within the chiller and freezer compartments and over the heat sink to the aircraft interior. Both circulation paths shall have filters installed to ensure the air impinging upon the thermoelectric modules and heat sinks is clean to ____(a)____. These filters shall be easily removable by a single crewmember without disassembly of major components of the ASWMS, without special tools or devices, and within ____(b)____ seconds. These filters shall be commercially available. The heated air from the exterior heat sink shall not be exhausted directly toward the food preparation area, passengers, or heat sink or insulated surfaces of other refrigeration equipment.

REQUIREMENT RATIONALE (3.2.1.3.2.3)

Thermoelectric refrigeration systems require forced air to circulate to distribute the cooling effect. However, they are also very sensitive to dirt, debris, and heat on the heat sinks.

REQUIREMENT GUIDANCE

a. Since these elements are extremely sensitive to dust and dirt, the air circulated over them must be adequately filtered.

b. The need to maintain high standards of cleanliness requires the filters be cleaned frequently. Therefore, the filters must be accessible for rapid replacement.

c. Thermoelectric refrigeration has proved effective in maintaining temperatures once equilibrium is achieved, but has difficulty in decreasing the temperature of initially hot equipment. For this reason, if thermoelectric refrigeration is used, the refrigeration capacity required in 3.2.1.3.2 may have to be increased, as necessary to ensure the unit is able to provide the desired performance.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.1.3.2.3 Verification of thermoelectric refrigeration. Verification of those refrigeration units which utilize thermoelectric refrigeration devices shall be conducted in accordance with 4.2.1.3.2. In addition, the forced air circulation within the chiller and freezer compartments and over the heat sink shall be verified by _____ and replacement of the filters shall be verified by _____. The filter type and availability and the heat flow direction from the exterior heat sink shall be verified by _____.

VERIFICATION GUIDANCE (4.2.1.3.2.3)

With thermoelectric refrigeration, it is important to ensure the equipment will meet the requirements of 3.2.1.3.2, as well as this subsection. Current thermoelectric component designs are not effective in reducing the heat content of preheated equipment. However, they perform well as temperature maintenance devices. Advances in this technology and proper selection of component capacities may permit the use of thermoelectrics in this application.

The forced air function should be verified by tests. The replaceability of the filters should be verified by demonstration.

The exhaust heat flow and the filter type and availability may be verified by inspection of the ASWMS drawings.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.1.3.2.4 Drink station. A chilled water drink station(s) shall be located at the ____(a)____. This unit shall chill the potable water to no more than ____(b)____ degrees F. The refrigeration equipment shall meet the requirements of 3.2.1.3.2.1, 3.2.1.3.2.2, or 3.2.1.3.2.3. If a galley or lavatory is part of the ASWMS, the potable water and waste water storage ____(c)____ (shall/shall not) be provided from that unit's tanks. The drink station shall be usable ____(d)____ (with and/or without) drinking cups, as defined by ____(d)____. A cold cup dispenser and waste receptacle ____(d)____ (shall/shall not) be mounted immediately next to the drink station. The drink station shall have a means of catching and containing water drips, misses, or spills from the water outlet. All waste and potable water plumbing shall meet the requirements of 3.2.2.2 or 3.2.4.

REQUIREMENT RATIONALE (3.2.1.3.2.4)

In applications where chilled drinking water is required for crew or passenger consumption, then the unit must be equipped to provide the necessary drinking water.

REQUIREMENT GUIDANCE

a. The location of the drink station(s) should be specified in general terms such as, "next to the medical technician's desk", "adjacent to the galley", or "away from the latrine door". It should not be specified in exact terms such as, "on this panel" or "at Bulkhead 76, Waterline 320" to permit the developer to select the exact location as best fits his design. For aeromedical evacuation, a chilled water dispenser should be provided next to the senior nurse's station (or senior medical technician's station when no nurse is aboard).

b. The water should be chilled to the lowest non-freezing temperature achievable within the other limitations of the ASWMS. For aeromedical evacuation, the water should be chilled to 70°F or less.

c. The source of the water and the collection of the waste water should be specified if there is any chance for confusion. A separate supply and waste tank may be required in those cases where the chilled water must be provided at some distance from any galley or lavatory or when independent operation without a galley or lavatory is desired.

d. The drink station should be designed for use with drinking cups to decrease wasted water. The cups should be as defined in *Federal Specification A-A-2577*, *A-A-2595*, or an equivalent. A drinking cup dispenser similar to those defined by *A-A-52061* should be readily available to ensure the station is usable. This dispenser should not be designed for use with a single style or type of cup to permit its use with a wide variety of commercial and military products. A trash receptacle should also be readily available to permit and encourage proper disposal of used cups. This receptacle should be watertight since many of the cups will have a significant amount of residue, and often filled cups are disposed of in any convenient container. For those cases where the drinking station is to be used without cups, the flow should be carefully limited and adjustable to limit wasted water. This should only be used for DV support aircraft.

REQUIREMENT LESSONS LEARNED

During the design review of a galley/lavatory system, it was found that the door to the trash dispenser for the drink station was not tall enough to accept a drinking cup without turning the cup on its side. Therefore, anyone inadvertently disposing of a cup with some liquid in it would spill the liquid onto the floor before the cup was in the trash.

4.2.1.3.2.4 Verification of drink station. The location of the drink station(s), the availability of drinking cups and trash receptacles, the source of the water, and the waste water storage shall be verified by _____. The temperature of the chilled water shall be verified in accordance with 4.2.1.1.2.1. The refrigeration equipment shall be verified as required in 4.2.1.3.2.1, 4.2.1.3.2.2, or 4.2.1.3.2.3. The waste and potable water plumbing shall be verified by the requirements of 4.2.2.2 or 4.2.4.

VERIFICATION GUIDANCE (4.2.1.3.2.4)

The location of the drink station(s), the availability of drinking cups and trash receptacles, the source of the water, and the waste water storage may be verified by inspection of the final drawings.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.1.3.3 Heating equipment. The ASWMS shall contain heating equipment for the preparation of sustenance. Each item of heating equipment shall incorporate an off/on switch, a power indicator, and a separate means of adjustable temperature control or timer for each compartment, when applicable. There shall be an additional indicator to show when power is being applied to the heating equipment through the temperature controller or timer. The equipment shall not use a flame as the heat source. Each individual item of heating equipment shall require no more than _____ amperes power at _____ Volts _____ (direct current or Hertz) for a total of no more than _____ amperes for all heating equipment. Outside surface temperatures on all surfaces directly accessible to the user and all surfaces directly handled by the user during any operation shall not exceed the requirements in 3.5.4.

REQUIREMENT RATIONALE (3.2.1.3.3)

Food prepared for consumption frequently requires heating from a refrigerated or frozen condition to a higher serving temperature. For solid food, this is most often performed in an oven, but a rangetop or hotplate is also used to meet specific preparation requirements. Coffee requires heating for brewing and for service; hot water is often necessary for other beverages (tea or hot chocolate) and for use in cleanup after the meal service.

REQUIREMENT GUIDANCE

There should be an individual power supply switch for each unit or item. A power on/off indicator should be integral with or located near this switch. Ovens should have either an adjustable temperature control or a timer, depending upon the type of oven and its intended use. Multi-compartmented ovens should have a separate controller for each compartment. All other types of heating equipment should incorporate a timer control. Each item with a timer should provide a different audible tone at the completion of its set time period. A second indicator, to show when the controller is energizing the heating elements, should be located on or near each item.

The timer range should be selected to allow the completion of the most time consuming heating operation intended for the appliance. Graduations and markings should be in minutes. It should be constructed so no manual movement of the mechanism will harm its internal components. If mechanical, a stop should be provided to ensure that no more than the number of allowed rotations is possible. Its accuracy should be within 5 percent of its full travel setting at any operating temperature of the ASWMS.

Those heating surfaces near any structures built of any flammable or combustible material must not be permitted to reach temperatures near the ignition or flashpoint temperatures of the material. The *Fire Protection Handbook* should be referenced for proper design of these elements.

The sentence on power requirements should be repeated for each item of heating equipment. The total current capacity should be based upon the power available from the aircraft systems on the non-critical bus. The voltages should be the same for each item. However, if different voltages are necessary for a specific application, then the power loss due to voltage transformers should be deducted from the total available power. Similarly, the frequency of the power requirements should be the same for all items.

REQUIREMENT LESSONS LEARNED

Serious corrosion problems were encountered on the interior surfaces that contacted heated liquids in hot beverage dispensers for the C-141. It was suggested a teflon coating may help reduce this by inhibiting the buildup of corrosion-enhancing parcipitates.

4.2.1.3.3 Verification of heating equipment. The ability of the ASWMS heating equipment to prepare sustenance for use shall be verified as follows. The ASWMS heating equipment's off/on switch, indicators, and adjustable temperature controls or timers shall be verified by ____(a)____. The voltage, frequency, and power requirements of each item of heating equipment shall be verified by ____(b)____. Exterior surface temperatures shall be verified by procedures set forth in 4.5.4.

VERIFICATION GUIDANCE (4.2.1.3.3)

a. The performance of the ASWMS heating equipment's off/on switch, indicators, and adjustable temperature controls or timers should be verified by demonstration. This demonstration should be used to determine the adequacy of these elements when used to prepare sustenance.

b. The voltage, frequency, and power requirements of each heating equipment item should be verified by tests. These tests should be conducted with the item set for the highest operating temperature while the ASWMS is at the lowest anticipated environmental temperature.

c. All the above demonstrations, as well as those indicated in 4.5.5, should be performed as a part of the full system demonstration of 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.1.3.3.1 Ovens. The ovens shall be able to achieve and maintain ___(a)___ degrees F internal sustenance temperature within ___(a)___ minutes. The ASWMS shall heat ___(b)___ (cubic feet of oven space or number of meals as previously defined). Door gaskets shall not take a permanent set, shall provide an adequate seal, shall be removable for cleaning and replacement, and shall not inadvertently loosen or disconnect during the equipment use. Oven doors shall be adjustable to maximize the door seal effectiveness. The insulation used for the ovens shall not permit the formation of areas of localized high heat transfer. Oven heating compartments shall contain drip guards. They shall also contain devices to prevent damage in the event of an explosive decompression. All interior components (drip guards, lights, heating elements, fans, brackets, etc.) shall be easily removable by a single person without tools or special equipment and shall be cleanable with soap and water.

REQUIREMENT RATIONALE (3.2.1.3.3.1)

The ASWMS ovens must be able to provide adequate heat energy to prepare the meals required to support the aircrew members and passengers without introducing hazards to the aircraft, aircrew, or passengers.

REQUIREMENT GUIDANCE

The requirements for the ovens currently used on the buffet/lavatory unit in the passenger/cargo compartment of the C-141 are described in *MIL-O-83993*. It was designed to support 132 passengers during an 18-hr flight.

Oven door gaskets are critical to the maintenance of the oven seal, yet are easily damaged, require frequent cleaning, and are subject to wear. Therefore, it is necessary they be designed for easy and rapid removal by a single person without tools or special equipment. At the same time, the gasket should not be allowed to come loose or fall out during normal use. The door should be adjustable to ensure continuous door seal effectiveness.

The oven insulation should be seamless to prevent localized hot spots at the joints. Similarly, insulation should not loosen, crack, pack, create voids or hot spots, or otherwise allow the formation of localized high heat transfer.

During the heating or preparation processes, food frequently has a tendency to splatter or spill. To permit rapid cleanup of these messes, oven compartments should contain easily removable drip guards. It should be a goal to make the removal, cleaning, and replacement of these drip guards performable while the oven is hot. Non-stick surfaces should be considered.

When designed for use in aircraft with pressurized cabins, the ASWMS ovens should contain a device to prevent damage to the equipment or injury to the crewmembers and passengers in the event of an explosive decompression. The sudden loss of cabin pressure could cause the door of an operating oven to blow open and the heated contents to be thrown out, burning personnel, spoiling the sustenance for use, and creating a mess for cleanup. A dump or relief valve should be employed to equalize the sudden pressure changes safely.

a. One previous oven design was required to warm six frozen meals from 30 to 145°F within 22 min. The oven was then required to maintain the meals between 150 and 160°F. Another previous design was required to heat six frozen meals from 10 to 175°F within 22 min. The temperature at the center of mass for the largest item should be used.

b. The volume of the oven and the area of a range top should be based upon the number of crewmembers and passengers supported. The time available for service is also necessary for determination of the heating unit size. However, these items should be large enough so all passengers can be served within 90 min.

REQUIREMENT LESSONS LEARNED

In one primordial design galley oven, the fans failed frequently and required constant removal and replacement. Also, filters were used to clean the air before it contacted the fan blades. These filters often became clogged with grease and dirt and needed frequent removal for cleaning. However, both the fans and the filters were inaccessible, not easily removable, and required tools not readily available.

The specification for the C-5B galley included the requirement that the oven be common with the C-5A. This oven was sized to accommodate the preparation of a particular type and number of meals used for the design of the C-5A galley system. However, these meals were no longer available for use in the USAF, which involved a costly contract change to enlarge the oven's interior dimensions to permit the use of an alternative meal.

4.2.1.3.3.1 Verification of ovens. The capacity of the ovens and their ability to reach the required temperatures in the specified time shall be verified by ___(a)___. The ovens shall be cold soaked for ___(b)___ minutes at ___(b)___ degrees F and maintained at an exterior environment of ___(b)___ degrees F. During this verification, the oven should be loaded with the type of meals specified in 3.2.1.1 as necessary to meet the aircraft's mission requirements. The performance of the door seal gaskets, door adjustments, insulation, drip guards, and decompression relief devices shall be verified by ___(c)___.

VERIFICATION GUIDANCE (4.2.1.3.3.1)

a. The capacity and operating temperature performance of the ovens should be verified by a test. The meals selected for this evaluation should be representative of those specified for the operation of the ASWMS in 3.2.1.1. It is preferable that this test be conducted with the oven installed in the ASWMS and not as a separate component.

b. During these tests, the exterior of the ASWMS should be cold soaked and maintained at the lowest required environmental temperature (see 3.2.5). The time required for a complete cold soak depends upon the size, mass, geometry, and materials used. A method to establish this time is described in *MIL-STD-810*.

c. The remaining performance verifications should be performed as part of the full system demonstration of 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.1.3.3.1.1 Conventional ovens. This section includes the requirements for all types of convection, conduction, forced air, steam, and/or radiant heat ovens. If internal fans are used, they shall operate continuously whenever power is supplied to the unit, whether or not the heating elements are powered. Ovens shall have a temperature indicator for each compartment. Oven heating elements shall be removable for cleaning and replacement and shall be shielded to prevent inadvertent contact by the user.

REQUIREMENT RATIONALE (3.2.1.3.3.1.1)

The ASWMS conventional ovens must provide a means of heating sustenance without introducing hazards to the aircraft or personnel.

REQUIREMENT GUIDANCE

Steam or pressure cooking ovens are not usually considered for use onboard aircraft, due to the personnel hazards associated with their use. Even low pressure steam systems, in the low pressure ambient environment of operating aircraft, can create burn and/or asphyxiation hazards in the event of a steam leak or improper operation. Therefore, these systems should only be used when 1) adequate safety devices are implemented and 2) no other equipment type can provide the performance required. It is doubtful that both conditions can be met; therefore, it is strongly recommended steam ovens not be used.

Internal fans are frequently used to ensure an even temperature is maintained throughout the unit or to transfer the heat energy from the generating source. The operating cycle of these fans should be designed to ensure this even heating is maintained throughout all cycles of the system's heating elements.

There are many types of temperature sensors which lend themselves to this application. These include bimetallic mechanical, thermocouples, electronic, etc. However, fine temperature resolution is not necessary. Indicators that can provide ±5°F are adequate for this use.

The oven heating elements should be removable and cleanable using soap and water to ensure the sanitary condition of the oven and to remove spills and splatters which could otherwise burn. The heating elements should be shielded to reduce the probability of burns to the user and contact with the oven contents.

An oven used previously in military galleys, the *HDU-23/B, is described on figure 4.*

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.1.3.3.1.1 Verification of conventional ovens. The operation and performance of internal fans, temperature indicators, heating elements, and shields shall be verified by _____.

VERIFICATION GUIDANCE (4.2.1.3.3.1.1)

The demonstration portion of this verification should be performed as part of the full system demonstration of *4.1. These performance* verifications should be performed during the operating temperature tests.

Guidance is provided in *ASTM E 145-68* for verification of the performance of commercial ovens that use gravity-convection or forced-ventilation for heat distribution and are used in laboratories and commercial facilities. These requirements should not be used as written, but should be extensively tailored. They can then provide guidance on the testing of conventional oven performance.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

115/200 VAC, 400 HZ, 30 AMP
4 WIRE, "Y" CONNECTED
CIRCULATING AIR HEATING
1750 WATT, 400° ±10°F FIXED
THERMOSTAT
5 - 30 MINUTE TIMER
FOOD RACK CAPACITY:
6 *MIL-M-13966* FROZEN MEALS
6 COMMERCIAL "TV" DINNERS
18 INFLIGHT FEEDING CANS
(3.0 DIA × 2.0 HIGH)
6 FOIL PACK MEALS

PERFORMANCE:
6 FROZEN MEALS AT 5°F IN
22 MINUTES

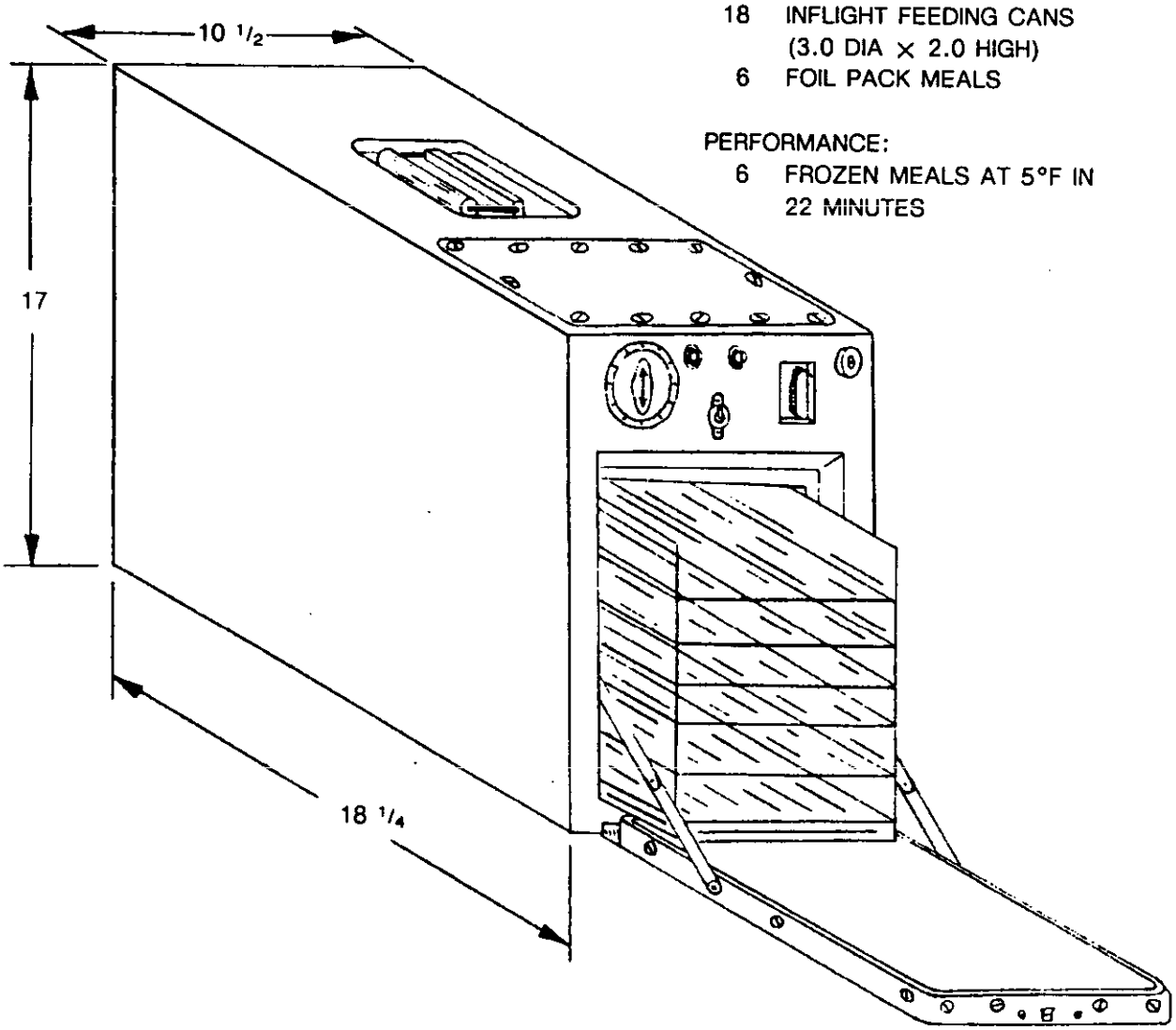


FIGURE 4. HDU-23/B oven.

3.2.1.3.3.1.2 Microwave ovens. Radiation external to the oven shall be no greater than the levels allowed by Attachment 3 of *AFOSH Standard 161-9* throughout the item's design life. Microwave ovens shall contain interlocks which meet the same reference to ensure no radiation can be generated with the door fully or partially open or insecurely latched. The microwave energy source shall be protected for up to ____(a)____ minutes from damage due to excessive reflected microwave radiation created by no load operating conditions. In addition to a timer, the microwave ovens shall have an adjustable power control from ____(b)____ to ____(b)____ Watts. Microwave ovens shall have uniform distribution of the microwave energy throughout the cooking compartment. A forced air system with a replaceable filter shall be incorporated to exhaust water vapors from the cooking compartment. The compartment shall be lighted whenever the oven is operating or the door is open. An operating instructions and warning placard shall be conspicuously placed on or near the oven.

REQUIREMENT RATIONALE (3.2.1.3.3.1.2)

Microwave ovens have become a common kitchen appliance. They are prized for their ability to rapidly heat or defrost a meal with low power requirements. Yet, there are serious limitations on their installation and use which must be observed.

REQUIREMENT GUIDANCE

Improper design or integration of a microwave oven can result in microwave radiation leaks around the door sills, through cracks in the structure, or through any windows. To protect the user, it is necessary to limit this leakage to allowable levels, as defined in *AFOSH 161-9*. Additionally, it is possible for a microwave oven to leak harmful radiation into the environment as it ages. This leakage may increase due to improper operation, maintenance, or cleaning procedures. Therefore, a periodic check to ensure the oven is continuing to operate safely, as defined in *AFOSH 161-9*, should be conducted.

To ensure user safety, an interlock to remove power from the radiation producing circuits before the door is permitted to open is needed. Although this need has become better known as microwave ovens proliferate, the user cannot be relied upon to ensure this condition.

Radiation leakage levels are regulated by the *Code of Federal Regulations Title 21, Subchapter J, Food and Drugs - Radiological Health*; *Title 29, Chapter 17, Labor, Occupational Health Administration*; and *Title 47, Part 18, Telecommunication - Industrial, Scientific and Medical Equipment*. The *National Sanitation Foundation Publication Number 4, Commercial Cooking and Hot Food Storage Equipment*, lists equipment in compliance with the applicable regulations. *Underwriters Laboratories 923, Microwave Cooking Appliances*, lists requirements for these ovens.

Federal Specification S-O-1425 provides detailed guidance on the design of any microwave oven. Also, *Federal Specifications A-A-50465* and *A-A-50466* list the requirements for microwave ovens for other than household or shipboard use.

All microwaves should be equipped with a timer that both provides an audible indication and removes the power from the radiation producing circuits. Adjustable power settings enable the user to control the heating process to prepare the food better for consumption. Microwave cooking tends to heat the surface layers of the food more rapidly than the interior portions. The user can allow time for the heat to transfer deeper into the interior of the food without overcooking the exterior surfaces by adjusting the power level. Although not required, a temperature sensing probe that turns off the oven when a desired temperature is reached may also be used to ensure complete cooking of the sustenance.

Some older, less efficient oven designs, which cannot be used in the ASWMS, do not contain a device to distribute the waves evenly throughout the oven or to rotate the food while it is cooking. Wave stirrers and rotating tables have been used to accomplish this. Without one or both of these devices, hot spots will develop in the food where the microwave power levels are greatest. This will cause uneven cooking and the food will be badly overcooked in some locations and undercooked in others.

The oven should ventilate the cooking compartment away from personnel or heat sensitive equipment. The flow rate should be adequate to prevent the visible buildup of steam and condensation in the compartment.

A placard should be placed near or on the microwave oven to provide operating instructions, example control settings for common microwave food items, and maintenance procedures. However, it is current USAF guidance that no warning of microwave use for heart pacemaker wearers is needed. See 3.5.1 for placard wording.

While many "home consumer"-type commercial microwave ovens exist, there are problems to address when they are planned for use in aircraft. These include power conversion from 400 Hz to 60 Hz with the associated weight increase and electromagnetic compatibility problems, sequential versus simultaneous meal cooking, cost of modification development and qualification, etc.

Commercial aircraft and military air vehicles have similar problems in the use of microwave ovens. Load and vibration levels are high due to the landing and takeoff environments, and maintenance of electromagnetic compatibility to prevent communication and navigation interference. In 1986, the FAA approved a microwave oven for commercial use that prepared 12 meals in 5 min. This oven met the load requirements and the vibration environment of figure 5. To permit an even distribution of the heat generating waves, an oscillator was provided at the top and bottom of the cavity. Despite this, the oven met the electromagnetic interference limits of figure 6. Noise filters were needed to eliminate the conducted electromagnetic interference. Additionally, it was built to require 3 phase, 400 Hz, 115V power at a maximum demand of 3.7 kw and to weigh 38.6 kg.

Another microwave unit has been developed by the U.S. Army for use in aircraft (*NATICK/TR-91/033L*) and has been tested with significant success. There were several electromagnetic interferences noted due to the operation of the unit. However, after a converter was changed on some avionics, the system was determined to be safe to fly. The test results are contained in the referenced document.

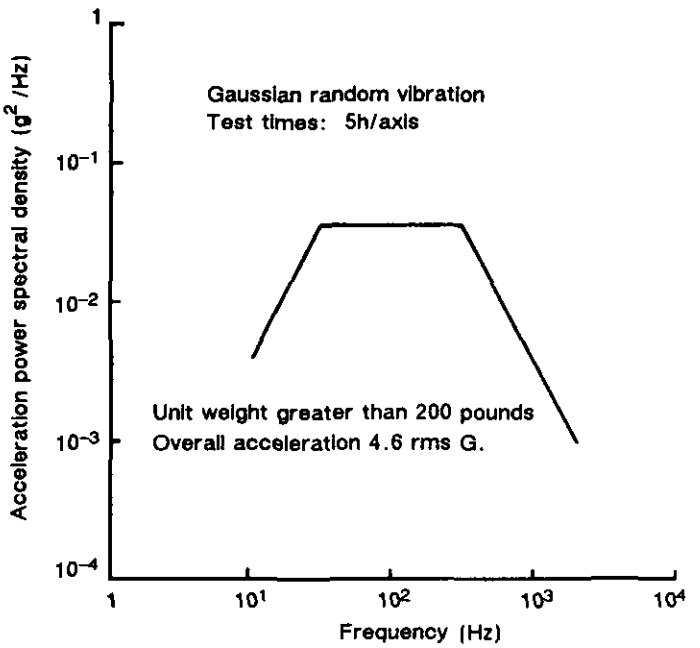
At one time, there was extensive controversy over the safety of microwave oven use in any environment. The *FAA TR AC-213-7* provides background information on the discussions (up to the date of publication—November 1973) and an evaluation on the use of microwave ovens in aircraft.

a. The oven should be able to operate unloaded for a reasonable period of time without failure. This condition causes the reflected radiation level to increase, which can harm the radiation generator. Commercial microwaves are required to operate in this condition for 1 hr or for the maximum setting of their timer, whichever is less.

b. The C-20 executive transport aircraft has a 1.25 cu ft interior volume, 600 Watt microwave oven installed for passenger meal preparation.

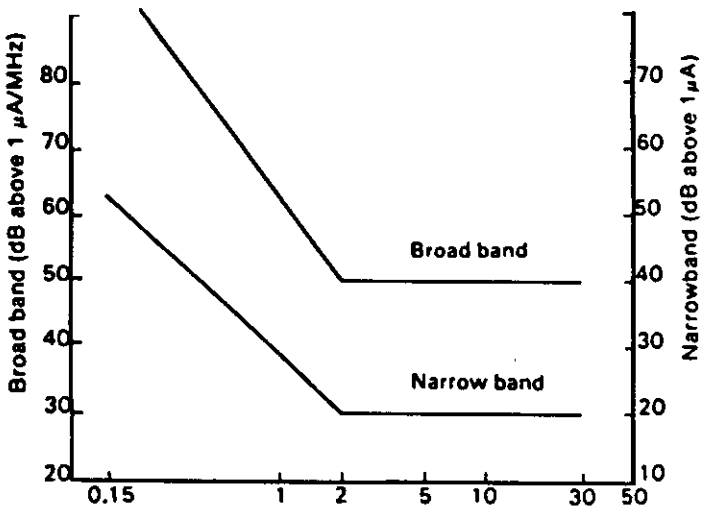
REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

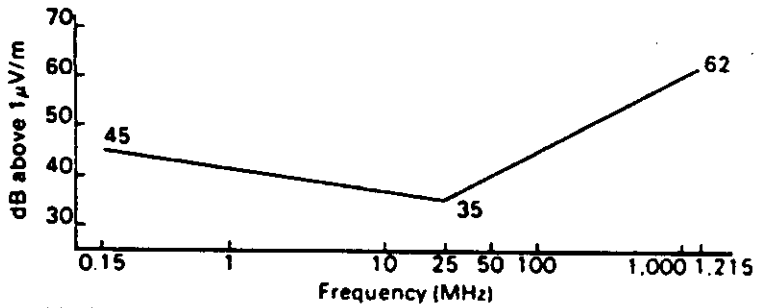


Ordinary microwave ovens:	Malfunction should not occur when a 1,000 Hz, 2mm amplitude vibration is applied to the X, Y, and Z axes, respectively, for 0.5 hours.
	Application of the above vibration in X, Y, and Z directions for 5 hours each should not cause any malfunction (unpacked product status).

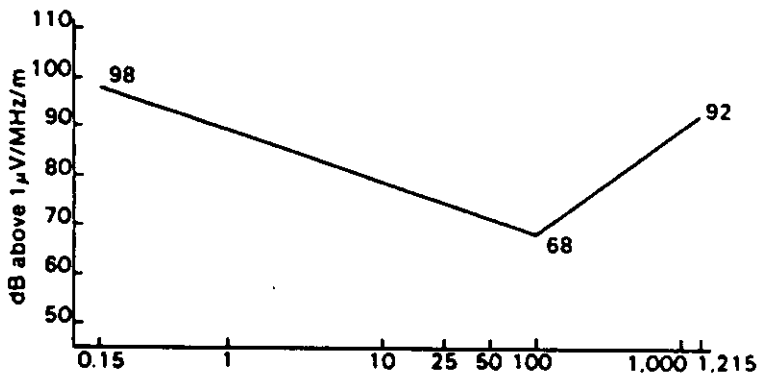
FIGURE 5. Vibration requirements for a commercial microwave oven.



Conducted interference limits power input using clamp (on current probe)



Maximum level of radiated CW interference from any one equipment



Maximum level of radiated broad band and pulsed CW from any one equipment

FIGURE 6. Electromagnetic interference requirement for a commerical microwave oven.

4.2.1.3.3.1.2 Verification of microwave ovens. Radiation external to the oven shall be verified by direct measurement on a unit operating at the highest power level at several, evenly spaced time intervals throughout a time period representative of its design life. This test should include _____ cycles of oven door opening and closing at the highest closing force level and _____ cycles of cleaning procedures. The protection of the microwave energy source from damage due to excessive reflected microwave radiation shall be verified by _____. The performance of the door interlock(s) shall be verified by _____ to verify they operate to remove power to the radiation generation system before the door begins to open. The adjustable power control shall be verified by _____. The air circulation and replacement shall be verified by _____. The operation of the cooking compartment light and the acceptability of the warning placard shall be verified by _____. The satisfactory distribution of the microwave energy shall be verified by _____.

VERIFICATION GUIDANCE (4.2.1.3.3.1.2)

Radiation measurements should be taken as directed by *AFOSH 161-9*. *American Society for Testing and Materials F1317-90* provides the test method to determine the power level of microwave ovens. The usual site of microwave energy leakage is the door and door seals. Special care should be taken to check the radiation all around the door sill and over the entire surface of any windows or screens. The door should be slammed shut at its highest design force a number of times throughout this exposure, to simulate the normal usage. This is important, due to the consequences of a loss of door sill (significant increase in radiation exposure) and the inability of a user to detect this loss until the next inspection cycle. A small container of water should be placed in the oven during all tests to serve as a load for the system and to prevent a harmful buildup of microwave energy within the oven. This verification should be conducted in concert with any reliability tests.

Probes or indicators should be used to verify the door interlocks operate to remove power to the radiation generation system before the door begins to open and that no radiation is allowed to leave the oven due to an attempt to open the door with the power applied. With the proper probe in place by the door sill and with the oven operating at maximum power, the door should be opened using the usual means of operation.

The ability of the oven to operate without a load for the required period of time should be tested by operating the oven for 1.5 times that amount.

The ability to adjust the power control may be verified by a simple test. The time required to begin boiling a liter of water could be measured at each power setting. The water should start at the same temperature for each setting and the initiation of boiling (first indication of bubbles, 212°F, etc.) should be consistent for each test. Alternatively, several ice cubes made from a measured liter of water could be placed in the oven for this test, and the time required for the oven to completely melt the ice would be measured for each setting.

The air replacement capability of the oven and the acceptability of the placard should be verified during the ASWMS demonstration.

The ability of the oven to cook the sustenance evenly should be demonstrated by distributing standard sizes of ice or water throughout the oven interior and observing that they are heated at the same rate.

Federal Specification S-O-1425 provides detailed guidance on the verification of microwave oven performance.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.1.3.3.2 Liquids heaters. Liquids heaters shall be designed to prevent liquids from entering the electrical and electronic elements. They shall have a power switch and a timer to turn them off after a set time period. Heaters for liquids with sealed compartments shall be designed to prevent damage in the event of an explosive decompression. The liquids heaters shall be fully drainable by gravity. Where appropriate for the type of liquids anticipated, cathodic protection may be utilized.

REQUIREMENT RATIONALE (3.2.1.3.3.2)

Heaters for liquid sustenance have their own peculiar design limitations which require consideration in the development of an ASWMS.

REQUIREMENT GUIDANCE

Due to the potential for electrical shock in the airborne environment, the liquid heating devices must ensure the liquids are not able to contact the electrical and electronic elements. This should include all anticipated normal and emergency aircraft maneuvers, environments, and user operations. The power switch and timer should be separate units to provide redundant power control. Finally, containers for the heated liquids, if sealed, should be equipped with a pressure relief or dump valve to protect the heater from the consequences of an explosive decompression. This relief valve should not permit the hot liquids to be directed toward a user or other aircraft occupant in the event of actuation. As with all liquid processors/containers, the heaters should be drainable by gravity with no remaining pockets of liquid. This is to prevent the undetected and/or unknown growth of harmful micro-organisms in a stored unit and the subsequent distribution of these organisms.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.1.3.3.2 Verification of liquids heaters. The operation of the liquids heaters shall be performed by _____. The performance of the pressure relief devices shall be verified by _____. The complete drainage by gravity shall be verified by _____.

VERIFICATION GUIDANCE (4.2.1.3.3.2)

The separation of the liquids in heaters from the electronic and electrical components should be verified by both a careful inspection of the device and its drawings and by its performance during the systems demonstration of the ASWMS. Verification of the performance of any pressure relief component should be performed as a test, with the liquid at the design operating temperature and pressure and the ambient pressure suddenly reduced by the largest anticipated pressure difference for the aircraft system. The complete drainage of the unit should be demonstrated during the systems-level demonstrations of the ASWMS.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.1.3.3.2.1 **Coffeemaker.** The ASWMS shall be able to provide ___(a)___ cups of coffee within ___(a)___ minutes, beginning with water at the lowest operating temperature, with minimal operator interaction. The coffeemaker shall be able to make coffee from either bulk coffee with a filter or from prepackaged coffee bags. An indicator shall show when the brewing cycle is complete. After brewing, the coffee shall be maintained at ___(b)___ degrees F. The coffeemaker shall contain provisions to hold the coffee pot in position throughout all aircraft normal and emergency maneuvers without spilling coffee. The coffeemaker shall not be damaged by operation with the coffee pot absent or empty and shall not damage an empty or near empty coffee pot. The coffee pot shall be designed for easy cleaning, pouring, and handling without burn hazard to the using personnel. The pot shall not break if dropped ___(c)___ feet onto a ___(c)___ surface and shall hold ___(c)___ cups of coffee.

REQUIREMENT RATIONALE (3.2.1.3.3.2.1)

Coffee is frequently used by aircrew members. The coffeemaker should meet the requirements above to ensure the crewmembers are able to use it without hazard.

REQUIREMENT GUIDANCE

Disposable, prepackaged coffee bags which contain a measured amount of coffee grounds are readily available in the supply system. These offer distinct advantages for those cases where the user must rapidly serve a large amount coffee or where the storage and use of bulk coffee is difficult. However, since the coffee bags may not be available at some remote operating sites, coffeemakers selected for their ability to use the bags should, as a goal, also be able to use bulk packaged grounds.

A visual indicator should be used to show that the brewing cycle is finished. However, audible indications may also be used.

If any internal components of the coffeemaker contain sections at pressures above the cabin ambient pressures when at altitude, then the coffeemaker should meet the same requirements for explosive decompression as the water heater.

a. The capacity of the coffeemaker should be based upon the total number of passengers and aircrew members the ASWMS is designed to support. A factor to account for the fraction of personnel who do not normally drink coffee should not be used, since many non-coffee-drinkers will partake of the coffee during the unusual, stressful, extremely cold, and/or fatiguing operations which military aircraft normally experience. The time required to brew a pot of coffee should be based upon the time requirement for serving a meal, since many people desire coffee with their meals. It is necessary to ensure the initial temperature of the unit is stipulated, since this parameter may influence the heat-up time and ability of the maker to maintain the coffee at the correct serving temperature.

b. To prevent excessive loss of water, the coffee should be kept well below the boiling temperature for the normal maximum cabin altitude.

c. If the coffeemaker has an integral coffee pot, a retention device should be included to hold the pot under the coffee spigot. This retention should prevent the movement of the pot throughout all the anticipated aircraft maneuvers. The capacity of the pot should be based upon the capacity of the coffeemaker, with 10 to 20 percent additional volume to reduce the probability of spilling while serving.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.1.3.3.2.1 Verification of coffeemaker. The capacity of the coffeemaker shall be verified by _____. The holding temperature of the coffee shall be verified by _____. The other operations of the coffeemaker shall be verified by _____.

VERIFICATION GUIDANCE (4.2.1.3.3.2.1)

The capacity of the coffeemaker and the holding temperature of the coffee should be verified by tests. The ambient temperature, the amount of grounds needed, the water required, and the amount of user operations should be monitored. All other operations of the coffeemaker, including the amount of user activity required, should be verified as a part of the full system demonstration of 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.1.3.3.2.2 Water heater. Heaters for liquids shall be capable of providing water at ___(a)___ degrees F at flow rates of ___(b)___ gallons per minute. This temperature and flow of water shall be available after ___(b)___ minutes of heating after prior cold soaking for ___(c)___ minutes at ___(c)___ degrees F and while maintained at an exterior environment of ___(c)___ degrees F. Heating elements shall be removable for cleaning and replacement. The interior of the water heater shall be easily cleaned and sanitized. Water heaters shall either prevent operation if the unit is empty or shall not be damaged from operation when empty. In the event of cabin depressurization, the water heater tank pressure shall be contained without damage to the system or hazard to personnel, or vented to the exterior of the aircraft until the tank and cabin pressure differential reach a safe level.

REQUIREMENT RATIONALE (3.2.1.3.3.2.2)

Water heaters should be included in the ASWMS design when the increased water temperature is desirable for sanitary, cleaning, or sustenance reasons. For example, heated water may be needed to ensure the users can completely clean and sanitize the ASWMS, due to the procedures involved, the type or amount of sustenance involved, or anticipated use or misuse of the ASWMS equipment. Water heaters may also be needed to serve hot water for tea, instant coffee, or hot chocolate.

REQUIREMENT GUIDANCE

The interior of the water heater should be accessible for the removal of heating elements and the cleaning of all interior components.

If not properly designed, application of power to the heating elements when the unit is empty or near empty can damage the system. Damage prevention may be accomplished by the incorporation of a sensor that removes power from the heating circuit when water is absent, by designing the elements to withstand the heating condition without water present, or by installing a power limitation device in the heating circuit.

National Sanitation Foundation Standard 5, Hot Water Generating and Heat Recovery Equipment, contains extensive guidance on the design of hot water generation equipment.

a. The temperature of the heated water should be based upon the intended use. Water to be used for hand washing, cleaning, or other activity that requires immersion of the hands or other body parts should be no more than 95°F. Water to be used for hot drinks should be from 140 to 170°F (or at the boiling point for water at the highest cabin altitude, whichever is lower). However, in accordance with *MIL-STD-909*, if hot water is to be used as the primary means of sanitization, then it must be no less than 170°F.

b. The hot water maximum flow rate should be based upon the anticipated needs for heated water for inflight cleaning purposes and drinking. The latter should include the amount of water necessary to provide crewmembers and passengers with tea, hot chocolate, and other heated beverages. Aeromedical evacuation may require additional hot water, both for service of the patients and for cleaning up after meals or treatment.

c. The time required for the above temperature to become available should be based upon the design mission(s) for the aircraft the ASWMS is to support. This cold soak temperature and maintenance temperature should be based upon the low storage requirement of 3.2.5.

REQUIREMENT LESSONS LEARNED

In previous galley designs, the water heater for hot drinks was an integral part of the coffeemaker. This provides a weight and space savings over the addition of a separate system to achieve this requirement.

4.2.1.3.3.2.2 Verification of water heater. The temperature, times, and flows of the water heater shall be verified by _____. The ability of the user to clean and sanitize the water heater and replace the heating elements shall be verified by _____.

VERIFICATION GUIDANCE (4.2.1.3.3.2.2)

Temperatures, times, and flows should be verified by test and demonstration. While the tests should be used to measure the capacity of the water heater, the demonstration, as a part of the full ASWMS demonstration, should verify the operational characteristics performance.

The demonstration portion of this verification should be performed as a part of the full system demonstration of 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.1.3.3.2.3 Hot cups. Hot cups shall be constructed of an unbreakable material and shall have an insulated handle, a pour spout, and a guard to protect the user's hand from heat on the exterior surface. Hot cups shall be Type ___(a)___ (I or II), as defined by *MIL-H-21303* and figure 1. The hot cups shall be able to hold ___(b)___ fluid ounces of water. When mounted into the appropriate bracket, the hot cup shall be able to heat water to ___(c)___ degrees F within ___(c)___ minutes and maintain the contents at ___(c)___ degrees F. The hot cup shall be protected from damage from operating for ___(d)___ minutes without any water or liquid content. The hot cup shall have a lid or cover designed to return condensate or splash to the interior with positive retention. The hot cup material shall be suitable for water, coffee, chocolate, and soups. Hot cup brackets shall be in accordance with *MIL-B-7525* or ___(e)___ and shall contain a power connector, a retaining device, and a timer. The bracket shall be able to hold and provide power for ___(e)___ (one or four) hot cups. An indicator light shall be provided on the bracket for each hot cup. The power connector shall be integral to the bracket and hot cup and shall require no operation to connect other than placing the hot cup into the bracket.

REQUIREMENT RATIONALE (3.2.1.3.3.2.3)

Hot cups have been in use in military aircraft for many decades. It is expected they will continue to find applications in some types of aircraft for many more years.

REQUIREMENT GUIDANCE

a. These items have been defined by *MIL-H-21303*, and *MIL-B-7525* defines the mounting brackets. Type I hot cups use 28V DC power, while Type II cups are designed to use 115V AC (400 Hz). To maximize commonality, the hot cups for the ASWMS should be consistent with these designations. The brackets and hot cups are designed for both 28V DC (22 amps for a single cup and 88 amps for a four-cup bracket) and 115V DC and AC (6 amps for a single- and 24 amps for a four-cup bracket).

b. The capacity of the existing hot cups is 35 ±2 fl oz.

c. The final temperature of the water should be no more than the boiling temperature of water at sea level, 212°F. The current hot cups operate between 170 and 190°F. They are required to reach 175°F from an initial temperature of 70°F within 12 min.

d. The existing hot cups are required to operate for 24 hr (1440 min) without any liquid content, without damage.

e. If a requirement other than *MIL-B-7525* is to be used for the bracket, it should be listed here.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.1.3.3.2.3 Verification of hot cups. The ability of the hot cups to attain the required temperature should be verified by _____ with the ASWMS cold soaked to _____ degrees F and the environment maintained at _____ degrees F. All operations with the hot cup shall be verified by _____.

VERIFICATION GUIDANCE (4.2.1.3.3.2.3)

The temperature performance of the hot cups should be verified by tests conducted with the hot cup filled to its design level, with the ASWMS cold soaked to its coldest storage temperature and the environment maintained at the lowest operating temperature (see 3.2.6). All other operations with the hot cup should be verified as an integral part of the ASWMS demonstration.

The demonstration portion of this verification should be performed as part of the full system demonstration of 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.1.3.3.3 Other heating equipment. The _____ (device name, such as ranges, hot plates, hot shelves, skillets, griddles, serving counters, etc.) shall be able to achieve and maintain _____ degrees F surface temperature within _____ minutes after being cold soaked for _____ minutes at _____ degrees F and maintained at an exterior environment of _____ degrees F. Any doors, heating elements, drip guards, decompression relief, power switches, timers, or other devices shall meet the requirements of the similar devices in the analogous oven or liquids heater performance requirements above.

REQUIREMENT RATIONALE (3.2.1.3.3.3)

A wide variety of heating equipment may also be included in the ASWMS design to meet special aircraft mission requirements. For example, ranges may be needed for DV aircraft galleys, or hot shelves may be desired to maintain the sustenance in a ready-to-eat condition. The particular type of equipment that may be specified cannot be limited in this document.

REQUIREMENT GUIDANCE

The maximum temperature desired for the heating device depends upon the use for which it is designed. When this temperature is selected, it should be remembered that liquids will boil at lower temperatures when at the lower pressures experienced at altitudes. The temperature should be limited to prevent boiling away of the heated product. Also, if an enclosed heating space is used, the lower environmental pressure will cause any steam generated to fill a larger volume when the enclosure is opened. This may cause a burn hazard for personnel and an operational hazard for electrical/electronic equipment due to condensation on cooler surfaces.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.1.3.3.3 Verification of other heating equipment. Heating devices shall be able to achieve and maintain the required temperature after being cold soaked for _____ minutes at _____ degrees F and maintained at an exterior environment of _____ degrees F. The operation of components shall be verified as required for similar devices in the analogous heating equipment verification requirements above.

VERIFICATION GUIDANCE (4.2.1.3.3.3)

The ability of the heating equipment to achieve and maintain the required temperature should be performed with the ASWMS cold soaked to the lowest storage temperature and maintained in an environment at the lowest operating temperature. The other operation of the heating equipment should be verified in accordance with similar devices in the preceding paragraphs. If no device meets that criteria, it should be verified in accordance with other accepted standards for equipment of that type.

The demonstration portion of this verification should be performed as part of the full system demonstration of 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.1.3.4 Sustenance stowage equipment. Storage shelves and drawers shall be designed to be compatible with the containers used for the sustenance designated in 3.2.1.1. Adequate non-refrigerated storage shall be available for the condiments, dinnerware, and utensils needed to prepare, serve, and ingest that sustenance. Drawers shall not be located above the eye level of the smallest sized user, as defined by the anthropometric requirements of 3.5.3. Drawers shall have no transverse or vertical movement, deformation, or jamming during opening and closing. Drawers shall have stops to prevent inadvertent pulling of the drawer out of the ASWMS structure. All drawers and shelves shall be removable without tools, cleanable with standard agents, and adjustable without tools. Shelves shall be enclosed with doors to prevent the loss of the stored sustenance or equipment throughout all mission maneuvers. Stowage shall be provided on the ASWMS for all detachable or temporary ASWMS components, such as refrigerator or oven inserts, ASWMS stowage environmental protection cover, and/or ASWMS servicing hoses. Components used for the preparation or handling of sustenance shall not be stored adjacent to components used by the ASWMS for any kind of waste handling. Drawers in refrigerated spaces shall have holes to allow air circulation.

REQUIREMENT RATIONALE (3.2.1.3.4)

Stowage for the various components required for sustenance preparation is necessary to ensure its ready availability and the safety of personnel throughout all aircraft maneuvers.

REQUIREMENT GUIDANCE

The stowage area, depending upon the type of sustenance the ASWMS is designed to prepare and serve, may require stowage for dishes, cutlery, paper or cloth napkins, and utensils. Potentially breakable items, such as dishes, may require special racks for protection.

To facilitate the service of sustenance, drawers need to be located below the users' eye level so they can see what items are contained therein. The drawers should be strong enough to support the anticipated full load of sustenance, equipment, or components. Drawers and shelves below the preparation surface should be able to withstand the weight of a user.

All materials and designs should be selected to ensure easy cleaning and sanitization.

REQUIREMENT LESSONS LEARNED

Access to the stowage for sustenance and preparation equipment is necessary while the vehicle is in flight. On one air vehicle under development, refrigerated food stowage is accomplished on a lower deck, usually a cargo deck. Access to this deck must be maintained to permit the proper preparation of the meals.

Experienced aircrew members have repeatedly emphasized the need for adequate storage space. A comment heard frequently during design reviews for this type of equipment was that it would be difficult to have "too much" storage space.

Failure to provide adequate stowage has caused the damage of accessory equipment which has precluded the use of the equipment (*AFLC/AML Lessons Learned Program #10364*).

4.2.1.3.4 Verification of sustenance stowage equipment. The compatibility of the stowage shelves and drawers with the required sustenance, equipment, and components shall be verified by _____. The adequacy of the shelf doors and equipment retention devices shall be verified by _____.

VERIFICATION GUIDANCE (4.2.1.3.4)

The demonstration portion of this verification should be performed as a part of the full system demonstration of 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.1.3.5 Preparation area/equipment. The ASWMS shall contain tables, counters, platforms, or other work surfaces for the preparation of ____(a)____ meals at one time. This area or equipment may be fixed and/or temporary. If temporary, it can be assembled or prepared within ____(a)____ minutes by a single aircrew member without tools. The equipment shall be rigidly secured and shall have a positive locking mechanism when in both the using and stowed positions or configurations. Stops shall be employed to limit any opening to the intended position or configuration. This equipment shall be designed to support the weight of ____(b)____. The surface of this area or equipment shall be within ____(c)____ degrees of level when the aircraft is in normal, level flight. Any slope shall be away from the user and toward a basin, a waste receptacle, or a refuse opening. When the preparation area contains a refuse opening, it shall have a hinged, spring-loaded, inward-opening cover with a drip collar. The opening shall be ____(d)____ inches in diameter or on the diagonal across two corners (if rectangular). The preparation area shall have ____(e)____ (number) utility outlet(s) rated at ____(e)____ amperes at ____(e)____ Volts ____(e)____ (direct current or alternating current) and with an integral, self-testing circuit breaker set at the rated amperage. The utility outlet shall be positioned to minimize hazards due to accidental spills during all operations at the work surfaces.

REQUIREMENT RATIONALE (3.2.1.3.5)

Workspace is needed to assemble the meals prior to service. This space must be adequate to meet the overall requirements of the ASWMS.

REQUIREMENT GUIDANCE

All materials and designs should be selected to ensure easy cleaning and sanitization. The C-135 specified the use of two removable shelves which could withstand a 200-lb weight and hold a minimum of two meals. The Critical Design Review (CDR) for the E-3A identified a need to include a cover over the galley sink to permit the use of this space during meal assembly.

a. There should be adequate room for the ASWMS user to set out the required number of meals at once while preparing them for use. This area may be a permanent or temporary counter or table top. If temporary, it may be removable, foldable, slide-out, or other mechanism. However, if moveable, it must be retained throughout all aircraft maneuvers, in both its stowed and deployed state. A single aircrew member must be able to set up the workspace rapidly without assistance. The time requirement should be based upon the size of the ASWMS, should be no more than 2 min, and should not be allowed to increase due to the complexities of the design approach selected.

b. As a minimum, the work surface should be able to support the weight of several layers of the design meals. For those ASWMS designs where there are items stored above (or functions for the user to perform above) the level of the work surface, it is also advisable to require the work surface to support the weight of the user. (See 3.2.1.3.5 Requirement Lessons Learned.)

c. A slope should be provided to ensure spills are controlled. The slope should be no more than 5° and no less than 1.5°. The slope should be toward any basin or refuse opening, if provided.

d. If a refuse opening is used, it must have a cover that is spring loaded to stay shut when not in use. It shall be sized to accept the largest possible refuse from the planned meals. The removable waste container beneath it should hold a disposable trash bag. The *SAE AS 1426* recommends the waste opening should accept a champagne bottle with a 4.33 in. diameter and 12 in. length. While few USAF air vehicles require the service of champagne, this provides an indication of the standard size used in commercial galleys.

e. The utility outlets and all related circuits should be able to carry 115 to 120V AC current at 60 Hz. The current rating should be based upon the anticipated use, but should be no less than that required by the largest anticipated power user. The outlet circuit breaker should contain a self-test feature.

REQUIREMENT LESSONS LEARNED

People sit on work surfaces, whether or not the surfaces are intended for this purpose. Flat surfaces on tables, workstations, etc., in previous galley designs are frequently damaged when crewmembers or maintainers sit or lean on them. They are then strengthened during aircraft overhaul to prevent further damage.

4.2.1.3.5 Verification of preparation area/equipment. The size, location, and weight capacity of the ASWMS work surfaces shall be verified by _____. The set up, assembly time, and retention of the surfaces (both stored and in use configurations) shall be verified by _____. The slope of the surfaces shall be verified by _____ level when the aircraft is in normal, level flight. The operation of the refuse opening, refuse container, and utility outlet shall be verified by _____.

VERIFICATION GUIDANCE (4.2.1.3.5)

The size, location, weight capacity, slope, and utility outlet capability of the ASWMS' surfaces should be verified by tests. The balance of these requirements may be verified as part of the full system demonstration of 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.2 Waste management systems. The ASWMS shall hygienically dispose of waste generated by the crewmembers and passengers as described in the following paragraphs. All waste disposal equipment, devices, components, or systems shall be easily disassembled, removed, cleaned, and sanitized by skill level _____ personnel.

REQUIREMENT RATIONALE (3.2.2)

The disposal of waste material onboard air vehicles must be considered whenever it is anticipated the aircraft will carry passengers or crewmembers.

REQUIREMENT GUIDANCE

The amount of ASWMS equipment and the performance capabilities achievable are constrained by the air vehicle's size, capabilities, and other performance requirements. Single- and dual-place aircraft are frequently limited to the use of "piddle packs" or crew relief horns. Smaller multi-place aircraft may have limited relief facilities, such as a urinal, based on the available space and the number of crewmembers. Passenger and larger multi-place aircraft may have a single or several full lavatories which contain wash basins and a toilet and/or urinals for the use by crewmembers, passengers, and DVs.

The mission durations, personnel complement, and mission concept requirements must be included to determine the required ASWMS capabilities. In situations where multiple missions are possible (such as cargo and passenger transport), then designing for the worst case conditions or utilizing loadable and removable (palletized) systems may be appropriate.

Passenger aircraft should utilize, wherever they meet the performance requirements of the air vehicle, commercial lavatories for passenger use. Those aircraft specifically designed for the transport of high-level government personnel or DVs frequently require highly specialized lavatory facilities for these individuals to permit changes of clothing and even showers.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.2 Verification of waste management systems. The hygienic disposal of waste generated by the crewmembers and passengers shall be verified as described in the following paragraphs. The easy disassembly, removal, cleaning, and sanitization of all waste disposal equipment, devices, components, or systems shall be verified by _____.

VERIFICATION GUIDANCE (4.2.2)

The following subsections provide detailed guidance on the verification of each specific requirement. All aspects of waste management should be considered during the verifications. Waste generated by the operation of equipment by the occupants or by the performance of the design missions should be verified as minimal or controlled.

Throughout the verification of the ASWMS, the waste management equipment operation, cleaning, and sanitization should be proven by demonstration of each capability of the specific components. This verification should be an integral portion of the full system demonstration discussed in 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.2.1 Human waste. Facilities and/or equipment shall be provided for human feces and urine collection, holding, and disposal.

REQUIREMENT RATIONALE (3.2.2.1)

All air vehicles which carry humans must have some system to handle human waste products. Even those aircraft whose operational missions are of notably short duration require this facility for ferry flights or for unexpectedly longer flights due to weather or operational considerations.

REQUIREMENT GUIDANCE

The previous "rule-of-thumb" for the capacity of the toilet equipment was based on 0.5 gal of feces per person for every 6 hr and 0.5 pt of urine per person for every 6 hr (or portion thereof). *Military Standard 909* states that for facilities where food handlers are employed, there should be toilets in accordance with table II. Whenever the toilets will not be used by women, urinals may be substituted for no more than one third the required number of toilets.

The B-1 waste collection equipment was designed on the basis of 7.25 cu in. plus 8 oz (0.376 qt) per hour of feces and 85.57 cu in. plus 48.96 oz (3.012 qt) per hour of urine, for 4 crewmembers on a 36-hr mission. The C-5 troop compartment toilet was designed to accommodate 38 people during a 15-hr mission.

This section is not intended to cover waste collection from medical patients, whose fecal and urinary output may be greater due to medical procedures and treatments required. These personnel are serviced by equipment described in 3.2.2.3.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.2.1 Verification of human waste. The performance of facilities and equipment for the collection, holding, and disposal of human feces and urine shall be performed by _____.

VERIFICATION GUIDANCE (4.2.2.1)

The verification of human waste handling systems may be performed with the use of a synthetic substitute for human wastes and waste water. This eliminates possible detrimental health effects on the test operators and personnel. A report prepared for the U.S. Army, *CALSPAN-ND-5296-M-1*, presents a detailed analysis of the contents of human waste and describes a mixture recommended for use as a synthetic substitute.

This verification should be an integral portion of the full system demonstration discussed in 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

TABLE II. Toilet facilities.

Number of employees of same sex	Minimum number of toilets required
1 - 15	1
16 - 35	2
36 - 55	3
56 - 80	4
81 - 110	5
111 - 150	6
Over 150	1 additional fixture for each 40 employees.

3.2.2.1.1 Human waste collection. Equipment shall be provided for the collection of ___(a)___ (types) human waste. Whenever more than one device (toilet or urinal) for the collection of human waste is located in the same space or compartment, modesty shields and/or splash shields shall be used to separate each service area. The collection equipment shall be designed to prevent waste spillage during accelerations of ___(b)___, or as defined in 3.2.6.11. Each unit shall be equipped with a flush valve or button. All collection equipment shall be able to be brush cleaned and sanitized and shall be free of recesses. The use of anti-cling interior surfaces shall be considered.

REQUIREMENT RATIONALE (3.2.2.1.1)

Human waste collection equipment must be able to handle urine and/or feces sanitarily in the anticipated quantities for the expected environments.

REQUIREMENT GUIDANCE

The *USPHS Handbook 308* provides several recommendations for the design of human waste collection equipment. Of particular interest is the recommendation that all waste handling equipment be kept separate from food handling equipment.

The B-1 toilet assembly is diagrammed on figure 7. It is designed to allow simple servicing by removing the tank and emptying it into a standard, ground based toilet facility. A commercial toilet was evaluated for this use, but rejected due to the extensive design changes, the low reliability, the lack of adequate seal from odors, and the vulnerability of the plastic bags (used for storage of the waste) to puncture.

a. Human waste may be created by any human occupant of an air vehicle. Sources of normal, human waste to consider include: feces, urine, vomitus, and menstruate. Medical human waste, such as blood products, wound exudate, or body parts, are not included as normal, human waste products but are included in section 3.2.2.3. Hair clippings or shavings and nail clippings—although a normal, human waste—are disposed of as general refuse.

b. Under the acceleration conditions of 3.2.6.11, the collection device should prevent the waste material from being spilled onto the compartment floor. Other acceleration conditions may be desired if the conditions under which it is anticipated the collection system may be used are significantly different from the maximum accelerations imposed on other aspects of the ASWMS design.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.2.1.1 Verification of human waste collection. The performance of modesty shields and/or splash shields shall be verified by ___(a)___. The ability of the collection equipment to prevent spilling waste with the given acceleration shall be verified by ___(b)___. The operation of each flush valve or button, the capability to perform brush cleaning and sanitization, the anti-cling surface, and the lack of recesses shall be verified by ___(c)___.

VERIFICATION GUIDANCE (4.2.2.1.1)

a. The adequacy of modesty shields should be verified by demonstration. Use of the collection device during this demonstration is not necessary. The subjects should simulate the concurrent use of all equipment by the number of personnel the ASWMS is designed to accommodate.

b. The ability of the collection equipment to prevent spillage during the required acceleration should be verified by test. This could be performed in the air vehicle or an appropriate simulator.

c. The cleaning and sanitation of the ASWMS human waste collection equipment should be tested with the use of a simulant as described in 4.2.2.1.1.1 or 4.2.2.1.1.2.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

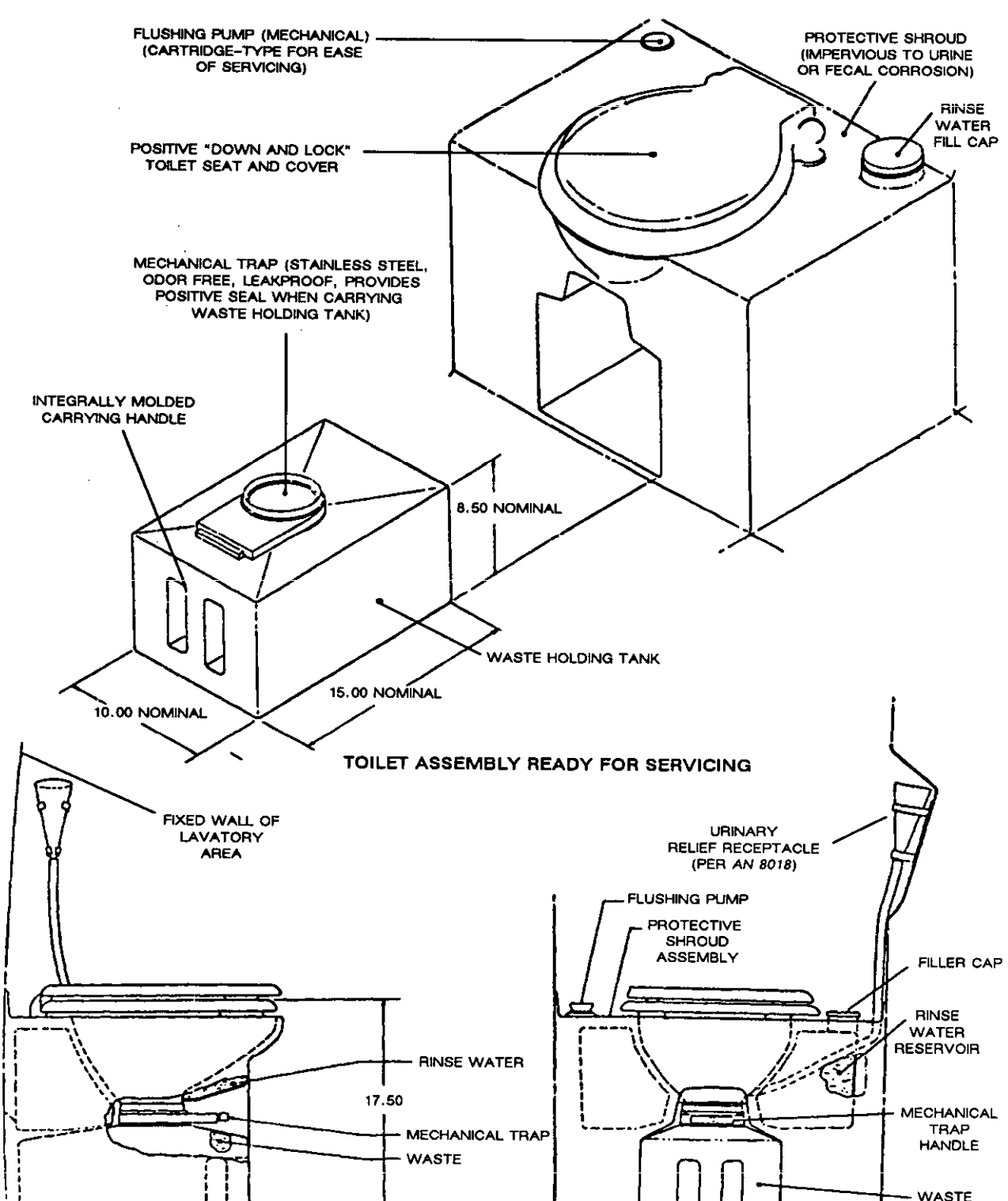


FIGURE 7. B-1 toilet assembly.

3.2.2.1.1.1 **Fecal relief equipment.** Toilets shall be of the ___(a)___ type and shall be self-cleaning after each use. The seat, seat cover, or bench shall be removable and shall be retained in both the full up or full down positions with all anticipated aircraft attitudes and accelerations. It shall be possible to use the toilet and flush it after each use with no waiting period required in excess of ___(b)___ minutes. The toilets shall require no more than ___(c)___ Volts ___(c)___ (alternating current/direct current) electrical power at ___(c)___ Hertz and ___(c)___ (amperes or Watts).

REQUIREMENT RATIONALE (3.2.2.1.1.1)

Fecal matter collection has unique requirements to ensure sanitary and odor-free handling.

REQUIREMENT GUIDANCE

The C-5 troop compartment toilet was required to have a splash restrictor, a sight trap to prevent users from viewing tank contents, and an anti-spillage device to prevent adverse aircraft attitudes from spilling toilet contents. The toilet used a flushing action from pumped and filtered tank contents to clean the bowl after each use.

Human fecal collection equipment must permit the user to use toilet paper to clean themselves after defecation. This paper may be described by *MIL-P-43988* or *A-A-697*. Immediate access to this paper by the toilet user is necessary. Storage of additional paper, accessible by the crewmembers for dispenser filling, is also necessary.

A sink with soap and water for washing the hands is strongly encouraged for toilet areas used by passengers, and required by law for toilet areas used by crewmembers who will be engaged in sustenance preparation or serving.

a. Toilets for use in aircraft vary widely in complexity and requirements. Simple chemical toilets are usually self-contained with integral chemical and waste storage. Recirculating toilets use ground servicing to remove the contents of the holding tanks. Also, manual and electrically operated flush toilets have been used with some success. Many flush-type toilets use a vigorous swirling action to clean and rinse the bowl after use.

There are also a large number of toilets which have, in the past, been judged inappropriate for use on aircraft. Recreational vehicle-type toilets which individually package the waste of each user appeared promising due to the lack of any need for flushing fluids, plumbing, or servicing. However, low user acceptance and unusual material and handling requirements have kept this type from being installed to date. Evaporative-type toilets would result in significantly smaller holding tank requirements, by boiling off the water in the waste. However, the extra equipment weight and power requirements have precluded use of this type. Finally, proposed systems which would atomize the waste and spray it into the jet exhaust plumes for incineration and disposal have not been used due to the extra cost required to develop such a capability.

Three sizes of chemical toilets designed for use in aircraft systems are described in *MIL-T-25186*. These are simple units with few moving parts, but require careful handling to ensure continued sanitary conditions. They should not be used as a primary facility for crewmembers or for large numbers of passengers.

If a recirculating type of system is used, the pump should be self-lubricating and able to operate dry for an extended period of time without damage. If a filter is used, it should be self-cleaning to minimize motor overloading and/or overheating. If self-contained toilet systems are used, protection against corrosion and overfilling should be incorporated.

b. The time required before reuse of the toilet facility should be limited according to the number of people it is designed to serve and the time available for their use. Long delays, on the order of 3 to 5 min, may be tolerated for a few people with sufficient time or units available. However, shorter delays should be considered for passenger applications.

c. The power requirements for the fecal collection equipment should be based upon the available power to the ASWMS and the power needed by all other ASWMS equipment.

REQUIREMENT LESSONS LEARNED

During a design review of a lavatory system, a toilet paper holder was identified that was constructed of a weak form of plastic. This would create a frequent maintenance task for the replacement of broken rollers.

4.2.2.1.1.1 Verification of fecal relief equipment. The operation of the toilets shall be verified by _____.

VERIFICATION GUIDANCE (4.2.2.1.1.1)

This requirement should be performed by a test of the collection system, using a substitute for the fecal material.

Canned dog food was used as a more sanitary substitute for feces in the performance verification of the C-5 toilet. For the operational test of the pump and filter operation, the tank was charged with 600 sheets of toilet paper, 14 sheets of paper hand towels, 6 sanitary napkins, 6 tampons, 2 pairs of women's nylon hose and 2 cloth hand towels. The tank was then filled with water and the toilet was tested for 200 flushes.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.2.1.1.2 Urination relief equipment. Provisions shall be included for the crew to use _____ (pilot relief bags, "piddle packs", crew relief horns, urinals, or other equipment) to relieve themselves of urine. "Piddle packs" shall be stowed in the _____ before use and in the _____ after use. Crew relief horns shall drain to _____ (overboard, human waste tank, or liquid waste tank). The entire interior surfaces of urinals shall be rinsed with each flush. Urinal drains shall be non-clogging and screened to prevent the introduction of improper trash (e.g., cups, paper towels, etc.). Any overboard drainage system shall have a shutoff valve operable from the user location, be designed to shut when not held open, and have no adverse effect on the cabin pressurization system or schedule.

REQUIREMENT RATIONALE (3.2.2.1.1.2)

Urine collection has unique requirements to ensure the sanitary and odor-free handling of urine.

REQUIREMENT GUIDANCE

A "horn" valve urinal for pressurized aircraft is defined in *MIL-V-6536*. It is currently in use on the B-1 aircraft. A stationary urinal for aircraft is defined in *MIL-U-6632*. A relief bag ("piddle pack") for the use of crewmembers who may not leave their seats during aircraft operations is described in *MIL-B-83665*. If this bag is used as the primary means of urination relief, then ready availability of the bag before use and the careful stowage of the bag after use must be considered in the air vehicle design. If a crew relief horn is used, the drainage of the urine should be directed to an appropriate storage tank or overboard. Note that overboard drainage of human waste is strongly discouraged. (See 3.2.2.2.3 Requirement Guidance.)

Urination equipment has been used for the improper disposal of many items of lavatory refuse. The loss of one of these devices due to this or any factor could have a serious negative impact on the mission performance of the vehicle or the aircrew. Consequently, care should be taken in the ASWMS design to ensure the urinals are protected from the inadvertent introduction of improper wastes.

If overboard disposal of urine is under consideration, see 3.2.2.2.3.

REQUIREMENT LESSONS LEARNED

Leaks of used pilot relief bags have occurred during flights in fighter aircraft. This creates not only a difficult mess to clean up, but also poses a sanitary risk for maintainers, introduces a highly corrosive fluid into areas which may not be designed to withstand it, and can cause electrical equipment malfunction.

A crewmember's life and a modern fighter were lost when the crewmember unbuckled his seatbelt to use the piddle pack. Conjecture is that the belt buckle jammed into the ejection handles and initiated an ejection while the crewmember was not restrained by the seatbelt. This clearly emphasizes that all aspects of the man/machine interface must be evaluated during air vehicle design.

4.2.2.1.1.2 Verification of urination relief equipment. Urination equipment shall be verified by _____.

VERIFICATION GUIDANCE (4.2.2.1.1.2)

This requirement should be verified by a test that involves a sanitary substitute for actual urine.

The verification of urine handling systems may be performed with the use of a synthetic substitute for human wastes and waste water. This eliminates possible detrimental health effects on the test operators and personnel. *Air Force Wright Aeronautical Laboratory Technical Report 81-4186*, although primarily concerned with the development of bilge inhibitors, also presents a detailed analysis of the composition of urine and a synthetic substitute for use in performance testing.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.2.1.1.3 Human waste holding tank(s). The ASWMS toilets and/or urinals _____ (shall/shall not) have a holding tank(s) separate and independent from the liquid waste system tanks. This tank(s) ___(a)___ (shall/shall not) be integral with the toilets and ___(a)___ (shall/shall not) be removable for emptying, cleaning, sanitization, and servicing. If removable, a carrying handle adequate to support the weight of the ___(b)___ (empty/filled) tank shall be included. All interior seams shall be smooth. There shall be a positive retention device for the tank when in position. The tanks shall have a level indicator that shall be located to maximize its accuracy and shall be fully cleanable. This indicator shall provide sufficient warning to preclude system shutdown due to a full waste holding tank. Connections to any chemical treatment charging line shall be above the highest anticipated liquid waste level. A check valve shall be used in the servicing line, hose, or valve.

REQUIREMENT RATIONALE (3.2.2.1.1.3)

Human waste is highly corrosive and contains organisms which may pose a serious health threat to any personnel who come into contact with it. Furthermore, its odor is nauseating and unpleasant. Therefore, the human waste holding equipment must meet additional requirements.

REQUIREMENT GUIDANCE

Human waste tanks in commercial aircraft are frequently removable holding tanks directly beneath toilets. These are easily carried by a single ground crewmember. Similar designs have been used for crewmember facilities on various military aircraft.

The C-5B troop toilet compartment was required to have a 40-gal holding tank for fecal and urinary wastes. This tank incorporated a rinsing system for ground service cleaning.

Waste holding tanks and their associated plumbing should be able to interface with the emptying, cleaning, and rinse water filling operations of the lavatory servicing carts. In designs where the holding tank is not removable from the aircraft, the system must interface with the operations of the servicing cart. Current servicing cart requirements are defined in *MIL-L-26208*.

a. Many toilet/urinal systems have a holding tank as an integral part of the system design. Others require the use of a separate holding tank. A single tank is best where several toilets or urinals are included in the air vehicle, which permits a savings of weight and volume and simplifies the cleaning, sanitation, and maintenance.

b. If the tank is to be serviced while in position, the carrying handles need support only the weight of the empty tank. However, if the tank is to be removed for emptying, cleaning, sanitization, or servicing, then the handles should support the weight of a filled tank.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.2.1.1.3 Verification of human waste holding tank(s). The ability of the holding tanks to maintain, process, and/or remove the waste shall be verified by _____. Tanks integral to the toilet shall be verified in concert with the verification of toilet operation.

VERIFICATION GUIDANCE (4.2.2.1.1.3)

This verification should be performed as a test using an appropriate simulant for the human waste materials.

For the verification of the performance of the waste holding tank's sanitary ground service flushing, the C-5 troop compartment toilet facility precharged the tank (40 gal capacity) with 280 sheets of 4.5 × 4.5 in. toilet paper, 92 sheets of paper hand towels, and 11 lb of canned dog food.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.2.1.2 System cleaning/sanitization/ disinfection. The ASWMS human waste systems shall be able to be cleaned, sanitized, and disinfected with commercially available agents during ground servicing operations.

REQUIREMENT RATIONALE (3.2.2.1.2)

Due to the extreme hazard and obnoxious content of human waste systems, the cleaning, sanitizing, and disinfecting of these systems and their elements requires special emphasis.

REQUIREMENT GUIDANCE

Although the system should be designed for sanitary use while airborne, the actual maintenance of the system in a clean condition should be performed while the air vehicle is on the ground. Portions of the systems designed for removal for routine maintenance actions should be designed to permit thorough cleaning and sanitization before removal from the system. Their removal should not permit the escape of human waste material or odors.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.2.1.2 Verification of system cleaning/ disinfection. The ability of the ASWMS human waste systems to be cleaned, sanitized, and disinfected with commercially available agents shall be verified by _____.

VERIFICATION GUIDANCE (4.2.2.1.2)

This requirement should be verified by demonstration using simulants for human waste material.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.2.1.3 Ventilation. The ASWMS human waste system spaces or compartments shall be ventilated to the aircraft _____ (interior/exterior). Ventilation ports shall be located away from all normal aircraft entrances and air intake ports.

REQUIREMENT RATIONALE (3.2.2.1.3)

Human waste material has a highly objectionable odor. Also, the elimination of human waste, both feces and urine, is frequently accompanied by flatulence. Whatever the source, the odors need to be removed from crewmember and passenger occupied spaces.

REQUIREMENT GUIDANCE

Ventilation of the waste system spaces overboard requires careful design. The cabin pressurization schedule must not be compromised due to the loss of air volume. The exterior ports location must be away from all air intake ports to prevent the reintroduction of the odors into the breathing spaces. On aircraft for DVs, the exterior ventilation ports should be away from normal aircraft entrances to prevent the odors from interfering with mission functions.

The ventilation system should be able to extract waste gases and prevent their release into inhabited sections of the air vehicle. If the air contaminated with waste gases is recirculated, it should be treated to ensure noxious gases, germs, bacteria, etc., are entrapped in a filter or destroyed through a catalytic, oxidization, or decomposition process. This is to prevent these elements from being transported to and ingested by personnel other than the emitter. Wherever air vehicle or compartment design permits, the ventilation system should provide an active and complete exchange of compartment air once every minute.

The C-5 troop compartment toilet required overboard ventilation of the toilet compartment and the air volume directly above the liquid level inside the holding tank.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.2.1.3 Verification of ventilation. The ability of the ASWMS human waste system spaces or compartments to be ventilated to the aircraft exterior shall be verified by _____.

VERIFICATION GUIDANCE (4.2.2.1.3)

This verification should be performed as a test to measure the amount of air flow achieved from each waste handling or storage compartment or space.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.2.2 Liquid waste. The ASWMS shall have a liquid waste handling system that ___(a)___ (is/is not) an integral part of the ___(a)___ (galley or lavatory) system. The liquid waste system shall be completely drained by gravity when not in use, with no pockets of liquid remaining. The liquid waste system shall be designed, located, insulated, and/or constructed to prevent freezing of the contained liquid or damage to the ASWMS due to freezing at the extremes of the air vehicle's flight environment, and for ___(b)___ minutes after the aircraft has been secured from flight in the coldest air vehicle operating ambient conditions. The liquid waste handling system shall be able to withstand an internal pressure/vacuum of ___(c)___ psig during servicing without bursting, collapsing, or other deformation. Liquid galley wastes, as collected from the galley basin, shall be separated from human wastes. The system shall be able to handle waste matter from a garbage disposal.

REQUIREMENT RATIONALE (3.2.2.2)

Liquid waste may be generated onboard aircraft from many sources, especially from galley and lavatory equipment and compartments. It must be properly controlled to prevent hazards to the aircrew members and aircraft components.

REQUIREMENT GUIDANCE

a. Liquid waste systems may be required for aircraft with or without galleys or lavatories. When these units are available, the system may or may not be an integral part of the galley, the lavatory, or another system.

b. Since the ASWMS may experience periods of freezing temperatures, the ASWMS water system must either protect the waste from these temperatures or protect itself from damage from the volumetric expansion of water as it transforms into ice. This can be accomplished by a variety of methods including freeze plugs, expandable containers, flexible materials, and so on. If fragible devices are used, such as freeze plugs, then there must be a positive and obvious indication of the device's condition and there must no impediment from ready replacement with common hand tools without major component or module removal. Fill in this blank to allow time after the aircraft is secured to service the waste system and remove any pockets of waste water.

c. The *SAE AS 1426* recommends drain water systems be able to withstand pressures of 50 to −10 psig. The C−17 specification requires the liquid waste system withstand a 9 psig vacuum.

d. The anticipated amount of liquid wastes from galleys would rapidly fill lavatory−type waste containers if not separated. Also, this would increase the amount of waste that must be treated as human waste by ground facilities.

The following National Sanitation Foundation Standards contain extensive guidance on the sanitary design of particular forms of liquid waste handling, storage, and treatment systems:

NSF 40	*Individual Aerobic Wastewater Treatment Plants*
NSF 41	*Wastewater Recycle/ Reuse and Water Conservation Devices*
NSF Criteria C−9	*Evaluation of Special Processes, Components, or Devices Used in Treating Wastewater.*

REQUIREMENT LESSONS LEARNED

At the CDR for the C−5B galley/lavatory system, the drainage of the galley sink into the lavatory waste tank was identified as the site of possible significant problems which required expensive redesign efforts to correct. Although a "foul air valve" was included, wear or particulate matter could cause this valve to jam open and allow foul and noxious odors to be released into the galley sink and coffeemaker areas.

4.2.2.2 Verification of liquid waste. The separation or integration of the liquid waste system from other ASWMS subsystems shall be verified by ___(a)___. The design, location, insulation, and/or construction to prevent freezing and permit drainage by gravity of the liquid waste contents shall be verified at temperatures of 3.2.6.3 or ___(b)___ when held for ___(b)___ minutes. The ability of the liquid waste handling system to withstand the required internal pressure/vacuum due to servicing shall be verified by ___(c)___.

VERIFICATION GUIDANCE (4.2.2.2)

The demonstration portion of this verification should be an integral portion of the full system demonstration discussed in 4.1.

a. The separation or integration of the liquid waste system may be verified by an inspection of the system drawings and of the final product.

b. The prevention of freezing and freezing damage should be verified as a test at the required temperatures and time. The complete drainage of the system should be performed as a demonstration.

c. The ability of the ASWMS liquid waste handling system to withstand the required pressures/vacuums should be verified by a test of the entire system at the required pressure levels. High test pressures may also be desired for proof of system integrity.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.2.2.1 Liquid waste tank(s). Liquid waste tank(s) shall be easily removable, cleaned, and sanitized, and shall have surge suppression. The tank capacity shall be ___(a)___. The tank opening for cleaning shall require no tools to operate, shall be ___(b)___ inches in diameter minimally, and shall utilize captive fasteners. If a non-round opening shape is used, it shall be sufficient size to contain a circle of the above diameter. The tanks shall have a non-spill vent with surge preventors that shall exhaust outside all passenger compartments. A carrying handle(s) adequate to support the weight of the ___(c)___ (empty/filled) tank shall be included. All interior seams shall be smooth. There shall be a positive retention device for the tank when in position. The tanks shall have a fully cleanable level indicator located to maximize its accuracy. Connections to any chemical treatment charging line shall be above the highest anticipated liquid waste level. A check valve shall be used in the servicing line, hose, or valve.

REQUIREMENT RATIONALE (3.2.2.2.1)

Liquid waste tank are necessary to contain the accumulated waste products.

REQUIREMENT GUIDANCE

a. The capacity of the tank should be based upon the anticipated accumulation of liquid wastes. All sources of waste generation should be included. The C-135 galley was required to have one 10- to 12-gal tank for the containment of galley liquid wastes. It should be noted that this volume did not include space for human waste stowage.

b. The opening of the tank should be sized to permit a ground crewmember to reach all surfaces within the tank when cleaning and sanitizing the system. Therefore, it should be based upon the internal dimensions of the specific tank design and the anthropometric dimensions of the tank.

c. If the tank is to be serviced while in position, the carrying handles need support only the weight of the empty tank. However, if the tank is to be removed for emptying, cleaning, sanitization, or servicing, then the handles should support the weight of a filled tank.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.2.2.1 Verification of liquid waste tank(s). The construction, retention, removal, cleaning, sanitization, venting, and surge suppression of liquid waste tank(s) shall be verified by ___(a)___. The tank capacity and the size and operation of the tank opening shall be verified by ___(b)___. The adequacy of the carrying handle(s); the operation of the level indicator including its accuracy, location, and cleanability; the functioning of connections to any chemical treatment charging line; and the servicing line check valve shall be verified by ___(c)___.

VERIFICATION GUIDANCE (4.2.2.2.1)

a. Verification of the construction, retention, removal, cleaning, sanitization, venting, and surge suppression of liquid waste tank(s) should be performed by a demonstration.

b. The tank capacity and the size and operating of the tank opening (for cleaning) should be verified by inspection of the system drawings.

c. The adequacy of the carrying handles, the operation of the level indicator, and the functioning of connections and valves in the charging line or servicing lines should be verified by a full system test.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.2.2.2 Liquid waste plumbing. The waste plumbing and connections shall be designed to prevent leaks under all operating and maintenance conditions, completely drain by gravity (with the exception of traps under the basins) to the waste tank, and shall not be connectable to the potable water system (with the exception of the cross-connect spool). Plumbing shall be easily disassembled for cleaning and shall drain to the liquid waste tanks by gravity when vented to the ambient air with an aircraft cruise attitude of ___(a)___ degrees pitch and a taxi attitude of ___(a)___ degrees pitch. Interior surfaces of the waste system plumbing shall be smooth and shall have a bend radius of no less than ___(b)___ inches.

REQUIREMENT RATIONALE (3.2.2.2.2)

The liquid waste system plumbing must be able to handle the flow of liquid waste products from basins or drip pans to the holding tank.

REQUIREMENT GUIDANCE

a. The C-17 requires the liquid waste system to drain to the holding tanks by gravity when at a 3.0° cruise pitch and 0.0° taxi pitch (both nose up). The Society of Automotive Engineers recommends a normal cruise attitude of 2° nose up and taxi attitude of 1° nose down for commercial galley systems.

b. To prevent the accumulation of waste material, the walls of the plumbing, valves, and fittings should be smooth and all tubing bends should be as gradual as the design constraints permit. The *SAE AS 1426* recommends no less than 2.5 times the tubing diameter.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.2.2.2 Verification of waste plumbing. The ability of the waste plumbing and connections to prevent leaks, to drain completely by gravity (with the exception of basin traps) to the waste tank, and to be non-connectable to the potable water system (with the exception of the cross-connect spool) shall be verified by ___(a)___. Ease of disassembly and cleaning of all plumbing shall be verified by ___(a)___. Interior surfaces and bend radius of the waste system plumbing shall be verified by ___(b)___.

VERIFICATION GUIDANCE (4.2.2.2.2)

a. These verifications should be conducted as an integral part of the system-level demonstration of 4.1. Some disassembly of the system may be required to prove complete system drainage. Water may be used for this demonstration, except for those locations where the liquid waste physical properties are significantly different (i.e., soda pop, oil, syrup, etc.).

b. The plumbing interior surfaces and bend radii should be verified by inspection of the drawings and finished products.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.2.2.3 Inflight dumping. Overboard dumping of the system or portions of the system while in flight shall be selectable and controllable by the aircrew from the _____ aircrew station. Dumping outlets shall be located to ensure no human waste will strike or collect on any exterior surface of the aircraft. Overboard dumping outlets shall be designed to prevent the outlet from freezing and the loss of cabin pressurization throughout the draining operation.

REQUIREMENT RATIONALE (3.2.2.2.3)

Inflight dumping has been used for the discharge of all types of liquid and human waste. Although it is now strongly discouraged, there are some applications, such as dishwater or potable water overflow, where this method does remain a viable alternative to onboard stowage.

REQUIREMENT GUIDANCE

Inflight dumping or draining of non-hazardous drains and non-human waste continues to be used in the design of air vehicles. The C-20 specifies that ice storage drawers, galley basins, etc., are plumbed to a drain mast, usually through a crewmember-operable drain valve.

However, the use of inflight dumping of human waste is strongly discouraged. In fact, international agreements have made it illegal to dump human waste over foreign countries since 1933, and federal law has made it illegal for interstate travel since 1947. *Title 21 CFR Part 1250.53* prohibits the discharge of "excrement or garbage" from any interstate air conveyance except at approved servicing areas. However, it must be acknowledged that this has been a viable solution for limited use in the past. When used, operational and maintenance design considerations must be remembered. (A more detailed review of the applicable laws and technical considerations for inflight dumping is contained in *PB-218 418, "The Public Health Acceptability of In Flight Waste Disposal".*) Operationally, certain control of all dumping processes must be maintained to ensure only appropriate dumping sites are used. A single crewmember must have both the responsibility and control to ensure this maintenance. Dumping valves must be leakproof over the entire life of the system with a high degree of confidence. The outlet must be located so the operators or maintainers are not exposed to any potentially hazardous products.

Preventive maintenance of the dumping system should be eliminated and corrective maintenance should be minimized. Waste is usually highly corrosive. Therefore, care must be taken in the selection of the materials and processes selected for this use to ensure maintenance requirements are controlled.

REQUIREMENT LESSONS LEARNED

The overboard drainage of waste from urinals has caused excessive maintenance requirements due to the corrosion of surrounding materials (*AFLC/AML Lessons Learned Program #231* and *#10170*).

4.2.2.2.3 Verification of inflight dumping. Location and design of the overboard dumping outlets shall be verified by ___(a)___. The ability of the ASWMS to dump liquid wastes while in flight without the outlet freezing, without waste accumulating on exterior aircraft surfaces, and without the loss of cabin pressurization shall be verified by ___(b)___.

VERIFICATION GUIDANCE (4.2.2.2.3)

a. These design elements should be verified by the inspection of drawings and the ASWMS equipment.

b. The ability of the ASWMS to operate as required should be verified during flight tests of the air vehicle. During these tests, a simulant for the anticipated discharged liquids may be used.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.2.2.4 Liquid waste drains. There shall be a check valve and a trap in all equipment and basin drains to prevent the introduction of liquid waste and its noxious odors into crewmember or passenger spaces. All drains shall have a screen to prevent the loss of personal items (e.g., rings, pins, medals, buttons, etc.) and prevent clogging of the drain lines by inadvertent or improper disposal of waste material. Basins shall have a means of plugging the primary drain to collect water. Each basin shall have a secondary drain to prevent the water from overflowing the basin in the event the main drain should become plugged. The minimum inside diameter for basins and sinks shall be no less than _____ inches and for other devices shall be no less than _____ inches. The operation of any drain shall have no adverse effect on the cabin pressurization system or schedule.

REQUIREMENT RATIONALE (3.2.2.2.4)

Wherever liquid waste requires collection, some form of drain is necessary to direct it into the liquid waste plumbing and holding systems.

REQUIREMENT GUIDANCE

Drainage to the waste tank requires a check valve to limit the possibility of surging waste water pushing out of the drain. A trap is necessary to seal the drain from the potentially highly disagreeable odors from the waste tank. This trap must be drainable to ensure the complete removal of waste water before storage.

The *SAE AS 1426* recommends that drain screens prevent the passage of particles larger than 0.08 in. equivalent diameter and toothpick-shaped objects. Screens should be cleanable while in place, but removable only during ground service operations. This is to ensure that passengers or inexperienced operators do not tamper with the drain system. The specification recommends sink and basin drain inside diameters be no less than 0.9 in. and coffeemakers, water coolers, etc., should be no less than 0.44 in.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.2.2.4 Verification of liquid waste drains. The operation of the check valve and trap in all liquid waste drains shall be verified by ___(a)___. The inclusion of a screen, the functioning of a drain plug, and the presence of a secondary drain shall be verified by ___(b)___. The size of the drains shall be verified by ___(b)___. The effect of drains on the pressurization system shall be verified by ___(c)___.

VERIFICATION GUIDANCE (4.2.2.2.3)

a. The operation of the check valve and trap should be verified by the test of these devices using simulants and the aircraft attitudes of 3.2.2.

b. The screen, drain plug, secondary drain, and drain sizes should be verified by inspection of the drawings and finished product.

c. The effect of drainage on the air vehicle pressurization system should be verified during flight testing whenever inflight dumping is utilized.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.2.3 Medical waste. The ASWMS shall facilitate the control, handling, and storage of medical waste generated by _____. The ASWMS shall process _____ medical waste. The ASWMS shall facilitate removal of the waste from the patient's bedside.

REQUIREMENT RATIONALE (3.2.2.3)

Medical missions, when imposed upon the air vehicle, require specialized handling of waste matter generated in the treatment and care of patients. These requirements must meet the legal, medical, and aeronautical needs of the personnel who provide and receive the service.

REQUIREMENT GUIDANCE

In addition to the special medical waste handling procedures and equipment, air vehicles intended for the transport of medical patients may also require modifications to the human waste handling system design criteria. For example, the capacity of the human waste holding tank may need to be increased due to the use of intravenous (IV) medication or feeding which increases the amount of urine generated by the patient. Another example is the waste facilities must be designed so a medical technician can quickly empty, clean, and sanitize bedpans and urinals.

Of more significance to the design of medical transport vehicles is that the general refuse system cannot be permitted to be used for the disposal of much of the waste generated during the care and treatment of patients. The *40 CFR Part 259.10(a)* and *(b)* contain definitions of several terms used for the requirements on medical waste. However, the special operations, missions, and uses of medical air vehicles require that the ASWMS meet the requirements for facilities, transfer facility, and transporter, depending upon the target air vehicle.

In accordance with *40 CFR Part 259.10*, medical waste is defined as "...any solid waste which is generated in the diagnosis, treatment (e.g., provision of medical services), or immunization of human beings or animals, in research pertaining thereto, or in the production or testing of biologicals". An added note to this definition indicates mixtures of medical waste and solid wastes or hazardous wastes are to be handled as both medical wastes and hazardous wastes. Body fluids are defined by this section as liquids "...emanating or derived from humans and limited to blood; dialysate; amniotic, cerebrospinal, synovial, pleural, peritoneal and pericardial fluids; and semen and vaginal secretions". Body fluid waste is a major contributor to medical waste.

The *40 CFR Part 259.30* defines regulated medical waste. It is summarized in table III. The regulation should be referenced before use.

The requirement for a plastic bag specifically designed to store medical waste such as used cotton, bandages, swabs, etc., is provided by *MIL-B-43444*. Class I is for the lighter weight waste, while class 2 is intended for heavier waste, such as that saturated with body fluids. Neither of these bags are intended for medical sharps waste.

The following National Sanitation Foundation Standards contain extensive guidance on the sanitary design of medical waste handling systems:

NSF 30	*Cabinetry and Laboratory Furniture for Hospitals*
NSF 49	*Class II (Laminar Flow) Biohazard Cabinetry.*

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.2.3 Verification of medical waste. The ability of the ASWMS to handle, control, store, process, and remove medical waste shall be verified by _____.

VERIFICATION GUIDANCE (4.2.2.3)

This verification should be an integral portion of the full system demonstration discussed in 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

TABLE III. Regulated medical waste.

Waste Class	Description
(1) Cultures and Stocks	Cultures and stocks of infectious agents and associated biologicals.
(2) Pathological Wastes	Human pathological wastes including removed body parts, fluids, or specimen.
(3) Human Blood and Blood Products	Waste human blood, blood products, items now or previously saturated with human blood, dried or caked human blood, items which hold or held human blood.
(4) Sharps	Sharp medical instruments which have been used in animal or human patient care, such as needles, syringes, scalpel blades, or broken glassware that had been in contact with infectious agents.
(5) Animal Wastes	Contaminated animal carcasses, body parts, or bedding.
(6) Isolation Wastes	Biological waste and discarded materials contaminated with blood, excretion, exudates, or secretions from humans or animals which are isolated due to a highly infectious or communicable disease.
(7) Unused Sharps	Sharps which have not yet been used.

3.2.2.3.1 Medical waste stowage. The ASWMS shall provide controlled storage for all forms of medical waste as described in 3.2.2.3. All *medical waste containers shall have self-closing* covers, be sealed, use leakproof plastic bags, and be appropriately marked as containing a biohazard. All medical wastes shall be separated into _____ (sharps, pathological, medicinal, blood, body fluids, etc.).

REQUIREMENT RATIONALE (3.2.2.3.1)

Legal restrictions apply to the stowage of medical waste and must be met in the design of systems expected to operate domestically.

REQUIREMENT GUIDANCE

In accordance with *40 CFR Part 259.40*, medical waste must be segregated into sharps (used and unused), fluids, and other medical regulated waste. In accordance with *40 CFR Part 259.41*, medical waste containers must be rigid, leak resistant, impervious to moisture, sufficiently strong to prevent bursting under normal use, and sealed to prevent leakage during transport. In addition, sharps must be contained within puncture-proof containers and fluid quantities greater than 20 cm^2 must be in packaging that is break resistant and tightly closed. Unless only red plastic bags can be used as inner containers, the container must have an indelible label that includes the words "Medical Waste", the words "Infectious Waste" or the universal biohazard symbol (as required by *40 CFR Part 259.44* and shown on figure 8).

Small, unit sized needle and sharps disposal containers are readily available from a number of commercial sources. The ASWMS should permit the use of a wide variety of these products.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.2.3.1 Verification of medical waste stowage. The ability of the ASWMS to control storage of waste medical sharps and biohazard material and to maintain medical wastes in the appropriate separate containers shall be verified by _____.

VERIFICATION GUIDANCE (4.2.2.3.1)

The safe, sanitary, and reliable stowage of medical waste should be demonstrated using uncontaminated simulants for the medical waste. For example, uncontaminated needles, scalpels, etc., should be used to demonstrate that medical sharps can be contained within the developed or selected equipment. Similarly, training equipment could be used to show the adequacy of the equipment in the disposal of medical tubes, bags, and other equipment. Uncontaminated meat products could also be used for the demonstration of the disposal of pathological wastes.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

FIGURE 8. Universal biohazard symbol.

3.2.2.3.2 Patient human waste. The ASWMS shall support the collection, disposal, and/or stowage of patient urine, feces, and vomitus.

REQUIREMENT RATIONALE (3.2.2.3.2)

Like all other air vehicle occupants, medical patients will generate urine, feces, and vomitus. The ASWMS must facilitate the sanitary disposal of this waste matter.

REQUIREMENT GUIDANCE

The ASWMS must permit the disposal of patient human waste using commercially available and military standard collection equipment (bedpans, urinals, air sickness bags, etc.) and practices.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.2.3.2 Verification of patient human waste. The ability of the ASWMS to support the collection and stowage of patient urine, feces, and vomitus shall be verified by _____.

VERIFICATION GUIDANCE (4.2.2.3.2)

This verification should be an integral portion of the full system demonstration discussed in 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.2.3.3 Medical/nursing considerations/ implications. The ASWMS shall contain _____ equipment to support the medical doctors', nurses', and technicians' needs. The ASWMS shall safely store samples of patient excrement, tissues, and fluids, or samples saved for later testing or analysis.

REQUIREMENT RATIONALE (3.2.2.3.3)

The ASWMS must support and not interfere with the medical procedures and the operation of medical equipment required for the care and treatment of patients.

REQUIREMENT GUIDANCE

The medical providers (doctor, nurse, or technician) require adequate support equipment to perform their professional functions. Examples of equipment to be considered are desks, countertops, and file drawers to record and store patient data and records; treatment equipment and medication storage and preparation area; linen and towels storage; annunciator panels from patients and to/from the cockpit; etc. Samples of the patient's excrement or body fluids may require storage at controlled environments for later analysis.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.2.3.3 Verification of medical/nursing considerations/implications. The ability of the ASWMS to support the medical doctors', nurses', and technicians' needs shall be verified by _____.

VERIFICATION GUIDANCE (4.2.2.3.3)

This verification should be an integral portion of the full system demonstration discussed in 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.2.4 Foreign waste. During international flights, the collection, handling, separation, and stowage of animal or vegetable meal residue that remains after the completion of meal services shall be supported by the ASWMS.

REQUIREMENT RATIONALE (3.2.2.4)

Foreign waste must be maintained separately for transfer to the US Department of Agriculture or their representative upon entering the continental United States. This precaution is regulated by law and is necessary to protect the indigenous domestic animal and plant population from foreign pests and organisms. Other governments have similar requirements.

REQUIREMENT GUIDANCE

The imposition of this requirement should not increase the volume of refuse collected during international flights or the procedures to be followed by the aircrew members. The trash will be generated with or without this requirement. But due to the need to comply with the law, design consideration during the air vehicle development will preclude the addition of extra effort by the aircrew members to maintain this separated refuse.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.2.4 Verification of foreign waste. The collection, stowage, and transfer of foreign wastes from the ASWMS shall be verified by _____.

VERIFICATION GUIDANCE (4.2.2.4)

This verification should be an integral portion of the full system demonstration discussed in 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.2.5 General refuse

3.2.2.5.1 Refuse sources and quantities. The system shall be able to store a minimum of _____ cubic feet of trash from the _____.

REQUIREMENT RATIONALE (3.2.2.5.1)

General refuse will be generated wherever human occupants of an air vehicle are required to perform any operation. This refuse requires collection, storage, and disposal when the air vehicle is landed.

REQUIREMENT GUIDANCE

Sources of general refuse include meal containers, paper or plastic utensils and tableware, wrappers, office-type waste (paper, pens, folders, files, etc.), cans, or bottles. This can also include vegetable or animal matter left after a meal has been prepared or eaten whenever this matter is not required to be segregated as foreign waste (i.e., domestic flights, international flights which do not cross borders, etc.).

The amount of each type of expected refuse will vary depending upon each system's design mission, the number of occupants, and the operations being performed. If other design considerations require it, the maximum dimensions of each type should also be provided.

The C-135 galley was required to have one collapsible frame-type dry waste container that could hold one 30 × 14 × 40 in. plastic bag. However, on long flights with a large number of passengers, this container required periodic emptying with storage of the filled bags. Since no space onboard the aircraft was intended for this use, this caused frequent stowage problems. A simple refuse container used for the C-5A troop compartment galley is depicted on figure 9.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.2.5 Verification of general refuse

4.2.2.5.1 Verification of refuse sources and quantities. The ability of the ASWMS to store the required quantities of trash from all sources shall be verified by _____.

VERIFICATION GUIDANCE (4.2.2.5.1)

This verification should be an integral portion of the full system demonstration discussed in 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

MATERIAL: FIBERGLASS REINFORCED PLASTIC
WEIGHT: 8 LBS

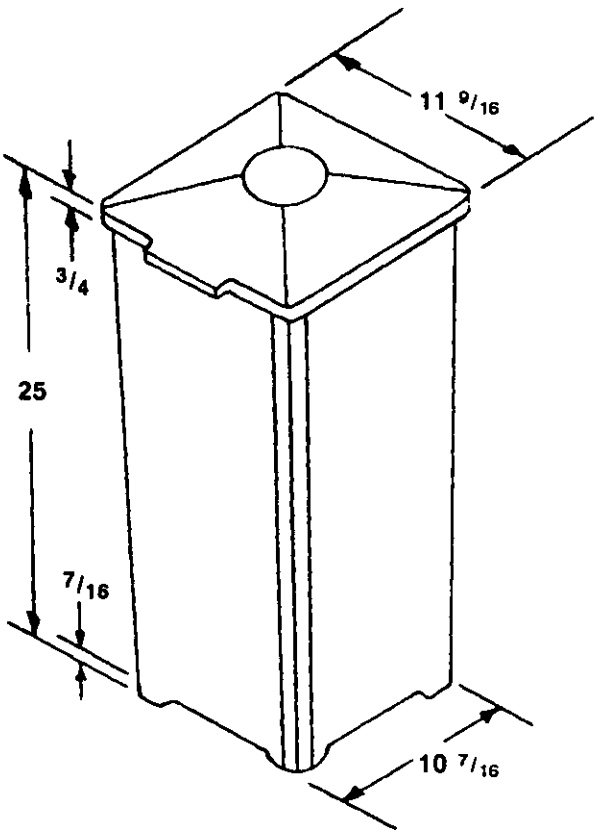


FIGURE 9. Typical refuse container.

3.2.2.5.2 Refuse stowage and removal. Refuse containers shall be conveniently placed in the ___(a)___ (galley(s), lavatories, passenger compartment, aircrew lounge, etc.) compartments and shall be ___(b)___ cubic feet in size, or shall hold ___(b)___ cubic feet of dry refuse. Openings to trash receptacles shall accept standard disposable refuse, waste, equipment, and items without disassembly, reconfiguration, folding, or content spillage. Refuse containers shall be designed to be easily emptied without content spillage during this process. All receptacles shall utilize standard commercial or military plastic bag liners and shall be easily assembled, mounted, disassembled, cleaned, and sanitized. Although primarily intended for dry waste, the containers must be watertight to prevent the spill of inadvertently disposed liquids. Refuse containers shall include self-closing covers; shall prevent the spread of obnoxious, irritating, or unpleasant odors from the anticipated refuse to the occupied space; and shall prevent the spread of wastepaper fires beyond the container interior. The door to the container shall be embossed with the words, "No Smoking" and the international symbol for this expression, with the letters and figure filled with high contrast, durable paint.

REQUIREMENT RATIONALE (3.2.2.5.2)

To control the waste material during stowage and removal, the containers must able to hold the anticipated quantity of refuse of each type safely.

REQUIREMENT GUIDANCE

Guidance on the handling and storage of passenger and crewmember generated general refuse is contained in *USPHS Handbook 308*. *National Sanitation Foundation Standard 21, Thermoplastic Refuse Containers,* contains extensive guidance on the sanitary design of particular forms of refuse containment systems.

a. General refuse containers should be conveniently located near all waste generating stations. Each galley or lavatory space should also have at least one refuse container.

b. The refuse containers must have sufficient space to hold the maximum amount of trash expected to be generated for the space in which the container is located. This container's size should include room for all non-ASWMS related trash also generated in that space.

REQUIREMENT LESSONS LEARNED

During the preliminary design review for one galley/lavatory system, it was found that the opening to the general refuse container did not have enough space to put a standard coffee cup into the trash without turning it on its side and thereby spilling its contents. Furthermore, removal of the contents required the use of a screwdriver to open the servicing door.

Overstringent specifications applied to the purchase of a simple trash container caused a four-fold increase in the item's cost. Those requirements needed for safety of the aircraft and personnel must not be relaxed, but additional requirements should be closely monitored (*AFLC/AML Lessons Learned Program #11125*).

4.2.2.5.2 Verification of refuse stowage and removal. The adequacy of the refuse containers' placement and operation shall be verified by ___(a)___. The ability of the dry waste containers to prevent the spread of wastepaper fires beyond the container interior shall be verified by ___(b)___.

VERIFICATION GUIDANCE (4.2.2.5.2)

a. The adequacy of the containers' location, operation, and capacity should be verified as an integral portion of the system-level demonstration of 4.1.

b. The ability of the refuse container to contain paper fires should be verified by test.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.2.5.3 Refuse compactors. The ASWMS _____ (shall/shall not) contain a refuse or trash compactor able to reduce ___(a)___ cubic feet of general refuse to ___(a)___ cubic feet. The compactor ___(b)___ (shall/shall not) be able to crush ___(b)___ (bottles/cans/etc.) of ___(b)___ (size or description). The compactor shall have a safety interlock to prevent operation with the door open and shall crush the trash into a leakproof, readily available military and/or commercial container. The trash compactors shall individually require no more than ___(c)___ amperes power at ___(c)___ Volts ___(c)___ (direct current or Hertz) for a total of no more than ___(c)___ amperes for all compactors.

REQUIREMENT RATIONALE (3.2.2.5.3)

Trash compactors are used commercially to help control the large amount of waste material generated by flights of longer durations. They can provide these same benefits to military systems used in similar situations.

REQUIREMENT GUIDANCE

The *NSF Standard 13, Refuse Compactors and Compactor Systems*, contains extensive guidance on the sanitary design of this equipment.

Commercially developed compactors for passenger aircraft are readily available on the market and should be used when their performance meets the military requirements.

a. If a compactor is desired for a particular use, its capacity should be based upon the anticipated waste generation as defined in 3.2.2.5.1.

b. Hard objects, such as bottles or cans, can make the design of trash compactors more difficult. If compaction of these items is anticipated or desired, the construction details for that item are necessary to ensure the design will be directed toward the compaction of the actual anticipated item of refuse.

c. The power requirements for each compactor should be based upon the power available for the ASWMS equipment. Refrigerated storage equipment, lavatories, and other equipment may require concurrent operation.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.2.5.3 Verification of refuse compactors. The performance of the refuse compaction equipment shall be verified by _____.

VERIFICATION GUIDANCE (4.2.2.5.3)

This verification should be an integral portion of the full system demonstration discussed in 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.2.6 Hazardous waste (excluding medical). The ASWMS shall contain, control, and store wastes from hazardous cargo and/or aircraft hazardous material. These wastes shall include threats to aircraft equipment, structure, personnel, operations, and/or _____. The ASWMS shall include _____ equipment to control, clean, sanitize, and stow hazardous wastes. The ASWMS shall permit rapid and complete removal, disposal, and decontamination of hazardous waste handling equipment.

REQUIREMENT RATIONALE (3.2.2.6)

There is a possibility of the use, storage, or generation of hazardous material onboard aircraft, which will then generate waste that must be carefully handled due to the hazard it imposes on personnel or the environment.

As of the date of this document, the latest information on the USAF hazardous waste reduction programs is contained in the MITRE Corporation report *WP-92W0000023*. This document provides background information on the definition of hazardous material, the appropriate regulations, case studies, and military and commercial programs for the reduction of the use of hazardous materials and processes. It also contains technical information on the effects of pollutants and their possible substitutes, as well as additional resources for the latest information on specific hazardous materials. This document should be referenced for details on the design of systems for the handling of hazardous wastes.

REQUIREMENT GUIDANCE

Reference MITRE Corporation report *WP-92W0000023*.

REQUIREMENT LESSONS LEARNED

Unique and innovative methods of containment and stowage are rapidly being developed. A "Drip Nip®" is a reusable foam pad that can be placed under the site of a hazardous material spill or leak to collect and absorb the fluid. Once wrung out and rinsed with clear water, it is ready for reuse. It is being used primarily for the control of leaks from engines (and has been extensively and successfully used for such by the USAF Museum) (*AFLC/AML Lessons Learned Program #9057*).

An aircraft mission was aborted when a cargo of 55-gal drums of solvent (which had been certified for air shipment) began popping open at 17,000 ft and emitting noxious fumes. The drums were discovered less than full and not air freight eligible (*AFLC/AML Lessons Learned Program #10060*).

One large cargo aircraft required a ready supply of engine oil that was kept in the cargo compartment. Frequent handling of these cases caused injuries and leaking of oil (with associated slip and fire hazards) (*AFLC/AML Lessons Learned Program #10573*).

4.2.2.6 Verification of hazardous waste (excluding medical). The ability of the ASWMS to contain, control, store, clean, remove, dispose, and decontaminate hazardous waste material shall be verified by _____.

VERIFICATION GUIDANCE (4.2.2.6)

The demonstration parts of this verification should be an integral portion of the full system demonstration discussed in 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.3 Sustenance or waste management spaces and compartments. Each compartment shall be grounded through a separate pin in the electrical connector. Grounding resistance shall not exceed ____(a)____ ohms. Compartments must be designed to fit within the envelope and the design constraints of the air vehicle system. Compartments intended for temporary loading within cargo compartments shall meet the requirements of 3.6.1.5. Equipment unrelated to the ASWMS but mounted on or in the ASWMS compartments shall be included in all load calculations and tests. Structures, hand holds, equipment, or projections of the ASWMS which may be grasped by personnel for assistance due to sudden or unexpected aircraft motion shall be capable of withstanding ____(b)____ pounds applied in any direction. Service panels and doors shall be designed for easy opening by maintainers yet shall discourage opening by passengers or other unauthorized personnel. Compartments shall be designed to prevent damage in the event of a rapid decompression.

REQUIREMENT RATIONALE (3.2.3)

Specialized compartments are frequently constructed to support sustenance and waste management systems. These galleys and lavatories have specialized requirements which must be met to permit the safe and sanitary operation of the ASWMS.

REQUIREMENT GUIDANCE

a. The C-17 lavatory requires grounding resistance for all compartment structures of less than 0.01 ohm.

b. The *SAE AS 1426* recommends all parts of any compartment that could be used by personnel to contain the equipment needed to prevent an occupant from falling in the event of sudden or unexpected vehicle maneuvers. This equipment should be able to withstand 300 lb.

REQUIREMENT LESSONS LEARNED

Commercially procured vehicles have been purchased without the addition of tiedown and slinging attachments. Without these, the items cannot be loaded for transport without excessive delays for "jury-rigging" tiedowns. The same problem could be experienced with transportable, commercially-procured lavatories which do not have adequate tiedowns provided (*AFLC/AML Lessons Learned Program #20186*).

Excessive corrosion of compartments and the surrounding air vehicle structures has occurred due to the use of corrosive materials and inadequate floor sealing. See 3.2.5.1.1.4 (*AFLC/AML Lessons Learned Program #10774*).

The existing cargo space galley/lavatory systems have inadequate headroom due to the design requirements for the equipment's overall exterior height and the need for fork lift tine tunnels for loading and ground handling. This demonstrates the need to evaluate carefully all the design requirements for applicability to the specific design effort.

4.2.3 Verification of sustenance or waste management spaces and compartments. The floor pan, fit into the air vehicle, service doors and panels, and possible hand holds shall be verified by ____(a)____. Electrical grounding of the compartment and rapid decompression performance shall be verified by ____(b)____. Loading of compartments into the air vehicle's cargo compartments shall be verified as required by 4.6.1.5.

VERIFICATION GUIDANCE (4.2.3)

a. Verification of the floor pan, fit into the air vehicle, service doors and panels, and possible hand holds should be performed as an integral portion of the demonstration of 4.1.

b. Verification of the electrical grounding of the compartment and the rapid decompression performance should be performed as a test. All normally accessible surfaces of the compartment, during both operation and maintenance, should be tested for grounding resistance.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.3.1 Oxygen. The ASWMS spaces or compartments shall be designed and constructed so the using aircrew members have immediate access to _____ oxygen equipment. The equipment shall be positioned to permit immediate use by all standing and seated occupants within _____ minutes.

REQUIREMENT RATIONALE (3.2.3.1)

United States Air Force and Federal Aviation Administration regulations require oxygen be available in lavatory and galley areas.

REQUIREMENT GUIDANCE

The appropriate federal regulations and *AFGS-87226* should be referenced for guidance. Dropout continuous masks, pressure demand masks with regulators, and portable assemblies may all be appropriate, based on the ASWMS design and use. The time required for use is defined in *AFGS-87226*.

REQUIREMENT LESSONS LEARNED

Equipment designed to meet only the requirements of the Federal Aviation Regulations have been acquired for use within the USAF. However, military oxygen systems may have additional performance requirements which must be considered during the design process.

4.2.3.1 Verification of oxygen. The verification of the ASWMS oxygen systems' performance shall be _____.

VERIFICATION GUIDANCE (4.2.3.1)

Portions of this verification should be performed as described in *AFGS-87226* or by the Federal Aviation Certification procedures. The demonstration portions of this verification should be an integral portion of the full system demonstration discussed in 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.3.2 Counter(s). A one piece, impact resistant counter with a _____ inch raised edge and _____ inch splash shield on the wall shall be provided. If a basin is provided in the compartment, it shall be set into the countertop.

REQUIREMENT RATIONALE (3.2.3.2)

A workspace is needed in most compartments to permit the user to perform his duties.

REQUIREMENT GUIDANCE

The C-17 lavatory specification requires a 0.25 in. raised edge with a 3.00 in. splash shield.

Specialized requirements for the countertop may be added as required. For example, an air vehicle galley for DVs may need a cutting board. A passenger transport aircraft that may be used for the carriage of families with young children (humanitarian, dependent transport, etc.) may need additional lavatory countertop space to permit the changing of diapers. Finally, the C-20, an aircraft designed for the transport of high-level executives, requires a full-length mirror on the back of the compartment door to permit the executive to ensure a professional appearance before leaving the aircraft.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.3.2 Verification of counter(s). The size, design, and construction of counters in the compartment shall be verified by _____.

VERIFICATION GUIDANCE (4.2.3.2)

This verification should be an integral portion of the full system demonstration discussed in 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.3.3 Door(s). Compartment doors shall have louvers for ventilation. Lavatory doors shall have an interior lock which shall have an exterior, backlighted occupied notice. These locks shall have provisions for exterior emergency unlocking. There shall be visual indication on the interior of the door if the lock is not securely latched. Door openings shall be well rounded and shall have no sharp corners or edges. When open, doors shall not block the crew and/or passenger access to passageways, egress routes, or other critical equipment. Door knobs or handles which are twisted to actuate shall open the door when turned in either direction.

REQUIREMENT RATIONALE (3.2.3.3)

Doors are needed on compartments to provide privacy for the occupants, to aid in the containment of odors, or to separate the functions of the vehicle's occupants.

REQUIREMENT GUIDANCE

If compartment doors are used, they must not pose a threat to the air vehicle or its occupants.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.3.3 Verification of door(s). The adequacy of vent louvers and interior locks (including exterior backlighted occupied notice, exterior emergency unlocking, and visual indication that the door is securely latched) shall be verified by _____.

VERIFICATION GUIDANCE (4.2.3.3)

This verification should be an integral portion of the full system demonstration discussed in 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.3.4 Smoke detector. A smoke detector shall be mounted in the ___(a)___ spaces or compartments. It shall be mounted ___(b)___ and shall provide alarm indication at the ___(c)___ crewstation. The detector system installation shall be consistent with the requirements of *MIL-F-87168*.

REQUIREMENT RATIONALE (3.2.3.4)

Lavatory smoke detectors are needed to ensure that fires in this space are rapidly detected, even when unoccupied.

REQUIREMENT GUIDANCE

The *SAE ARP 4001* describes recommendations for the proper selection, design, construction, and installation of smoke detectors in lavatories.

a. A smoke detector should be mounted in all self-enclosed lavatories. Enclosed galleys where the designed cooking, heating, or sustenance preparation processes permit should also contain a smoke detector.

b. The detector's mounting should be based upon the unit's individual design and the compartment's geometry. The mount location should be selected to optimize its ability to detect smoke and fumes and to alert the crewmembers as to this condition.

c. The crewstation at which the alarm is sounded or lighted should be selected in accordance with the air vehicle's overall design and mission capabilities. A warning should be provided at the pilot's station and crew chief's station. Also, if a galley, communications, or mission commander's station are included, an alarm should be provided.

REQUIREMENT LESSONS LEARNED

There have been at least three incidents where personnel have tampered with and disabled smoke detectors in urinals. This has permitted the aircraft to be placed in an undetectable hazardous condition. Wire safety seals and tamperproof enclosures are recommended for smoke detectors, especially in passenger lavatories (*AFLC/AML Lessons Learned Program #10429*).

4.2.3.4 Verification of smoke detector. The mounting and operation of the smoke detector shall be verified by _____.

VERIFICATION GUIDANCE (4.2.3.4)

This verification should be an integral portion of the full system demonstration discussed in 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.3.5 Floor seal. The _____ (galley, lavatory, or other compartment or space where sustenance is prepared or waste is handled, removed, managed, or controlled) shall have a sealed floor that will hold _____ gallons of liquid with the aircraft in normal cruise flight attitude, without leaks or spills to adjacent compartments, floor spaces, structural cavities, bilges, or other areas.

REQUIREMENT RATIONALE (3.2.3.5)

Floors in spaces where sustenance or waste operations are performed are subject to spills or leaks which may cause corrosion or damage to equipment or may create personnel hazards due to electrical shocks or slips and falls.

REQUIREMENT GUIDANCE

The amount of liquid that the floor should be able to hold should be based upon a realistic estimate of the possible spills or leaks which may occur during the operation or maintenance of the equipment contained in that space. The floor is not expected to hold the entire contents of the potable water system. But it should be able to contain the water that could leak due to faulty fittings, o-rings, or connectors while the leak is being discovered, isolated, and secured.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.3.5 Verification of floor seal. The ability of the floor seals in all galley, lavatory, or other compartment or space where sustenance is prepared or waste is handled, removed, managed, or controlled shall be verified by _____.

VERIFICATION GUIDANCE (4.2.3.5)

This verification should be performed as a test that demonstrates the floor is sealed adequately to hold the specified quantity of liquid.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.3.6 Galley-unique requirements. The galley shall be designed to facilitate monitoring of the passengers by crewmembers who are using the galley equipment. A fire extinguisher shall be provided either as a built-in unit or a portable unit located in ready access to crewmembers operating the galley. Fire extinguishers provided for galley compartment protection shall be particularly effective for grease and electrical fires. Fire extinguisher installation shall be consistent with the requirements of *MIL-F-87168*. Sustenance preparation, storage, and serving equipment shall meet the requirements of 3.2.1.3.

REQUIREMENT RATIONALE (3.2.3.6)

When there is a compartment or space used primarily in the preparation and storage of sustenance, then the following requirements may apply.

REQUIREMENT GUIDANCE

Any space or compartment used primarily for the storage or preparation of sustenance is termed a galley. Figure 10 is a representation of galleys designed to support crewmembers, while figure 11 illustrates a galley for passenger support. Galleys should be constructed to reduce damages and hazards caused by abusive use, improper handling, or liquid spills.

Unique solutions to the problems inherent in galley design are actively being sought by commercial aviation. Most of these suggestions have implications for the design of military aircraft for the transport of DVs. One proposed innovation for larger aircraft is the inclusion of the galley or portions of the galley in a lower deck space. This requires the maintenance of pressurization and environmental conditions in this space, and inclusion of a means to transfer personnel and meals from the galley deck to the passenger deck. This would permit the rapid loading of galley equipment and meals through cargo-type doors and would permit more efficient utilization of the passenger spaces. Small bar units could then provide for the passengers' needs between the meal services.

The types and numbers of fire extinguishers which may be included aboard an aircraft are described in *MIL-F-87168*. The total amount of fire extinguishing agent available for use within a given enclosed area must be controlled to prevent the occurrence of a toxic environment.

The *SAE ARP 695* contains guidance on the construction and design of galleys for use in commercial aircraft.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.3.6 Verification of galley-unique requirements. The ability of crewmembers to use the galley equipment while monitoring passengers shall be verified by _____. The adequacy of galley compartment fire extinguishers shall be verified by _____.

VERIFICATION GUIDANCE (4.2.3.6)

This verification should be an integral portion of the full system demonstration discussed in 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

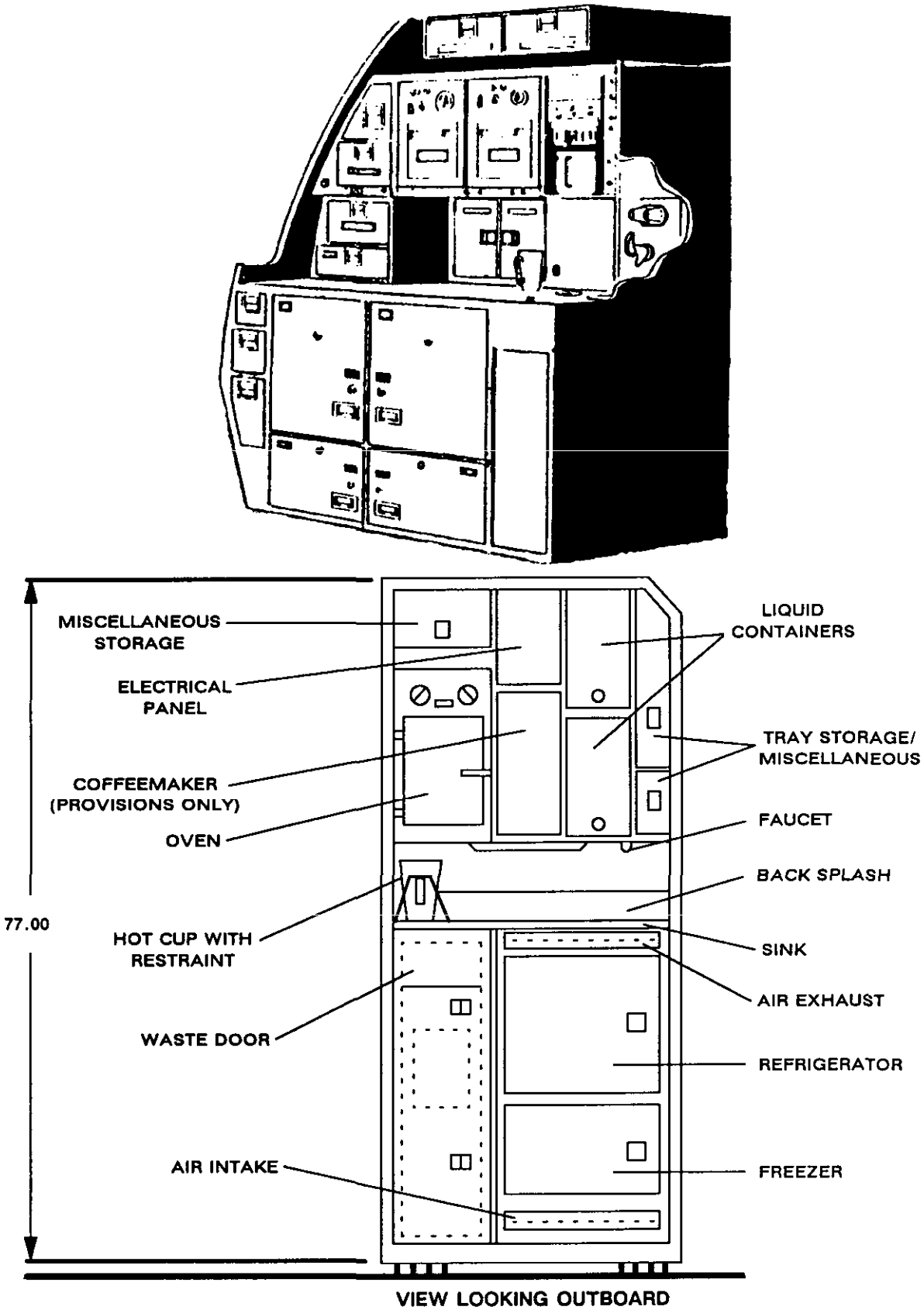


FIGURE 10. Examples of crewmember support galleys.

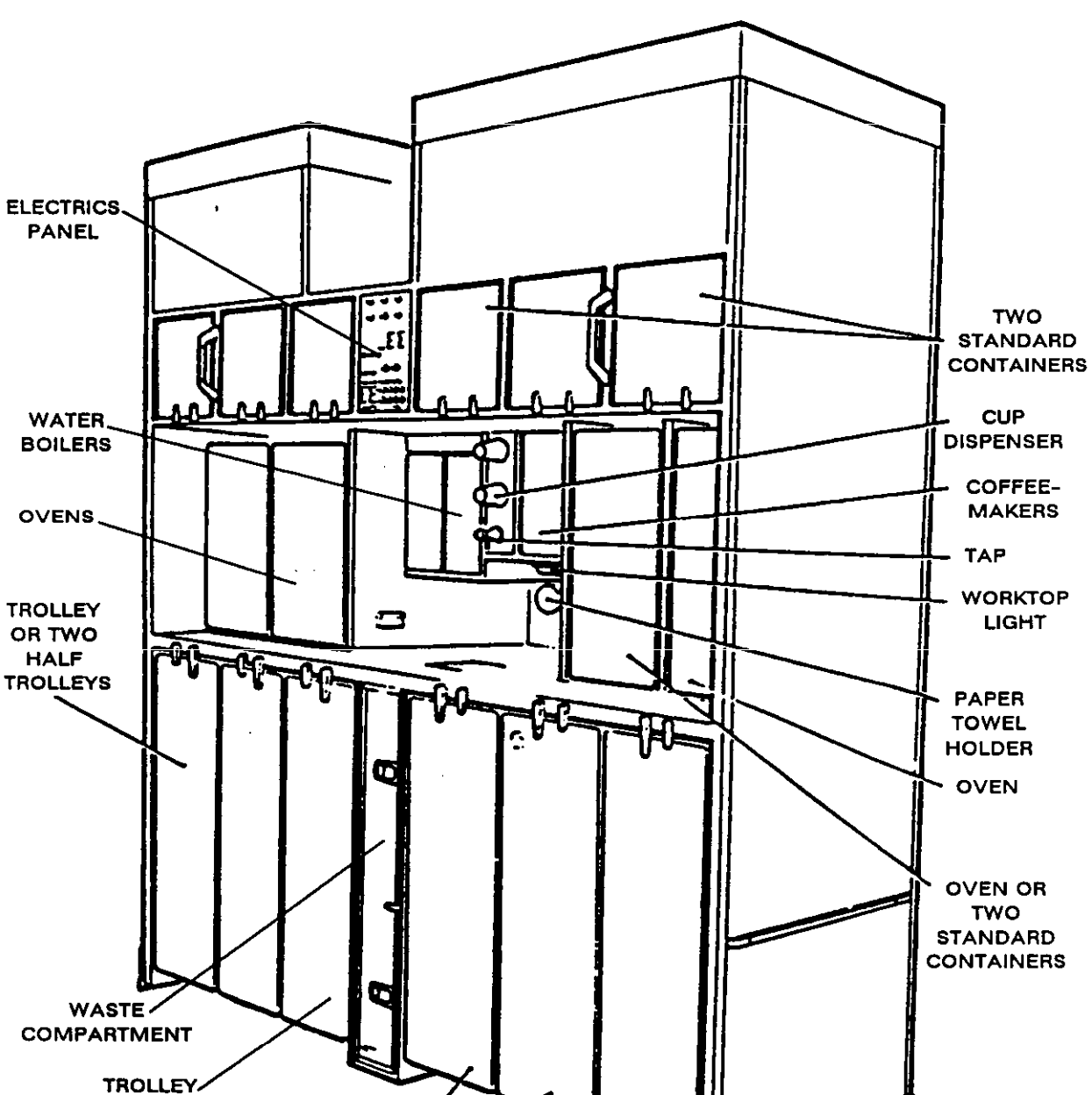


FIGURE 11. Example of passenger support galley.

3.2.3.6.1 Galley fixtures. The galleys shall be equipped with a wastepaper bin (able to hold used disposable cups, sustenance containers, and sustenance preparation remains); paper cup dispenser; hand grips (near the sustenance preparation area); vent fan (which is user selectable); and dispensers for paper towels, airsickness bags, and soap. Each lavatory shall have ___(a)___ (number) ___(a)___ amperes, 115V, 60 Hz utility outlet(s) with integral, self-testing breaker(s). The ventilation system shall remove ___(b)___ cubic feet of air per minute with all ventilation ducting in place and shall vent to ___(b)___ (the aircraft cabin or exterior).

REQUIREMENT RATIONALE (3.2.3.6.1)

There may be a variety of fixtures needed in galley compartments to facilitate the preparation and storage of sustenance. Even though smoking is not permitted, the cooking processes in the galley may create smoke that will require removal.

REQUIREMENT GUIDANCE

a. Utility outlets should be sufficient in number and placement to facilitate the use of electrical utensils and specialized preparation equipment. The number needed may be greater for vehicles intended for the transport of DVs than for a small crew galley and should be selected accordingly. The current carrying capacity should be based upon the current requirements of the electrically powered utensils readily available on the commercial market.

b. Ventilation is required to remove smoke, vapors, and odors which frequently form during preparation of sustenance. The capacity of the system should be based upon the anticipated amount of ventilation required for the style of sustenance preparation anticipated. Gourmet cooking for DVs will produce a greater quantity of smoke, vapors, and odors than the warming of previously prepared sustenance. The ventilation should be to the aircraft exterior whenever the aircraft pressurization system permits.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.3.6.1 Verification of galley fixtures. The adequacy of the galley's wastepaper bin, cup dispenser, hand grips, vent fan, and dispensers shall be verified by ___(a)___. The adequacy and placement of electrical utility outlets and the ability of the ventilation system to remove the required smoke, vapors, and odors and to vent to the correct location shall be verified by ___(b)___.

VERIFICATION GUIDANCE (4.2.3.6.1)

a. The demonstration part of this verification should be an integral portion of the full system demonstration discussed in 4.1.

b. The performance of the utility outlet design and the ventilation system design should be verified by test.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.3.6.2 Galley basin(s). The galley shall have ___(a)___ (number) basin(s) or sink(s) which shall have ___(a)___ (hot and/or cold) potable water faucets, spring loaded to shut when released. The water shall fall into the sinks in all flight attitudes from ___(b)___ degrees pitch to ___(b)___ degrees pitch. The basin opening shall be ___(c)___ inches in diameter (or ___(c)___ inches diagonally, if rectangular) to permit the cleaning and sanitization of trays, coffee pots, and other sustenance equipment. Basins and sinks shall hold ___(d)___ cubic inches when the drain is plugged and the aircraft is in a ___(d)___ degrees pitch attitude. See 3.2.2.2 for liquid waste system requirements.

REQUIREMENT RATIONALE (3.2.3.6.2)

To permit the sanitary preparation for meals and to clean and sanitize equipment after meals, a basin in the galley area is frequently necessary. Potable water basins also may be needed in applications where there is no galley or lavatory for the same purposes.

REQUIREMENT GUIDANCE

This paragraph should be repeated as necessary to specify the requirements for each basin, unless all galley basins must meet the same requirements.

a. The first two blanks should be completed to identify the number of basins. If available, the galley basins should be supplied with both hot and cold water. The faucets should be spring loaded to close and should be a design similar to that used in the lavatory.

b. The *SAE AS 1426* recommends the water fall into the sink or basin in attitudes from 5° nose down to 15° nose up.

c. The basin opening should be sized to permit the cleaning and sanitization of all food preparation equipment, utensils, and devices. This should include, but need not be limited to, trays, coffee pots, plates, spoons, forks, knives, etc. A means of plugging the drain to allow a small quantity of water to collect for the purpose of cleaning and sanitizing the ASWMS should be provided. If a separate drain plug is used, then there should be positive retention when not in use. The strainer should also be removable to permit cleaning.

d. The *SAE AS 1426* recommends the sink or basin hold the contents of a single coffee server or 93 cu in., whichever is larger, while in a 10° nose up attitude.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.3.6.2 Verification of galley basins. The galley basins' operation, water supply, drainage, and maintenance shall be verified by _____.

VERIFICATION GUIDANCE (4.2.3.6.2)

This verification should be an integral portion of the full system demonstration discussed in 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.3.6.3 Galley annunciator panel. A galley annunciator panel shall contain a receiving station for the lavatory annunciator call switch and a passenger warning sign with the message, "Return to Seat". The emergency call receiver shall have an acknowledgment switch that shall remove the signal and be accessible while seated on the galley seats. The message shall be illuminated manually by the crew from the ___(a)___ (crew position) and automatically upon ___(a)___ (emergency conditions). The galley annunciator panel shall provide the additional functions of ___(b)___.

REQUIREMENT RATIONALE (3.2.3.6.3)

Crewmembers responsible for galley operations spend a significant amount of time at this station. Therefore, emergency communications to and from this station are necessary.

REQUIREMENT GUIDANCE

a. The aircraft command position should be able to initiate this warning manually. It may further be desirable to have automatic initiation due to conditions such as depressurization, extreme adverse attitudes, or extreme accelerations and buffeting.

b. The panel may have additional functions, based upon the design missions of the air vehicle. Medical aircraft may need a warning light and audible signal at this station from the lavatory compartment(s) and may also need verbal communications to the medical technician's station. The C-20 executive transport aircraft has a requirement for a handset intercom from the galley to the cockpit and communications station.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.3.6.3 Verification of galley annunciator panel. The ability of the galley annunciator panel to receive a signal from the lavatory annunciator call switch and a signal warning crewmembers to return to their seats shall be verified by _____.

VERIFICATION GUIDANCE (4.2.3.6.3)

This verification should be an integral portion of the full system demonstration discussed in 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.3.6.4 Self-service equipment. The ASWMS shall contain _____ (type of self-service equipment, such as drink dispensers, cup dispensers, snack trays, etc.). An operating instructions and warning placard shall be posted immediately adjacent to the equipment in a position that permits the user to read the directions while performing the tasks.

REQUIREMENT RATIONALE (3.2.3.6.4)

Smaller ASWMS installations without an attendant specifically trained and assigned to operate the ASWMS equipment may require incorporation of self-service devices or equipment.

REQUIREMENT GUIDANCE

The specific equipment types should be listed here. Requirements or limitations on the use of these devices should also be included. The operating instructions should include directions for using the device to serve and to reload the device for continued service.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.3.6.4 Verification of self-service equipment. The self-service equipment shall be verified by _____.

VERIFICATION GUIDANCE (4.2.3.6.4)

This equipment should be verified during the ASWMS system-level demonstration of 4.1. Special features of its design, to meet the limitations of the aeronautical environment, may require special test procedures.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.3.6.5 Service and waste carts. The ASWMS shall contain ___(a)___ (number) service carts (also known as service trolleys) for the distribution of ___(b)___ (food and/or beverages) to the crew, passengers, patients, and other personnel and for the collection of post-meal debris. Carts shall be able to hold ___(b)___ (number) ___(b)___ (serving trays, beverages, or other sustenance). Carts shall be able to withstand periodic high temperature and pressure cleaning and sanitization with standard military and commercial agents in ground kitchen facilities. Cart stowage restraints shall be able to hold a fully loaded service cart. Each cart shall have a braking system that operates from a "dead man" switch on the handle or a foot pedal. The service cart's wheel loads shall not exceed ___(c)___ pounds per wheel and the diameters shall be no less than ___(c)___ inches.

REQUIREMENT RATIONALE (3.2.3.6.5)

In applications where the crew is required to serve a large number of crewmembers and/or passengers, they will require the assistance of a service cart to allow the sustenance to be distributed in an expeditious manner.

REQUIREMENT GUIDANCE

The *SAE ARP 4171* describes safety requirements for food and beverage service carts. *National Sanitation Foundation Standard 59, Food Carts,* contains extensive guidance on the design of food service carts.

a. The number of service carts necessary should be based upon the number of personnel that must be served, the time available for service, and the number of crewmembers available to serve.

b. Service carts may be specifically configured for beverages only, food only, or both food and beverages. The number of items that the carts should be able to carry should be based upon the number of people to be served, the number of people to do the serving, and the anticipated time available to perform this task.

c. The *SAE AS 1426* estimates the weight of a fully loaded service cart at 250 lb. The wheel supported weight and diameter must be limited to ensure the air vehicle's floor structure is able to support a loaded cart. The *SAE AS 1426* recommends a wheel weight of no more than 62.5 lb and a minimum diameter of 3 in.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.3.6.5 Verification of service and waste carts. The service carts' performance shall be verified by _____.

VERIFICATION GUIDANCE (4.2.3.6.5)

This equipment should be verified during the ASWMS system-level demonstration of 4.1. Special features of its design, to meet the limitations of the aeronautical environment, may require special test procedures.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.3.6.6 Galley seats. The ASWMS shall contain ___(a)___ (number) galley seat(s). The seat(s) shall be located adjacent to any emergency, communications, or oxygen equipment, controls, or indicators. The seat(s) shall be positioned to permit the occupant a full view of all passengers and reduce the impact of crash conditions or equipment failure. Furthermore, the seat(s) and its attachment load path to the primary aircraft structure shall meet the crash survivability requirements of *MIL-STD-1807* and the design requirements for non-ejection seats of ___(b)___ (specification or standard) without any failure that would cause injury to the seat's occupant or to other passengers or crewmembers. The seats shall have sufficient strength, rigidity, and durability to withstand the accelerations (inertia loads) specified herein without permanent deformations, loss of rigidity, or loss of structural functioning for the design usage of ___(c)___.

REQUIREMENT RATIONALE (3.2.3.6.6)

Crewmembers may be assigned to this space and therefore require safe seating for all air vehicle motions while they remain near the galley and emergency equipment and devices during all phases of the mission.

REQUIREMENT GUIDANCE

a. The number of seats should be the same as the maximum number of personnel assigned to operate the equipment in the galley compartment.

b. Requirements from *MIL-STD-1807*, *MIL-S-2668*, *MIL-S-25073*, or *MIL-S-58095*, as appropriate, for the specific seat design should be entered in this blank. The entire specification should not be cited, but specific paragraphs should be referenced.

c. The design usage of the seat shall include the usage rate per mission and the number of cycles of opening and closing of the seat. It can be estimated from the number of flight hours and the type and duration of missions performed by the aircraft.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.3.6.6 Verification of galley seats. The design, number, and location of the galley seat(s) shall be verified by _____. The ability of the seats to function as required shall be verified as described in *MIL-STD-1807* design requirements of _____. This verification shall be a dynamic test of the seat, ASWMS supporting structure, the aircraft supporting structure, and all connectors. Verification of the strength, stiffness, and durability of the galley attendant seats to withstand flight loads for the defined usage shall be by _____.

VERIFICATION GUIDANCE (4.2.3.6.6)

The demonstration portions of this verification should be included as a part of the full system demonstration of 4.1.

Verification of the strength, stiffness, and durability of the seat should be done consistently with the approaches used to verify the strength, stiffness, and durability of passenger seats carried on similar commercial and/or military aircraft.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.3.7 Lavatory-unique requirements. Each lavatory shall have sufficient room to permit an occupant to ___(a)___. The lavatory shall contain ___(b)___ (toilets and/or urinals) as specified in 3.2.2.1.1.1 or 3.2.2.1.1.2.

REQUIREMENT RATIONALE (3.2.3.7)

When there is a compartment or space that is primarily used in the elimination of human waste products or the performance of sanitary health care, then the following requirements may apply.

REQUIREMENT GUIDANCE

Any space or compartment used primarily for the elimination of human waste products or the performance of health and hygiene operations is termed a lavatory. Figure 12 presents a typical lavatory on a cargo-type aircraft. Figure 13 presents a typical troop compartment lavatory.

The *SAE ARP 1315* contains guidance on the construction and design of lavatories for use in commercial aircraft.

a. Lavatory compartments for DVs should have adequate room to permit them to change clothing within the compartment. Medical lavatories may require space to permit a medical attendant to assist a patient during emergency situations. Other lavatories should have room sufficient to permit the use of all installed equipment and fixtures.

b. The number of toilets and urinals in each lavatory should be based upon the needs of the occupants of the air vehicle.

REQUIREMENT LESSONS LEARNED

Previous lavatories designed solely for use by male members of the military have been inadequate when the aircraft mission requires their use by women and non-military users. Humanitarian and rescue missions may involve the use of these facilities by a wide range of personnel. Lavatory activities which may occur due to these situations include diaper changing, young children assistance, preparation for meeting the press, etc.

4.2.3.7 Verification of lavatory-unique requirements. The ability of the lavatory occupant to perform the required tasks and operate the installed equipment shall be verified by _____.

VERIFICATION GUIDANCE (4.2.3.7)

This verification should be an integral portion of the full system demonstration discussed in 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

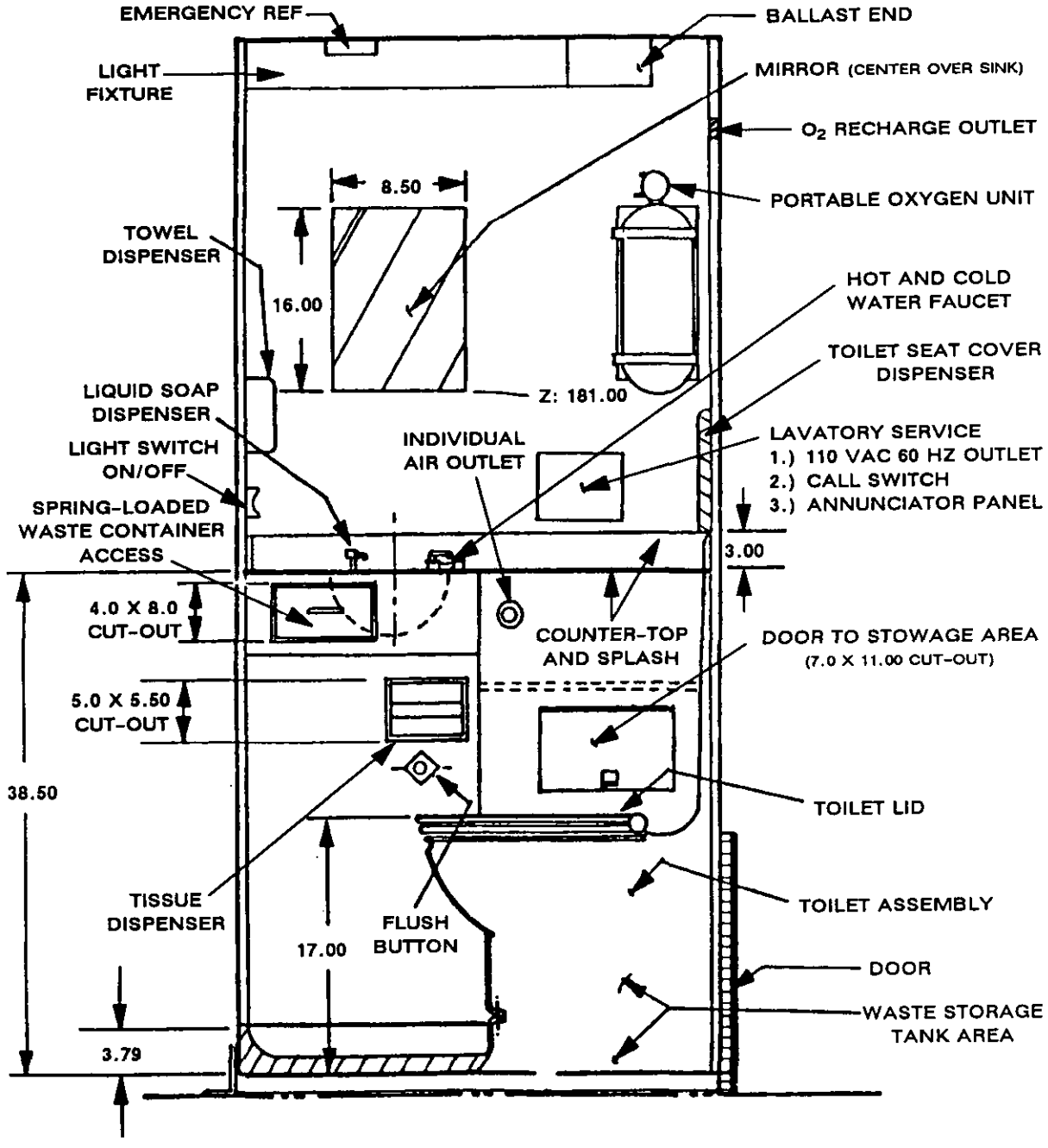


Figure 12. Cargo-type aircraft crew lavatory.

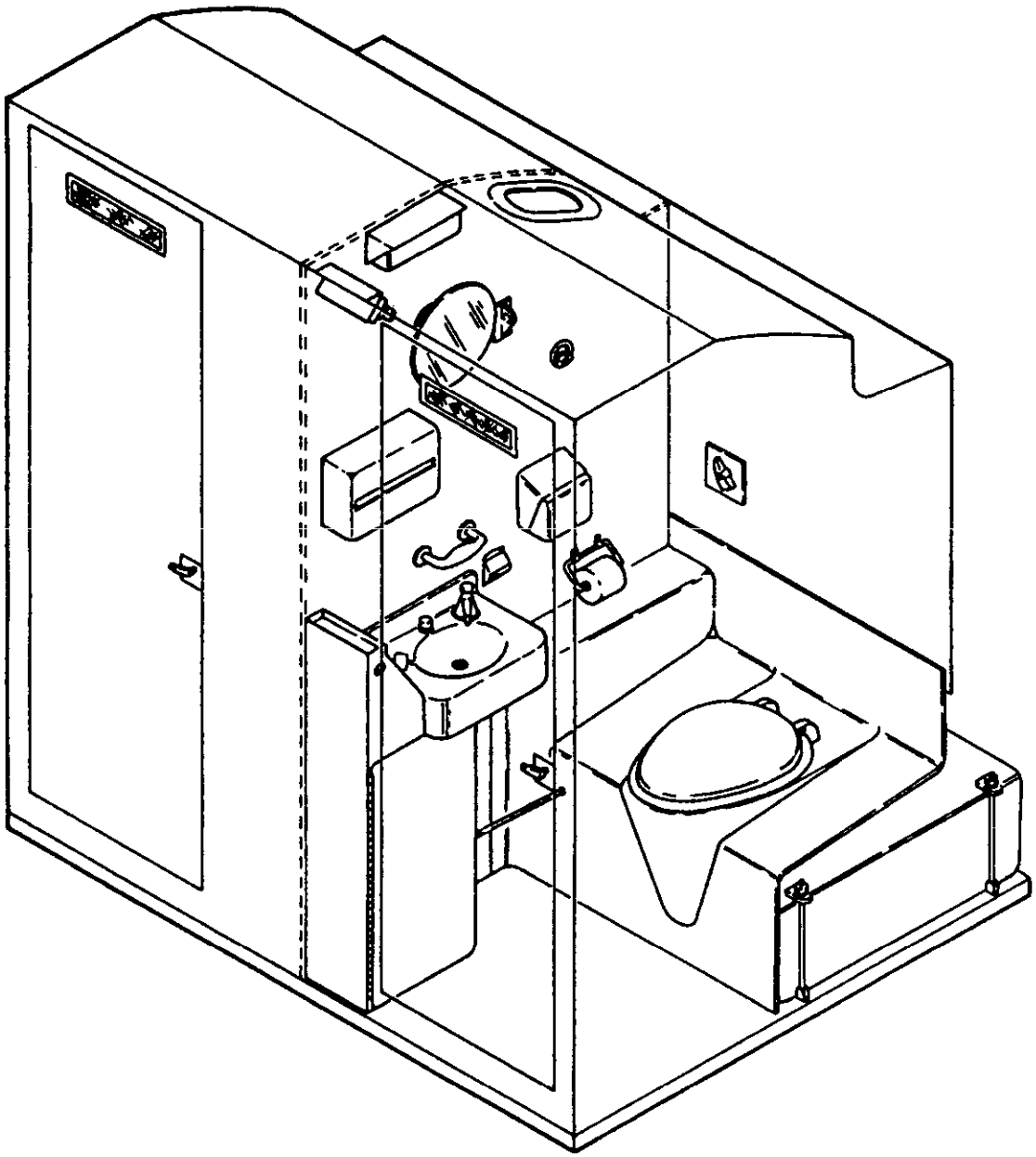


FIGURE 13. Typical troop compartment lavatory.

3.2.3.7.1 Lavatory fixtures. The lavatories shall be equipped with ___(a)___. Each lavatory shall have a ___(b)___ amperes, 115V, 60 Hz utility outlet with ground fault circuit interrupts and an integral, self-testing breaker. The ventilation fan shall remove ___(c)___ cubic feet of air per minute with all ventilation ducting in place and shall vent to ___(c)___ (the aircraft cabin or exterior).

REQUIREMENT RATIONALE (3.2.3.7.1)

There may be a variety of fixtures needed in lavatory compartments to facilitate the elimination of waste and the grooming and hygiene needs of the aircraft occupants.

REQUIREMENT GUIDANCE

a. Equipment which has been installed in previously designed aeronautical lavatories and should be considered includes: a mirror; waste paper bin (capable of containing used sanitary napkins and air sickness bags); paper cup dispenser; hand grips (near any toilet and urinal); vent fan (which operates whenever the lights are on); and dispensers for fresh tissues, sanitary napkins, paper towels, airsickness bags, and soap. Also, a small shelf (with a lip or railing to prevent articles from falling) under the mirror to hold toiletries or other handcarried articles should be considered.

b. Utility outlets should be sufficient in number and placement to facilitate the use of electrical grooming appliances such as razors, hair dryers, hair styling appliances, etc. The current carrying capacity should be based upon the current requirements of the readily available commercial devices.

c. Ventilation is required to remove vapors and odors which frequently form during waste elimination. The capacity of the system should be based upon the amount of use anticipated. The ventilation should be to the aircraft exterior whenever the aircraft pressurization system permits.

REQUIREMENT LESSONS LEARNED

During an early design review for an aeronautical galley, a plastic toilet paper roll holder was identified that was inherently weak in design. This would require frequent replacement and caused significant time in operation with broken holders and significant maintenance costs.

A towel dispenser was located directly over the toilet in one lavatory design. This interfered with the use of the toilet and created a hazard since even shorter personnel would strike their head on this dispenser when rising from the seat.

During a recent conflict, it was noted several times that many aircraft lavatories do not have sufficient design to provide feminine napkin dispensing or disposal. Due to the increasing role of women in the military, this requirement should not be overlooked.

4.2.3.7.1 Verification of lavatory fixtures. The functional adequacy of the installed fixtures shall be verified by ___(a)___. The design, number, and placement of lavatory electrical outlets and the ability of the ventilation system to remove the odors and dispose of them to the proper location shall be verified by ___(b)___.

VERIFICATION GUIDANCE (4.2.3.7.1)

a. This verification should be an integral portion of the full system demonstration discussed in 4.1.

b. The performance of the utility outlet design and the ventilation system design should be verified by a test.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.3.7.2 Lavatory basins. Lavatory basins shall have an indentation on the basin's upper surface to hold bar soap. The lavatory basin shall have ___(a)___ (hot and/or cold) potable water faucets which are spring loaded to shut when released. The basin opening shall be ___(b)___ inches in diameter (or ___(b)___ inches diagonally, if rectangular). There shall be a soap dispenser adjacent to the basin. See 3.2.2.2 for liquid waste system requirements.

REQUIREMENT RATIONALE (3.2.3.7.2)

All lavatories need a basin to permit the crewmembers and/or passengers to maintain their personal hygiene. For the same purpose, potable water basins may be needed in applications where there is no galley or lavatory.

REQUIREMENT GUIDANCE

a. This section should be repeated as necessary to specify the requirements for each basin, unless all lavatory basins must meet the same requirements. If available, the lavatory basins should be supplied with both hot and cold water. The faucets should be spring loaded to close and of a design similar to those used in the galley (if any).

b. The basin opening should be sized to permit all personal hygiene operations, including washing of hands and face and shaving. A means of plugging the drain to allow a small quantity of water to collect for the purpose of cleaning and sanitizing the ASWMS should be provided. If a separate drain plug is used, then there should be positive retention when not in use. The strainer should also be removable to permit periodic clearing and cleaning.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.3.7.2 Verification of lavatory basins. The lavatory basins' operation, water supply, drainage, and maintenance shall be verified by _____.

VERIFICATION GUIDANCE (4.2.3.7.2)

This verification should be an integral portion of the full system demonstration discussed in 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.3.7.3 Lavatory annunciator panel. An annunciator panel containing a call switch and a passenger warning sign with the message, "Return to Seat" shall be installed. The message shall be illuminated manually by the crew from the ___(a)___ (crew position) and automatically upon ___(a)___ (emergency conditions). An emergency call button shall be wired to the ___(b)___ (crew position) to alert the ___(b)___ (aircrew and/or medical technician) and shall be accessible from the toilet seat. The galley annunciator panel shall provide the additional functions of ___(c)___.

REQUIREMENT RATIONALE (3.2.3.7.3)

Aeronautical emergencies can occur at any time. Occupants of lavatory compartments need to be alerted of impending emergency conditions and of the need to regain their seats as quickly as possible. There are also other communications required to and from this facility.

REQUIREMENT GUIDANCE

a. The aircraft command position should be able to initiatie this warning manually. It may be further desirable to have automatic initiation due to conditions such as depressurization, extreme adverse attitudes, or extreme accelerations and buffeting.

b. Medical air vehicles should have a call button in the lavatory to alarm at the medical technician's station.

c. The panel may have additional functions, based upon the design missions of the air vehicle. For example, special mission and medical aircraft may need to have verbal communications to and from the lavatory compartment(s).

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.3.7.3 **Verification of lavatory annunciator panel.** The operation of the lavatory annunciator panel and its ability to call crewmembers as required and warn passengers when it is necessary to return to their seat shall be verified by _____.

VERIFICATION GUIDANCE (4.2.3.7.3)

This verification should be an integral portion of the full system demonstration discussed in 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.3.7.4 **Shaving.** Each lavatory shall include provisions for shaving, including razor blade disposal. This blade disposal shall accept the wide variety of disposable razors and blades available on the commercial market.

REQUIREMENT RATIONALE (3.2.3.7.4)

Shaving is an important aspect of personnel hygiene, is required by regulation for a correct military appearance, and is necessary for DVs prior to important meetings, briefings, or other occasions when they represent the US Government.

REQUIREMENT GUIDANCE

This requirement may not be desired for every case where a lavatory is installed, but should be considered and included whenever possible.

The blade disposal should be designed to permit the disposal of all types of razor blades. Some older style disposals would allow the discarding of only the older, flat, two-sided blades. However, the disposable blades available on the commercial market are now a wide variety of shapes and dimensions. The disposal should be designed to accommodate all styles which may be used with the ASWMS.

Each disposal port should have a spring-loaded cover over the opening for disposal. Any opening intended for the removal of the used blades should include the biohazard warning shown on figure 8, since spent blades may be contaminated with the user's blood.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.3.7.4 **Verification of shaving.** The ability of the lavatory to support shaving, including razor blade disposal, shall be verified by _____.

VERIFICATION GUIDANCE (4.2.3.7.4)

This verification should be an integral portion of the full system demonstration discussed in 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.4 Potable water system. The ASWMS shall have a potable water system that ___(a)___ (is/is not) an integral part of the ___(a)___ (galley, lavatory, and/or aircraft systems). It shall transfer potable water from the storage container to the point of service. The system shall be entirely made of non-corrosive material that shall impart no taste or odors nor release any chemicals to the water. The potable water system shall be completely drained by gravity when not in use, with no remaining pockets of water. The potable water system shall be designed and constructed to prevent ___(b)___ (freezing of the contained water or damage to the ASWMS due to freezing) during all extremes of the air vehicle systems' flight environment. The potable water system shall be able to withstand a pressure of ___(c)___ psig during system filling. The system shall withstand, without damage or deformation, an ultimate pressure of ___(d)___ psig. Ground service connections for the potable water system shall be in accordance with 3.6.1.6.3. All potable water tanks, lines, inlets, and hoses shall be labelled, "Drinking Water Only".

REQUIREMENT RATIONALE (3.2.4)

Potable water is a basic requirement for the continuation of life. These requirements should be included whenever the mission duration requires drinking water service.

REQUIREMENT GUIDANCE

Water has been characterized by chemists as the "universal solvent" due to its ability to absorb a wide variety of substances. Since many of the things that the water may pick up from the plumbing can give the water a displeasing or even disgusting taste or odor, this must be rigidly and carefully controlled.

The ASWMS may sit for long periods in storage. If the potable water plumbing is not completely drained during this time, hazardous organisms may multiply to unacceptable levels. Then, when the system is removed from storage and placed into use, personnel could become violently and lethally ill. Therefore, pockets of water cannot be permitted to remain in the ASWMS after it is drained. As a goal, there should be a single point drain to remove all water from the system with no remaining entrapment.

Note there may be more than one potable water system onboard the aircraft. For example, the C-17 uses its own integral system for crewmembers, 5-gal insulated jugs for emergencies, and a "comfort pallet's" potable water system for passengers. Examples of typical potable water systems are presented on figures 14 through 16.

The *USPHS Handbook 308* describes guidance on the design of potable water systems. *National Sanitation Foundation Standard 61, Drinking Water System Components - Health Effects,* contains extensive guidance on the selection of components and material for potable water treatment systems:

a. Potable water systems may be required for aircraft with or without galleys or lavatories. When these units are available, the system may or may not be an integral part of the galley, the lavatory, or other systems.

b. Since the ASWMS may experience periods of freezing temperatures (in storage and in operational use), the ASWMS water system must either protect the water from these temperatures or protect itself from damage from the volumetric expansion of water as it transforms into ice. This can be accomplished by a variety of methods, including freeze plugs, expandable containers, flexible materials, and so on. If fragible devices are used, such as freeze plugs, then there must be positive and obvious indication of the device's condition

and there must no impediment from ready replacement with common hand tools without major component or module removal.

c. During filling of the system through the *servicing connections*, the pressure may be greater than normally experienced during operation. The *SAE AS 1426* recommends the potable water system be able to withstand 125 lb of pressure. The C-17 galley uses 135 psig while the lavatory uses 144 psig.

d. The design ultimate pressure should be approximately two times the maximum pressure the system will see when operating. The C-17 lavatory uses 216 psig.

REQUIREMENT LESSONS LEARNED

A section of the potable water holding tanks were located below the water drain line connections on several military transport aircraft. Sludge collected in these low areas, which promoted the growth of bacteria, gave the water a foul odor, and made the water hazardous to personnel. It was very difficult to purge and clean these holding tanks adequately to ensure the complete removal of all deposited sludge.

4.2.4 Verification of potable water system. The ability of the users to completely drain the system, both tanks and plumbing, by gravity shall be verified by ___(a)___. The ability of the system to maintain the operating pressure and withstand the filling pressure shall be verified by ___(b)___.

VERIFICATION GUIDANCE (4.2.4)

a. The drainage of the system should be demonstrated during the system-level demonstrations. No air pressure or other drying method should be permitted to be blown into the system. After the gravity drainage is completed, the system should be disassembled, as required, to show no pockets of water remain.

b. The operating and filling pressures should be verified by a system test. In one aircraft, the crew galley water system filling pressure performance is tested by raising the system pressure from 0 to 50 psig in 1 min through the filling connection, and then decreasing it back to 0 at the same rate.

c. The demonstration portion of this verification should be performed as a part of the full system demonstration of 4.1.

VERIFICATION LESSONS LEARNED

On the C-17, environmental testing to ensure the system would perform as required under the condition of extreme cold was considered out of scope because the technical requirements did not explicitly state the need for this verification.

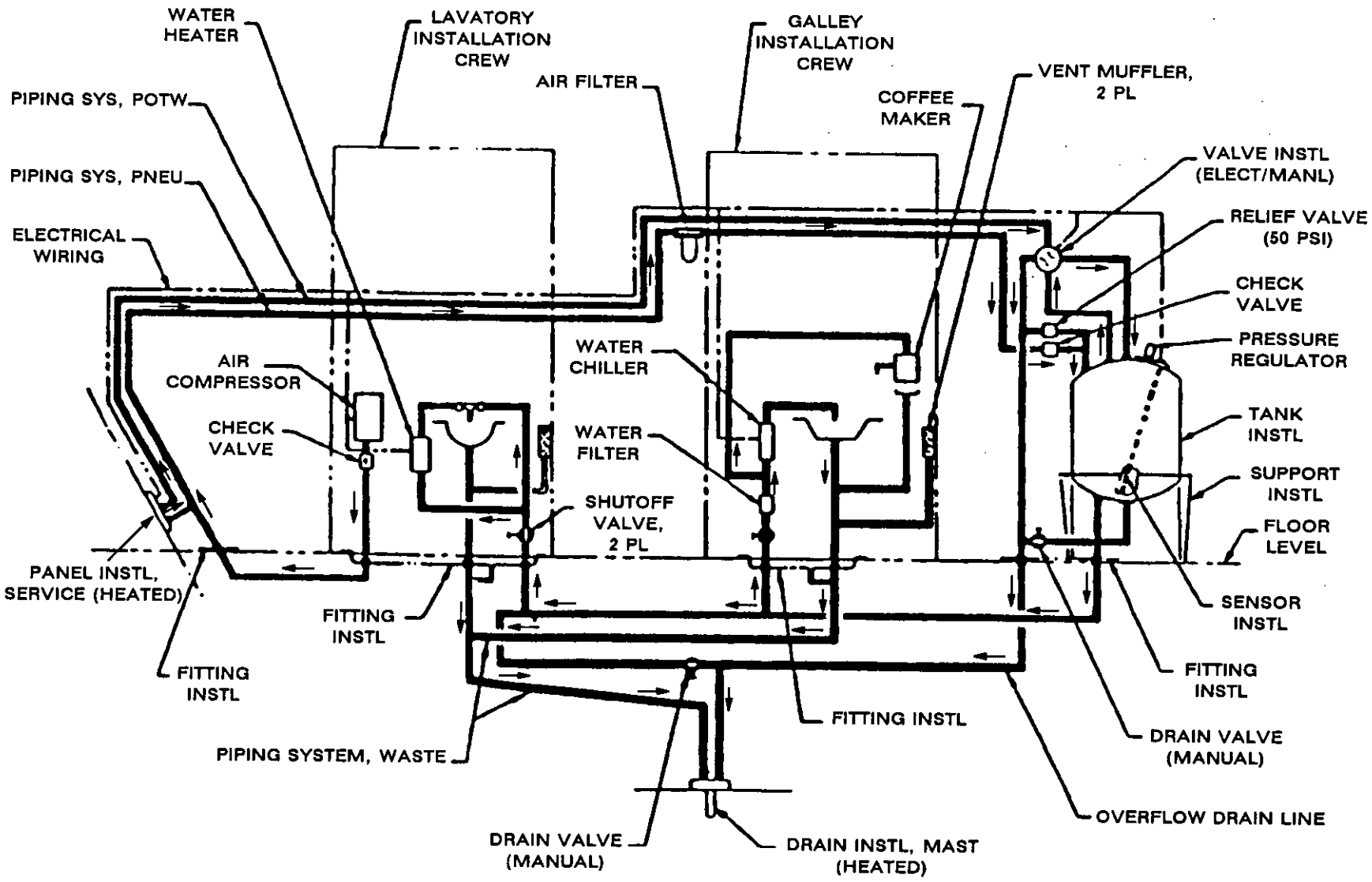
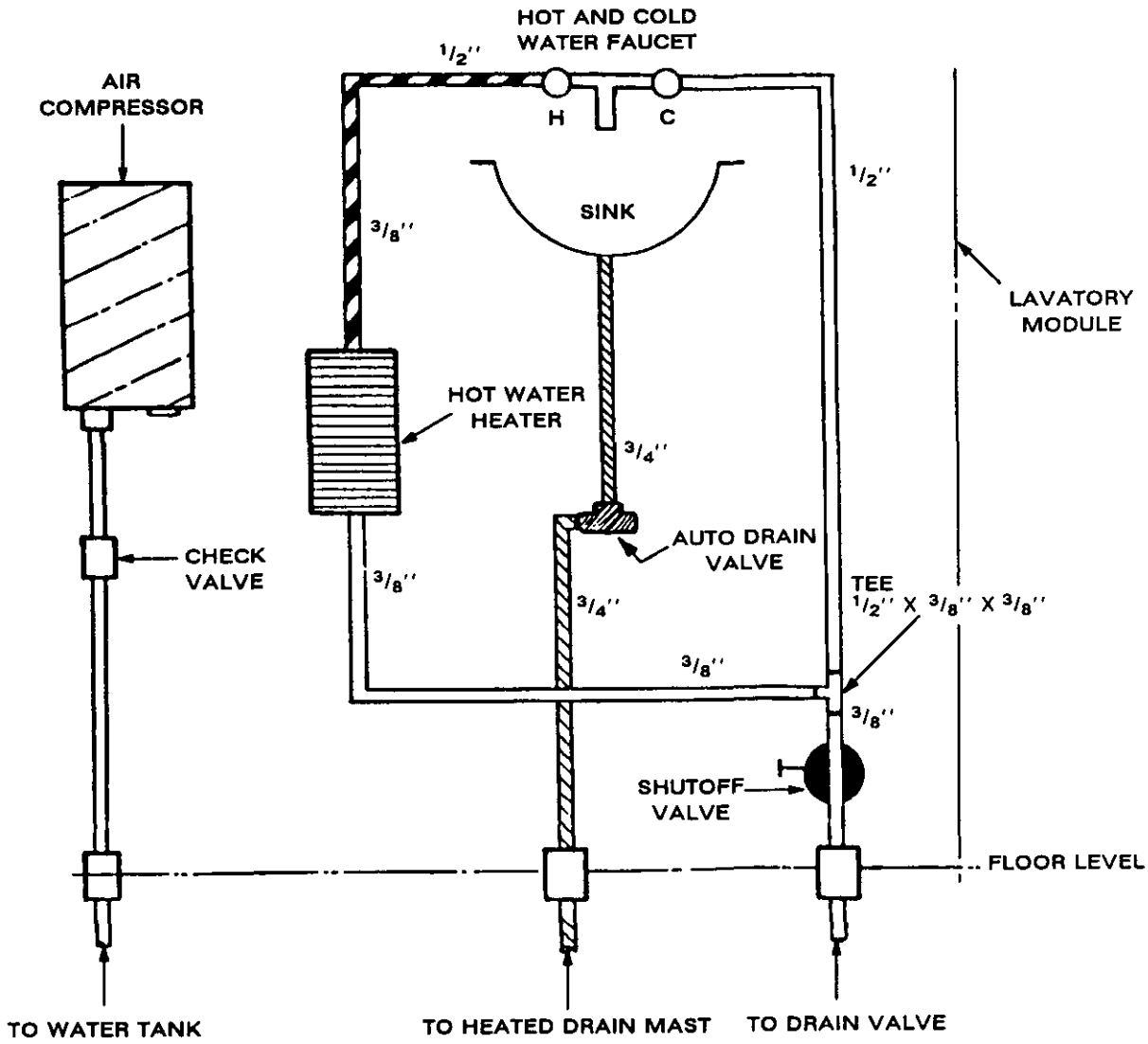


FIGURE 14. C-17 integral potable water system.



LEGEND:

WATER DRAIN LINE

HOT WATER LINE

WATER SUPPLY LINE

FIGURE 15. Typical lavatory system.

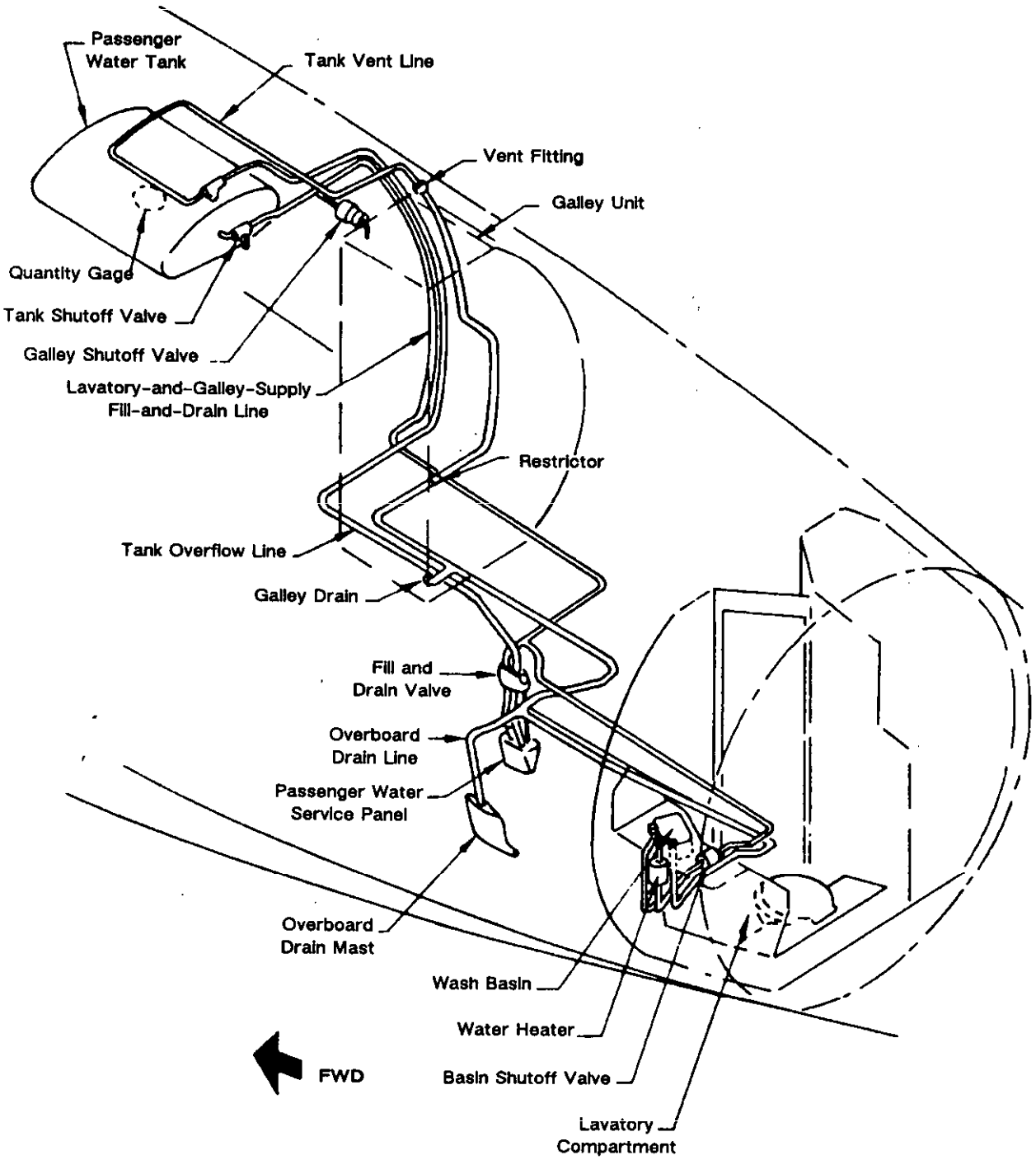


FIGURE 16. Example of potable water plumbing.

3.2.4.1 **Potable water plumbing.** Potable water shall be supplied to the locations specified in 3.2.1.1.2.1 at the minimum flow rates specified therein. The system shall use semi-permanent, non-leaking quick disconnects which are easily disassembled for cleaning and are not connectable to the waste system plumbing connectors. At a single point, the potable water system shall connect to the waste water system for gravity drainage and overfill protection. This single subsystem cross connector shall be a normally disconnected spool (with associated valves and check valves) to reduce the probability of backflow from the waste system to the potable water system. If more than one potable water supply tank is used in the ASWMS design, then the system shall be designed to permit the switching of tanks while in flight. The potable water system shall be routed to avoid water spills from leaks or condensation. The potable water supply to passenger usable services shall be designed to permit crewmembers to secure the flow to these devices. A potable water emergency shutoff valve, with a placard describing its purpose and direction of operation to close, shall be located at ___(a)___. The potable water system shall have a relief valve set to prevent pressures from exceeding ___(b)___ psig at any point in the system. Additional relief valves shall be located at the supply to the ___(b)___ (equipment) and set to relieve at ___(b)___ psig.

REQUIREMENT RATIONALE (3.2.4.1)

Potable water is a basic requirement for the continuation of life. These requirements should be included whenever the mission duration requires the service of drinking water.

REQUIREMENT GUIDANCE

The connectors used throughout the system should not be able to interface with any of the waste water system connectors. To do so could permit the potable water, or a portion of the system, to become contaminated with hazardous wastes. This may be accomplished by different sizes of connectors and pipes; however, various sizes will also be required to regulate the flow through the ASWMS. It may be more feasible to use different connector mechanization or geometry. If used, the cross connection preventor should be designed to prevent the user from overriding or bypassing the protection (i.e., by removing pins or using common plumbing reducers).

When not in use, the cross connector spool should be retained in position, but rotated so the spool is out of the flow path. A valve will be needed on the potable water side to prevent the water from spilling out of the spool connector. A valve will be needed on the waste water side for the same purpose, and to ensure that no noxious fumes, gases, or vapors are permitted to enter the compartment. A check valve will also be needed on the waste water side, to prevent backflow of waste water into the potable water system when the spool is in use.

In the event that water resources become limited during a mission, the crewmember needs the ability to control the passenger use of water to conserve the amount remaining.

An additional requirement levied by the C-135 galley specification was that the potable water plumbing should not be affected by temperature extremes of -60 to 100°F. This was different from the environmental extremes required of the other aircraft systems.

a. The emergency shutoff valve should be located as near as possible to the source of potable water, as close as possible to the aircrew station, before branches of the supply line to other equipment, and as readily accessible as possible. Additional shutoff valves should be located at each compartment serviced by the potable water system.

b. The relief valve should be set low enough to ensure the system is not exposed to any pressure excursions beyond two times the operating pressure. Equipment able to generate excessive pressure, such as coffeemakers or water heaters, should also have pressure relief protection set to a level low enough to preclude damage to that device. The C-17 lavatory uses relief valves set at 45 to 55 psig.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.4.1 Verification of potable water plumbing. The distribution of the potable water shall be verified as described in 4.2.1.1.2.1. The connectors' operation (including the cross connection spool) shall be verified by ___(a)___. This verification shall include an attempt to interconnect the potable and liquid waste systems at all connectors. The system material and routing shall be verified by ___(b)___. Switching between supply tanks, aircraft potable water connectors interconnection, and emergency shutoff shall be verified by ___(c)___. The pressure relief valve(s) should be verified by a ___(d)___.

VERIFICATION GUIDANCE (4.2.4.1)

a. All connectors which may require operation by the user or maintainer throughout the life of the system should be evaluated during the demonstrations of 4.1. Similarly, attempts should be made to connect to the waste system at all locations where the waste system connectors are separated during normal and emergency operation or maintenance.

b. The adequacy of the system routing may be verified by inspection of the system and its drawings.

c. The switching between tanks, interconnection, and emergency shutoff should be verified by a demonstration.

d. The operation of the pressure relief valve(s) should be verified by a test of the system with the relief valve in place.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.4.2 Potable water tanks. The potable water system shall have a tank(s) to contain ___(a)___ gallons of potable water. Potable water tanks shall contain baffles or other provisions to prevent surging of the contents, yet shall be easily accessible for cleaning and sanitization. The tank opening for cleaning shall require no tools to operate, shall be ___(b)___ inches in diameter minimally, and shall utilize captive fasteners. If a non-round opening shape is used, it shall be a size sufficient to contain a circle of the above diameter. The tanks shall have a non-spill vent with surge preventors and shall be removable. A carrying handle(s) adequate to support the weight of the tank when full shall be included. The tank shall be insulated to eliminate or reduce condensation. All interior seams shall be smooth. There shall be a positive retention device for the tank when in position. The use of multiple tanks is acceptable. The tanks shall have a fully cleanable level indicator that shall be located to maximize its accuracy. A check valve shall be used in the fill line, hose, or valve. If a lavatory uses the same source as the galley, drinking fountain, and/or coffeemaker, then the amount available for the lavatory shall be controllable by the crewmembers. Potable water tanks shall be designed to permit manual filling by the air or ground crew when ground support equipment is not available.

REQUIREMENT RATIONALE (3.2.4.2)

A means of holding potable water until required is necessary for all potable water systems. These requirements provide the basis for ensuring the tanks remain usable for the purpose they were intended.

REQUIREMENT GUIDANCE

It is important that the potable water tanks be designed both to prevent surging of the contents and to be thoroughly cleaned and sanitized. Uncontrolled movement of the water (surging) can cause damage to the tank and structural supports and can (for large tanks) affect the flight control characteristics of the aircraft. A dirty or uncleaned tank can support the growth of hazardous micro-organisms which can prove harmful or lethal to personnel. Surge preventors may be designed both to be functional and to permit full cleaning and sanitization by incorporating moveable or removable sections or by providing access openings in the preventors.

A vent is necessary to ensure air is permitted to replace the water taken from the tank. However, this vent must have a positive surge preventor in line to ensure the aircraft maneuvers do not cause the water to be lost through the vent. This vent should not be part of the overfill protection since this could permit the introduction of noxious fumes, gases, or vapors from an overflow connected to the waste system.

Those tanks designed to be carried should incorporate handles to facilitate this process. The number and location of these handles may vary dependent upon the operational concept (moving the tank empty or full), the tank size and geometry, the number of personnel required to move the tank, and the anticipated support available for transporting the tank. If the tank must be lifted into a position on top of or within the top of the ASWMS, the handles should be designed to facilitate this operation.

Retention of the tank when in position must be fully integrated into the ASWMS design. This equipment must be able to hold the tank when completely full of water, throughout the acceleration environment of 3.2.6.11.

In some applications, a single, large tank may prove to be too cumbersome or may not fit other design constraints. Multiple tanks may permit greater design flexibility and may allow the producer to meet some other design objectives. However, whenever multiple tanks are considered, the additional maintenance and logistics burden created by multiple tanks should also be considered. If used, the tanks should be identical to permit interchangeability and aimplify the logistics required.

A level indicator is necessary to permit the operator to monitor and ration, if necessary, the available water. This indicator should be a simple device. However, all components in the interior of the tank must be fully cleanable. A remote reading indicator is desirable but usually is not a firm requirement.

The fill line should have a check valve to prevent backflow into the support equipment or base water facilities.

The flow of water should be controllable by the operator to permit rationing, if necessary. This does not need to be a remote operation, but must be inoperable by passengers if it is located in the lavatory.

a. The ASWMS potable water tanks must be able to contain the amount of water required by 3.2.1.1.2.1. The C-135 galley was required to have two removable potable water tanks that held 10 gal each. A third potable water tank, located off the galley and in another area of the aircraft, was to be provided by the Government (the contractor was responsible only for the connection to the potable water system).

An insulated jug (*MIL-J-25718*) and a water bag (*MIL-B-8571*) have been used to augment the existing water supply in aircraft to support unusual numbers of crewmembers or passengers, as necessary for special missions or operations. However, these should not be used as the primary source of potable water supply. When they are used, design consideration must be given to the collection of drips or small spills from the bag or jug outlet. A drip pan or catch basin should be incorporated beneath the spigot, with adequate volume to contain small spills and a capacity for easy, periodic emptying by the crewmembers. The mounting for these containers should be designed to withstand the air vehicle accelerations and shock loads when full. Access to the container should permit refilling of the device while in flight without removal from the mount.

b. The diameter of the cleaning access opening is 5 in. in one current potable water tank, and 4 in. in another. The opening should be sized and positioned to ensure the maintenance crewmembers can reach the entire tank volume during cleaning and sanitization operations.

REQUIREMENT LESSONS LEARNED

The C-5A 50-gal potable water tank required removal for cleaning and sanitization. However, due to the design of this item and its supporting structure, it was very difficult to remove. Although conscientious crewmembers attempt to perform all planned maintenance as required, non-flight critical maintenance that consumes excessive manhours such as this can be delayed.

The C-5B 52-gal tank for the removable troop compartment galley was stored in the cargo compartment. This caused the tank to rely upon a potable water pump to provide adequate pressure to the galley and subjected the tank to the possibility of freezing under some environmental conditions.

A 5-gal "Igloo®" picnic-style cooler is used to keep the passenger drinking water cool on some older airborne galleys. In one case, the cooler mounting was designed in such a way that the crewmembers were unable to open its lid to refill the cooler (from the potable water tank) with the cooler mounted in position for use. In other cases, no rigid mounting was provided. The C-5B galley provided rigid mounting by including a compartment for the igloo with foam bumpers.

4.2.4.2 Verification of potable water tanks. The adequacy of the surge preventors, cleaning accesses and openings, carrying handles, retention, fill line check valve, and supply control shall be verified by _____. The performance of the insulation and interior corners shall be verified by _____.

VERIFICATION GUIDANCE (4.2.4.2)

The performance of the surge preventors, cleaning accesses and openings, carrying handles, retention, fill line check valve, and lavatory supply control should be verified during the system-level demonstration of 4.1. The insulation and interior corners should be verified by inspection of the finished product and of the drawings.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.4.3 Potable water pressurization system. The potable water system shall provide ___(a)___ psi pressure or more at all faucets or outlets. Pressure shall be generated by ___(a)___ (pneumatic source, compressor, or pump). The potable water pump shall require no more than ___(b)___ amperes power at ___(b)___ Volts ___(b)___ (direct current or Hertz).

REQUIREMENT RATIONALE (3.2.4.3)

A means of moving the potable water from the storage location to the using sites, as required in the preceding paragraphs, is necessary.

REQUIREMENT GUIDANCE

a. The system must develop adequate pressure to provide an acceptable flow rate at each outlet. This may be generated, based upon the system design criteria, by an elevated tank, by pneumatic pressure applied to the tank, or by a potable water pump. However, pumps should not be used where power supply is limited or maintenance of water flow is critical (as for medical support). The C-20 pressurizes the potable water system either from an electrically powered compressor or from the aircraft engine bleed air system.

b. The power requirements for the potable water pressurization system should be based upon the available power to the ASWMS and the power needed by all other ASWMS equipment.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.4.3 Verification of potable water pressurization system. _____.

VERIFICATION GUIDANCE (4.2.4.3)

This verification should be an integral portion of the full system demonstration discussed in 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.4.4 Potable water treatment. The ASWMS shall be designed to treat non-potable water to remove _____, thereby making it palatable and fit for human consumption. It shall maintain already potable water in a usable condition. The ASWMS potable water system shall meet the non-treatment requirements of *AFR 161-44*.

REQUIREMENT RATIONALE (3.2.4.4)

Some treatment of the potable water may be considered for larger aircraft, especially those employed for the transport of DVs. Small, infrared decontamination units are available for limited flow rates and have been used with considerable success in commercial aircraft.

REQUIREMENT GUIDANCE

The following National Sanitation Foundation standards contain extensive guidance on particular forms of potable water treatment systems:

NSF 41	*Wastewater Recycle/ Reuse and Water Conservation Devices*
NSF 42	*Drinking Water Treatment Units - Aesthetic Effects*
NSF 53	*Drinking Water Treatment Units - Health Effects*
NSF 55	*Ultraviolet Microbiological Water Treatment Systems*
NSF 58	*Reverse Osmosis Drinking Water Treatment Systems*
NSF 60	*Drinking Water Treatment Chemicals - Health Effects*
NSF 61	*Drinking Water System Components - Health Effects*
NSF 62	*Drinking Water Distillation Systems*

Whatever treatment process is used, if any, it should not introduce additional hazards to the aircraft or its occupants. Chlorine gas should not be used because it is highly toxic and corrosive. Other forms of chlorine compounds should be used only with careful attention to the possible irritating, toxic, and corrosive effects of any leakage or spills of the substances. Radiation treatments may also be employed to prevent the transfer of harmful organisms through the drinking water.

If a treatment is employed, a method of drinking water testing should also be considered. It is preferable that this testing be conducted at the water delivery site.

REQUIREMENT LESSONS LEARNED

The C-5 potable water system required retrofit with a filter to clean the potable water before it is dispensed, due to a unappealing discoloration of the water caused by the potable water system. While the water was safe for drinking, many personnel were concerned about its quality and safety and did not drink as much as they should have for health purposes.

4.2.4.4 Verification of potable water treatment. The ability of the ASWMS potable water system to meet the requirements of *AFR 161-44* shall be verified by _____.

VERIFICATION GUIDANCE (4.2.4.4)

The ability to perform the non-treatment requirements of *AFR 161-44* and the adequacy of the system materials may be verified by inspection of the system and its drawings.

The references listed in 3.2.4.4 Requirement Guidance for potable water treatment also contain extensive guidance on the verification of these systems.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.5 Construction

3.2.5.1 Materials, processes, and parts. Materials, processes, and parts shall be selected in consonance with *MIL-STD-1587*, *MIL-STD-1568*, and the requirements listed in the following subparagraphs.

3.2.5.1.1 Materials and processes. The materials used for the ASWMS shall be commensurate with the operational and maintenance capability of the system and the life cycle exposure. The ASWMS shall contain no hazardous materials nor require any hazardous processes. It shall require no process or material prohibited by federal, state, or local law. As amplified by 3.2.5.1.1.1, materials nutritious to fungus shall be avoided wherever possible and shall be treated whenever they must be used. Any honeycomb- or sandwich-type panels used shall have all edges, cutouts, or holes sealed to protect the core material and prevent the entrance of moisture or foreign material. All selected materials shall not be adversely degraded due to exposure to aircraft fluids, disinfectants, cleaning or sanitization agents, or pressurized cleaning processes. The following removable modules, equipment devices, or parts shall be able to withstand periodic high temperature and pressure cleaning and sanitization with cleaning agents in ground kitchen facilities: _____.

REQUIREMENT RATIONALE (3.2.5.1.1)

The selection of a particular material must be commensurate with its intended use, including loading and environmental conditions.

REQUIREMENT GUIDANCE

Whenever materials are proposed for which only a limited amount of data is available, the acquisition activity should be provided with sufficient background data so a determination of the suitability of the material can be made. The allowable structural properties should include all applicable environmental effects as defined in section 3.2.6.

The selection of materials and processing techniques should be based on comparison between material properties of candidate materials and the operational requirements for each particular application. The requirements contained in *MIL-STD-1568*, *AFSC DH 1-2*, and *MIL-STD-1587* should be adhered to.

The word "materials" includes surface finish or construction material (such as paint, glue, or laminates). The word "processes" includes all sealing, treating, and joining methods. Processing shall not contribute to the degradation of the properties of the materials in the operating environment.

The *SAE Aerospace Material Specification 1450* defines the performance requirements for insecticides and disinfectants which will meet the regulations of the US Department of Agriculture and the World Health Organization. The ASWMS material must be capable of repeated exposure to these chemicals. The C-5 troop compartment toilet listed nine commercial sanitation chemicals with which the system had to maintain compatibility. While these particular chemicals are no longer available (and therefore not listed here) this method of specifying a wide variety of sanitation chemicals may have merit for a particular developmental acquisition.

Information on the reduction of fire hazards is contained in *MIL-F-87168, Fire and Explosion Hazard Protection Systems, Aircraft, General Specification for*.

REQUIREMENT LESSONS LEARNED

Residue from chemical softeners used in the forming of thermoplastic materials has been known to contribute to abnormally rapid development of bacteria in aircraft water systems.

On the C-20B, lens covers over lights located above the galley range top were warped by the heat from the cooking surfaces. Design modifications added cooling holes to the lenses and relocated the lights away from the heat source.

A hygroscopic adhesive was used in the construction of some honeycomb panels for aircraft. The moisture absorption caused delamination of the panels. This is further complicated in the ASWMS design by the creation of a site for the growth of hazardous organisms (*AFLC/AML Lessons Learned Program #10541*).

A non-hazardous cleaning compound that has shown some ability to clean all areas of aircraft systems effectively, including galleys, is Calla 800® (NSN 6850-01184-3182) (*AFLC/AML Lessons Learned Program #9056*).

4.2.5 Verification of construction

4.2.5.1 Verification of materials, processes, and parts

4.2.5.1.1 Verification of materials and processes. The ability of the ASWMS materials to meet the operational and maintenance requirements of the system shall be verified by ___(a)___. The acceptability of the structural properties shall be verified by ___(b)___. The ability of required removable modules, equipment devices, or parts to withstand periodic high temperature and pressure cleaning with cleaning and sanitization agents shall be verified by ___(c)___. The absence of hazardous materials and processes; of processes or materials prohibited by federal, state, or local laws; of materials nutritious to fungus; and of materials which may be degraded due to exposure to aircraft fluids, disinfectants, cleaning or sanitization agents, or pressurized cleaning processes shall be verified by ___(d)___. The sealing of all edges, cutouts, or holes in honeycomb- or sandwich-type panels shall be verified by ___(d)___.

VERIFICATION GUIDANCE (4.2.5.1.1)

The early verification of the materials selected for use in the ASWMS helps keep the weight and cost of the system down while meeting operational and maintenance performance requirements.

The materials to be used in each of the structural components need to be identified as early in the program as practical. Proper selection of material properties may be verified within the strength analyses, which typically call out the allowables and references.

a. The overall performance of the ASWMS in the air vehicle and aeronautical environment for which it was designed should be verified as an integral portion of the systems demonstration of 4.1.

b. Material with limited data should be verified by a test, demonstration, or analysis, in that order of preference and based upon the available information. For those materials with sufficient data to permit a thorough analysis, the verification should be performed as an analysis.

c. The ability of the removable modules or parts to meet the environment of the cleaning and sanitization process should be verified by a test or demonstration of the item in the cleaning system.

d. All other verifications in this section may be performed by an inspection of the drawings or the actual delivered product.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.5.1.1.1 Materials in contact with food and/or water. All materials used where they may contact sustenance shall not contain or pass any odor or flavor nor hazardous or toxic chemicals (such as lead or cadmium) to any food, water, or other drink. There shall be no material used in contact with food or water that will support chemical reactions with any sustenance, support the growth of fungus, or attract insects. All material used in contact with food or water shall not etch, pit, crack, or have any other structural, visual, or performance deterioration. Chemical softeners shall not be used in the bending or forming of thermoplastic materials. All potable water line materials shall be suitable for use with super chlorinated water. All materials will be selected to maximize or ensure easy cleaning and sanitization. No hygroscopic material shall be used. Flexible lines shall not be convoluted, but shall have stainless steel fittings.

REQUIREMENT RATIONALE (3.2.5.1.1.1)

Unless properly designed, food and/or water may form unique environments which may interact with common aircraft materials. They may react with the materials to make these unsuitable for further use, they may react with the food and make it unfit for human consumption, or they may create unsanitary or unhygienic conditions.

REQUIREMENT GUIDANCE

Food includes all forms of sustenance used by aircrew members.

A disinfectant used to sanitize food service equipment when adequate hot water is not available is described in *MIL-D-11309*. All equipment which may contact food or water should be able to sustain repeated exposures to this chemical, as described in the referenced specification.

To ensure no pockets of water remain to freeze or to permit the growth of micro-organisms, the interior of all potable water lines and equipment should be smooth walled. In the past, requirements were laid that flexible potable water lines should be polytetrafluoroethylene (PTFE) lined.

The following National Sanitation Foundation standards contain extensive guidance on the sanitary design selection of food service materials:

NSF 14	*Plastics Piping Components and Related Materials*
NSF 35	*Laminated Plastics for Surfacing Food Service Equipment*
NSF 51	*Plastic Materials and Components Used in Food Equipment.*

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.5.1.1.1 Verification of materials in contact with food and/or water. The absence of materials in contact with any food, water, or other drink that may contain or pass any odor, flavor, or hazardous or toxic chemicals; that will support chemical reactions due to this contact; that will support the growth of fungus; that attracts insects; that may etch, pit, crack, or have any other structural, visual, or performance deterioration due to this contact; or that is hygroscopic shall be verified by _____. The compatibility of potable water line materials with super chlorinated water shall be verified by _____.

VERIFICATION GUIDANCE (4.2.5.1.1.1)

Wherever these performance requirements have not been previously verified in a sufficiently similar environment and use, they should be verified by properly designed tests and demonstrations.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.5.1.1.2 Materials in contact with human or liquid wastes. No aluminum or porous materials shall be used in direct contact with human waste. All materials for handling wastes shall be acidproof and shall have corners with a minimum radius of _____ inch. Flexible lines shall not be convoluted.

REQUIREMENT RATIONALE (3.2.5.1.1.2)

Unless properly designed, liquid wastes may form unique environments which may interact with common aircraft materials and systems. They may react with the materials to make these unsuitable for further use or they may further decompose and create unsanitary or unhygienic conditions.

REQUIREMENT GUIDANCE

Aluminum and other materials subject to corrosion will react to the highly acidic conditions of human waste. Porous materials, such as wood, should not be used on any interior part of the system in contact with waste, due to the entrapment of the waste in the material.

The largest acceptable radius should be selected to ensure no waste is trapped in the interior corners of the system.

All plumbing lines and devices should have smooth walls to ensure no waste clings to the interior of waste lines. Flexible waste lines may be either PTFE or silicon lined.

REQUIREMENT LESSONS LEARNED

Urine and other forms of human liquid waste are extremely corrosive. It has been estimated that over two million dollars have been spent in the repair of C-141 bilges due to the corrosion-caused leaks of waste products into the bilge areas. The mechanisms of increased corrosion due to human liquid wastes and the use of specially formulated, non-toxic chemicals to inhibit bilge corrosion are discussed in *AFWAL-TR-81-4186*.

4.2.5.1.1.2 Verification of materials in contact with human or liquid wastes. The absence of aluminum or porous materials, the use of acidproof materials, the radius of corners, and the flexible lines (including the lack of convolutions) shall be verified by _____.

VERIFICATION GUIDANCE (4.2.5.1.1.2)

These requirements should be verified by inspection of the ASWMS drawings and of the delivered final product.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.5.1.1.3 Flammable materials. Combustible materials shall meet the requirements of *FAR 25.853* and *FAR 25.1359*. All materials shall be selected to minimize the density and toxicity of the smoke produced when burned. All materials used shall be burn resistant and/or self extinguishing as required by *FAR Part 25*. Textile materials, such as draperies, curtains, coated fabrics, and insulation, shall have a maximum after flame time of _____ sec, a maximum burn length of _____ inches and a maximum flame time of drippings of _____ seconds when tested in accordance with Part I of *FAR Part 25.853(b)*, Appendix F.

REQUIREMENT RATIONALE (3.2.5.1.1.3)

In any aeronautical mishap or emergency situation, there is the possibility a fire will occur. A fire onboard an aircraft places the occupants in extreme danger and therefore must be avoided by all means, especially by designing all systems to limit the spread of any fire.

REQUIREMENT GUIDANCE

Military Standard 1807 contains pertinent guidance and lessons learned on the selection of materials for use in aircraft interiors.

The C-17 lavatory specification requires the flammability performance as described in table IV.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.5.1.1.3 Verification of flammable materials. The density and toxicity of the smoke produced when the material is burned shall be verified by _____. The burn resistance and/or self-extinguishing capability of the materials shall be verified by _____. The flame time, burn length, and dripping flame time of textile materials shall be verified by _____.

VERIFICATION GUIDANCE (4.2.5.1.1.3)

Whenever acceptable test data is available to describe the required performances, it should be analyzed to verify compliance with the performance requirement. However, when only insufficient or uncertifiable data is available, then the material must be tested to ensure its performance will meet the requirements.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

TABLE IV. Material flammability.

	Average for 5 specimens	Any 1 specimen
After Flame Time	5	10
Burn Length	8	10
Flame Time (Drippings)	5	10

3.2.5.1.1.4 Corrosion control. The ASWMS shall withstand the natural and induced environments of 3.2.6 and of the sustenance and wastes of 3.2.1.1 and 3.2.2.1 for the design life cycles without producing corrosion products which are unsanitary, unhygienic, difficult to clean, uneconomical to repair, difficult to inspect, or unacceptable due to low residual strength or poor aesthetics.

REQUIREMENT RATIONALE (3.2.5.1.1.4)

Corrosion prevention systems must be effective for minimum periods of service usage to minimize the life cycle costs associated with corrosion damage inspection and repair. Corrosion prevention measures are required to minimize the impact of corrosion problems on the durability and maintenance costs over the lifetime of the ASWMS.

REQUIREMENT GUIDANCE

All materials and processes should be selected to prevent corrosion. All surfaces should be treated or covered as necessary to prevent corrosion in the environments of 3.2.6 or due to contact with waste or sustenance material. Confined areas, open panels cores, and inaccessible cavities should be permanently sealed.

Corrosion due to the contact of dissimilar metals, as defined in *MIL-STD-889*, should be avoided by using metals with similar electrochemical potential. If due to other design constraints dissimilar metals or other corrosion generating material combinations (such as salt and metal) must be used near one another, intimate contact should be avoided by the use of insulation that separates the two materials. The treatment of porous materials for flame resistance or any other process should not permit the material to retain salts or other corrosive products.

Corrosion inhibitors specially formulated for the protection of bilges under galley or lavatory equipment are discussed in *AFWAL-TR-81-4186*.

REQUIREMENT LESSONS LEARNED

Corrosion has occurred in closed hollow structural members when drain holes were not provided. However, due to the use of water and cleaners on and about ASWMS material, any drain holes must be covered or otherwise designed to prevent them from becoming a site for the introduction of moisture into any closed hollow members. These holes can also be used to permit periodic inspection of the member to ensure no internal corrosion is occurring (*AFLC/AML Lessons Learned Program #761*).

A plywood floor induced corrosion in metal members supporting this floor. Without a sealant or other treatment, the plywood holds enough water to create the corrosion. Plywood in contact with metal should be avoided in the design (*AFLC/AML Lessons Learned Program #760*).

Thin panels, used for their light weight and durability, became deformed and allowed water to become entrapped. The use of sealants in an attempt to solve this problem deformed the panels further and permitted additional moisture to collect. The panels and sealant must be carefully designed to ensure that corrosion is prevented (*AFLC/AML Lessons Learned Program #644*).

The Air Force Corrosion Prevention and Control (CPC) program is located at the Air Force Corrosion Program Office (AFCPO) at Warner-Robins AFB GA and is the focal point for the development and support of data on corrosion prevention. They may be contacted at (912) 926-3284 or FAX (912) 926-6619 (*AFLC/AML Lessons Learned Program #80014*).

Waste fluids have leaked through cargo compartment floors and caused corrosion in the bilge areas. Material selection and protective coatings have been identified as major methods to reduce this maintenance problem. Also, the use of seals at all fasteners was discussed (*AFLC/AML Lessons Learned Program #1071*).

4.2.5.1.1.4 Verification of corrosion control. The ability of the ASWMS to control corrosion in the environments of 3.2.4 or due to contact with waste or sustenance material shall be verified by _____.

VERIFICATION GUIDANCE (4.2.5.1.1.4)

The corrosion prevention measures should be developed in accordance with the requirements of *MIL-STD-1568*. *Military Standard 810* may also be used to develop environmental performance verifications.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.5.1.1.5 Surfaces. All surfaces shall be designed to be easily and completely cleaned and sanitized with a damp cloth, soap, and water. During normal use for the lifetime of the ASWMS in the environments of 3.2.6, all surfaces shall be scuff, chip, crack, scale, dent, and scratch resistant; shall be free of cracks, crevices, and other recesses; and shall not erode. Floors and walkways shall be covered with a non-skid surface with a non-skid lifetime of _____ in the environments of 3.2.6 and for the service life of 3.3. Surfaces exposed to view shall be covered as appropriate to render them _____. Surfaces not exposed to view or inaccessible for maintenance and cleaning shall be painted or treated for positive prevention of hidden corrosion. All equipment, structures, and surfaces at floor level shall be protected from damage by the users' boots and shoes by a kickplate.

REQUIREMENT RATIONALE (3.2.5.1.1.5)

The surfaces of the ASWMS must maintain their aesthetic, safety, and functional capabilities throughout the life of the equipment.

REQUIREMENT GUIDANCE

If not protected, floor-level mounted equipment, structures, and surfaces may be damaged. Damage may be superficial, such as small dents, scrapes, or marking of the surface which detract from the appearance of the ASWMS. Or the damage may be more serious, such as loosened connectors, broken equipment, or compromised performance. Either level of damage is unacceptable and must be prevented by the addition of appropriate kickplates.

The kickplates' design and installation must not reduce the effectiveness of any component of the ASWMS in meeting its design requirements. In particular, accessibility to equipment for cleaning, maintenance, or repair cannot be limited.

Floors should maintain their non-skid characteristics even when wet to prevent a crewmember or passenger from slipping and thereby injuring himself. The blank should be completed to require the surfaces to be aesthetically pleasing or camouflaged, as best suits the design mission of the aircraft system.

The following National Sanitation Foundation standards contain extensive guidance on the sanitary design selection of surface materials:

NSF 35	*Laminated Plastics for Surfacing Food Service Equipment*
NSF 52	*Supplemental Flooring.*

REQUIREMENT LESSONS LEARNED

When the original E-3A carpets began to wear excessively, a replacement carpet was developed from a tougher material with the same color and pattern combination. However, due to the visual properties of the new material, the pattern was much more noticeable. Some crewmembers, when looking down the corridor, had difficulty walking on the carpet because of the optical illusions it created. This color/pattern/material combination had such a strong influence on these crewmembers that it was designated as having a negative impact on the mission effectiveness and had to be replaced.

4.2.5.1.1.5 Verification of surfaces. The cleanability; scuff, chip, dent, and scratch resistance; non-skid capability; and non-susceptibility to cracking, chipping, scaling, or eroding due to age or extremes of environmental conditions of all surfaces shall be verified by _____. The presence and effectivity of kickplates shall be verified by _____.

VERIFICATION GUIDANCE (4.2.5.1.1.5)

This verification should be performed as an inspection of the drawings and of the delivered product. Inspection of the drawings alone could permit the incorporation of unintended undesirable performances.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.5.1.2 Parts. With the exception of the water basin drains, traps for food particles, liquids, or condensate shall be eliminated. Modular component construction shall be utilized wherever feasible. The removal of parts, components, equipment, modules, or combinations of the foregoing shall not adversely affect the performance of all remaining unrelated portions of the ASWMS. Standard military or commercial parts shall be used, wherever practicable and whenever they meet the performance requirements, in the following order of precedence: _____.

REQUIREMENT RATIONALE (3.2.5.1.2)

The ASWMS' parts have unique requirements which must be met to ensure the system will meet its design mission.

REQUIREMENT GUIDANCE

The *SAE AS 1426* recommends the following order of precedence for standard parts: 1) parts recognized as industry standards for the intended use, 2) military standard parts, 3) other parts commonly used and recognized by the aircraft industry, and 4) manufacturer's standard parts. The last alternative, which should be used only when parts from the preceding choices cannot meet the necessary performance, should be the design of a new part.

REQUIREMENT LESSONS LEARNED

Commonality with existing systems should be maintained wherever feasible. However, this requirement must be tempered with an objective assessment of that part's ability to meet the performance criteria of the overall system in the environment and its ability to perform the required mission tasks. For example, the C-5B oven's initial design was to be common with the C-5A. However, that design could only accommodate a meal size and type that was no longer available in military or commercial systems.

4.2.5.1.2 Verification of parts. The ability to use commercial components to replace failed or obsolete parts, the use of modularity in the design, the ability of the remainder of the ASWMS to function with parts or modules removed, and the use of standard parts shall be verified by _____.

VERIFICATION GUIDANCE (4.2.5.1.2)

These requirements can be verified through an inspection of the drawings and of the delivered items.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.5.1.2.1 Radii. All external edges formed by the meeting of two planes shall be rounded with a radius of no less than _____ inch. Internal corners formed by two planes shall also be rounded with a radius of no less than _____ inch. All external corners or protrusions formed by the meeting of three or more planes shall be rounded with a radius of no less than _____ inch. Internal corners formed by three or more planes shall also be rounded with a radius of no less than _____ inch.

REQUIREMENT RATIONALE (3.2.5.1.2.1)

Limitation on the radius of external corners is needed to remove personnel hazards (cuts, bruises, etc.) and equipment hazards (cut lines, abraded lines, tears, etc.). Internal corners need radii to prevent the accumulation of food waste (crumbs, spillage, etc.) and to permit more thorough cleaning and sanitization.

REQUIREMENT GUIDANCE

As a minimum, all sharp edges should be broken and free of burrs and irregularities.

The *SAE AS 1426* recommends a minimum spherical radius of 0.375 in. for internal corners (three or more planes) in all areas subject to food spillage (such as counters and food storage areas). This is to minimize the cleaning and sanitization effort required and the health hazard associated with unkept food particles.

Furthermore, the *SAE AS 1426* recommends external corners (two or more planes) have a radius (or spherical radius) of 0.25 in. minimum to reduce the hazard of personnel injury.

National Sanitation Foundation Standard 2, Descriptive Details – Food Service Equipment, provides detailed information on the use of radii in the design and construction of equipment to meet the applicable sanitary requirements.

REQUIREMENT LESSONS LEARNED

The weapons bay doors of an aircraft experienced multiple instances of equipment damage and the operators suffered numerous injuries due to sharp corners and protrusions (*AFLC/AML Lessons Learned Program #10734*).

4.2.5.1.2.1 Verification of radii. The use of radii on all corners and edges shall be verified by _____.

VERIFICATION GUIDANCE (4.2.5.1.2.1)

This requirement may be verified by an inspection of the drawings and of the delivered system.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.5.1.2.2 Retention and latches. All doors, drawers, compartments, removable components, modules, carts, insert equipment, folding and/or extending components, and/or bins shall have latches to prevent inadvertent opening or closing. This requirement shall be met throughout all (normal and/or emergency) aircraft motions, vibrations, shocks, and accelerations, with the device loaded to the maximum design limit. These latches shall be positive acting in both the opened and closed positions and shall operate without tools. There shall be a _____ (tactile, aural, or visual) indication of the latch holding the item in both positions. Latches or other retention devices shall be used for the _____ (item name) to hold it in the _____ (open/closed/extended/ etc.) position. When the size of an object, its anticipated path of travel, its location, or other circumstance of its design permit it to be a possible and immediate hazard to personnel, secondary latches or retention shall also be used.

REQUIREMENT RATIONALE (3.2.5.1.2.2)

The individual elements of the ASWMS must not create hazards to the user during use. To do so, they must not be permitted to open, close, or move about during aircraft motion due to maneuvers or environmental factors.

REQUIREMENT GUIDANCE

Retaining devices should be provided for every loose or movable item which by its motion could cause personal injury or impede an emergency evacuation.

The *SAE AS 1426* recommends the addition of secondary restraints for all carts, modules, containers, doors, drawers, folding equipment, or other insert or moveable item where the preceding conditions apply.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.5.1.2.2 Verification of retention and latches. The adequacy of the retention devices and systems design shall be verified by _____.

VERIFICATION GUIDANCE (4.2.5.1.2.2)

This requirement should be verified by test or demonstration. Heavier items which thereby contain more inertia, and containers which may spill and thereby increase operational hazards, should be tested to ensure the retainer can prevent the inadvertent motion of the items during the anticipated aircraft motions.

This requirement should be verified during environmental verification (4.2.6.11, Acceleration; 4.2.6.12, Vibration; 4.2.6.13, Acoustic noise; 4.2.6.14, Shock; 4.2.6.15, Gunfire) and by demonstration. Demonstration(s) should be performed as part of the full system demonstration of 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.5.1.2.3 Joints. All joints shall be smooth, even, and sealed to prevent entrapment or entrance of liquids, foodstuffs, or vermin. The surface color of joints shall blend with the adjoining surfaces. The surface of joints shall not be tacky or adhere to normal dirt and dust and shall be easily cleanable. The bottom edge of galleys and lavatories shall be sealed to prevent the entrance and accumulation of dirt, liquids, foodstuffs, or vermin under the unit.

REQUIREMENT RATIONALE (3.2.5.1.2.3)

Joints and seams between adjacent materials must be properly designed to ensure the ASWMS remains sanitary throughout its life.

REQUIREMENT GUIDANCE

National Sanitation Foundation Standard 2, *Descriptive Details – Food Service Equipment*, provides detailed information on the use of radii in the design and construction of equipment to meet the applicable sanitary requirements.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.5.1.2.3 Verification of joints. The joints' construction and performance shall be verified by _____.

VERIFICATION GUIDANCE (4.2.5.1.2.3)

This requirement may be verified by an inspection of the drawings and of the delivered system.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.5.1.2.4 Removable panels, doors, drawers, and work surfaces. All panels, doors, drawers, and work surfaces shall be flush to the adjoining surfaces when stowed or closed. They shall be retained in both the open and closed (or in use and stored) positions, shall be designed for misuse (e.g., personnel standing on drawers), and shall operate smoothly without binding when filled to their design load.

REQUIREMENT RATIONALE (3.2.5.1.2.4)

Portions of the ASWMS may be removable to permit access or to establish a temporary capability.

REQUIREMENT GUIDANCE

When these capabilities are not necessary for the specific design approach, this requirement should not be included in the specification.

REQUIREMENT LESSONS LEARNED

Items which require retention must do so in the environment to which they will be exposed during operations (*AFLC/AML Lessons Learned Program #11430*).

4.2.5.1.2.4 Verification of removable panels, doors, drawers, and work surfaces. The construction and performance of panels, doors, drawers, and work surfaces shall be verified by _____.

VERIFICATION GUIDANCE (4.2.5.1.2.4)

These requirements should be verified by demonstration and inspection. The demonstration portion of this verification should be conducted as an integral portion of the system demonstration of 4.1.

VERIFICATION LESSONS LEARNED

3.2.5.2 Spill control. Work surfaces and equipment shall be designed to capture accidental spills, condensation, overflows, or seal leakages. Overflow tubes and drip pans shall be used.

REQUIREMENT RATIONALE (3.2.5.2)

Spills onboard aircraft are a major source of hazards to equipment and personnel and therefore must be prevented by design.

REQUIREMENT GUIDANCE

This requirement should be included wherever liquids are handled or stored in the ASWMS design. All possible sources of spills of any liquid should be considered. This could include potable water, cooking grease and oil, lubricants, waste liquids, etc.

REQUIREMENT LESSONS LEARNED

During an early design review for a passenger galley, it was discovered that the "Igloo®" cooler for supplemental potable water for passengers was mounted without provisions to catch the drips and spills from the serving valve.

4.2.5.2 Verification of spill control. The ability of work surfaces and equipment to capture accidental spills, condensation, overflows, or to seal leakages shall be verified by _____.

VERIFICATION GUIDANCE (4.2.5.2)

This verification should be conducted as an integral portion of the demonstrations of 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.5.3 Lighting. All work surfaces and control panels shall have adequate illumination without glare. Lighting shall be designed for rapid replacement of lamps without tools and with retention of all fasteners and parts. Lighting fixtures shall be designed with a protective cover and shall not form shadows over work surfaces when user is in place. Fluorescent lighting ballast, if used, shall have built-in thermal protection. Lighting shall be as required by *AFGS-87240*.

REQUIREMENT RATIONALE (3.2.5.3)

Overhead lighting alone cannot be relied upon to provide adequate light for operations with the ASWMS equipment. Both the galley and lavatory-type equipment can present hazards to the user if inadequate lighting is provided.

REQUIREMENT GUIDANCE

The *SAE ARP 712* describes detailed design recommendations for galley lighting.

Recent research has demonstrated the red lighting previously and frequently required for night adaptation in military systems does not effectively increase a user's ability to see at night after exposure to interior lighting.

REQUIREMENT LESSONS LEARNED

One aircraft requires twelve different types of light bulbs at two different voltages for the instrumentation. The number of light bulbs should be minimized within the constraints of the human factors engineering requirements (*AFLC/AML Lessons Learned Program #232*).

4.2.5.3 Verification of lighting. The lighting at all work surfaces and control panels shall be verified by _____. The replacement of lighting shall be verified by _____. The ability to provide this light without shadows shall be verified by _____. Thermal protection for fluorescent lighting ballast shall be verified by _____.

VERIFICATION GUIDANCE (4.2.5.3)

The presence of adequate lighting without shadows and the replacement of light elements should be verified by demonstrations. The thermal protection of the lighting system elements should be verified by test.

The demonstration portions of this verification should be conducted as an integral portion of the full system demonstration of 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.5.3.1 Light fixture, emergency. The lavatory and all enclosed spaces shall have a ceiling-mounted emergency light that shall produce a minimum illumination of _____ footcandles on the floor and the door handle. The light shall automatically operate upon the following conditions: _____.

REQUIREMENT RATIONALE (3.2.5.3.1)

Enclosed spaces, such as lavatories, require emergency lighting to permit the occupant to perform his mission or to escape during a loss of electrical power to the normal space lighting.

REQUIREMENT GUIDANCE

This requirement should be written as recommended by *AFGS-87240*.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.5.3.1 Verification of lighting, emergency. The illumination magnitude at the required positions and the automatic operation shall be verified by _____.

VERIFICATION GUIDANCE (4.2.5.3.1)

This requirement should be verified as recommended by *AFGS-87240*.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.5.3.2 Light fixture, normal. Normal white lighting of a minimum illuminance of _____ footcandles shall be provided in the _____. The light switch for the normal light shall be _____ (a two-position hand switch, a variable intensity control, or an integrable part of the door lock system). If a part of the door lock system, it shall be wired to turn on when the door is locked. In either case, it shall be a two-pole switch. The normal lighting _____ (shall/shall not) be compatible with night vision systems, as described by _____.

REQUIREMENT RATIONALE (3.2.5.3.2)

Adequate lighting should be provided to permit the use of all ASWMS equipment under normal flight conditions.

REQUIREMENT GUIDANCE

This requirement should be written as recommended by *AFGS-87240*.

The *SAE AS 1426* recommends a minimum normal lighting level of 5 fc lighting at floor level, 10 fc at counter level, and 20 fc at control panels.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.5.3.2 Verification of light fixture, normal. The illuminance, location, and control of normal lighting shall be verified by _____.

VERIFICATION GUIDANCE (4.2.5.3.2)

This requirement should be verified as recommended by *AFGS-87240*.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.5.4 Electrical distribution. Electrical power systems shall be designed in accordance with requirement ___(a)___ of *MIL-STD-454*, shall be fully compatible with the aircraft electrical power system, and shall safely support the simultaneous maximum power operation of all equipment. The electrical power provided shall be as described in 3.6.1.3 and the electrical connections to the air vehicle shall be as described in 3.6.1.6.1. Insulation resistance shall be greater than ___(b)___ megaohms for the environmental conditions of section ___(b)___. The ASWMS assemblies shall be able to withstand, without damage or breakdown, a minimum of ___(c)___ applications, ___(c)___ minutes in duration, of ___(c)___ Volts ___(c)___ (alternating current/direct current) at ___(c)___ Hertz between parallel connected terminals and the case with a leakage of no more than ___(c)___ milliamperes. All non-conductive finishes shall be removed from both contact surfaces of materials in the electrical or ground path to ensure the continuity of the electrical bonding. Electrical equipment (such as motors, terminals, lights, etc.) shall be isolated and/or protected from lint, moisture, aerosol spray, soap, cleaning and sanitation agents, and other hazard sources. See 3.6.1.1 for electromagnetic and electrical interference requirements, 3.6.1.3 for electrical power requirements, and 3.6.1.6.1 for electrical connectors interface requirements.

REQUIREMENT RATIONALE (3.2.5.4)

Many of the devices used by and with the ASWMS will need electrical power to operate. The preceding requirements should be included to ensure the safe use of these devices despite the presence of conducting liquids.

REQUIREMENT GUIDANCE

In applications where more than one item with high power consumption requirements are installed in the ASWMS, but are not intended for concurrent operation, a selector switch in the distribution panel should be included. This switch would permit the use of one or the other item, but not their concurrent use.

a. This blank should be completed by listing the appropriate requirement numbers from *MIL-STD-454* for the system under development. The following is a sample of the types of requirements addressed. *Military Standard 454* must be referenced during requirement selection to ensure proper and complete specification.

Requirement Number	Title
1	Safety Design Criteria—Personnel Hazards
8	Electrical Overload Protection
9	Workmanship
25	Electrical Power
27	Batteries
28	Controls
37	Circuit Breakers
50	Indicator Lights
52	Thermal Design
55	Enclosures
58	Switches
62	Human Engineering
74	Grounding, Bonding and Shielding

Many other requirements are also contained in *MIL-STD-464* and may be pertinent to a specific design. Further tailoring of individual requirements may be accomplished by specifying particular paragraphs within a requirement.

b. The C-17 lavatory specification requires the electrical system provide 20 mΩ of insulation resistance at 500 ±50V DC for 1 min in all required environmental conditions.

c. The C-17 lavatory specification also requires the electrical system withstand ten 1-min applications of 1,250V AC at 60 or 400 Hz with a leakage less than 0.5 mA.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.5.4 Verification of electrical distribution. The capacity of the electrical power system and its compatibility with the aircraft electrical power system shall be verified by _____. The design of the electrical connections to the air vehicle shall be verified as described in 4.6.1.6.1. The insulation resistance shall be verified by measuring the resistance when exposed to _____ Volts DC for _____ minutes between all mutually isolated circuits. The ability of the ASWMS assemblies to withstand high voltages as required shall be verified by _____. The electrical grounding of the ASWMS shall be verified by _____. Protection of electrical equipment from sources of hazard shall be verified by _____.

VERIFICATION GUIDANCE (4.2.5.4)

Due to the potential for severe consequences if an electrical short circuit should develop, all these requirements should be verified by a test of the delivered product.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.5.4.1 Electrical control panels. A control panel for all ASWMS equipment shall be located near the systems it powers. It shall be located away from steam, condensate, and liquids. It shall contain all power switches, warning lights, indicators, resetable circuit breakers, and timers. It shall also contain a master circuit breaker for all equipment controlled from this panel. The ASWMS compartments' light switches and utility outlet circuit breakers shall also be contained herein. All controls shall be prominently marked to indicate the purpose of the control, the range of controls, and the device powered or controlled. As a goal, there shall be a single master control panel. If not readily visible to any occupants, a placard shall be used to indicate the location of the hidden control panel(s).

REQUIREMENT RATIONALE (3.2.5.4.1)

A control panel provides a centralized position for all equipment controls, prevents their inadvertent operation, and protects them from the liquids used in operation of the ASWMS.

REQUIREMENT GUIDANCE

On the C-135, the control panel contained: one two-position main power switch, two timers for food warming cups, two on/off indicator lights for the food warming cups, one two-position switch for the work surface lights, circuit breakers for each item of insert equipment, one two-position switch for the coffeemaker, and two two-position switches for the ovens.

REQUIREMENT LESSONS LEARNED

Fuses for equipment that frequently blows fuses need to be readily accessible. One piece of support equipment that had fuses to protect motors when the item jammed required the removal of twenty bolts for access. Since this item jammed frequently, there was considerable wear on these bolts (*AFLC/AML Lessons Learned Program #10976*).

4.2.5.4.1 Verification of electrical control panels. The location, function, controls, and indicators of the control panel for the ASWMS equipment shall be verified by _____.

VERIFICATION GUIDANCE (4.2.5.4.1)

These requirements should be verified by a demonstration and test. The demonstration portion of these verifications should be conducted as an integral portion of the full system demonstration of 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.5.4.2 Electrical utility outlets. A placard shall be mounted near each outlet that identifies its specific usage, voltage, and current capability. Galley preparation areas and lavatory utility outlets shall each have an integral, self-testing circuit breaker set at the outlet's rated amperage. All 60 Hz, 120V AC electrical outlets shall be three-prong grounded outlets with ground fault isolation. Utility outlets shall be positioned to minimize hazards due to accidental spills during all normal and emergency operations at the work site. Outlets at the _____ shall provide _____ Hertz power at _____ Volts AC and _____ amperes current.

REQUIREMENT RATIONALE (3.2.5.4.2)

Utility outlets are needed with galley equipment to permit the use of sustenance preparation equipment and in the lavatory spaces to permit the use of shaving and grooming aids.

REQUIREMENT GUIDANCE

Unless specially designed equipment is intended, these utility outlets should provide 60 Hz, 120V AC electrical power at a current capacity above that required by most commercial household appliances. Any outlets with frequency, voltage, or current capacities outside this range should utilize a plug design that will not accept the common household appliance two- or three-prong plug. Outlets should incorporate integral ground fault circuit interrupts, especially when near potentially conductive fluids.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.5.4.2 Verification of electrical utility outlets. The placard at each outlet and the location and design of all electrical outlets shall be verified by _____. The operation of the self-testing circuit breaker at each utility outlet shall be verified by _____.

VERIFICATION GUIDANCE (4.2.5.4.2)

The placard location and design of all outlets should be verified by inspection of the drawings and of the delivered products. The circuit breakers should be verified by test.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.5.4.3 Electrical power wiring. All wiring shall be identified in accordance with ____(a)____. Wire sizes shall be selected in accordance with ____(b)____. All electrical equipment shall be designed to prevent the entrance of moisture, soap, or cleaning and sanitization agents. A placard shall be included in all compartments and major assemblies to show and identify all internal wiring and terminals. Wiring to connectors mounted on the aircraft structures shall contain sufficient length to ensure there are no loads imparted to the connector. Wiring bundles shall be constructed to prevent the crewmembers or passengers from stepping on them or using them as hand holds.

REQUIREMENT RATIONALE (3.2.5.4.3)

The electrical wiring for the ASWMS must have adequate capacity to carry power for the equipment it is designed to power.

REQUIREMENT GUIDANCE

a. Wires may be identified by color coding, stripes, labels, or other acceptable device, provided the identifier is repeated at frequent intervals along the length of the wire to permit identification at any point. Wire identification and routing placards are necessary for the troubleshooting and maintenance of units. The C-17 lavatory specification requires the electrical wiring to be identified in accordance with *MIL-W-5088*.

b. Wire sizes must be selected to ensure the current carrying capability of the conductor is not exceeded. The minimum wiring size necessary to carry the load safely should be used for all circuits. The C-17 lavatory specified a minimum AWG No. 20.

REQUIREMENT LESSONS LEARNED

Dummy receptacles should be provided to stow and protect electrical connectors when not in use. In an aircraft where this was not done, a shock hazard for personnel and equipment developed when wear and damage was produced on an improperly stowed connector (*AFLC/AML Lessons Learned Program #11075*).

4.2.5.4.3 Verification of electrical power wiring. The wiring type, size, insulation, and bundles; the routing placard in each compartment and on major assemblies; and the length of the wiring to the aircraft connections shall be verified by _____.

VERIFICATION GUIDANCE (4.2.5.4.3)

These requirements should be verified by an inspection of the drawings and of the delivered product.

VERIFICATION LESSONS LEARNED

3.2.5.5 Noise effects on personnel. The ASWMS shall not produce hazardous noise levels (as defined in *AFR 161-35* and *MIL-STD-1789*) or noise levels which result in the degradation of operator performance. The ASWMS shall not produce any drumming or rattling of components, equipment, or parts. Worst-case ASWMS noise and ambient aircraft noise shall be considered in an integrated fashion in accordance with the requirements of *AFR 161-35*, *MIL-STD-1789*, or _____.

REQUIREMENT RATIONALE (3.2.5.5)

The intent of this requirement is to protect operators from long-term hearing damage and to prevent performance degradation.

REQUIREMENTS GUIDANCE

Typically, *MIL-STD-1789* should be invoked for aircraft acquisition or modification programs. This standard provides a maximum allowable daily noise exposure (called Total Daily Exposure) for each crewmember, based upon the mission length and overall noise levels for each mission segment (e.g., cruise, take-off, etc.). *Military Standard 1789* is normally tailored to consider the additional noise that results from the use of mission equipment such as the ASWMS and also to consider any special communications or performance requirements which could be negatively influenced by the presence of noise. Therefore, it is important to coordinate with the REO for *MIL-STD-1789* (ASC/ENECS, WPAFB OH 45433-6503) to ensure all appropriate ASWMS noise is considered in the analyses and verifications required by that document.

If the program does not use *MIL-STD-1789* or if special considerations require the use of a different approach, the requirement should be tailored using *AFR-161-35* and *MIL-STD-1789* as guides. The overriding concern in all cases should be the protection of operator hearing and the prevention of user performance degradation.

Detailed requirements may not be cost effective in cases where the overall noise levels are very low (e.g., 75 dB(A)). In such cases, a single, overall A-weighted measure may be used. The REO for *MIL-STD-1789* has personnel trained in the application and tailoring of these requirements.

4.2.5.5 Verification of noise effects on personnel. Verification of acoustical noise levels shall be in accordance with the requirements of *MIL-STD-1789* or _____.

VERIFICATION GUIDANCE (4.2.5.5)

The verification requirements of *MIL-STD-1789* reflect the current ANSI standard requirements for calibration, microphone placement, recording techniques, etc. *Military Standard 1789* also reflects the standard for data required in terms of frequency range, band frequencies, etc. These requirements can be tailored to allow for special circumstances (e.g., use of non-standard frequency meters). However, use of the standard methods will facilitate comparative analysis and will provide a database for future programs. If these requirements cannot be used, tailor the requirement as necessary. Also, for the verification of very low overall noise levels, the use of a hand-held sound meter may be acceptable. Assistance in tailoring the verification can be obtained from the REO listed above.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.5.6 Structural integrity. All structural elements of the ASWMS shall have sufficient strength, rigidity, and durability to resist the accelerations (inertia loads) defined herein without permanent deformations, loss of rigidity, or loss of proper structural functioning for the specified usage of _____. In addition, all elements of the ASWMS and all load paths to the primary aircraft structure shall have sufficient strength and stiffness to withstand the crash loads specified herein without failure so injury to crewmembers or passengers is prevented. All elements of the ASWMS shall be designed so their installation does not create unintentional load paths which would cause these elements to react or transmit primary structural loads, and does not degrade the structural integrity of primary structural members to which they are attached.

REQUIREMENT RATIONALE (3.2.5.6)

The structural integrity of the ASWMS needs to be ensured.

REQUIREMENT GUIDANCE

Primary structural integrity requirements for the flight portions of the ASWMS service life are developed by the aircraft structural integrity engineers as part of aircraft flight and ground loads. Equipment duty cycles, personnel requirements (numbers, locations, tasks, etc.), and contents (tools, utensils, consumables, etc.) are combined with basic aircraft loads to produce ASWMS structural requirements. Ground handling and transportation requirements are developed based on scenarios provided by ground handling and logistics engineers. Complete and accurate specification of the duty cycles, personnel, contents, ground handling, and transportation requirements is necessary to develop correct requirements.

The C-17 galley and lavatory specifications and the C-135 galley specification used the following load factors. The C-17 lavatory specification also requires a dwell time of 3 sec at each acceleration.

The C-135 galley was designed to withstand the above accelerations when fully loaded including all inserts, foods, liquids, utensils, and other incidentals. However, during the development of the KC-135, the load factor was increased to 16 G's (direction unspecified).

The C-5 troop compartment galley had a design limit and ultimate load with a 170-lb occupant using the facility, and an ultimate load factor without an occupant as described in table VI. Loads were to be calculated with the holding tank within 1.5 in. of being full. Lateral loads were to be combined with a 1.5 G's downward acceleration.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.5.6 Verification of structural integrity. The structural integrity of the ___(a)___ secondary aircraft structure elements of the ASWMS shall be verified by ___(a)___. The structural integrity of the remaining elements shall be verified by ___(b)___.

VERIFICATION GUIDANCE (4.2.5.6)

Methods to ensure structural integrity include analysis, test, demonstration, and comparisons based upon similarity to other equipment already approved for similar applications with very similar usage. Verification of crash load capabilities is normally done by analysis.

The structural integrity and environmental acceleration verifications (4.2.6.11) overlap. In general, larger assemblies will be verified by analysis and static test; smaller items will be verified by centrifuge test.

a. Elements of the ASWMS which are large enough to be considered secondary aircraft structures should be identified in the first blank and appropriate verification methods identified in the second blank. Such elements' structural integrity is normally verified by analysis, test, or demonstration.

b. The remaining elements would normally be considered to be installed equipment and would be verified by appropriate test, demonstration, or similarity.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

TABLE V. C-17 and C-135 load factors.

Direction Applied	C-17 Galley and Lavatory Acceleration Load in G's	C-135 Galley Acceleration Load in G's
Aft	2.25	—
Forward	3.00	12
Left and Right	3.75	2
Up	3.45	2
Down	8.25	6.5

TABLE VI. C-5 troop compartment galley design and ultimate loads.

Direction of Load	With Occupant		Without Occupant
	Design Limit Load (G's)	Design Ultimate Load (G's)	Design Ultimate Load (G's)
Forward	0.8	—	9.0
Aft	1.0	—	1.5
Down	—	5.28	—
Up	1.52	—	2.28
Lateral	—	±1.95	—

3.2.6 Environmental requirements. The ASWMS shall be designed to withstand, without degradation, exposure to the natural and induced environments of an equipment life cycle. The equipment life cycle shall be ____(a)____. In addition, the ASWMS shall be designed to operate as specified herein while exposed to the life cycle environments of ____(b)____. The guidance contained in *MIL-STD-210* and *MIL-STD-810* shall be utilized in this effort.

REQUIREMENT RATIONALE (3.2.6)

Equipment should be designed to endure and function as needed in all of the environments encountered during a life cycle.

REQUIREMENT GUIDANCE

The ASWMS and its equipment should withstand exposures to all extremes of both natural and induced environments anticipated during its life cycle. This should include environmental exposures under both normal and emergency operations of the air vehicle, as well as other operational activities (i.e., loading, storage, etc.).

The first step in the process of environmental design is to define the environmental life cycle including duty cycles and duty cycle environments. This includes all phases of the life cycle including but not limited to manufacturing and production (including Environmental Stress Screening), transportation, handling, storage, maintenance, and operational use.

The ASWMS should withstand exposure to storage environments without damage to its equipment while in a ready-for-stowage condition. This includes the drainage of liquid systems and the use of environmental covers or weather covers. When returned to an operating environment, the equipment must meet all performance requirements.

a. Insert the definition of the environmental life cycle for the ASWMS. The life cycle definition should be broken down to ASWMS elements and sub-elements, as required.

b. Insert the ASWMS equipment duty cycles as related to the environmental life cycle. Further guidance is contained in *MIL-STD-810*, paragraph 4 and subparagraphs.

REQUIREMENT LESSONS LEARNED

The environmental requirements in many past programs consisted of "standard tests" and/or did not consider all phases of the life cycle. Thus, environmental requirements were sometimes too harsh and other times not as severe as the actual environments. This resulted in added testing, premature failures, functional degradation, and excessive weight. Examples are:

a. A fuel bladder passed standard slosh and vibration tests. After transportation, the bladder developed leaks. Investigation showed that shipping truck vibration caused the problem.

b. An aircraft external store was tested to an avionics box shock requirement. A shipping container was designed based on the peak acceleration level of the shock test (15 G's). The combined store/container system could not be certified for use because the 15-G avionics box shock cannot be rationally related to shipping container shock.

4.2.6 Verification of environmental requirements. Verification that the ASWMS will withstand without degradation and will operate during exposure to the environments of an equipment life cycle shall be accomplished by a combination of environmental measurement, analysis, and test. Analyses and/or tests shall be conducted to account for simultaneous application of environmental stresses (e.g., simultaneous application of vibration, temperature, and humidity). Test methods shall be tailored with regard to equipment size and configuration as well as environmental exposure. Wherever analysis data are not available to define environments adequately, direct measurement of the environment(s) must be accomplished.

VERIFICATION RATIONALE (4.2.6)

Verification that equipment will endure the environmental life cycle and function as required is necessary.

VERIFICATION GUIDANCE

Verification that equipment will endure the environmental life cycle and function as required should be accomplished by a coordinated program of analysis, test, and environmental measurements. The synergistic effects of all combinations of anticipated design environments must be accounted for. Test and analysis methods must be applied to the appropriate hardware level; i.e., a large galley unit should be treated as aircraft structure whereas a small microwave oven should be treated as an item of installed equipment.

The technical requirements of the specification should be matched by planning, scheduling, reporting, and other managerial requirements in the statement of work for the contract or effort.

Further guidance is contained in *MIL-STD-810*, paragraph 4 and subparagraphs.

VERIFICATION LESSONS LEARNED

Verification of equipment performance in life cycle environments should be accomplished in a coordinated program tailored to the specific applications and environments of the item being developed. Examples of problems encountered due to the application of "standard" environmental verification requirements are:

a. A laser designator pod was tested to outdated sinusoidal vibration intended for avionics boxes. The pod failed and was redesigned to pass the test. Flight performance was severely reduced by the redesign. Several years and much effort were required to bring performance back to near the level of the original design. It appears the original design would have passed a realistic, tailored test.

b. A galley was tested to a shock requirement intended for avionics boxes. The test rig was a railroad car with the galley aboard run against a barricade. The barricade had to be developed by trial and error to give the required shock pulse. The galley should have been designed as acceleration (load factor) loaded structure and not shock tested.

3.2.6.1 Environmental stress screening (ESS). The ASWMS shall be designed to withstand, without degradation, exposure to the combination of ESS environmental stresses and the environments of an equipment life cycle. The equipment shall be exposed to ____(a)____ ESS cycles defined as follows: ____(b)____.

REQUIREMENT RATIONALE (3.2.6.1)

Environmental Stress Screening exposures are typically assumed not to consume production item life. This assumption is generally incorrect. Environmental Stress Screening can consume large portions of equipment life. Therefore, ESS exposures are part of the equipment environmental life cycle.

REQUIREMENT GUIDANCE

a. Enter the maximum number of ESS cycles an item can be exposed to before it is rejected as not meeting production and/or maintenance standards.

b. The ESS cycle should be defined in this blank. Typically, this would be done by reference to an ESS production acceptance procedure.

REQUIREMENT LESSONS LEARNED

Several instances have occurred where avionics boxes have been subjected to numerous ESS cycles before production acceptance requirements were met. At this point, environmental specialists were asked to determine whether significant life had been consumed. It was likely that the item had sustained significant damage and might be worn out. Further, this same result may occur from subjecting the item to the minimum ESS cycle. Equipment should be designed for ESS in addition to the rest of the environmental life cycle.

4.2.6.1 Verification of environmental stress screening (ESS). The ASWMS environmental analysis and test process shall include ESS environmental stresses. Further, exposure to maximum ESS stress level(s) and duration(s) shall be the initial element of all environmental verification tests.

VERIFICATION RATIONALE (4.2.6.1)

Environmental Stress Screening exposures may consume a significant part of equipment life. Thus, ESS exposure should be included in environmental life verifications.

VERIFICATION GUIDANCE

Environmental Stress Screening exposure occurs before other portions of the equipment life cycle. Therefore, it should be applied to test hardware before other environmental tests are conducted.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.6.2 Low pressure (altitude). The ASWMS shall be designed to withstand, without degradation, exposure to the following low pressure environments of an equipment life cycle: ___(a)___. The ASWMS shall be designed to operate as specified herein during exposure to the following low pressure environments of an equipment life cycle: ___(b)___. The ASWMS shall withstand, without failure, an explosive decompression of ___(c)___.

REQUIREMENT RATIONALE (3.2.6.2)

Equipment must be designed to endure without degradation and operate as specified herein in the low pressure environments of a life cycle.

REQUIREMENT GUIDANCE

The C-17 lavatory is required to function at altitudes from -1,800 to 50,000 ft. The C-5 troop compartment toilet was required to withstand atmospheric pressures from 1,300 ft below sea level to 50,000 ft above sea level. The *SAE AS 1426* for commercial galleys recommends galleys operate at 8,000 ft to sea level after exposure to 40,000 to -1,000 ft.

Additional guidance is contained in *MIL-STD-810*, Method 500.

a. Insert a quantifiable and measurable definition of the life cycle low pressure environments which the ASWMS must experience without performance degradation. Although the ASWMS need not operate as required during this exposure, it must be able to meet all performance requirements after the exposure is completed.

b. Insert a quantifiable and measurable definition of the life cycle low pressure environments in which the ASWMS must operate as required.

c. The explosive decompression requirement is frequently given in terms of the initial and final cabin altitude and the time required to stabilize at the new altitude. For the C-17 galley and lavatory structures, doors, hinges, and latches, the requirement is to begin at 10,000 ft (20.58 inHg) cabin altitude and to lose pressure to 50,000 ft (3.425 inHg) in 15 sec and hold for it there for 15 min. There should be no degradation in performance when it is returned to 10,000 ft cabin altitude.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.6.2 Verification of low pressure (altitude). Verification that the ASWMS will withstand without degradation and operate during exposure to the low pressure environments of an equipment life cycle shall be accomplished by ___(a)___. Verification shall be accomplished as follows: ___(b)___.

VERIFICATION GUIDANCE (4.2.6.2)

Additional guidance is contained in *MIL-STD-810*, Method 500.

a. Verification that the equipment will endure the environmental life cycle and function as required should be accomplished by analysis, test, and environmental measurement. The synergism of combined environments should be accounted for. Test and analysis methods should be appropriate to the hardware.

b. Describe in quantifiable detail the critical parameters and evaluation criteria for the analysis, test, and measurements required for verification.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.6.3 Temperature. The ASWMS shall be designed to withstand, without degradation, exposure to the following temperature environments of an equipment life cycle: ___(a)___. The ASWMS shall be designed to operate as specified herein while exposed to the following temperature environments of an equipment life cycle: ___(b)___.

REQUIREMENT RATIONALE (3.2.6.3)

Equipment should be designed to endure the temperature environments of a life cycle without degradation or loss of function.

REQUIREMENT GUIDANCE

Previously, these requirements were frequently given in terms of the maximum storage and operating temperatures. Aircraft interior temperatures of 125°F have been measured in desert climates in the continental US. In Saudi Arabia, these temperatures have been as high as 200°F. The C-17 galley has a requirement for a flat "working range" of +55 through +113°F with extremes of -45 and +165°F. The C-17 lavatory is required to meet its performance requirements following an exposure of -65 to 160°F and to operate during an exposure to -40 to 120°F. The C-135 galley was required to operate and withstand temperatures from -60 to 100°F. It also had a requirement that all gaskets would not take a permanent set and would not deteriorate from exposures to temperatures from -40 to 140°F. The C-5 troop compartment toilet was required to operate in a temperature environment of 35 to 160°F, and to withstand "short term" exposures when empty and not operating of -80 to 185°F. The *SAE AS 1426* for commercial galleys recommends an environmental exposure of +5 to +131°F. They further recommend 35 to 100°F at the water supply connection during tank filling operations.

Additional guidance is contained in *MIL-STD-810*, Methods 501, 502, and 503.

a. Insert a quantifiable and measurable definition of the life cycle temperature environments that the ASWMS must experience without performance degradation. Although the ASWMS need not operate as required during this exposure, it must be able to meet all performance requirements after the exposure is completed.

b. Insert a quantifiable and measurable definition of the life cycle temperature environments in which the ASWMS must operate.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.6.3 Verification of temperature. Verification that the ASWMS will withstand without degradation and operate during exposure to the temperature environments of an equipment life cycle shall be accomplished by ___(a)___. Verification shall be accomplished as follows: ___(b)___.

VERIFICATION GUIDANCE (4.2.6.3)

Additional guidance is contained in *MIL-STD-810*, Methods 501, 502, and 503.

a. Verification that equipment will endure the environmental life cycle and function as required should be accomplished by analysis, test, and environmental measurement. The synergism of combined environments should be accounted for. Test and analysis methods should be appropriate to the hardware size and configuration.

b. Describe in quantifiable terms the critical parameters and evaluation criteria of the analyses, tests, and/or measurements required for verification.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.6.4 Solar radiation. The ASWMS shall be designed to withstand, without degradation, exposure to the following solar radiation environments of an equipment life cycle: ____(a)____. The ASWMS shall be designed to operate as specified herein while exposed to the following solar radiation environments of an equipment life cycle: ____(b)____.

REQUIREMENT RATIONALE (3.2.6.4)

Equipment should be designed to endure without degradation and function in the solar radiation environments of a life cycle.

REQUIREMENT GUIDANCE

Additional guidance is contained in MIL-STD-810, Method 505.

a. Insert a quantifiable and measurable definition of the life cycle solar radiation environments that the ASWMS must experience without performance degradation. Although the ASWMS need not operate as required during this exposure, it must be able to meet all performance requirements after the exposure is completed.

b. Insert a quantifiable and measurable definition of the life cycle solar radiation environments in which the ASWMS must operate.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.6.4 Verification of solar radiation. Verification that the ASWMS will withstand without degradation and operate during exposure to the solar radiation environments of an equipment life cycle shall be accomplished by ____(a)____. Verification shall be accomplished as follows: ____(b)____.

VERIFICATION GUIDANCE (4.2.6.4)

Additional guidance is contained in *MIL-STD-810*, Method 505.

a. Verification that equipment will endure the environmental life cycle and function as required should be accomplished by analysis, test, and environmental measurement. The synergism of combined environments should be accounted for. Test and analysis methods should be appropriate to the hardware size and configuration.

b. Describe in quantifiable terms the critical parameters and evaluation criteria of the analyses, tests, and/or measurements required for verification.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.6.5 Rain. The ASWMS shall be designed to withstand, without degradation, exposure to the following rain environments of an equipment life cycle: ___(a)___. The ASWMS shall be designed to operate as specified herein while exposed to the following rain environments of an equipment life cycle: ___(b)___.

REQUIREMENT RATIONALE (3.2.6.5)

Equipment should be designed to endure without degradation and function in the rain environments of a life cycle.

REQUIREMENT GUIDANCE

These values are frequently given in terms of drop size, flow rate, and wind speed and direction.

Additional guidance is contained in *MIL-STD-810*, Method 506.

a. Insert a quantifiable and measurable *definition of the life cycle rain environments* that the ASWMS must experience without performance degradation. Although the ASWMS need not operate as required during this exposure, it must be able to meet all performance requirements after the exposure is completed.

b. Insert a quantifiable and measurable definition of the life cycle rain environments in which the ASWMS must operate.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.6.5 Verification of rain. Verification that the ASWMS will withstand without degradation and operate during exposure to the rain environments of an equipment life cycle shall be accomplished by ___(a)___. Verification shall be accomplished as follows: ___(b)___.

VERIFICATION GUIDANCE (4.2.6.5)

Additional guidance is contained in *MIL-STD-810*, Method 506.

a. Verification that equipment will endure the environmental life cycle and function as required should be accomplished by analysis, test, and environmental measurement. The synergism of combined environments should be accounted for. Test and analysis methods should be appropriate to the hardware size and configuration.

b. Describe in quantifiable terms the critical *parameters and evaluation criteria of the* analyses, tests, and/or measurements required for verification.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.6.6 Humidity. The ASWMS shall be designed to withstand, without degradation, exposure to the following humidity environments of an equipment life cycle: ____(a)____. The ASWMS shall be designed to operate as specified herein while exposed to the following humidity environments of an equipment life cycle: ____(b)____.

REQUIREMENT RATIONALE (3.2.6.6)

Equipment should be designed to endure without degradation and function in the humidity environments of a life cycle.

REQUIREMENT GUIDANCE

These values are frequently given in terms of a percent humidity at a temperature. The C-17 lavatory is required to meet its performance requirements during and after an exposure to 100 percent humidity, including periodic condensation at 68 to 149°F without degradation of material or performance. The *SAE AS 1426* for commercial galleys recommends the operating environmental requirement be met after an exposure to 0 to 100 percent humidity with condensation formation within a temperature of -67 to +185°F and 40,000 to -1,000 ft altitude.

Additional guidance is contained in *MIL-STD-810*, Method 507.

a. Insert a quantifiable and measurable definition of the life cycle humidity environments that the ASWMS must experience without performance degradation. Although the ASWMS need not operate as required during this exposure, it must be able to meet all performance requirements after the exposure is completed.

b. Insert a quantifiable and measurable definition of the life cycle solar radiation environments in which the ASWMS must operate.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.6.6 Verification of humidity. Verification that the ASWMS will withstand without degradation and operate during exposure to the humidity environments of an equipment life cycle shall be accomplished by ____(a)____. Verification shall be accomplished as follows: ____(b)____.

VERIFICATION GUIDANCE (4.2.6.6)

Additional guidance is contained in *MIL-STD-810*, Method 507.

a. Verification that equipment will endure the environmental life cycle and function as required should be accomplished by analysis, test, and environmental measurement. The synergism of combined environments should be accounted for. Test and analysis methods should be appropriate to the hardware size and configuration.

b. Describe in quantifiable terms the critical parameters and evaluation criteria of the analyses, tests, and/or measurements required for verification.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.6.7 Fungus. The ASWMS shall be designed to withstand, without degradation, exposure to the following fungus environments of an equipment life cycle: ___(a)___. The ASWMS shall be designed to operate as specified herein while exposed to the following fungus environments of an equipment life cycle: ___(b)___.

REQUIREMENT RATIONALE (3.2.6.7)

Equipment should be designed to endure without degradation and function in the fungus environments of a life cycle.

REQUIREMENT GUIDANCE

Additional guidance is contained in *MIL-STD-810*, Method 508.

a. Insert a quantifiable and measurable definition of the life cycle fungus environments that the ASWMS must experience without performance degradation. Although the ASWMS need not operate as required during this exposure, it must be able to meet all performance requirements after the exposure is completed.

b. Insert a quantifiable and measurable definition of the life cycle fungus environments in which the ASWMS must operate.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.6.7 Verification of fungus. Verification that the ASWMS will withstand without degradation and operate during exposure to the fungus environments of an equipment life cycle shall be accomplished by ___(a)___. Verification shall be accomplished as follows: ___(b)___.

VERIFICATION GUIDANCE (4.2.6.7)

Additional guidance is contained in *MIL-STD-810*, Method 508.

a. Verification that equipment will endure the environmental life cycle and function as required should be accomplished by analysis, test, and environmental measurement. The synergism of combined environments should be accounted for. Test and analysis methods should be appropriate to the hardware size and configuration.

b. Describe in quantifiable terms the critical parameters and evaluation criteria of the analyses, tests, and/or measurements required for verification.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.6.8 Salt fog. The ASWMS shall be designed to withstand, without degradation, exposure to the following salt fog environments of an equipment life cycle: ___(a)___. The ASWMS shall be designed to operate as specified herein while exposed to the following salt fog environments of an equipment life cycle: ___(b)___.

REQUIREMENT RATIONALE (3.2.6.8)

Equipment should be designed to endure without degradation and function in the salt fog environments of a life cycle.

REQUIREMENT GUIDANCE

These terms usually define the percent saline solution, drop size, flow rate, and time from exposure to examination. The C-17 lavatory requires exposure to a salt concentration of 5 percent at temperature of 95°F for 48 hr. The C-5 troop compartment toilet was required to "withstand the salt-sea atmosphere as encountered along coastal regions".

Additional guidance is contained in *MIL-STD-810*, Method 509.

a. Insert a quantifiable and measurable definition of the life cycle salt fog environments that the ASWMS must experience without performance degradation. Although the ASWMS need not operate as required during this exposure, it must be able to meet all performance requirements after the exposure is completed.

b. Insert a quantifiable and measurable definition of the life cycle salt fog environments in which the ASWMS must operate.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.6.8 Verification of salt fog. Verification that the ASWMS will withstand without degradation and operate during exposure to the salt fog environments of an equipment life cycle shall be accomplished by ___(a)___. Verification shall be accomplished as follows: ___(b)___.

VERIFICATION GUIDANCE (4.2.6.8)

Additional guidance is contained in *MIL-STD-810*, Method 509.

a. Verification that equipment will endure the environmental life cycle and function as required should be accomplished by analysis, test, and environmental measurement. The synergism of combined environments should be accounted for. Test and analysis methods should be appropriate to the hardware size and configuration.

b. Describe in quantifiable terms the critical parameters and evaluation criteria of the analyses, tests, and/or measurements required for verification.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.6.9 Sand and dust. The ASWMS shall be designed to withstand, without degradation, exposure to the following sand and dust environments of an equipment life cycle: ___(a)___. The ASWMS shall be designed to operate as specified herein while exposed to the following sand and dust environments of an equipment life cycle: ___(b)___.

REQUIREMENT RATIONALE (3.2.6.9)

Equipment should be designed to endure without degradation and function in the sand and dust environments of a life cycle.

REQUIREMENT GUIDANCE

The C-17 has a requirement that the lavatory shall operate as required after the following exposure: wind velocity 300 to 1750 ft/min, concentration 0.1 to 0.5 gram/cu ft, grain size 100 to 325 mesh screen. composition 97 to 99 percent S_iO_2, and temperature 73°F for 6 hr and 145°F for 22 hr.

Additional guidance is contained in *MIL-STD-810*, Method 510.

a. Insert a quantifiable and measurable definition of the life cycle sand and dust environments that the ASWMS must experience without performance degradation. Although the ASWMS need not operate as required during this exposure, it must be able to meet all performance requirements after the exposure is completed.

b. Insert a quantifiable and measurable definition of the life cycle sand and dust environments in which the ASWMS must operate.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.6.9 Verification of sand and dust. Verification that the ASWMS will withstand without degradation and operate during exposure to the sand and dust environments of an equipment life cycle shall be accomplished by ___(a)___. Verification shall be accomplished as follows: ___(b)___.

VERIFICATION GUIDANCE (4.2.6.9)

Additional guidance is contained in *MIL-STD-810*, Method 510.

a. Verification that equipment will endure the environmental life cycle and function as required should be accomplished by analysis, test, and environmental measurement. The synergism of combined environments should be accounted for. Test and analysis methods should be appropriate to the hardware size and configuration.

b. Describe in quantifiable terms the critical parameters and evaluation criteria of the analyses, tests, and/or measurements required for verification.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.6.10 Explosive atmosphere. The ASWMS shall safely operate during exposure to a ___(a)___ explosive atmosphere environment during an equipment life cycle. The ASWMS shall ___(b)___ (contain/prevent) ignition during operation in this environment.

REQUIREMENT RATIONALE (3.2.6.10)

Equipment should be designed to function in the explosive atmosphere environments anticipated to exist during the operating phases of its life cycle.

REQUIREMENT GUIDANCE

Method 511 of *MIL-STD-810* contains some discussion on the operation of equipment in an explosive atmosphere.

a. An analysis should be conducted to determine those environments of the equipment's life cycle which may contain a flammable fuel/air mixture and to determine the ignition sources present in the equipment at those times. Consideration should be given to all fluids and gases which may be present in the aircraft: air vehicle generated, ASWMS operation or use generated, other fluids carried onboard the aircraft, medical fluids, etc.

b. The two major methods of explosive atmosphere protection are the prevention of ignition of the atmosphere by ensuring the separation of the fuel/air mixture and the ignition source, and the prevention of the propagation of the ignition by containing any ignition within the item.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.6.10 Verification of explosive atmosphere. Verification that the ASWMS will withstand without degradation and operate during exposure to the explosive atmosphere environments of an equipment life cycle shall be accomplished by ___(a)___. Verification shall be accomplished as follows: ___(b)___.

VERIFICATION GUIDANCE (4.2.6.10)

Additional guidance is contained in *MIL-STD-810*, Method 511.

a. Verification that equipment will endure the environmental life cycle and function as required should be accomplished by analysis, test, and environmental measurement. The synergism of combined environments should be accounted for. Test and analysis methods should be appropriate to the hardware size and configuration.

b. Describe in quantifiable terms the critical parameters and evaluation criteria of the analyses, tests, and/or measurements required for verification.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.6.11 Acceleration. The ASWMS shall be designed to withstand, without degradation, exposure to the following acceleration environments of an equipment life cycle: ____(a)____. The ASWMS shall be designed to operate as specified herein while exposed to the following acceleration environments of an equipment life cycle: ____(b)____.

REQUIREMENT RATIONALE (3.2.6.11)

Equipment should be designed to endure without degradation and function in the acceleration environments of a life cycle.

REQUIREMENT GUIDANCE

Acceleration requirements are given in G (acceleration divided by the acceleration of gravity) units of sustained acceleration. These represent aircraft maneuver load factors and survivable crash conditions and are typically broken down into components along the three primary axes of the aircraft. For highly maneuverable aircraft, rotational accelerations about these axes may also be specified.

Acceleration requirements are developed by aircraft structural engineers as part of the structural integrity effort (3.2.5.6).

Additional guidance is contained in *MIL-STD-810*, Method 513.

a. Insert a quantifiable and measurable definition of the life cycle acceleration environments that the ASWMS must experience without performance degradation. Although the ASWMS need not operate as required during this exposure, it must be able to meet all performance requirements after the exposure is completed.

b. Insert a quantifiable and measurable definition of the life cycle acceleration environments in which the ASWMS must operate.

REQUIREMENT LESSONS LEARNED

Acceleration—a slowly applied and sustained acceleration, and shock—a rapidly applied and relieved acceleration, are often confused. They are not equivalent. Shock excites a transient vibration of the dynamic modes of the item. Acceleration applies a fully distributed static load to the item. Design and verification for these environmental factors are independent.

4.2.6.11 Verification of acceleration. Verification that the ASWMS will withstand without degradation and operate during exposure to the acceleration environments of an equipment life cycle shall be accomplished by ____(a)____. Verification shall be accomplished as follows: ____(b)____.

VERIFICATION GUIDANCE (4.2.6.11)

For items which are structurally simple or contain no electronics or highly complex mechanical devices, verification is usually by static load test or stress analysis. Some complex mechanical devices (e.g., a hydraulic actuator) are not sensitive to acceleration on the detail level and can be verified in this way.

Highly complex items are not amenable to the static test loading methods and would require extremely complex analyses. It is normally preferable to centrifuge test these items. For large assemblies containing complex subassemblies, it may be more cost effective to centrifuge subassemblies and check the total assembly by analysis or static test.

Acceleration verification methods should be tailored to the configuration and sensitivity of each portion of the ASWMS. Additional guidance is contained in *MIL-STD-810*, Method 513.

a. Verification that equipment will endure the environmental life cycle and function as required should be accomplished by analysis, test, and environmental measurement. The synergism of combined environments should be accounted for. Test and analysis methods should be appropriate to the hardware size and configuration.

b. Describe in quantifiable terms the critical parameters and evaluation criteria of the analyses, tests, and/or measurements required for verification.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.6.12 Vibration. The ASWMS shall be designed to withstand, without degradation, exposure to the following vibration environments of an equipment life cycle: ____(a)____. The ASWMS shall be designed to operate as specified herein while exposed to the following vibration environments of an equipment life cycle: ____(b)____. During this exposure, all ASWMS equipment, components, or parts designed to latch or be retained shall not release, fail, or jam. The ASWMS shall meet this requirement in all configurations and all positions of doors, panels, shelves, or _____ equipment.

REQUIREMENT RATIONALE (3.2.6.12)

Equipment should be designed to endure without degradation and function in the vibration environments of a life cycle.

REQUIREMENT GUIDANCE

Vibration environmental exposures of the ASWMS' life cycle should be defined. Definition should be carried down to the appropriate unit or subassembly level. Where data are not available, measurements should be accomplished. Other environmental factors (particularly temperature and humidity) should be considered for potential synergistic effects. As an example of a particular application, tables VII and VIII describe the vibration requirements for the C-17 and the C-5, respectively.

As another example, the C-17 lavatory requires the system operate and withstand a random vibration environment of frequencies between 5 and 2000 Hz for a functional power density of 0.004 g^2/Hz for 0.5 hr, followed by endurance power density of 0.04 g^2/Hz for 1.0 hr, followed by a repeat of the functional levels.

Additional guidance is contained in *MIL-STD-810*, Method 514.

a. Insert a quantifiable and measurable definition of the life cycle vibration environments that the ASWMS must experience without performance degradation. Although the ASWMS need not operate as required during this exposure, it must be able to meet all performance requirements after the exposure is completed.

b. Insert a quantifiable and measurable definition of the life cycle vibration environments in which the ASWMS must operate.

REQUIREMENT LESSONS LEARNED

In an aircraft air conditioning unit, rigid tubing that connected a refrigeration compressor, oil cooler, and other components developed cracks due to externally induced vibration fatigue. Vibration isolation or vibration-absorbing techniques were not used in the design. Environmental Stress Screening was not performed (*AFLC/AML Lessons Learned Program #11403*).

A gimballed mirror in an electro-optical device was tested to an incorrectly derived vibration requirement. The gimbal failed. Several years were spent developing a unit that would pass the test. Performance was degraded by the resultant redesign. An evaluation of the original design showed it should have passed a properly derived vibration test.

TABLE VII. C-17 galley vibration requirement.

(units)	W1 g^2/Hz	W0 g^2/Hz	f1 Hz	f2 Hz	f3 Hz	X dB/oct	Y dB/oct	Time hour
Functional levels	0.004	0.004	5	5	2000	0	0	1
Endurance levels	0.04	0.04	5	5	2000	0	0	1

TABLE VIII. C-5 troop compartment vibration requirement.

Frequency (Hz)	Double Amplitude Displacement	Peak Vibration Acceleration
5 - 14	0.10	—
14 - 23	—	±1.0
23 - 32	0.036	—
32 - 500	—	±2.0

4.2.6.12 Verification of vibration. Verification that the ASWMS will withstand without degradation and operate during exposure to the vibration environments of an equipment life cycle shall be accomplished by ___(a)___. Verification shall be accomplished as follows: ___(b)___.

VERIFICATION GUIDANCE (4.2.6.12)

Additional guidance is contained in *MIL-STD-810*, Method 514.

a. Verification that equipment will endure the environmental life cycle and function as required should be accomplished by analysis, test, and environmental measurement. The synergism of combined environments should be accounted for. Test and analysis methods should be appropriate to the hardware size and configuration.

b. Describe in quantifiable terms the critical parameters and evaluation criteria of the analyses, tests, and/or measurements required for verification.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.6.13 Acoustic noise exposure. The ASWMS shall be designed to withstand, without degradation, exposure to the following acoustic noise environments of an equipment life cycle: ___(a)___. The ASWMS shall be designed to operate as specified herein while exposed to the following acoustic noise environments of an equipment life cycle: ___(b)___.

REQUIREMENT RATIONALE (3.2.6.13)

Equipment should be designed to endure without degradation and function in the acoustic noise environments of a life cycle.

REQUIREMENT GUIDANCE

Most ASWMS elements will not be directly exposed to acoustic noise of sufficient intensity to affect life or function. In addition, some types of equipment are not susceptible to acoustic noise. Requirements should be tailored accordingly. Guidance is provided in *MIL-STD-810*, Method 515.

a. Insert a quantifiable and measurable definition of the life cycle acoustic noise environments which the ASWMS must experience without performance degradation. Although the ASWMS need not operate as required during this exposure, it must be able to meet all performance requirements after the exposure is completed.

b. Insert a quantifiable and measurable definition of the life cycle acoustic noise environments in which the ASWMS must operate.

REQUIREMENT LESSONS LEARNED

Confusion and error often occur in the development of acoustic noise environmental requirements. It is important to understand both the severity of the environment and the susceptibility of the item to establish these requirements. Engineers familiar with acoustic noise generation and with equipment response to acoustic noise should establish these requirements.

4.2.6.13 Verification of acoustic noise exposure. Verification that the ASWMS will withstand without degradation and operate during exposure to the acoustic noise environments of an equipment life cycle shall be accomplished by ___(a)___. Verification shall be accomplished as follows: ___(b)___.

VERIFICATION GUIDANCE (4.2.6.13)

a. Verification that equipment will endure the environmental life cycle and function as required should be accomplished by analysis, test, and environmental measurement. The synergism of combined environments should be accounted for. Test and analysis methods should be appropriate to the hardware size and configuration.

b. Describe in quantifiable terms the critical parameters and evaluation criteria of the analyses, tests, and/or measurements required for verification.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.6.14 Shock. The ASWMS shall be designed to withstand, without degradation, exposure to the following shock environments of an equipment life cycle: ___(a)___. The ASWMS shall be designed to operate as specified herein while exposed to the following shock environments of an equipment life cycle: ___(b)___.

REQUIREMENT RATIONALE (3.2.6.14)

Equipment should be designed to endure without degradation and function in the shock environments of a life cycle.

REQUIREMENT GUIDANCE

Shock environments in aircraft are relatively mild. These environments have not been defined in any detail. Requirements are arbitrary "design" tests intended to demonstrate a minimum level of integrity. These tests are not significant for equipment designed for high vibration levels. "Design shock" requirements may be waived for such equipment.

Shocks due to pyrotechnic devices can be severe and very damaging. Requirements should reflect this. Pyrotechnic shock is very difficult to predict accurately and measurements are usually necessary to establish the environment.

Crash shock requirements impact personnel safety and are based on measurements taken during test crashes. They should be applied as prescribed in *MIL-STD-810*, Method 516, without tailoring.

a. Insert a quantifiable and measurable definition of the life cycle shock environments which the ASWMS must experience without performance degradation. Although the ASWMS need not operate as required during this exposure, it must be able to meet all performance requirements after the exposure is completed.

b. Insert a quantifiable and measurable definition of the life cycle shock environments in which the ASWMS must operate. The C-5 troop compartment toilet was required to withstand an 11-ms shock of 20 G's while in operation and an 11-ms shock of 40 G's while inoperative.

REQUIREMENT LESSONS LEARNED

Requirements have often been improperly developed for shock. This is due to the incorrect assumption that "design shock" requirements are sufficient for both aircraft and shipping environments. The item is supported differently and the shock loading differs in these two cases. The requirements must be considered separately.

4.2.6.14 Verification of shock. Verification that the ASWMS will withstand without degradation and operate during exposure to the shock environments of an equipment life cycle shall be accomplished by ___(a)___. Verification shall be accomplished as follows: ___(b)___.

VERIFICATION GUIDANCE (4.2.6.14)

a. Verification that equipment will endure the environmental life cycle and function as required should be accomplished by analysis, test, and environmental measurement. The synergism of combined environments should be accounted for. Test and analysis methods should be appropriate to the hardware size and configuration.

b. Describe in quantifiable terms the critical parameters and evaluation criteria of the analyses, tests, and/or measurements required for verification.

VERIFICATION LESSONS LEARNED

Equipment is often improperly qualified for transportation shock. Dummy equipment is packaged for shipment and subjected to transportation shock tests. A peak G response is measured on the dummy equipment and compared to the peak G requirement for "design shock." If the response G is equal to or less than the "design shock" G, the test is considered successful. This is incorrect. Response to a shock is a wide frequency band transient vibration. Equal peak G is not a significant comparison. Each test should be conducted with actual equipment.

Organizations often attempt by analysis to show equipment will meet shock requirements. This is impractical. The analysis required to illustrate shock response is extremely complex and must be proved by laboratory calibration tests. In general, it is much more cost effective to test the equipment.

3.2.6.15 Gunfire. The ASWMS shall be designed to withstand, without degradation, exposure to the following gunfire environments of an equipment life cycle: ___(a)___. The ASWMS shall be designed to operate as specified herein while exposed to the following gunfire environments of an equipment life cycle: ___(b)___.

REQUIREMENT RATIONALE (3.2.6.15)

Equipment should be designed to endure without degradation and function in the gunfire environments of a life cycle.

REQUIREMENT GUIDANCE

Gunfire vibration produces severe vibration in local areas around gun muzzles and along the projectile path. However, much ASWMS equipment is located in aircraft or in portions of aircraft where gunfire vibration is not significant. When gunfire vibration is significant, it varies widely over relatively short distances. Detail gunfire requirements should be carefully developed.

Additional guidance is contained in *MIL-STD-810*, Method 519.

a. Insert a quantifiable and measurable definition of the life cycle gunfire environments which the ASWMS must experience without performance degradation. Although the ASWMS need not operate as required during this exposure, it must be able to meet all performance requirements after the exposure is completed.

b. Insert a quantifiable and measurable definition of the life cycle gunfire environments in which the ASWMS must operate.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.6.15 Verification of gunfire. Verification that the ASWMS will withstand without degradation and operate during exposure to the gunfire environments of an equipment life cycle shall be accomplished by ___(a)___. Verification shall be accomplished as follows: ___(b)___.

VERIFICATION GUIDANCE (4.2.6.15)

Additional guidance is contained in *MIL-STD-810*, Method 519.

a. Verification that equipment will endure the environmental life cycle and function as required should be accomplished by analysis, test, and environmental measurement. The synergism of combined environments should be accounted for. Test and analysis methods should be appropriate to the hardware size and configuration.

b. Describe in quantifiable terms the critical parameters and evaluation criteria of the analyses, tests, and/or measurements required for verification.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.2.6.16 Other environments. The ASWMS shall be designed to withstand, without degradation, exposure to the following other environments, not specified above, of an equipment life cycle: ___(a)___. The ASWMS shall be designed to operate as specified herein while exposed to the following other environments, not specified above, of an equipment life cycle: ___(b)___.

REQUIREMENT RATIONALE (3.2.6.16)

Equipment should be designed to endure without degradation and function in the other environments of a life cycle.

REQUIREMENT GUIDANCE

Additional guidance may be found throughout *MIL-STD-810*.

a. Insert a quantifiable and measurable definition of the life cycle other environments which the ASWMS must experience without performance degradation. Although the ASWMS need not operate as required during this exposure, it must be able to meet all performance requirements after the exposure is completed.

b. Insert a quantifiable and measurable definition of the life cycle other environments in which the ASWMS must operate.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.2.6.16 Verification of other environments. Verification that the ASWMS will withstand without degradation and operate during exposure to the other environments of an equipment life cycle shall be accomplished by ___(a)___. Verification shall be accomplished as follows: ___(b)___.

VERIFICATION GUIDANCE (4.2.6.16)

Additional guidance may be found throughout *MIL-STD-810*.

a. Verification that equipment will endure the environmental life cycle and function as required should be accomplished by analysis, test, and environmental measurement. The synergism of combined environments should be accounted for. Test and analysis methods should be appropriate to the hardware size and configuration.

b. Describe in quantifiable terms the critical parameters and evaluation criteria of the analyses, tests, and/or measurements required for verification.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.3 Product integrity. The ASWMS life shall be established to the requirements of the applicable integrity programs for the operating functions incorporated into the hardware, as tailored to the aircraft system installed. The following performance parameters are incorporated: ___(a)___. The following integrity program requirements shall be applied: ___(b)___.

REQUIREMENT RATIONALE (3.3)

The integrity programs are applied as the product assurance requirements to establish the capability of the hardware to function for the ASWMS' service life.

REQUIREMENT GUIDANCE

Failure to quantify the hardware requirements and show they are met in the hardware by elimination of the verification process has led to fielded hardware with unexpectedly high levels of failure. The application of the integrity programs requires design verification prior to acceptance for production. It also requires production process controls be in place and verified to reduce to a minimum the process variations which contribute to premature hardware failure and to the spread of failure times which increase maintenance demand and burden.

a. Performance parameters are functions incorporated in the hardware as follow: power and signals are electric, fluid carrying or holding is chemical or mechanical, integration interfaces to airframes are aircraft structural, and commanded higher order computational instruction sets are software. These performance parameters are to be inserted into the first blank.

b. For each performance parameter identified in the first blank, the applicable Section 3 requirements and Section 4 verifications of the corresponding integrity program Mil-Prime and Air Force Guide Specifications are to be applied and incorporated into the contractor-prepared system specification. The referenced guide specification number is to be inserted into the second blank. The following functions and their associated documents apply:

1. Airframe interfaces: *Aircraft Structural Integrity Requirements, AFGS-87221*

2. Mechanical structures (including chemical and fluid contact): *Mechanical Equipment & Subsystems Integrity Program, AFGS-87249*

3. Electrical/electronic: *Requirements for the Integrity of Avionics/Electronics, MIL-A-87244*

4. Command electronic controls requiring higher order language: *Software Development Integrity Program (SDIP), MIL-STD-1803.*

The completion of the Section 3 blanks will include quantified numbers or a reference to a source where the quantified number value is found and will be verified against. Completion with subjective, qualitative, or unverifiable text is unacceptable. The completion of the Section 4 blanks will include a referred test procedure or reference to a contractor-prepared test procedure to show the corresponding Section 3 performance requirement is met by the developed hardware.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.3 Verification of product integrity. The ASWMS shall be verified to the integrity program requirements tailored by 3.3, and incorporated into the system specification.

VERIFICATION RATIONALE (4.3)

See 3.3 Requirement Rationale.

VERIFICATION GUIDANCE

See 3.3 Requirement Guidance.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.4 Safety. The ASWMS and its associated equipment shall be analyzed for safety hazards in accordance with paragraph _____ of *MIL-STD-882*. The ASWMS shall incorporate hand holds in locations where a crewmember or passenger is required to stand to operate equipment (such as galleys or urinals). This is to provide personnel with a means of catching themselves if unexpected or unanticipated turbulence should suddenly cause the aircraft to move beneath them. The following areas shall be designated as fire containment areas: _____. These areas shall be constructed of fire resistant material; shall minimize openings for ventilation, entry, or other use; shall employ either self-closing openings or placards to advise that the opening must be kept closed when not in use; and shall minimize the use of wiring, hoses, or other equipment within that space.

REQUIREMENT RATIONALE (3.4)

The appropriate sections of *MIL-STD-882* should be referenced to ensure a safe design. Care should be taken to ensure that only design requirements are included in the specification.

REQUIREMENT GUIDANCE

The *ASTM F446-85* provides guidance for the design of grab bars. Although intended for restroom facilities, the design principles may be applied to any grab bar design.

a. The specific portions of *MIL-STD-882* which apply to the ASWMS design should be cited here. Care should be taken to ensure that only design requirements, not administration or managerial tasks, are included.

b. The *SAE AS 1426* lists serving carts, waste carts, waste containers, waste chutes, waste stowage compartments, storage compartments for paper and plastic products (towels, napkins, etc.), ovens, and oven vents as fire containment areas.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.4 Verification of safety. The compliance with *MIL-STD-882* shall be verified by _____. Incorporation of hand holds shall be verified by _____. Design and construction of fire containment areas shall be verified by _____.

VERIFICATION GUIDANCE (4.4)

The *ASTM F446-85* provides guidance on the verification of grab bar performance.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.5 Human engineering. Human engineering requirements shall be applied in accordance with the criteria set forth in *MIL-STD-1800*, *MIL-STD-1472*, *AFGS-87240*, and the following subparagraphs. The requirements in these documents include, but may not be limited to, the design of controls and displays, lighting, anthropometric considerations, personal comfort and safety, and ease of maintenance.

REQUIREMENT RATIONALE (3.5)

The ASWMS is intimately related to the health and comfort of all air vehicle occupants. Therefore, some consideration must be given to those human factors elements concerned with sustenance and waste management systems.

REQUIREMENT GUIDANCE

Extensive guidance is contained in *MIL-STD-1800*, *MIL-STD-1472*, and *AFGS-87240* on the specification of human engineering requirements. However, the attached provides information on those requirements peculiar to the ASWMS.

REQUIREMENT LESSONS LEARNED

The elimination of human factors engineering inputs to a program because of cost considerations directly caused more costly redesign of an aircraft system (*AFLC/AML Lessons Learned Program #1141*).

4.5 Verification of human engineering. _____.

VERIFICATION GUIDANCE (4.5)

The references cited above contain extensive guidance on the verification of human engineering requirements.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.5.1 Labels and placards. Controls and modes shall be labelled to ensure correct identification, utilization, actuation, and/or manipulation. Legends and abbreviations shall conform to *MIL-STD-783* and *MIL-STD-12*, respectively. Placards shall be indelibly printed on a permanently mounted, rigid material. Placards shall be located conspicuously and in a manner that clearly references the affected equipment. Placard placement shall facilitate the use of the placard while operating the equipment in the described manner. Placard surfaces, adhesives, and layers shall not deteriorate due to normal cleaning with soap, detergent, or bleach solutions. They shall also not deteriorate due to the use of solvents used to prepare surfaces for placard application or adhesives used to mount the placards. Placards shall not deteriorate or loosen from their mount due to the application and rapid removal of masking tape. Mounted placard edges shall be sealed for sanitation.

REQUIREMENT RATIONALE (3.5.1)

Due to the wide number of personnel who use the ASWMS equipment and the numerous hazards associated with its use, placards and labels should be used to ensure correct operation.

REQUIREMENT GUIDANCE

The C-17 galley requirements specified placards which stated, "Wash Hands Before Handling Food" and "Latch and Stow all Doors, Drawers and Shelves during Takeoff and Landing". All waste containers were required to state, "No Cigarettes" and waste containers with hold open devices to state, "Close Door When Not in Use". Others placards were required for electrical outlets and panels as described in 3.2.5.4.2.

The *SAE AS 1426* recommends the following placard requirements:

a. Movable equipment and structures with inherent design limitations which restrict their use in certain conditions should have placards which describe the limitations and conditions.

b. Doors or moveable items which can restrict emergency egress should be placarded to read, "STOW AND LATCH CLOSED DURING TAKEOFF, TURBULENT WEATHER, AND LANDING."

c. Each compartment, shelf, drawer, or stowage location should be placarded to read, "MAXIMUM WEIGHT OF CONTENTS _____ POUNDS".

d. Emergency equipment should be placarded to indicate the proper use.

e. Each compartment should have at least one placard in a conspicuous position that reads, "CLOSE AND LATCH ALL DOORS, DRAWERS, AND SHELVES DURING TAKEOFF, TURBULENT WEATHER, AND LANDING."

f. Waste chute openings closure doors which are not automatically closed when released should be placarded on the lid in such a manner as to be visible, when open, to read, "CLOSE WASTE OPENINGS WHEN NOT IN USE."

g. Each electrical outlet should be placarded to identify specific usage, voltage, frequency (or DC), and available amperage.

h. Each passenger accessible stowage compartment should be placarded to indicate the intended purpose of the stowage.

i. Each water supply shutoff valve should be placarded to indicate its purpose and direction to turn to close.

The *SAE ARP 1315* recommends a placard that reads, "No Smoking in the Lavatory" be prominently displayed in the lavatory. This should be used despite regulations which prohibit smoking onboard aircraft since lavatories may be used by untrained personnel unfamiliar with the regulations.

The *21 CFR Part 120.38(b)* requires a sign in restrooms used by food handlers to remind them to wash their hands after every use of toilet facilities.

The *40 CFR Part 259.44* requires medical waste containers be labelled, "Medical Waste", "Infectious Waste", or with the universal biohazard symbol.

Microwave ovens should have a placard with the following wording: "Precautions to avoid possible exposure to excessive microwave energy: (1) Do not attempt to operate this oven with the door open. (2) Do not allow soil or residue to accumulate on sealing surfaces. (3) Do not operate the oven if it is damaged. It is particularly important that the oven door close properly and that there is no damage to the door (bent), hinges or latches (broken or loosened), door seals, or sealing surfaces. (4) The oven should not be adjusted or repaired by anyone except properly qualified service personnel."

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.5.1 Verification of labels and placards. _____.

VERIFICATION GUIDANCE (4.5.1)

These requirements should be verified by inspection of the drawings and of the delivered product.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.5.2 Component lifting. Equipment designed to be installed or lifted by a single aircrew member shall weigh no more than _____ pounds when in the condition or configuration the operation is to take place. Equipment designed to be installed or lifted by two aircrew members shall weigh no more than _____ pounds when in the designed condition or configuration.

REQUIREMENT RATIONALE (3.5.2)

Many components of the ASWMS may be designed to be carried on board and lifted into place. Others may require adjustment or movement into alternative configurations. The design of these components must take into account the maximum lifting capability of the personnel assigned.

REQUIREMENT GUIDANCE

Military Standard 1472 provides guidance on this requirement.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.5.2 Verification of component lifting. _____.

VERIFICATION GUIDANCE (4.5.2)

Military Standard 1800 provides guidance on this verification.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.5.3 Anthropometry. All equipment designed for use or operation by USAF aircrew members shall accommodate, at a minimum, the central _____ percent of the USAF _____ (male and/or female) aircrew population. All equipment designed to be used by passengers shall accommodate the central _____ percent of the _____ population, as described by the _____ database.

REQUIREMENT RATIONALE (3.5.3)

The ASWMS must be designed to function with all populations that may need to use it during the performance of the design missions.

REQUIREMENT GUIDANCE

Military Standard 1800 provides extensive guidance on this requirement.

The aircrew and passenger population may be different, due to the stringent selection criteria of the military services, the ages of the military personnel, and the required physical condition of military personnel. That portion of the ASWMS that may be used by any member of the general public should be designed to standard, commercial anthropometric requirements.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.5.3 Verification of anthropometry. _____.

VERIFICATION GUIDANCE (4.5.3)

Military Standard 1800 provides extensive guidance on this verification.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.5.4 Touch temperature. The surface temperatures of any component of the ASWMS subject to routine touch shall not exceed the limits specified in table I. The surface temperatures of any component of the ASWMS subject to inadvertent touch shall not exceed the limits specified on figure 2.

REQUIREMENT RATIONALE (3.5.4)

The heating equipment used as part of the ASWMS can generate sufficient heat to pose a risk of pain and burns to the operator/maintainer if contact with bare skin occurs. This requirement establishes safe surface temperatures as derived from empirical data.

REQUIREMENT GUIDANCE

Four major factors—thermal conductivity of the material, duration of skin contact, epidermal thickness, and skin moisture affect the temperature at which a surface can be safely touched. These factors should determine the thermal limits specified. For further information, see *ASCC AIR STD 61/39*.

REQUIREMENT LESSONS LEARNED

4.5.4 Verification of touch temperature. The touch temperature of all exposed surfaces shall be verified by test. Temperature measurements shall be taken after assurance that the component under test is fully functional and the maximum surface temperature has been achieved during normal operation and under normal conditions.

VERIFICATION RATIONALE (4.5.4)

A test by direct measurement is needed to provide the data from which it can be ascertained that maximum surface temperatures permitted have not been exceeded.

VERIFICATION GUIDANCE

A system component is properly verified when the surface temperature is at or below the allowable limits specified. Measurements should be taken when the item's operating temperature and environmental extreme have been reached during normal operations and under normal conditions. Adequate time is needed to ensure the maximum surface temperature has been achieved. The maximum time setable on any timer should not be used since the time could be repeatedly reset by an operator.

Verification should be conducted at various locations on the exterior surface. Special attention should be given to all corners and pieces (near door jambs or seals).

VERIFICATION LESSONS LEARNED

3.5.5 Training. The ASWMS design shall accommodate any training use derived from applicable training requirements analyses or specified in the system requirements document.

REQUIREMENT RATIONALE (3.5.5)

The major design-related interface between the ASWMS and the training system for its operation and maintenance is the possibility of use of the actual installed equipment for training purposes. Such use would have to be specified as a result of an analysis of training requirements (a formal or informal Training System Requirements Analysis [TSRA]) or unilaterally specified in the system requirements document. *If the ASWMS is to be so* used, it may require designed-in operational training modes or hooks for onboard embedded maintenance training.

It should also be understood that any reliability, duty cycle, or number of cycles requirements for ASWMS equipment included elsewhere in the specification must include the use of the equipment for training purposes and training missions.

REQUIREMENT GUIDANCE

If prior TSRA results are contractually imposed, examine those results for any impact on the ASWMS design requirements. If a TSRA is required as part of the weapon system contract, ensure the training system development and the air vehicle development are sufficiently linked to mutually define any onboard training features of the ASWMS equipment.

Training mission requirements for the aircraft should be included in the user's concept of operations, and for operation and maintenance training requirements in the user's concept of training. Use of the aircraft or the equipment for training should be included in the reliability and duty cycle calculations for the specification factor.

REQUIREMENT LESSONS LEARNED

Training systems are now being developed in parallel with the air vehicles which they support, and any onboard embedded training features must be included in the design of the onboard systems. Also, duty cycles of equipment for training can be an order of magnitude greater than the same equipment for operational use.

4.5.5 Verification of training. Incorporation of required operation and maintenance training features shall be initially verified by analysis of system design and finally through functional and physical configuration audits. Incorporation of training use in reliability and duty-cycle calculation shall be verified through the reliability program. If a training system is being acquired under the contract, testing of the training features of the onboard ASWMS equipment will be as specified in *the training system specification.*

VERIFICATION GUIDANCE (4.5.5)

The verification paragraph can and should be modified for the requirements of a specific program. A prime contractor who uses this guide specification to generate a Type A specification for an ASWMS would have sufficient information available.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.6 Interface requirements

3.6.1 Aircraft interfaces

3.6.1.1 Electromagnetic effects (EME). The ASWMS shall be designed to achieve electromagnetic compatibility with all subsystems and equipments within the system and with the electromagnetic environment. The ASWMS shall meet the electromagnetic effects requirements for systems as specified in *MIL-STD-1818*. Specifically, the requirements for the ASWMS are as follow: _____.

REQUIREMENT RATIONALE (3.6.1.1)

Systems are complex from a materials usage and electronics standpoint. Many materials in use are not metallic and have unique electromagnetic properties which require careful design considerations. Flight-critical electronics on aircraft are now common. Wide use of high-power radio frequency (RF) transmitters, sensitive receivers, other sensors, and additional electronics creates a potential for problems within the system or from external influences. The system must be designed to be compatible with itself, other systems, and the external electromagnetic environment to ensure required performance and prevent costly redesigns after-the-fact for resolution of problems.

REQUIREMENT GUIDANCE

The ASWMS needs to be designed to achieve system compatibility. Every effort needs to be made to meet these requirements during initial design rather than on an after-the-fact basis. Since each system has its own unique requirements and characteristics, general electromagnetic compatibility (EMC) design criteria documents may not be adequate. System and subsystem/equipment control plans should be used to aid in program management and to describe requirement interpretation and specific design measures being implemented to meet requirements. The specific aspects of the EME control area are addressed in *MIL-STD-1818*. Additional guidance on EMC can be found in *MIL-HDBK-237* and *SAE ARP 4242*. The particular requirements of *MIL-STD-1818* may not be applicable for certain ASWMS applications. Although *MIL-STD-1818* is primarily intended for use on airborne platforms, tailoring of the specific design requirements and verification approaches can make it applicable to any type of system, including ASWMS.

REQUIREMENT LESSONS LEARNED

Lessons learned from specific requirements are contained in the appendix of *MIL-STD-1818*.

4.6 Verification of interface requirements

4.6.1 Verification of aircraft interfaces

4.6.1.1 Verification of electromagnetic effects (EME). The electromagnetic effects design requirements for the ASWMS shall be verified in accordance with the methods for verification contained in *MIL-STD-1818*, Section 5.

VERIFICATION RATIONALE (4.6.1.1)

The verification rationale for each method is provided in *MIL-STD-1818*. *Military Standard 1818* is a Mil-Prime document and contains rationale for each verification method in the appendix.

VERIFICATION GUIDANCE

The Mil-Prime format of *Military Standard 1818* contains extensive guidance for requirement verification in the appendix.

VERIFICATION LESSONS LEARNED

Information regarding lessons learned for each verification is contained in the appendix of *MIL-STD-1818*.

3.6.1.2 Electrostatic discharge (ESD). No part, component, or element of the ASWMS shall inadvertently actuate when subjected to a _____ Volt electrostatic discharge. After the discharge is applied, the system shall function as required.

REQUIREMENT RATIONALE (3.6.1.2)

Many electronic components are susceptible to damage through the buildup and discharge of electrostatic electricity. Equipment that is itself not susceptible to this phenomenon must also prevent the accumulation and transfer of static electricity to prevent damage to other costly and mission-critical items.

REQUIREMENT GUIDANCE

Current guidance requires the system not inadvertently operate when exposed to 25,000V of electrostatic discharge.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.6.1.2 Verification of electrostatic discharge (ESD). The ASWMS shall be subjected to a _____ picofarad capacitor charged to the required voltage and discharged through a _____ ohm resistor connected in series between the sensor contacts. The contact points shall then be reversed, changing polarity, and the test repeated. The ASWMS shall meet its requirements after this exposure.

VERIFICATION GUIDANCE (4.6.1.2)

Current guidance recommends the system be exposed to the 25,000V from a 500 ± 25 picofarad capacitor through a 5000 ± 250 ohm resistor.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.6.1.3 Electrical power requirements. The electrical power system shall provide electrical power to the terminals of the power utilization equipment having the characteristics in accordance with _____. The ASWMS shall require _____ Volts, at _____ frequency, _____ phase, _____ (Y or Delta) connected and _____ amperes for all systems and components. All loads shall be balanced and grounded.

REQUIREMENT RATIONALE (3.6.1.3)

To ensure electrical compatibility between the electrical power system (EPS) and the equipment that uses electric power, it is necessary to establish an electric power interface requirement. For manned aircraft, electrical equipment is built to operate from electrical power as defined by *MIL-STD-704*; thus, *MIL-STD-704* defines the electrical power quality for both the EPS and the using equipment (at the input power terminals) on manned aircraft. The interface characteristics controlled include voltage, frequency, distortion, and phase displacement—including steady state and transient limits.

REQUIREMENT GUIDANCE

The current USAF issue of *MIL-STD-704* should be specified for the electric power interface for new aircraft equipment unless there are overriding considerations which arise. Specify the appropriate limits/interfaces from *MIL-STD-704* and/or the peculiar aircraft limit/interface requirements.

When the ASWMS is added to an existing aircraft, the specified power quality must be compatible with the original aircraft requirements. Therefore, the current *MIL-STD-704* should be specified only if it ensures power quality equal to or greater than the original requirement. It will be necessary to compare the requirements of the current version of *MIL-STD-704* with earlier versions of the specification to make this determination.

Subsystem power requirements are incorporated into the electrical load analysis of the aircraft. It is desirable to have subsystem electrical power requirements in the same format as the aircraft load analysis. The format may require a breakdown of real and reactive power as well as system operating times to determine transient loading conditions and total generator loadings. Provision for subsystem voltage and current requirements remains the most basic element. Useful information on how to present data in an electrical load analysis is provided in *MIL-E-7016*, but exact formats will vary between aircraft.

REQUIREMENT LESSONS LEARNED

Both the E-3A and E-4B aircraft have had problems of incompatibility between aircraft power and using equipment. In the case of the E-3A, the EPS had to be reworked to accommodate the equipment even though the original power quality requirements were met. These problems point out that the power interface requirements must be carefully chosen and consistently applied to both the EPS and the using equipment.

4.6.1.3 Verification of electrical power requirements. Compliance of the ASWMS with the requirements of 3.6.1.3 shall be verified by analyses and tests as follow: _____.

VERIFICATION RATIONALE (4.6.1.3)

In order for the EPS to provide power with the required characteristics and quality, the subsystem components which contribute to these characteristics must perform as required.

VERIFICATION GUIDANCE

Verification of component performance can be obtained by qualification testing. Component requirements and test results should be analyzed to ensure component performance is consistent with overall subsystem requirements. The final verification lies in subsystem testing in the laboratory and on the aircraft.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.6.1.4 Weight and moment effects. The maximum weight of the ASWMS in its _____ (fully loaded or empty and unloaded) configuration shall not exceed _____ pounds. This weight includes all detachable or removable equipment, components, parts, modules, etc.

REQUIREMENT RATIONALE (3.6.1.4)

This requirement is needed to ensure adequate data is acquired to permit accurate determination of weight and balance. Also, to prevent weight growth and the associated performance decrement, the weight and moment effects of all aeronautical equipment require constant vigilance during the developmental design phases.

REQUIREMENT GUIDANCE

The C-17 galley maximum weight (empty and all tanks dry) was 252 lb. The C-17 lavatory (empty and all tanks dry) maximum weight was 150 lb. The C-135 galley maximum weight was 740 lb.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.6.1.4 Verification of weight and moment effects. The maximum weight of the ASWMS shall be verified by _____.

VERIFICATION GUIDANCE (4.6.1.4)

This requirement should be verified by a test of the entire ASWMS in the operating configuration. The ASWMS should be loaded and/or filled as directed by the above requirement.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.6.1.5 Loading restrictions. There ___(a)___ (shall/shall not) be partial assembly of the ASWMS after loading onboard the aircraft. All removable units shall load through existing hatches or cargo doors without alteration or disassembly of the door. Forklift tines entries shall be ___(b)___ wide, ___(b)___ high, and ___(b)___ long. The ASWMS shall accommodate loading operations with a forklift travelling at the maximum speed of ___(b)___ miles per hour. The ASWMS shall accommodate the aircraft rail-roller system as defined by ___(c)___. The ASWMS shall have winch and hoisting cable attachments able to support the mass of the ASWMS distributed between all points with a ___(d)___ factor of safety without distortion of the ASWMS or its equipment. The cable attachments shall be accessible with any environmental protection cover in place. The ASWMS' wheels should have a load of no more than ___(e)___ pounds per wheel, diameter of no less than ___(e)___ inches, and width no less than ___(e)___ inches. Attachments for the ASWMS to the air vehicle shall meet the load requirements of 3.2.3 multiplied by ___(f)___ for the forward direction, ___(f)___ for the aft direction, ___(f)___ for the ___(f)___ direction, ___(f)___ for the downward direction, and ___(f)___ for both lateral directions.

REQUIREMENT RATIONALE (3.6.1.5)

This requirement applies to removable, temporary, or portable units only and should not be used for ASWMS permanently mounted within the airframe.

REQUIREMENT GUIDANCE

The *SAE AS 1426* recommends that all removable modules, equipment, or parts pass through a 32 × 72 in. doorway with 6 in. radius corners.

a. While the optimum design for the ASWMS would be to require no assembly after it is loaded into the aircraft, other design constraints may make this goal unachievable. When tradeoffs are performed with all requirements, this is one that can be somewhat relaxed to permit the full compliance with more important requirements.

b. The forklift tines tunnels, if used, should be large enough to fit both military and commercial equipment. They should be positioned as required to permit transfer of the ASWMS by a forklift at its maximum operating speed.

c. If the air vehicle for which the ASWMS is being designed contains a rail-roller system, the section of the air vehicle specification that describes this feature should be referenced here.

d. The winch and lifting attachments should be designed to support the weight of the entire ASWMS with a safety factor based upon the anticipated loading conditions. The weight should be empty or full, based upon the anticipated loading scenario.

e. The C-17 crew galley specification requires a maximum load of 65 lbs per wheel, a minimum wheel diameter of 1.25 in., and a minimum wheel width of 0.60 in.

f. The *SAE AS 1426* recommends a safety factor of 1.33 for the forward direction for static load tests and stress analyses, and 1.15 for the other directions for stress analyses.

REQUIREMENT LESSONS LEARNED

On one older transportable galley/lavatory unit, the door vents for the lavatory were located just above the forklift tine entries. This created a maintenance problem since the tines often missed the entries and struck the vents, which frequently had to be replaced.

4.6.1.5 Verification of loading restrictions. The verification of any partial assembly of the ASWMS after loading onboard the aircraft, loading of removable units through existing hatches or cargo doors, and hoisting and/or forklift operations shall be by _____. The winch operations and the rolling of the ASWMS on the aircraft rail-roller system and on paved aircraft taxiways shall be verified by _____. Attachments for the ASWMS to the air vehicle shall be verified by _____.

VERIFICATION GUIDANCE (4.6.1.5)

These requirements should be verified by test of the final ASWMS design in the aircraft on which it was designed to be loaded.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.6.1.6 Connectors. The potable water hoses and connectors shall not be physically connectable to the liquid waste hoses or connectors. All hoses or electrical lines shall be flexible and shall not induce loads on the connectors, the ASWMS, or the aircraft structure. The ASWMS shall store all hoses and connectors for connection of the ASWMS to the aircraft or support service systems. All liquid lines shall have a valve in the line between the connector and the system. The connectors to liquid handling subsystems shall be protected by a leakproof cap when not in use.

REQUIREMENT RATIONALE (3.6.1.6)

The ASWMS requires connection with the aircraft to function as an integral part of the air vehicle system. Furthermore, the ASWMS' elements require interconnection with one another in a manner consistent with their intended use.

REQUIREMENT GUIDANCE

The potable water and waste liquids systems should be designed to prevent their interconnection and ensure the drinking water supply is not contaminated. This has been achieved in the past by using different sizes and geometries for the connectors of the two systems.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.6.1.6 Verification of connectors. The presence and operation of a valve in all liquid lines between the connector and the system and of a leakproof cap on the connector shall be verified by ___(a)___. The inability to connect potable water hoses and connectors to the liquid waste hoses or connectors; the flexibility and loads induced by all hoses or electrical lines; and the storage of all hoses and connectors for connection of the ASWMS to the aircraft or support service systems shall be verified by ___(b)___.

VERIFICATION GUIDANCE (4.6.1.6)

a. The inclusion of a cut-off valve at the connector and a leakproof cap should be verified by inspection of the drawings and delivered products.

b. The other requirements should be demonstrated as an integral portion of the full system demonstration of 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.6.1.6.1 Electrical connectors. The ASWMS units which are removable from the aircraft shall mate with a ___(a)___ (nomenclature or specification number) ___(a)___ (male/female) electrical connector. The connector shall be located at ___(b)___ (location) and shall have ___(b)___ feet cord length. The ASWMS shall include stowage for the cord. When connected, the power cord shall not obstruct any passage around equipment. Connectors shall be operable by a single hand without tools.

REQUIREMENT RATIONALE (3.6.1.6.1)

The electrical connection with the air vehicle needs to be described in sufficient detail to ensure adequate performance.

REQUIREMENT GUIDANCE

a. The C-17 galley specification requires the electrical connector conform to *MIL-C-26482*, Series 2. The ASWMS which are being designed to support existing aircraft should specify the male or female connector necessary to match the existing aircraft system. The ASWMS for new systems also need to specify the connector gender to ensure a match when the systems are first mated.

b. The location of connectors on the ASWMS and the cord length should be specified based upon the connections within the aircraft. Routing of the cord to clear obstructions, to ensure no obstructions, and to prevent tripping hazards should be taken into account for the length calculation. Furthermore, adequate length is necessary to ensure no stresses are placed on the connector from the ASWMS.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.6.1.6.1 Verification of electrical connectors. The capacity, location, size, and type of the electrical connectors to the ASWMS shall be verified by _____. The length of the electrical cord and its stowage, the connecting operation, and the non-obstruction of passageways and equipment by the connected cord shall be verified by _____.

VERIFICATION GUIDANCE (4.6.1.6.1)

a. The type, location, size, and capacity of the connector should be verified by inspection of the drawings and the delivered product.

b. Adequate cord length and stowage, connector operation, and non-obstruction should be verified as an integral portion of the full system demonstration of 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.6.1.6.2 Ventilation connections. Connections for exterior vents (tank and space ventilation) shall be in accordance with ____(a)____ (specification paragraph number). The ventilation inlet and outlet flanges shall be able to withstand, without permanent deformation or failure, a force of ____(b)____ pounds axial thrust in the ____(b)____ (inward/outward) direction and a moment of ____(b)____ pound-inches about the axial centerline.

REQUIREMENT RATIONALE (3.6.1.6.2)

In many applications, the ASWMS' ventilation will require connection to the aircraft. This may be for the passage of odors from one space to another or to the aircraft exterior.

REQUIREMENT GUIDANCE

a. The paragraph number that defines the interface between the ASWMS and the aircraft should be cited here.

b. The forces and moments imposed on the aircraft by the ASWMS' ventilation connectors should be based upon the strength of the connectors and the supporting structures.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.6.1.6.2 Verification of ventilation connections. Connections for all exterior vents and the forces and moments these connections can withstand shall be verified by _____.

VERIFICATION GUIDANCE (4.6.1.6.2)

The performance of these connections should be verified by test measurements of the connecting forces using the delivered products.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.6.1.6.3 Ground servicing connectors. Potable water service connections shall not be located in the same box, area, or space and shall not be downstream from any liquid or human waste service connections or overboard dump outlets. Both the waste and potable water systems shall have a valve in the line between the connector and the system. This valve shall be accessible and/or operable from the service connection location. The condition of this valve, opened or closed, shall be easily and directly observable from the service connection operating location. If the connections and valves are located behind a panel or door, the location and purpose of these devices shall be durably and legibly marked on the exterior of the access. Operating instructions, including valve positions for filling, draining, tank selection, or other operation, shall be posted in a position where it can be read while operating this equipment.

REQUIREMENT RATIONALE (3.6.1.6.3)

This requirement provides the technical direction necessary for the servicing of the potable water and liquid waste systems.

REQUIREMENT GUIDANCE

To prevent contamination from the inadvertent cross-connection of the potable water and liquid waste systems, the servicing outlets and connectors should be located in separate areas. To ensure positive control of the servicing operations, a valve located at the connection is desirable.

In many cases, servicing may be accomplished by personnel not fully aware of all details of the potable water or liquid waste systems. To reduce the risk of equipment damage, instructions should be posted on the inside of any access doors.

Figure 17 describes typical ground service connectors.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.6.1.6.3 Verification of ground servicing connectors. Verification that potable water service connections are not located in the same box, area, or space and are not downstream from any liquid or human waste service connections or overboard dump outlets shall be by ___(a)___. The adequacy of all operating instructions shall be verified by ___(b)___. The performance of the servicing valve, connector, and cap should be by ___(c)___.

VERIFICATION GUIDANCE (4.6.1.6.3)

a. The location of the service connections should be verified by inspection of the drawings and the delivered product.

b. The operating instructions should be verified as an integral portion of the full system demonstration of 4.1.

c. The valve, connector, and cap should be verified by testing at the highest operating, cleaning, filling, or servicing pressure.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

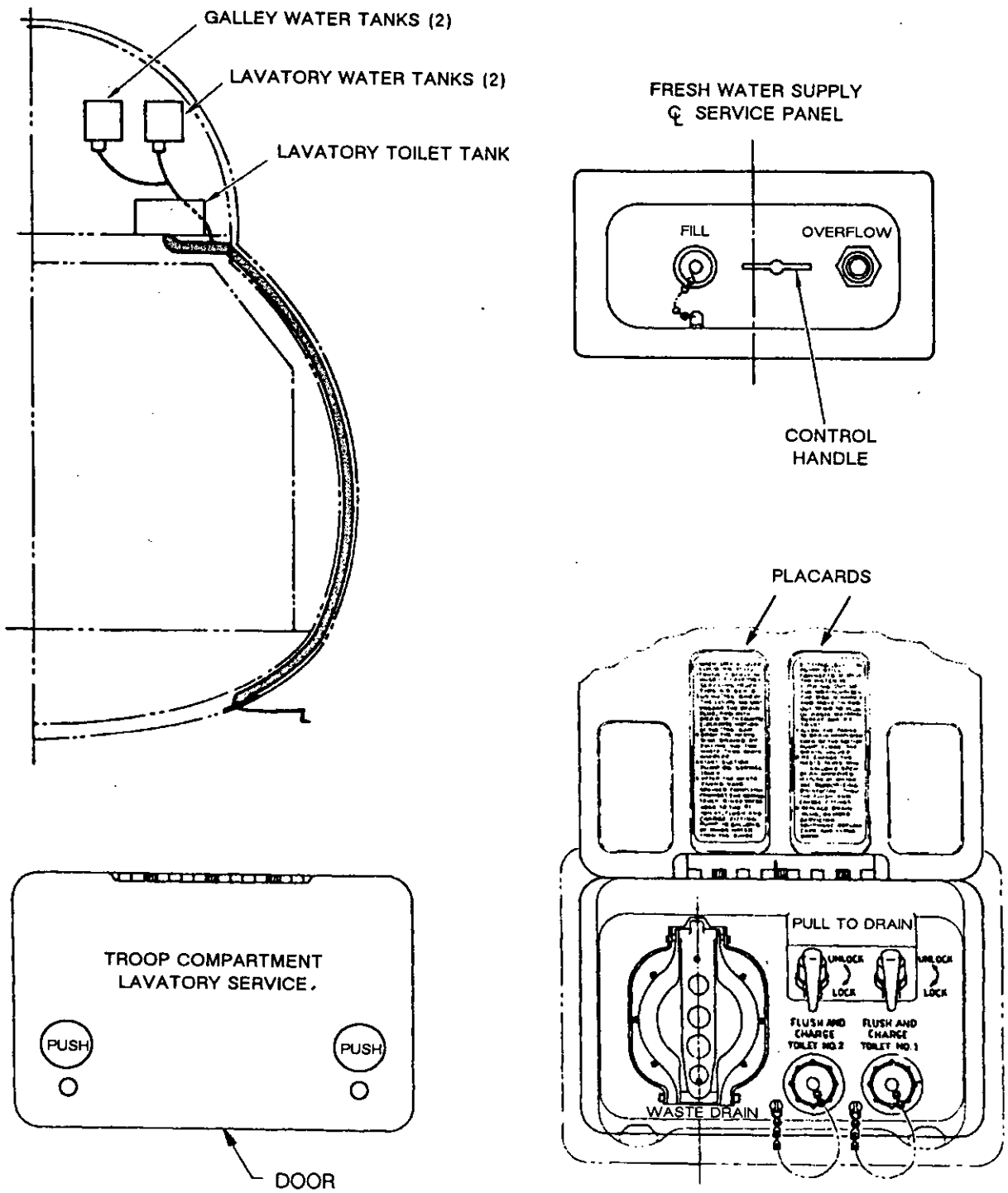


FIGURE 17. Ground service panels.

3.6.1.6.3.1 Liquid waste service connections. Liquid waste servicing connectors shall be quick disconnects in accordance with ___(a)___ (specification number) and shall meet the requirements of 3.2.2.1 and 3.2.2.2. The hose length shall be ___(b)___ inches and the hose diameter shall be ___(b)___ inches for the waste liquids hoses. Connection to liquid waste ground services shall be at a single location, shall require no more than one skill level ___(c)___ groundcrew member, shall add disinfectant to the waste tank, and shall not require a ladder for connection or operation when the ground crewmember is standing on the ___(c)___ (ground or service truck/cart). After service, provisions shall be available to rinse and disinfect the hose and the connection without removal. Backflow out of the toilets, urinals, basins, or other equipment connected to the liquid waste plumbing shall be prevented during the rinse or chemical addition. See 3.2.2.2.3 for inflight, overboard *dumping requirements*.

REQUIREMENT RATIONALE (3.6.1.6.3.1)

The ASWMS, if it is to handle waste liquid products, must interface with the equipment designed to offload that waste from the air vehicle.

REQUIREMENT GUIDANCE

a. Current ground service equipment for liquid waste have connectors in accordance with *MIL-T-38010*. The ASWMS should be designed to mate with this connector.

b. The waste hose length should be adequate to reach the service connections with the aircraft in the normal servicing condition. This may include the presence of other servicing equipment that precludes the placement of the liquid waste service equipment in the preferred location. The current waste hose minimum diameter is 3 in.

c. The skill level should be selected in accordance with the level of complexity of the equipment and its operating procedures.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.6.1.6.3.1 Verification of liquid waste service connections. Liquid waste servicing quick disconnects, hose length, connection to ground services, drainage of all liquids and solids, disinfectant addition, rinse, and other operation shall be verified by _____.

VERIFICATION GUIDANCE (4.6.1.6.3.1)

The performance of these requirements should be verified as an integral portion of the system demonstration of 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.6.1.6.3.2 Potable water service connection. Potable water servicing connectors shall be quick disconnects in accordance with ____(a)____ (specification number), shall meet the requirements of 3.2.1.1.2.1 and section 3.2.4, shall be easily accessible with the ASWMS installed, and shall not require tools. Operating instructions shall include a caution not to allow the filling pressure to exceed ____(b)____ psig. The hose length shall be ____(c)____ inches and the hose diameter shall be ____(c)____ inches for the potable water hoses. The potable water overflow outlet shall be observable from the location of the servicing connector. The potable water tank filling hose and connections shall be plainly labelled for potable water use only and shall not be connectable to the aircraft liquid or human waste service connectors.

REQUIREMENT RATIONALE (3.6.1.6.3.2)

The ASWMS, if it is to handle potable water, must interface with the equipment designed to onload that water to the air vehicle.

REQUIREMENT GUIDANCE

a. The current potable water connection is as specified by *MS21391*. This is designed to mate with the service truck fill hose connector of *MIL-T-83018*.

b. This pressure should be based upon the pressure capacity of the potable water system. Current potable water systems require the operator not to exceed 30 psig filling pressure.

c. The hose length should be adequate to reach the service connections with the aircraft in the normal servicing condition. This may include the presence of other servicing equipment that precludes the placement of the potable water service equipment in the preferred location.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.6.1.6.3.2 Verification of potable water service connection. Potable water servicing quick disconnects, hose length, operating instructions, and overflow outlets shall be verified by _____. Inability to connect the potable water system to the waste handling system, hoses, and connectors shall be verified by _____.

VERIFICATION GUIDANCE (4.6.1.6.3.2)

The performance of these requirements should be verified as an integral portion of the system demonstration of 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.6.1.7 Structural interface. For removable ASWMS equipment, attachments to the aircraft structure shall be made with quick and captive disconnects, with rigid connections in all directions to the existing aircraft mounting points, and with no requirement for special tools. The equipment design shall preclude the possibility of incorrect installation. There shall be no chatter at the connections to the aircraft. Any portion of the ASWMS that requires removal for access to other aircraft components or to structural attachments shall also incorporate captive fasteners and shall require a single hand tool common with the ASWMS unit installation. The ASWMS and its equipment shall be positioned so it does not obstruct passenger access to seats.

REQUIREMENT RATIONALE (3.6.1.7)

The ASWMS' components will be mounted in the air vehicle. The ASWMS' elements must be integrable with the air vehicle's structures. Both permanent and temporary mounting must meet these requirements.

REQUIREMENT GUIDANCE

The C-17 uses an envelope drawing with detail drawings to define the structural connections of the ASWMS to the air vehicle.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.6.1.7 Verification of structural interface. The removal and replacement of removable ASWMS equipment and the mounting of removable ASWMS units to the aircraft shall be verified by _____.

VERIFICATION GUIDANCE (4.6.1.7)

This requirement should be verified as an integral portion of the system demonstration of 4.1.

On the C-135, the galleys were required to be fit tested by installation into either the actual aircraft or a USAF-approved mockup.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.6.1.8 Clearances, exits, hatches, and compartment access. The ASWMS and its equipment, in any configuration, shall not block access to emergency and normal hatches and compartments. The ASWMS doors, drawers, and extending, sliding, or folding surfaces shall not block or interfere with the access to or operation of other aircraft equipment in any position (open, closed, unfolded, etc.).

REQUIREMENT RATIONALE (3.6.1.8)

The design and placement of the ASWMS within the aircraft must not interfere with a crewmember's ability to perform his mission. This includes any requirements to gain access to equipment or spaces.

REQUIREMENT GUIDANCE

This requirement should be applied on all ASWMS systems.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.6.1.8 Verification of clearances, exits, hatches, and compartment access. Access to emergency and normal hatches or compartments with doors, drawers, and extending, sliding, or folding surfaces in any position (open, closed, unfolded, etc.) shall be verified by _____.

VERIFICATION GUIDANCE (4.6.1.8)

While preliminary studies may be performed using system drawings, the final verification should be an integral part of the system demonstration of 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.6.1.9 Environmental control system interface. The smoke or odors generated by the operation of the ASWMS galley- or lavatory-type equipment shall ventilate to the _____ (exterior/interior) of the aircraft or shall be dissipated by the aircraft ventilation system without adverse impact on the cabin pressurization system. This ventilation shall be user controllable, _____ (shall/shall not) have a filter, and shall be without adverse impact to the cabin pressurization system. If necessary, this system shall allow a crewmember to disable it immediately.

REQUIREMENT RATIONALE (3.6.1.9)

The galley equipment of the ASWMS may create smoke and fumes when sustenance is prepared. This is particularly true of equipment designed to support DVs, since the preparation will more closely resemble that of ground-based kitchens. Noxious odors may also be created in the use of the ASWMS' lavatory equipment.

REQUIREMENT GUIDANCE

This requirement should be integrated with the human waste system ventilation requirements of 3.2.2.1.3 and the compartment requirements of 3.2.3.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.6.1.9 Verification of environmental control system interface. The ASWMS area ventilation shall be verified by _____.

VERIFICATION GUIDANCE (4.6.1.9)

The operation of this system should be verified by a test and as an integral portion of the full system demonstration of 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.6.1.10 Escape system interface. The ASWMS, in any configuration, shall not impede egress from the aircraft under emergency conditions.

REQUIREMENT RATIONALE (3.6.1.10)

The ASWMS must not interfere with emergency operations of the air vehicle systems or of the assigned personnel.

REQUIREMENT GUIDANCE

Guidance for this requirement is contained in *AFGS-87235*.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.6.1.10 Verification of escape system interface. The ASWMS shall be integrated with the escape system so egress from the aircraft under emergency conditions is not impeded.

VERIFICATION GUIDANCE (4.6.1.10)

This requirement should be verified as an integral portion of the full system demonstration of 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.6.2 Other interfaces

3.6.2.1 Ground service carts. The ASWMS shall be compatible with the _____ (type designations) ground service carts for the support of toilets, potable water filling, power, disassembly for cleaning, sanitization, or repair.

REQUIREMENT RATIONALE (3.6.2.1)

The ASWMS may be supported by one or several ground service carts, depending upon the equipment included in the ASWMS, the design mission, and the support needed.

REQUIREMENT GUIDANCE

If the refrigerators or freezers cannot be emptied between missions, if they require electrical power prior to the aircraft engine start-up, or if the ovens or other ASWMS equipment must be operated prior to engine start or after electrical power is secured, then the ASWMS must interface with the ground power service carts. In this case, the ground power carts must be able to provide sufficient power for all concurrent design activities.

Current potable water servicing trucks are equipped with connectors which mate with the *MS21391* aircraft drinking water servicing connector. This connector complies with *ISO 450* and *ASCC AIR STD 25/16*.

The C-17 uses a potable water truck to fill the potable water tanks. As defined by *MIL-T-83018*, this truck is equipped with a 250-gal water tank, a pumping system, static discharge reel (for aircraft grounding), a 50-ft hose and nozzle, and an accessory kit for various service requirements.

Current lavatory servicing carts, as defined by *MIL-L-26208*, are equipped with a 4-in. coupling assembly (Kaiser RoyLyn part number M2651-133) and a 1-in. recharging connection (Kaiser RoyLyn part number 0031-0118). These connections are part of a patented lavatory holding tank drain system and are used throughout the commercial industry. No formal standard exists for these connections.

The C-17 uses the Part Number AS32A Lavatory Servicing-Pumping Unit Tank to service the toilet. This unit is used to extract waste from the aircraft lavatory, to flush the lavatory with fresh water, to recharge the lavatory with water and deodorizer, and to transport the waste to a sewage disposal facility. This is a self-contained unit with a tank for waste and another for fresh water. It operates on 12V DC.

The C-5 troop compartment toilet required the waste handling system to withstand flushing by ground service units at the rate of 15 gal/min and a pressure of 20 to 30 psig and overpressure protection for 125 psig. The toilet filter was not to be removed during this process. This process was also used to charge the tank with adequate liquid for use.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.6.2 Verification of other interfaces

4.6.2.1 Verification of ground service carts. The compatibility of the ASWMS with the required ground service carts for the support of toilets, potable water filling, power, disassembly for cleaning, sanitization, or repair shall be verified by _____.

VERIFICATION GUIDANCE (4.6.2.1)

Compatibility of the ASWMS with required ground service carts should be verified as an integral portion of the system demonstration of 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.6.2.2 Ground stowage. The removable portion of the ASWMS ___(a)___ (shall/shall not) be contained on no more than a single pallet. The stored dimensions of the ASWMS shall be no more than ___(b)___ feet high, ___(b)___ feet wide, and ___(b)___ feet long. If a weather cover is used, it shall be easily removable by one person, shall be stowable within the ASWMS, and shall not tear or puncture from normal use. The ASWMS shall have rigid covers over all preparation and storage equipment or areas.

REQUIREMENT RATIONALE (3.6.2.2)

During periods of non-use, portions of the ASWMS or the entire ASWMS may be placed into ground stowage. This could require specialized equipment or devices to protect the ASWMS from the environment.

REQUIREMENT GUIDANCE

a. It is preferable to keep all portions of the ASWMS within a single pallet wherever possible. However, where larger systems are needed, it may not be possible without sacrificing other necessary requirements.

b. The as-stored dimensions of the ASWMS should be based upon the storage facility capabilities and should be minimized wherever possible.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.6.2.2 Verification of ground stowage. The storage capability, including the use of a weather cover, shall be verified by _____.

VERIFICATION GUIDANCE (4.6.2.2)

This requirement should be verified as an integral portion of the system demonstration of 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

3.6.2.3 Insulated food transporters. The ASWMS shall include a covered and insulated food transporter to carry the sustenance from the inflight kitchen to the aircraft while the food is maintained in its frozen or chilled condition. The transporter shall contain ____(a)____ (cubic feet of volume or number of meals). When unloaded, it shall be storable in the ASWMS equipment. It shall be damage resistant, weigh no more than ____(b)____ when loaded, have two carrying handles, and maintain the temperature of the sustenance within ____(c)____ degrees F for ____(c)____ minutes at an environmental temperature of ____(c)____ degrees F.

REQUIREMENT RATIONALE (3.6.2.3)

In many applications, the majority of the ASWMS equipment will remain onboard the aircraft and sustenance will be carried to the vehicle and loaded into the ASWMS. The sustenance must be protected from the environment during this operation to ensure it remains in an edible condition.

REQUIREMENT GUIDANCE

The *USPHS Handbook 308* recommends food transporters be enclosed and not be used for other purposes which may conflict with the sanitary transport of food.

a. Food transporters should be designed to accommodate the oven and refrigerator insert racks when fully loaded with prepared meals. Foldable or dismantlable food transporters have provided insulated and protected transfer of meals together with stowage of the emptied transporter.

b. The weight of the food transporter fully loaded with sustenance should be below that which can be easily handled by two aircrew members, as defined by *MIL-STD-1800, Human Engineering.*

c. Food should not remain unrefrigerated for more than a cumulative time of 4 hr.

REQUIREMENT LESSONS LEARNED

Contact the REO for this document (see 10.5).

4.6.2.3 Verification of insulated food transporters. The design, construction, function, operation, and storage of any food transporter shall be verified by _____.

VERIFICATION GUIDANCE (4.6.2.3)

This requirement should be verified by a test of the food transporter's ability to maintain the sustenance at the specified temperature for the required length of times at the highest ambient temperatures of the anticipated operating locations. The ability of the food transporter to integrate and operate with the balance of the ASWMS and the air vehicle should be verified as an integral portion of the system demonstration of 4.1.

VERIFICATION LESSONS LEARNED

Contact the REO for this document (see 10.5).

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
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I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER AFGS-87267	2. DOCUMENT DATE *(YYMMDD)* 921113

3. DOCUMENT TITLE
Sustenance and Waste Management Systems, Airborne

4. NATURE OF CHANGE *(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)*

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME *(Last, First, Middle Initial)*	b. ORGANIZATION	
c. ADDRESS *(Include Zip Code)*	d. TELEPHONE *(Include Area Code)* (1) Commercial (2) DSN *(If applicable)*	7. DATE SUBMITTED *(YYMMDD)*

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C. ADDRESS *(Include Zip Code)* ASC/ENES Wright-Patterson AFB OH 45433-6503	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church VA 22041-3466 Telephone (703) 756-2340 DSN 289-2340