NSF/ANSI Standard
for Plastics

Plumbing system components
for recreational vehicles

1 General

1.1 Scope

This Standard covers pipe, fittings, valves, traps, vents, tanks, pumps, connectors, fixtures, appliances, and similar appurtenances used in a plumbing system of a recreational vehicle.

1.2 Measurement

Decimal and SI conversions provided parenthetically shall be considered equivalent. Metric conversions have been made according to IEEE/ASTM SI 10.

1.3 Normative references

The following reference documents contain requirements that constitute requirements of this NSF/ANSI Standard. At the time of publication, the indicated editions were valid. All documents are subject to revision, and it is the responsibility of the user of this specification to determine the applicability of the most recent editions of these documents.

ANSI Z124.1 – 95. Plastic Bathtub Units
ANSI Z124.2 – 95. Plastic Shower Receptors and Shower Stalls
ANSI Z124.3 – 95. Plastic Lavatories
ANSI Z124.4 – 96. Plastic Water Closet Bowls and Tanks

ANSI/ASSE 1001-2008. Performance Requirements for Atmospheric Type Vacuum Breakers
ANSI/ASSE 1002 – 09. 2008 Performance Requirements for Anti-siphon Fill Valves for Gravity Water Closet Flush Tanks
ANSI/ASSE 1051 – 02. 2009 Performance Requirements for Individual and Branch Type Air Admittance Valves for Sanitary Drainage Systems

3 American National Standards Institute (ANSI), 11 West 42nd St., New York, NY 10036 www.ANSI.org
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ASME 20042013. Boiler and Pressure Vessel Code


Code of Federal Regulations, Title 121 CFR, Section 170-199. Food and Drug Administration, Department of Health and Human Services

IAPMO/ANSI Z124.1.2-2005 – Plastic Bathtub and Shower Units

IAPMO/ANSI Z124.3-2005 – Plastic Lavatories

IAPMO/ANSI Z124.4-2006 – Plastic Water Closet Bowls and Tanks

IAPMO PS 033-2000-2011. Flexible PVC Hose for Pools, Hot Tubs, Spas, and Jetted Bathtubs

IAPMO TS 1-2005-01-2011e1. Mechanical Seal Toilets With or Without Integral Wastewater Tanks for Use in Recreational Vehicles

IAPMO TS 12-97e1. Self-Contained, Electrically Operated Recirculating Chemically Controlled Toilet
2 Definitions

2.1 accessible: Fabricated to be exposed for cleaning and inspection using simple tools (screwdriver, pliers, open-end wrench, etc.).

2.1.1 readily accessible: Fabricated to be exposed for cleaning, inspection, and maintenance or removal using simple tools.

2.2 backflow: The flow of water or other liquids, mixtures, or substances into the distribution pipes of a potable water supply from any sources other than its intended source.

2.3 body waste: Solid waste materials, inclusive of urine and feces, deposited in plumbing fixtures.

2.4 burst protection: Prevention of physical damage to the potable water system by antifreeze at specified protection temperature and concentration of active ingredient.

2.5 corrosion-resistant materials: Materials that maintain their original surface characteristics under prolonged contact with the environment and chemical compounds.

2.6 drainage system: Piping that conveys body or liquid wastes to the drain outlet, excluding the sewer connector.

2.7 fixture: A receptor for water or waterborne wastes that discharges into a sanitary drainage system or waste holding tank.

2.7.1 fixture drain: The drain from a fixture’s trap or the drain outlet, or to the junction of that drain with any other drain pipe.

2.8 flood level: The level in the receptacle over which water would overflow to the outside of the receptacle.

2.9 flush water holding tank: A tank designed to be manually filled with water that is not intended to be plumbed into a potable water distribution system.
2.10 **liquid waste**: The discharge from any fixture, appliance, area, or appurtenance that does not include discharges from water closets and urinals.

2.11 **multiple fixture pump**: A pump to deliver water to two or more fixtures. Pumps may be manually or automatically activated.

2.12 **non-fouling**: Free from obstruction.

2.13 **recreational vehicle**: A vehicular unit primarily designed as temporary living quarter for recreational, camping, travel, or seasonal use that either has its own motive power, or is mounted on or towed by another vehicle. The basic entities are travel trailer, camping trailer, truck camper, motor home and fifth wheel trailer.

2.14 **removable**: Capable of being taken away from the main unit using only simple tools (screwdriver, pliers, open-end wrench, etc.).

2.14.1 **readily removable**: Capable of being taken away from the main unit without using tools.

2.15 **self-contained, recirculating, chemically controlled toilets**: Toilets with a pump to force flushing liquid (with required chemical) from the self-contained tank through a mechanical, self-cleaning filter into the peripheral rim of the bowl, to flush deposited contaminants back into the tank.

2.16 **single fixture pump**: A pump to deliver water to a single fixture other than a toilet. Pumps may be manually or automatically activated.

2.17 **smooth**: Free of pits, pinholes, cracks, crevices, inclusions, rough edges, and other surface imperfections detectable by visual and tactile inspection.

2.18 **trap**: A fitting or device designated and constructed to provide a liquid seal that will prevent the backflow of air without materially affecting the flow of liquid waste through it.

3 **Materials**

3.1 **General**

Materials shall withstand exposure to the use environment, pressure requirements, corrosive actions of chemicals and water, handling, and installation.

3.2 **Dissimilar materials**

Dissimilar materials may be used, but shall be protected against electrolytic action.

3.3 **Welding**

Welded seams and deposited weld materials shall meet the applicable corrosion resistance requirements.

3.4 **Potable water contact surfaces**
Surfaces of components intended for potable water contact shall comply with the requirements specified in NSF/ANSI 61.

3.5 Non-corrosion-resistant materials

Non-corrosion-resistant materials shall have all wetted surfaces covered with a protective coating. Cathodic protection may also be used to prevent or reduce corrosion.

4 Design and construction

4.1 General

Plumbing system components shall be designed and constructed to not be adversely affected by operation of the vehicle or the normal environment.

4.2 Cleanability

Surfaces or parts of components requiring routine cleaning shall be readily accessible and easily cleanable when assembled or removed. Demountable parts shall be readily removable.

4.3 Backflow and back siphonage

If a backflow protection device is required, it shall conform to the applicable requirements under ASME A112.18.3M.

4.4 Specific requirements for components

Individual components and appurtenances shall comply with the applicable requirements of 4 through 24.4.3 except as specifically exempted.

5 Connector couplings, caps, and drain hoses

5.1 Design and construction

5.1.1 Connector couplings and caps shall be readily accessible and shall be designed for easy attachment to the vehicle.

5.1.2 Connector couplings, caps, and hoses shall be watertight after attachment to prevent leakage.

5.1.3 Drain hoses shall have a nominal 3 in diameter. Body waste drain hoses shall be designed to support attachment of connector couplings, without deformation of the inside diameter of the hose when installed according to the manufacturer's instructions.

5.1.4 Body waste drain hoses shall be capable of being formed to not less than 90° (1.6 rad) with a 3 in radius. When formed, drain hoses shall be capable of passing a minimum 2¾ in (69.9 mm) diameter ball.

5.2 Performance
System components to be tested shall be mounted to a nominal 3 in diameter standpipe with the drain opening plugged. A pressure of 3 psig (20.7 kPa) shall be applied for 5 min, with no leakage of water from the system.

5.3 Marking and identification

Connector couplings, caps, and drain hoses shall be clearly and permanently marked with trade name or designation.

6 Side-vented drainage system

6.1 Scope

This section covers side-vented drainage systems installed in a recreational vehicle. Systems shall not reduce the flow below that which may pass through a basket strainer for a nominal 2 in sink opening. The same area used for liquid waste shall be used for air and venting purposes.

6.2 Materials

Components shall be manufactured of materials accepted for use in a drain, waste, and vent system (DWV) listed under NFPA 1192.

6.3 Design and construction

Systems shall be constructed of a minimum nominal 1.25 in diameter plastic pipe or drawn brass tubing at least a nominal 1.5 in diameter No. 20 Browne and Sharp gauge. A diverter or directional tee shall be used to connect the trap to the side-vented system, with a two-compartment sink. This equipment shall have no more than a nominal 2.0 in (50.8 mm) drain opening.

6.3.1 Drain outlet shall be a nominal 1½ in minimum IPS (iron pipe size), and contain a male or female IPS pipe thread.

6.3.2 A minimum nominal 1¼ in P trap shall be used in the side-vented system. It may be constructed of No. 20 Browne and Sharp gauge drawn brass tubing or accepted plastics. Wall thickness, socket depth, type, and grade of plastic materials shall comply with the applicable requirements in NSF/ANSI 14.

6.3.3 The baffle or diverter tee shall be manufactured of materials referenced in NFPA 1192, Section 6.3.2. It shall be designed to direct water down. It shall contain no crevices or cavities that will trap or hold waste particles.

6.4 Performance

6.4.1 The unit shall be tested with center line of the vent opening 2½ in (63.5 mm) above the sink bottom. Fill sink with water, close three-fourths of the vent area, and pull sink plug. When sink is drained, remove trap and check seal. A minimum 2.0 in (50.8 mm) water depth shall remain.

6.4.2 Repeat test with vent opened. There shall be no overflow from vent when plug is pulled.

6.5 Marking and identification
Plastics components shall be clearly and permanently marked with the following:

- manufacturer's name or trademark; and
- type of material.

7   Plumbing fixtures / receptors (except toilets)

7.1 Scope

Plumbing fixtures included in this Section are shower stalls, receptors, combination compartments, sinks, shower receptors, lavatories, bathtubs, shower stall and tub enclosures, etc.

7.2 Applicable standards

Plumbing fixtures / receptors for use in recreational vehicles shall comply where applicable with those standards listed in 1.3.

NOTE: The Wear and Cleanability test for plastic fixtures intended for use in recreational vehicles is not applicable.

7.3 Steel fixtures

Steel bathtubs 54.0 in (1371.6 mm) long and under 30 in (762 mm) wide shall be made of 16-gauge steel minimum. Steel sinks and lavatories 32.0 in (812.8 mm) or less in length and 31.0 in (787.4 mm) or less in width shall be made of 18-gauge steel minimum.

7.4 Design and construction

Plumbing fixtures shall have impervious finishes, free from defects and concealed fouling surfaces, and shall be capable of resisting road shock and vibration. Fixtures shall not permit backflow.

7.5 Showers

Showers shall have a finished dam, curb, or threshold at least 1.0 in (25.4 mm) lower than sides and back of receptor. No receptor shall be less than 2.0 in (50.8 mm) deep, nor more than 9.0 in (228.6 mm) deep, measured from the top of the dam or threshold to the top of the drain. The floor shall have a minimum pitch of 0.25 in (6.4 mm) and a maximum pitch of 2.0 in (12.7 mm) per foot, sloped uniformly to the drain.

7.6 Shower receptors

Shower receptors with integral walls extending 3 ft (0.90 m) or more above the floor, shall be at least 20 in (508 mm) wide and have a minimum horizontal cross-sectional area of 400 in$^2$ (2580 cm$^2$). The clear standing space of the receptor shall be at least 12 in (305 mm) wide with a minimum floor area of 240 in$^2$ (1548 cm$^2$). The joint around the drain connection, vent, and toilet outlet in a combination compartment shall be made watertight with a flange, clamping ring, or other means. Hinged shower doors shall open outward.

7.7 Shower and tub enclosures

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Shower and tub enclosures with integral walls including showers over bathtubs, shall be constructed of rigid and waterproof materials such as wire glass, laminated safety glass, fiberglass, reinforced plastic, thermoplastic, etc., to a minimum height of 72 in (177 cm).

7.8 Strainers

Strainers shall be provided for waste outlets of plumbing fixtures, other than toilets, and shall have an adequate unobstructed waterway.

7.9 Floor support

Receptor or shower stall floors shall be supported with nonabsorbent material designed to resist deformation under normal use conditions.

7.10 Watertight installation

Receptors and shower compartments shall have watertight joints when filled to the flood level.

7.11 Openings

Openings in the receptor or shower compartment (except drain outlet) shall be above the finished threshold.

7.12 Access

Plumbing fixtures, if provided, shall be accessible for cleaning, replacement, and repair.

7.13 Brackets

Wall-hung fixtures, if provided, shall be securely attached to walls with no strain transmitted to piping connections.

7.14 Marking and identification

Plumbing fixtures shall be clearly and permanently marked with the following:

- manufacturer's name or registered trademark; and
- model number.

8 Nonpressurized potable water tanks

8.1 Design and construction

8.1.1 Tanks shall have interiors with no recesses or crevices to trap contaminants or support microbiological growth.

8.1.2 Tanks shall contain at least one fill arrangement or fitting on the top or high point.
8.1.3 Tanks shall contain at least one drain fitting at the low point for draining and flushing. This requirement does not apply to portable rigid or collapsible tanks.

8.1.4 Tanks shall be vented to the atmosphere to allow escape or intake of air, to preclude tank collapse upon fast water withdrawal, or rupture by force filling. This requirement does not apply to collapsible tanks.

8.1.5 Venting, through the fill spout or cap, shall prevent rainwater or other contaminants from entering the tank opening. Interior vents shall be protected from dust, insects, and vermin.

8.1.6 Tank openings shall be sealed prior to shipment.

8.2 Performance

Tanks shall withstand a 10 foot pound-force (13.6-J) impact at 30 °F (-1 °C) and a 20 foot pound-force (27-J) impact at 90 °F (32 °C) when tested according to ASTM D2444 using Tüp B.

8.2.1 Tanks shall withstand a 3 ft (0.9 m) hydrostatic head without leakage when filled with water to the vent opening.

8.3 Marking and identification

Tanks shall be clearly and permanently marked with the following:
- manufacturer's name;
- model number;
- serial or part number; and
- “intended for potable water storage only.”

9 Pressurized potable water tanks, fittings, and filler caps

9.1 Scope

Pressurized water tanks, relief valves, fittings, and filler caps covered by this Section are used for storage of potable water.

9.2 Design and construction

9.2.1 Tanks shall comply with the structural standards in ASME Boiler and Pressure Vessel Code, Unfired Pressure Vessels, Section VIII. The manufacturer shall provide a certification of compliance.

9.2.2 Tanks shall have interiors with no recesses or crevices to trap contaminants or support microbiological growth.

9.2.3 Tanks shall contain at least one fill arrangement or fitting on the top or at the high point.

9.2.4 Tanks shall contain at least one drain fitting at the low point for draining and flushing.

9.3 Performance
Tanks, fill caps, and fittings shall withstand a minimum hydrostatic pressure test of 200 psi (1380 kPa). Tanks with inlet pressure regulators and relief devices shall withstand a minimum hydrostatic pressure of two times the designed working pressure for 5 min.

9.4 Marking and identification

Tanks, pressure caps, and filler caps shall be clearly and permanently marked with the following:

- manufacturer's name;
- model number;
- serial or part number;
- the statement "suitable for potable water";
- maximum pressure allowed;
- pressure relief valve setting; and
- maximum operating temperature.

10 Waste holding tanks

10.1 Design and construction

10.1.1 Tanks shall have interior surfaces free of recessed areas and shall have internal corners with a continuous radius of at least 1 in (25.4 mm). Tanks shall have a minimum uniform slope of 1/2 in (12.7 mm) per ft (0.3 m) to a 3 in (76.2 mm) minimum diameter drain outlet. Tanks shall be at least 3 in (76.2 mm) deep.

10.1.2 Tanks shall be reinforced to withstand the normal stresses of the use environment such as road shock or vibration.

10.1.3 Body waste tank inlet connections shall be vertical and shall have an internal 3.0 NPS (76.2 mm) or as recommended by the manufacturer of the toilet. The inlet may be integrated with a standard closet flange. Liquid waste tank inlet connections shall be vertical and shall have an internal 1½ NPS (38.1 mm).

10.1.4 Tanks shall be provided with a vent connection installed at the highest point or top of the tank. The connection shall be at least a nominal 1¼ in IPS diameter to permit a nominal 1¼ in vent takeoff to rise vertically. The vent connection shall not extend more than 2.0 in (17.2 mm) below the inside top of the tank.

10.1.5 Tanks shall be provided with a drain opening at the lowest point.

10.2 Performance

10.2.1 Tanks shall withstand a 10 foot pound-force (146-J) impact at 32 °F (0 °C) and a 20 foot pound-force (27-J) impact at 90 °F (32 °C) when tested according to ASTM D2444 using Tup B.

10.2.2 Tanks shall withstand a 3 ft (0.9 m) hydrostatic head without leakage when filled with water to the vent opening for 5 min.

10.3 Marking and identification
Tanks shall be clearly and permanently marked adjacent to the drain outlet with the following:

- manufacturer's name; and
- model number.

11 Mechanical seal toilets

11.1 Scope

Mechanical seal toilets covered by this Section are to be connected to the potable water system and the sanitary drainage system in recreational vehicles.

11.2 Materials

Vitreous china shall comply with requirements of ASME A112.19.2M/CSA B45.1. Plastics, if used, shall comply with the requirements of IAPMO/ANSI Z124.4; however sections 4 (Structural Strength and Integrity), 5.1 (Colorfast Test), 5.3 (Wear and Cleanability), and 5.4 (Cigarette Test) shall not apply. Metals shall be corrosion resistant.

11.3 Design and construction

11.3.1 Body waste outlet and passages shall be sized to pass a 2¾ in (69.9 mm) diameter ball, and have impervious surfaces. They shall be free of obstructions, recesses, or chambers that permit fouling. The mechanical seal and seat shall have leakproof seals.

11.3.2 Fixture bases shall be mounted on acceptable closet flanges with gaskets to provide gas- and watertight seals.

11.3.3 Flushing mechanisms shall ensure adequate cleansing of interior surfaces during flushing cycle at minimum operating pressures.

11.3.4 At least 1 in (25.4 mm) of water shall be retained in the bowl after flushing.

11.3.5 A single control shall be used for flushing and refilling.

11.3.6 The mechanical seal mechanism shall withdraw completely from the path of waste discharge during flushing.

11.3.7 The water flushing mechanism and components shall be accessible for adjustment, repair, and replacement.

11.3.8 An overflow in the toilet shall be optional when the toilet is equipped with an inlet opening at least nominal 2 in (12.7 mm) in diameter. The overflow line shall be at least a nominal 2 in diameter or less, if the diameter will take full discharge of supply valve, and form a trap with a seal at least 2 in (50.8 mm) deep and be accessible for cleaning. The trap may have a drain fitting. The overflow outlet shall discharge beneath the mechanical seal. A portion of the water in the overflow trap shall be replaced with fresh water at each flushing.
11.3.9 The toilet shall have an acceptable backflow preventer installed on the discharge side of the last control valve in the supply line, and be protected from physical damage and contamination.

11.4 Performance

11.4.1 The toilet shall operate at a minimum flow pressure of 8 psig (55.2 kPa) and a maximum static pressure of 100 psig (690 kPa).

11.4.2 During flushing, a clean bowl shall be completely covered with a film of water 1.5 in (38.1 mm) below the flushing rim.

11.4.3 The toilet shall be subjected to 1000 continuous cycles at a minimum of 20 psi (138 kPa) static pressure without failure.

11.4.4 Toilet bowls shall not lose more than 10 percent of water volume when operated according to the manufacturer's instructions and tested at 73 °F ± 3 °F (23 °C) for at least 24 h.

11.5 Load Test

Toilets shall meet the requirements of IAPMO TS-1, Section 5.8. Tanks shall meet the requirements of IAPMO TS-1, Section 5.9.

12 Self-contained, recirculating, chemically controlled toilets

12.1 Scope

Toilets covered by this section are self-contained, electrically operated, recirculating, and chemically controlled for use in recreational vehicles.

12.2 Applicable standards

Toilets covered by this Section shall meet the requirements of IAPMO TS 12, Section 6 (Function Test).

12.3 Materials

Vitreous china shall comply with requirements of ASME A112.19.2M/CSA B45.1. Plastics, if used, shall comply with the requirements of ANSI Z124.4 where Section 4 (Structural Strength and Integrity) and section 5.3 (Wear and Cleanability) are not applicable.

12.4 Load Test

Toilets shall meet the requirements of IAPMO TS-1, Section 5.8. Tanks shall meet the requirements of IAPMO TS-1, Section 5.9.

12.5 Marking and identification

Toilets shall be clearly and permanently marked with the following:
13 Water closets

13.1 Scope

This section covers non-mechanical seal type water closets.

13.2 Applicable standards

Water closets shall conform to ASME A112.19.2/CSA B45.1.

13.3 Marking and identification

Water closets shall be clearly and permanently marked in accordance with ASME A112.19.2/CSA B45.1.

14 Termination valves

14.1 Design and construction

14.1.1 Closure

Termination valves shall hold the sealing element closed. The sealing element shall withdraw completely from the path of the waste discharge and be nonfouling.

14.1.2 Size

Valves shall have a minimum nominal 3 in diameter for body waste, and a minimum nominal 1.5 in diameter for liquid waste.

14.1.3 Discharge

The discharge pipe, if provided, shall have a watertight cap that shall be permanently attached to the vehicle.

14.2 Replacement

Valves or valve mechanisms shall be removable for repair or replacement.

14.3 Performance

14.3.1 Leak test

Valves shall be mounted on a nominal 3 in diameter standpipe 6 ft (1.8 m) long. Termination valves shall not leak in any position when pressure tested with a hydrostatic pressure of ¼ psig (1.7 kPa) and 4.0 psig (27.6 kPa) for 5 min.

14.3.2 Pull test
The valve shall be mounted with a scale attached to the opening device at the handle. The valve shall fully open with a force of less than 20 lb (18 kg) after heat shock cycling of:

- 140 °F (60 °C) for 30 min; then
- -20 °F (−28.9 °C) for 30 min; then
- 140 °F (60 °C) for 30 min; then
- -20 °F (−28.9 °C) for 30 min; then
- 140 °F (60 °C) for 30 min; then
- 73 °F (23 °C) for 30 min.

14.4 Marking and identification

Termination valves shall be clearly and permanently marked with the following:

- manufacturer's name;
- model number; and
- direction of flow.

15 Hand-actuated water pumps

15.1 Scope

Hand-actuated water pumps covered by this Section are used for potable water systems. Basic components of the pump shall be included.

15.2 Design and construction

Pump components shall be accessible for maintenance, inspection, and service.

15.3 Performance

Pumps shall be capable of passing a particle no larger than 0.062 in (1.6 mm) without making the pump inoperable.

15.3.1 Pumps shall allow complete drainage of residual water in 30 min to prevent freezing.

15.3.2 Pumps shall be self-priming and capable of lifting a water column to a minimum height of 6 ft (1.8 m) through a nominal 3/8 in diameter suction line.

15.4 Marking and identification

Pumps shall be clearly and permanently marked with the following:

- manufacturer's name or trademark; and
- model number.

16 Electric water pumps
16.1 Scope

Electric water pumps covered by this section are used for potable water systems. Basic parts of the pump and accessories shall be included.

16.2 Screens

Screens shall be upstream of, and adjacent to, the pump and be accessible for cleaning. Screens shall have a screening area 10 times the cross-sectional area of the inlet or outlet of the device. The screen shall be capable of restricting particles in excess of 300 µm.

16.3 Performance

16.3.1 Working pressure

Pumps shall withstand a working pressure of 60 psi (414 kPa). Pumps intended to be subjected to external water supply pressures, e.g., municipal water supply pressures, or used with a pressure hot water generating device, shall withstand a working pressure of 100 psi (690 kPa).

16.3.2 Single-fixture pumps shall have an output delivery of 1 gpm (3.8 L/min) against an 8 ft (2.4 m) [4 psi (27.6 kPa)] head.

16.3.3 Multiple-fixture pumps shall have a delivery of 1.5 gpm (5.7 L/min) against a 23 ft (7 m) [10 psi (68.9 kPa)] head.

16.4 Instruction manual

A manual shall be provided and shall include installation, operation, and maintenance instructions. A parts list and pump curve shall be included.

16.5 Marking and identification

Pumps shall be legibly marked with:

- manufacturer's name or trademark;
- model number;
- maximum working pressure in psi (kPa);
- type;
- direction of flow; and
- electrical characteristics of motors.

17 Detachable waste holding systems

17.1 Scope
Detachable waste holding systems covered by this section are used in recreational vehicles for liquid waste only.

17.2 Tank design and construction

Tank storage capacity shall be at least 4 gal (15.0 L). Tanks shall have interior surfaces free of recessed areas, and shall be provided with handle(s), straps, or other means for carrying.

17.3 Traps

Rigid tanks shall have integral traps formed by extension of the inlet pipe. Traps shall activate when liquid reaches a minimum of 10% of the tank capacity. The tank inlet and trap shall not be less than 10% of the capacity of the tank. The tank inlet and trap shall be at least nominal 1.25 in (3.18 mm) in diameter.

17.3.1 Collapsible tanks shall have a trap and flexible drain system complying with 18.

17.4 Connections and draining

Provision shall be made for connecting the tank inlet to the matching inlet valve. This connection shall be made without using tools. The tank shall empty only through the inlet or vent.

17.5 Drain system design and construction

A pipe and fitting drain system shall connect the sink drain opening to the detachable waste holding tank inlet. The drain system shall terminate with a cap permanently attached to the vehicle. The minimum diameter of tubing, pipe, or fittings in the drain system shall be a nominal 0.625 in.

17.6 Performance

Flexible or semiflexible tubing used in the drain system shall be capable of sustaining an internal pressure of 5 psig (34.5 kPa) for 24 h without rupture. With the tank detached, the drain system shall not leak when filled with water to the flood level of the connected fixture.

17.7 Impact resistance

The tank shall be filled to capacity and impact tested by dropping the tank from 3 ft (0.9 m) onto a bottom corner. The tank shall not rupture or leak except through the inlet or vent. This test shall be conducted at 73 ± 3 °F (22.8 ± 1.5 °C).

17.8 Marking and identification

Tanks shall be clearly and permanently marked with the following:

- manufacturer's name;
- model number;
- end use application; and
- capacity.
18 Flexible drain systems

18.1 Scope

This section covers requirements for flexible drain systems including traps, strainers, showers, hoses, and connectors used on sinks in recreational vehicles.

18.2 Design and construction

18.2.1 All fixtures shall have a minimum free waterway of a nominal 1.25 in diameter.

18.2.2 The system shall be accessible for cleaning by a brush or other cleaning tool.

18.2.3 The outlet shall have a male fitting with a watertight cap for attachment to vehicle. The outlets for all systems shall have nominal diameter equal to or greater than the piping and fittings of the system.

18.2.4 All fixture traps shall have a water seal of at least 2 in (50.8 mm).

18.2.5 The system shall have a strainer on the inlet end to retain particles greater than ¼ in (6.4 mm), and be securely attached.

18.2.6 When installed in accordance with the manufacturer’s instruction, the system shall slope at all points along the system a minimum of 0.125 in per ft. This requirement does not apply to traps.

18.2.7 The interior of the system shall be non-fouling.

18.2.8 When installed on the drain system, the minimum bend radius of flexible hoses shall be equal to or greater than the manufacturer’s recommendations.

18.3 Performance

18.3.1 System components shall comply with 21.2 and 21.6 of this Standard as well as IAPMO PS 033, Section 3, Testing Requirements.

18.3.1.1 System Components shall permit free drainage of ¼ in (6.4 mm) particles or less.

18.3.1.2 System Components shall show no reduction in the water seal of the trap after draining one half of the water from the fixture.

18.3.1.3 The hose shall show no collapse or failure at a hydrostatic pressure of 5 psi (34.5 kPa) while being flexed to a 6 in (152.4 mm) radius at least 500 times each, at -20 °F (-28.9 °C) and 120 °F (48.9 °C).

18.4 Marking and identification
Flexible drain systems shall be clearly and permanently marked with the following:

- manufacturer's name or trademark;
- model number; and
- the statement "Use only for sinks or fixtures on recreational vehicles."

19 Air admittance valves

19.1 Scope

Devices covered by this section are air admittance valves. They automatically open to admit air to the drainage system above the connection of the trap arm as liquid is discharged from the fixture or appliance. These devices shall be secondary to the main drainage system vent.

19.2 Air admittance valves used in recreational vehicles shall comply with the performance requirements of ASSE 1051.

20 Stainless steel sinks

20.1 Scope

This Section is supplemental to ASME A112.19.3/CSA B45.4. It covers design and construction of stainless steel sinks and lavatories.

20.2 Recreational vehicle sinks

Recreational vehicle sinks shall comply to the following sections of ASME A112.19.3/CSA B45.4:

- Section 2.1 not including section 2.1.1;
- Section 2.2;
- Section 2.3 not including section 2.3.1 through 2.3.3; and
- Section 2.5.

20.2.1 Drain opening

Sinks and lavatories shall have a minimum nominal 2.0 in (50.8 mm) drain opening.

21 Flexible vent systems, pipe, and fittings

21.1 Scope

Flexible vent systems covered by this Section are for use as dry vents in recreational vehicles.

21.2 Performance
Pipe and fittings shall not increase in weight more than 0.50 percent when tested according to 21.6.

21.3 Dimensions

The flexible vent system shall have an unobstructed minimum internal nominal diameter of 1.25 in (31.8 mm) and a minimum wall thickness of 0.047 in (1.19 mm).

21.4 Flexibility

The flexible vent system shall withstand 300 flexures of 180° on a 6-in (152.4 mm) radius at both -20 °F (-28.9 °C) and 120 °F (48.9 °C) without permanent kinking, cracking, reduction of airways, or leakage. Leakage shall be determined by testing at a 5 psi (34.5 kPa) hydrostatic head for 24 hours. The testing shall be conducted with pipe and fittings attached according to the manufacturer's recommendations.

21.5 Fittings

Fittings may be an integral part of the flexible vent piping. They shall be clamped or permanently attached by solvent or other bonding to form a liquid or gas-tight seal. The portion of the fitting used to attach the flexible vent line to the drainage system shall be a standard configuration and compatible with the fitting. Any external clamp shall be corrosion-resistant.

21.6 Chemical resistance

Pipe and fittings shall not increase in weight more than 0.5 percent when tested according to ASTM D543 using the chemicals in table 1.

Table 1 – Chemical resistance testing

<table>
<thead>
<tr>
<th>Chemicals</th>
<th>Concentration in water solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>sodium chloride</td>
<td>5%</td>
</tr>
<tr>
<td>acetic acid</td>
<td>5%</td>
</tr>
<tr>
<td>Ivory soap®</td>
<td>5%</td>
</tr>
<tr>
<td>household detergent</td>
<td>5%</td>
</tr>
</tbody>
</table>

- Use pipe test specimens at least 6.0 in (152.4 mm) long. Fittings specimens shall be complete.
- Test three specimens with each reagent.
- Weigh specimen to the nearest 0.1 g and completely immerse in chemicals for 72 h.
- Remove from chemicals, wash specimens with tap water, dry with room temperature forced air both inside and out to ensure no chemicals remain in tubing corrugations, continue to air dry 120 to 135 min, and reweigh.
21.7 Water absorption  
Water absorption shall be determined as follows:

- Weigh 3 cleanly cut pipe specimens at least 6 in (152 mm) long, or 3 complete fittings, to the nearest 0.1 g.
- Immerse in water at 73 ± 3 °F (23 ± 2 °C) for 48 h.
- Remove specimens, dry with room temperature forced air both inside and out to ensure no water remains in tubing corrugations and reweigh immediately.

Calculate the average percent weight gain to the nearest 0.01% and use to determine compliance with 21.2.

21.8 Markings  
Flexible vent pipe and fittings shall be clearly and permanently marked with the following:

- manufacturer's name;
- model number and/or trade designation; and
- the statement “Intended only for dry vents in recreational vehicles.”

22 Antifreeze for potable water systems  
22.1 Scope  
Antifreeze covered by this Section is for use in potable water systems to provide burst protection.

22.2 Materials  
Formulation of antifreeze shall be non-toxic and shall comply with performance requirements specified in this section.

The following information shall be reviewed to determine that the potential health effects of products or materials are accurately and adequately identified:

- complete formulation information for the antifreeze product as follows:
  - the composition of the formulation (e.g., percent or parts by weight for each chemical in the formulation or reference to a standardized material specification);
  - a chemical abstract number (CAS no.), name, trade designation, and supplier for each chemical present in the formulation and a Material Safety Data Sheet (MSDS), when available; and
  - an indication as to whether the chemical is an ingredient, reactant, or processing aid.
22.2.1 Formulation review for acceptance

Each ingredient in the formulation of antifreeze shall be acceptable as a food additive based upon the requirements of Title 21 CFR, Section 170-199, or shall meet the health effects requirements of NSF/ANSI 60 as a miscellaneous water supply product.

The manufacturer shall submit a product label for review. The product label, product information, or technical bulletin shall include instructions for flushing the product from the plumbing system.

22.3 Performance

Propylene glycol antifreeze shall comply with the following requirements:

22.3.1 Burst protection

Antifreeze shall provide burst protection at the temperatures and the range or percent recommended by the manufacturer. Exposure conditions shall be at least 24 +/- 1 h. Testing shall be conducted in accordance with the following:

- Perform tests using two sets of test pipe. Both sets are to include three different nominal sizes of pipe (e.g., ¼", 3/8", ½") measured in three-foot lengths. The first set is to be of cross-linked polyethylene and the second set is to be copper tubing (type L) complying with applicable standards. Cross-linked polyethylene and copper piping are the most common piping materials used in the RV industry.
- Cap the test sets securely and place in a freezer chamber.
- Monitor temperature by a thermocouple device having an accuracy within ± 2 °F.
- Record temperature when a test set shows evidence of physical bursting.

22.3.2 Percent antifreeze concentration

Propylene glycol antifreeze shall contain the percent propylene glycol shown in Table 2. Verification shall be by gas chromatograph using ASTM E202.

<table>
<thead>
<tr>
<th>Burst protection temperature</th>
<th>Minimum percent by weight propylene glycol in total formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>- 50 °F (-45.6 °C)</td>
<td>30</td>
</tr>
<tr>
<td>- 60 °F (-51.1 °C)</td>
<td>38</td>
</tr>
<tr>
<td>- 100 °F (-73.3 °C)</td>
<td>60</td>
</tr>
</tbody>
</table>

22.3.3 Other antifreezes shall meet manufacturer’s specifications for minimum antifreeze content.
22.4 Compatibility

Antifreeze shall be compatible with the packaging used and the piping system materials recommended by the manufacturer, when tested according to ASTM D1384, and modified to expose only those materials referenced by the manufacturer. Weight loss shall not exceed 25 mg (equal to a corrosion rate of 1 mL per year). If used, metal inhibitors shall comply with item 22.2.

22.5 Marking and identification of antifreeze

Each container shall be clearly and permanently labeled with the following:

- manufacturer's name or trade name;
- recommended end use instructions and cautions;
- batch number;
- container volume;
- burst protection temperature level and percent glycol or antifreeze concentration; and
- specific active ingredient.

22.6 Quality control and records maintenance

22.6.1 Quality control

For each batch, the manufacturer shall determine the percent antifreeze and dye color match.

22.6.2 Records maintenance

For each batch, the manufacturer shall record the supplier and lot number of each ingredient. A sample (minimum one pint) shall be retained from each batch. Records and samples shall be maintained for two years from date of production.

23 Portable toilets

23.1 Scope

Portable toilets covered by this section are intended for use in recreational vehicles and may be with or without a detachable holding tank.

23.2 Materials

The tanks shall be constructed of a non-corrosive material such as stainless steel, thermoplastic, thermoset plastic, or of materials with noncorroding surfaces.

23.3 Flush water holding tank design and construction

The tanks shall provide not less than 2 U.S. gal (7.6 L) storage capacity. Tanks shall not be designed to be plumbed into a potable water distribution system.

23.3.1 Portable tanks shall be provided with a readily accessible means of attaching to the mating wastewater holding tank.
23.3.2 Portable flush water holding tank shall be provided with handles for carrying.

23.4 Waste holding tank design and construction

The tank shall provide not less than 2 U.S. gal (7.6 L) storage capacity.

23.4.1 The portable waste holding tank shall be provided with a readily accessible means of attaching to the mating flush water tank.

23.4.2 The portable waste holding tank inlet port shall seal in both directions when in the closed position.

23.4.3 The portable toilet and/or portable waste holding tank shall be provided with a handle for carrying.

23.4.4 The portable waste holding tank shall be provided with a sealing closure.

23.4.5 Waste outlets, including discharge fittings, hoses, or other appurtenant devices, shall be capable of passing a 2.0 in (50.8 mm) diameter ball.

23.5 Performance

Portable toilets shall comply with the following requirements when operated according to the manufacturer's instructions.

23.5.1 Flush and waste tanks shall be watertight when filled to capacity.

23.5.2 Toilet bowls shall not lose more than 10% of water volume when operated according to the manufacturer's instructions and tested at 73 ± 3 °F (23 ± 0.5 °C) for at least 24 h.

23.5.3 The flushing mechanism shall be designed so that all interior bowl surfaces are rinsed during the flushing cycle. All component parts shall be accessible for adjustment or replacement.

23.5.4 Portable toilets shall be subjected to a minimum of 1000 flush cycles without evidence of failure.

23.5.5 Flush and waste tanks shall withstand a 10 foot pound-force (13.6-J) impact at 32 °F (-1.1 °C) and a 20 foot pound-force (27.1-J) impact at 90 °F (32.2 °C) when tested in accordance with ASTM D2444 using Tup B.

24 Installed toilet systems with detachable waste holding tanks

24.1 Scope

Toilet systems covered by this section are intended for installation in recreational vehicles. They are specifically designed with removable portable waste holding tanks and may or may not be supplied with water from the potable water distribution system.

24.2 Materials

The tanks shall be constructed of non-corrosive materials such as stainless steel, thermoplastic, thermoset plastic, or of materials with noncorroding surfaces.
24.3 Design and construction - plumbed systems

24.3.1 The toilet system shall be designed with a means to prevent accidental overfill of the waste holding tank to preclude waste spillage inside the vehicle or in the tank compartment.

24.3.2 The toilet shall be equipped with a vacuum breaker or equivalent device meeting the applicable requirements of ASSE 1001 installed on the discharge side of the last control valve in the potable water supply line, and be protected from physical damage and contamination.

24.3.3 The toilet or bowl portion shall be sealed to the detachable waste holding tank. The connection shall be readily accessible.

24.4 Design and construction – systems that are not plumbed

24.4.1 The toilet system shall be designed with a means to prevent accidental overfill of the waste holding tank to preclude waste spillage inside of the vehicle or in the tank compartment.

24.4.2 The toilet or bowl portion shall be sealed to the detachable waste holding tank. The connection shall be readily accessible.

24.4.3 The toilet or bowl portion shall be provided with a flush water holding tank.

24.5 Detachable waste holding tank design and construction

The tank shall provide not less than 3 U.S. gal (11.4 L) storage capacity.

24.5.1 The toilet or bowl portion shall be sealed to the detachable waste holding tank. The connection shall be readily accessible.

24.5.2 The waste holding tank inlet and outlet ports shall be provided with a sealed closure.

24.5.3 The detachable waste holding tank shall be provided with a handle for carrying.

24.5.4 The waste holding tank outlet, including discharge fittings, hoses, or other appurtenant devices, shall be capable of passing a 2 in (50.8 mm) diameter ball.

24.6 Performance requirements

Installed toilets with detachable waste holding tanks shall comply with the following requirements when operated according to the manufacturer's instructions.

24.6.1 Detachable waste holding tanks shall be watertight when filled to capacity.

24.6.2 Toilets with plumbed systems shall operate at a minimum flow pressure of 8 psig (55.2 kPa) and a maximum static pressure of 100 psig (690 kPa).

24.6.3 Toilet bowls shall not lose more than 10 percent of water volume when operated according to the manufacturer's instructions and tested at 73 ± 3 °F (23 ± 0.5 °C) for at least 24 h.
24.6.4 The flushing mechanism shall be designed so that interior bowl surfaces are rinsed during the flushing cycle.

24.6.5 The toilet and detachable waste holding tank shall be subjected to a minimum of 1000 flush cycles without evidence of failure.

24.6.6 The detachable waste holding tank shall withstand a 10 foot pound-force (13.6-J) impact at 32 °F (0 °C) and a 20 foot pound-force (27.1-J) impact at 90 °F (32.2 °C) when tested in accordance with ASTM D2444 using Tup B.