

HAWAII ADMINISTRATIVE RULES

TITLE 12

DEPARTMENT OF LABOR AND INDUSTRIAL RELATIONS

SUBTITLE 8

HAWAII OCCUPATIONAL SAFETY AND HEALTH DIVISION

PART 10

PRESSURE RETAINING ITEMS

CHAPTER 224.1

PRESSURE VESSELS

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Historical Note: This chapter is based substantially upon chapter 224. [Eff 12/6/82; am 12/19/83; am 12/8/86; am and comp 12/6/90; am 11/18/12; R 12/21/19]

§12-224.1-1 Scope. The requirements in this section shall apply to pressure vessels, except for the exemptions in section 12-220-2.1 (c)(3) and (4), and is not limited to the following:

- (1) All unfired pressure vessels with design pressure exceeding fifteen (15) psi or five (5) cubic feet in volume;
- (2) Hot water storage tanks with a nominal water containing capacity greater than one hundred-twenty (120) gallons;
- (3) Unfired autoclaves greater than five (5) cubic feet in volume regardless of operating pressure;
- (4) Fired or self-contained sterilizers, jacketed kettles, steam cookers, and autoclaves exceeding a heat input of three (3.0) kw or a volume of one and a half (1.5) cubic feet;
- (5) Unfired jacketed kettles with a cooking capacity of forty (40) gallons or more;
- (6) Heat exchangers with a heat input exceeding 200,000 Btu/H or five (5) cubic feet in volume;
- (7) Hydro pneumatic tanks exceeding one hundred twenty (120) gallons in volume;
- (8) Expansion tanks exceeding five (5) cubic feet in volume for hot water heating system; and
- (9) Pressure Vessels for Human Occupancy (PVHOs). [Eff and comp; 12/21/19; am and comp SEP - 3 2024] (Auth: HRS §397-4) (Imp: HRS §397-4)

§12-224.1-2 General requirements. (a) All pressure vessels in operation in this jurisdiction shall have a current and valid operating permit issued to a specific location by the department. Changes in ownership shall require notifying the department and may require reinspection.

(b) All pressure vessels shall bear the ASME Code Symbol Stamp "HLW", "U", "U2", "U3", "RP" or ASME certification mark with the appropriate designator and

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the NB registration number. The ASME/NB stamping shall be legible, and insulation and paint shall not conceal the stamping.

(c) Upon completion of the installation of a new pressure vessel, it shall be marked by an inspector employed by the department with a state serial number, consisting of letters and figures not less than 5/16 inch in height and arranged as HPV####-Year.

(d) Replacement of an existing pressure vessel shall be in accordance with the requirements for new installations. [Eff and comp 12/21/19; comp SEP - 8 2024] (Auth: HRS §397-4) (Imp: HRS §397-4)

§12-224.1-3 Responsibilities of owners and users. (a) The owner or user of the pressure vessel is responsible for ensuring that all equipment meet the requirements of the jurisdiction at the point of installation including licensing, registration, and certification of those performing installations.

(b) Owners or users shall ensure operating permit renewal inspections are completed prior to the permit expiration date. It is the responsibility of the owner or user to schedule pressure vessel permit renewal inspections.

(c) Operation of pressure vessels with expired operating permits is not allowed and may be subject to penalties as described in this part. Requests for the extension of operating permits may be considered for valid reasons by submitting a written request to the chief boiler inspector. The unavailability of special inspectors to conduct inspections is not a valid reason for requesting permit extensions; inspectors employed by the department may perform the inspections in the absence of special inspectors. [Eff and comp 12/21/19; comp SEP - 8 2024] (Auth: HRS §397-4) (Imp: HRS §397-4)

§12-224.1-4 Inspections. (a) Initial acceptance

inspections shall be conducted and witnessed by the chief boiler inspector or deputy inspector designee. These inspections may include internal inspection where construction permits, post installation pressure test at the inspector's discretion, and operational testing of controls and safety devices by the installer, contractor, or owner. Tests shall be made in conformance with the procedures set forth in ASME BPVC, NBIC, and this part.

(b) Permit renewal inspections. Pressure vessels shall receive a permit renewal inspection every two years. Pressure vessels that are under the ownership, inspection, and supervision of an OUIO may be inspected on a different inspection frequency upon approval by the chief boiler inspector.

(c) Additional inspection requirements include the following:

- (1) Internal inspections, where construction permits and hydrostatic testing, which may be required at the inspector's discretion, shall occur when deemed necessary for continued safe operation of the pressure vessel;
- (2) The owner shall develop safety policies and procedures for entering pressure vessels and confined spaces;
- (3) Pressure vessels used for the treatment of wood shall be scrubbed clean for close visual inspection every ten years;
- (4) The installer shall exercise care during installation to prevent loose weld material, welding rods, small tools, and miscellaneous scrap metal from getting into the vessel. Prior to making the final closure, the installer shall inspect the interior of the vessel and its appurtenances for the presence of foreign debris, and if present the debris shall be removed;
- (5) Subject to the department's requirements, a leak test may be performed on any components whose pressure test is not documented under the items' manufacturer's data report. This leak test should not exceed ninety percent (90%) of the lowest pressure relief device

- setpoint. The test data shall be recorded, and the data made available as required; and
- (6) Prior to final acceptance, an operational test shall be performed on the completed installation. The test shall include operating controls, limit controls and safety devices, and witnessed as required by the department. The test data shall be recorded, and the data made available to the department as evidence that the installation complies with provisions of the governing code(s) of construction.
[Eff and comp 12/21/19; am and comp SEP - 3 2024] (Auth: HRS §397-4)
(Imp: HRS §397-4)

§12-224.1-5 Technical installation requirements.

(a) All pressure vessels shall be installed as required in section 12-220-2.1 and this chapter. An application for installation permit shall be submitted to the department prior to the commencement of work. Pressure vessels installed without an installation permit may be subject to citations with penalties up to \$10,000 per day pursuant to section 12-220-22.

(b) First acceptance inspection and certification. The following shall apply to first acceptance inspections and certifications:

- (1) Upon completion of the installation, the contractor or owner shall arrange for acceptance inspection with the department;
- (2) The installing contractor shall operationally test the pressure vessel controls and safety devices prior to scheduling first acceptance inspection with the department;
- (3) The chief boiler inspector or designated deputy inspector shall conduct the first data inspection, acceptance inspection, and apply the required state pressure vessel identification marking; and
- (4) The installing contractor shall test the pressure vessel as directed and witnessed by the chief boiler inspector or designated

deputy inspector.

(c) Clearances. All pressure vessel installations must allow sufficient clearance for normal operation, maintenance, and inspection (internal and external). Except as otherwise authorized by the department, clearances for pressure vessels shall not be less than three (3) feet where inspection openings are provided. Vessels having manholes shall have five (5) feet clearance from the manhole opening and any wall, ceiling, or piping that may prevent a person from entering. All other sides shall not be less than eighteen (18) inches between the vessel and adjacent walls or other structures. Alternative clearances in accordance with the manufacturer's recommendations are subject to acceptance by the department.

(d) Pressure relief devices. All pressure vessels shall be protected by pressure relief devices in accordance with the following requirements:

(1) Device requirements:

- (A) Each pressure vessel shall be provided with pressure relief devices, to protect against overpressure. These pressure relief devices shall bear the National Board "NB" symbols, the ASME certification mark, and the appropriate designator, as required by the ASME BPVC;
- (B) Deadweight or weighted lever pressure relief valves shall not be used;
- (C) An unfired steam boiler shall be equipped with pressure relief valves as required in NBIC Part 1, 2.9;
- (D) Pressure relief devices shall be selected (e.g., material, pressure, etc.) and installed such that their proper functioning will not be hindered by the nature of the vessel's contents; and
- (E) Relief valves, safety valves, or safety relief valves shall be of the hand lift lever type whenever possible to facilitate actuating and testing the device for free operation;

(2) Number of devices. At least one device shall be provided for protection of a pressure

vessel. Pressure vessels with multiple chambers with different maximum allowable working pressures shall have a pressure relief device to protect each chamber under the most severe coincident conditions;

- (3) Location. The following shall apply to location of devices:
 - (A) The pressure relief device shall be installed directly on the pressure vessel, unless the source of pressure is external to the vessel and is under such positive control that the pressure cannot exceed the maximum overpressure permitted by the original code of construction and the pressure relief device cannot be isolated from the vessel, except as permitted by NBIC Part 1, 4.5.6(e)(2);
 - (B) Pressure relief devices intended for use in compressible fluid service shall be connected to the vessel in the vapor space above any contained liquid or in the piping system connected to the vapor space; and
 - (C) Pressure relief devices intended for use in liquid service shall be connected below the normal liquid line. The liquid level during upset conditions shall be considered;
- (4) Capacity. The following shall apply to the capacity of pressure relief devices:
 - (A) The pressure relief device(s) shall have sufficient capacity to ensure that the pressure vessel is not exposed to pressure greater than that specified in the original code of construction;
 - (B) Vessels connected by a system of piping not containing valves that can isolate any pressure vessel shall be considered as one unit when determining capacity requirements;
 - (C) Heat exchangers and similar vessels shall be protected with a pressure relief device of sufficient capacity to avoid

- overpressure in case of internal failure;
and
- (D) The owner shall make information regarding the basis of pressure relief device selection, including required capacity, available to the jurisdiction;
- (5) Set pressure. The following shall apply to the set pressure of pressure relief devices:
- (A) When a single pressure relief device is used, the set pressure marked on the device shall not exceed the maximum allowable working pressure; and
 - (B) When more than one pressure relief device is provided to obtain the required capacity, only one pressure relief device set pressure needs to be at the maximum allowable working pressure. The set pressures of the additional pressure relief devices shall be such that the pressure cannot exceed the overpressure permitted by the code of construction;
and
- (6) Installation and discharge piping requirements. The following shall apply to the installation and discharge piping of pressure relief devices:
- (A) The opening through all pipe and fittings between a pressure vessel and its pressure relief device shall have at least the area of the pressure relief device inlet. The characteristics of this upstream system shall be such that the pressure drop will not reduce the relieving capacity below that required or adversely affect the proper operation of the pressure relief device. When a discharge pipe is used, the size shall be such that any pressure that may exist or develop will not reduce the relieving capacity below that required or adversely affect the proper operation of the pressure relief device. It shall be as short and straight as possible and

- arranged to avoid undue stress on the pressure relief device;
- (B) A non-reclosing device installed between a pressure vessel and a pressure relief valve shall meet the requirements of subparagraph (A);
 - (C) The opening in the pressure vessel wall shall be designed to provide unobstructed flow between the vessel and its pressure relief device;
 - (D) When two or more required pressure relief devices are placed on one connection, the inlet cross-sectional area of this connection shall be sized either to avoid restricting flow to the pressure relief devices or made at least equal to the combined inlet areas of the pressure relief devices connected to it. The flow characteristics of the upstream system shall satisfy the requirements of NBIC Part 1, 4.5.6(e); and
 - (E) There shall be no intervening stop valves between the vessel and its pressure relief device(s), or between the pressure relief device(s) and the point of discharge, except under the following conditions:
 - (i) When these stop valves are so constructed or positively controlled that the closing of the maximum number of block valves at one time will not reduce the pressure relieving capacity below the required relieving capacity;
 - (ii) Upon specific acceptance of the jurisdiction, when necessary for the continuous operation of processing equipment of such a complex nature that shutdown of any part is not feasible, a full area stop valve between a pressure vessel and its pressure relief device shall be provided for inspection and repair purposes only. This stop valve shall

be arranged so that it can be locked or sealed open, and it shall not be closed except by an authorized person who shall remain stationed there during that period of operation while the valve remains closed. The valve shall be locked or sealed in the open position before the authorized person leaves the station;

(iii) A full area stop valve shall also be placed on the discharge side of a pressure relief device when its discharge is connected to a common header for pressure relief devices to prevent discharges from these other devices from flowing back to the first device during inspection and repair. This stop valve shall be arranged so that it can be locked or sealed open, and it shall not be closed except by an authorized person who shall remain stationed there during that period of operation while the valve remains closed. The valve shall be locked and sealed in the open position before the authorized person leaves the station. This valve shall only be used when a stop valve on the inlet side of the pressure relief device is first closed;

(iv) A pressure vessel in a system where the pressure originates from an outside source shall have a stop valve between the vessel and the pressure relief device, and this valve need not be sealed open, provided it also closes off that vessel from the source of the pressure;

(v) All pressure relief devices shall

- relieve to a safe point of discharge;
- (vi) Discharge lines from pressure relief devices shall be designed to facilitate drainage or be fitted with drains to prevent liquid from collecting in the discharge side of a pressure relief device. The size of discharge lines shall be such that any pressure that may exist or develop will not reduce the relieving capacity of the pressure relief device or adversely affect the operation of the pressure relief device. It shall be as short and straight as possible and arranged to avoid undue stress on the pressure relief device;
 - (vii) Pressure vessel pressure relief devices and discharge piping shall be safely supported. The reaction forces due to discharge of pressure relief devices shall be considered in the design of the inlet and discharge piping. Design of supports, foundations, and settings shall consider vibration (including seismic when necessary), movement (including thermal movement), and loadings (including reaction forces during device operation) in accordance with jurisdictional requirements, manufacturer's recommendations, and/or other industry standards, as applicable; and
 - (viii) Pressure relief devices shall be installed so they are readily accessible for inspection, repair, or replacement.
- (e) Supports. Pressure vessels and associated piping shall be safely supported. The potential for future pressure tests of the vessel after installation

shall be considered when designing vessel supports. Design of supports, foundations, and settings shall consider vibration (including seismic and wind loads where necessary), movement (including thermal expansion and contraction), grounding/bonding to minimize electrolytic corrosion, and loadings (including the weight of water during a pressure test) in accordance with department requirements, manufacturer's recommendations, and other industry standards, as applicable.

(f) Piping. Piping loads on the vessel nozzles shall be considered. Piping loads include weight of the pipe, weight of the contents of the pipe, and expansion of the pipe from temperature and pressure changes (wind and seismic loads). The effects of piping vibration on the vessel nozzles shall also be considered.

(g) Bolting. All mechanical joints and connections shall conform to the manufacturers' installation instructions and recognized standards acceptable to the jurisdiction.

(h) Instruments and controls. The following shall apply to the instruments and controls of pressure vessels:

(1) Level indicating devices of steam drums of unfired steam boilers shall be provided with two level indicating devices. Direct level indicating devices shall be connected to a single water column or connected directly to the drum, and the connections and pipe shall be not less than NPS 1/2 (DN 15). Indirect level indicating devices acceptable to the jurisdiction may be used; and

(2) The pressure indicating devices of each pressure vessel, or system of pressure vessels with no intervening valves, shall be equipped with a pressure gage graduated to not less than one and a half (1-1/2) times nor more than three (3) times the pressure which the safety or safety relief valve is set.

(i) Isolating valves. Each pressure vessel or multiple pressure vessels connected in series shall have isolating valves which isolate the vessel or vessels from the system in which it or they are installed.

(j) Additional requirements for compressed air vessels. The following shall apply to compressed air vessels:

- (1) Under no circumstances shall an air receiver be buried underground or located in an inaccessible place;
- (2) Belt guards shall be installed on air compressor units fitted with drive belts;
- (3) Drain pipe and valve shall be installed at the lowest point of every pressure vessel subject to internal corrosion to provide for draining or the removal of accumulated oil and water from an air receiver. Adequate automatic traps may be installed in addition to drain valves. The drain valve on an air receiver shall be opened and drained frequently at such intervals as to prevent the accumulation of excessive amounts of liquids in the receiver; and
- (4) The use of thermoplastic piping, known as PVC piping, to transport compressed air or other compressed gases, or the testing of this piping with compressed air or other compressed gases, in exposed above ground locations is prohibited. All thermoplastic piping used to transport compressed air or other compressed gases shall be buried underground or encased in shatter-resistant materials. In designing a thermoplastic piping system to transport compressed air or other compressed gases, the strength at the operating temperature, the pressure, the energetics, and specific failure mechanisms shall be evaluated.

(k) Additional requirements for hot water storage tanks. The following shall apply to hot water storage tanks:

- (1) Temperature and pressure relief devices. Each potable hot water storage tank shall be equipped with an ASME/NB certified temperature and pressure relief valve set at a pressure not to exceed the maximum allowable working pressure and 210 degrees Fahrenheit or the maximum allowable working temperature of the

- vessel as designed. The temperature and pressure relief valve shall meet the requirements of NBIC Part 1 4.5;
- (2) Potable hot water storage tanks exceeding the pressure limit of ASME Code Section IV shall meet the original code of construction and shall be protected by a pressure relief valve set not to exceed the vessel's maximum allowable working pressure. A temperature limiting device shall be installed so that the water inside the storage tank does not exceed 210 degrees Fahrenheit (99 Celsius).
Examples of temperature limiting devices:
- (A) Operating temperature control and high temperature limit switch with manual reset installed at the potential source;
 - (B) Automatic self-adjusting over-temperature protection;
 - (C) Tempering and mixing valves; and
 - (D) Solenoid operated dump valves with thermostat probe rated for 210 degrees Fahrenheit maximum scale range setting;
- (3) Clearances and accessibility. In addition to the clearance requirements under section 12-224.1-5(c), each hot water storage tank shall have at least twelve (12) inches bottom clearance; and:
- (A) The required nameplate (marking or stamping) shall be exposed and accessible;
 - (B) The openings when required shall be accessible to allow for entry for inspection and maintenance; and
 - (C) Each hot water storage tank shall meet the requirements of NBIC Part 1, 4.3.2;
- (4) Each hot water storage and potable hot water storage tank shall have a thermometer so located that it shall be easily readable at or near the outlet. The thermometer shall be so located that it shall at all times indicate the temperature of the water in the storage tank; and

- (5) Shut off valves. Each hot water storage and potable hot water storage tank shall be equipped with stop valves in the water inlet piping and the outlet piping for the tank to be removed from service without having to drain the complete system. Each tank also shall be equipped with a bottom drain valve to provide for flushing and draining of the vessel.
 - (1) Additional requirements for tanks and heat exchangers include the following:
 - (1) Steam to hot water supply. When a hot-water supply is heated indirectly by steam in a coil or pipe within the service limitations set forth in NBIC Part 1, 3.2, Definitions, the pressure of the steam used shall not exceed the safe working pressure of the hot water tank, and a pressure relief valve at least NPS 1 (DN 25), set to relieve at or below the maximum allowable working pressure of the tank, shall be applied on the tank;
 - (2) High-temperature water to water heat exchanger. When high-temperature water is circulated through the coils or tubes of a heat exchanger to warm water for space heating or hot-water supply, within the service limitations set forth in NBIC Part 1, 3.2, Definitions, the heat exchanger shall be equipped with one or more NB capacity certified pressure relief valves set to relieve at or below the maximum allowable working pressure of the heat exchanger, and of sufficient rated capacity to prevent the heat exchanger pressure from rising more than ten percent (10%) above the maximum allowable working pressure of the vessel; and
 - (3) High-temperature water to steam heat exchanger. When high-temperature water is circulated through the coils or tubes of a heat exchanger to generate low pressure steam, within the service limitations set forth in NBIC Part 1, 3.2, Definitions, the heat exchanger shall be equipped with one or more

National Board capacity certified pressure relief valves set to relieve at a pressure not to exceed fifteen (15) psig (100 kPa), and of sufficient rated capacity to prevent the heat exchanger pressure from rising more than five (5) psig (34 kPa) above the maximum allowable working pressure of the vessel. For heat exchangers requiring steam pressures greater than fifteen (15) psig (100 kPa), refer to NBIC Part 1, Section 2 or Section 4.

- (m) Description and concerns of specific types of pressure vessels.
 - (1) Compressed air vessels, including receivers, separators, filters, and coolers. Considerations of concern include temperature variances, pressure limitations, vibration, and condensation. Drain connections shall be verified to be free of any foreign material that may cause plugging; and
 - (2) Pressure Vessels for Human Occupancy (PVHOs). The following shall apply to the inspection of PVHOs:
 - (A) General and operational. PVHOs shall be constructed in accordance with ASME PVHO-1, which adopts ASME BPV Section VIII, therefore, the vessels shall bear a "U" or "U2" ASME designator. Inspections shall be conducted using ASME PVHO-2 for reference. FOR PVHOs manufactured from non-traditional materials, such as fabrics, PVHO-1 Code Cases shall apply and have all the documentation required by the code case, but not necessarily have any related section ASME BPV Section VIII forms;
 - (B) Cast and ductile iron fittings are not allowed;
 - (C) Due to the human occupancy element, a person shall be in attendance to monitor the PVHO when in operation, in the event there is an accident;
 - (D) The installation shall be such that there is adequate clearance to inspect it

properly. In some applications, such as underground tunneling, it may be impossible to perform a complete external inspection;

- (E) Internal inspection. Where existing openings permit, perform a visual internal inspection of the vessel. Look for any obvious cracks and note areas that are subject to high stress such as welds, welded repairs, head-to-shell transitions, sharp interior corners, and interior surfaces opposite external attachments or supports. The vessel shall be free of corrosion, damage, dents, gouges, or other damage. All openings leading to external fittings or controls shall be free from obstruction. All exhaust inlets shall be checked to prevent a chamber occupant from inadvertently blocking the opening;
- (F) External inspection. The inspector shall closely examine the external condition of the pressure vessel for corrosion, damage, dents, gouges, or other damage. The lower half and the bottom portions of insulated vessels shall receive special focus, as condensation or moisture may gravitate down the vessel shell and soak into the insulation, keeping it moist for long periods of time. Penetration locations in the insulation or fireproofing such as saddle supports, sphere support legs, nozzles, or fittings shall be examined closely for potential moisture ingress paths. When moisture penetrates the insulation, the insulation may actually work in reverse, holding moisture in the insulation or near the vessel shell. Insulated vessels that are run on an intermittent basis or that have been out of service require close scrutiny. In general, a visual inspection of the vessel's insulated surfaces shall

be conducted once per year. The most common and superior method to inspect for suspected corrosion under insulation (CUI) damage is to completely or partially remove the insulation for visual inspection. The method most commonly utilized to inspect for CUI without insulation removal is by X-ray and isotope radiography (film or digital), or by real time radiography, utilizing imaging scopes and surface profilers. The real-time imaging tools will work well if the vessel geometry and insulation thickness allows. Other less common methods to detect CUI include specialized electromagnetic methods (pulsed eddy current and electromagnetic waves) and long-range ultrasonic techniques (guided waves). There are also several methods to detect moisture soaked insulation, which is often the beginning for potential CUI damage. Moisture probe detectors, neutron backscatter, and thermography are tools that can be used for CUI moisture screening. Proper surface treatment (coating) of the vessel external shell and maintaining weather-tight external insulation are the keys to prevention of CUI damage;

- (G) Inspection of parts and appurtenances (e.g., piping systems, pressure gage, bottom drain). As stated above, cast iron is not allowed on PVHOs and shall be replaced with parts fabricated with other suitable materials, in accordance with ASME BPVC Section II. If valves or fittings are in place, check to ensure that these are complete and functional. The inspector shall note the pressure indicated by the gage and compare it with other gages on the same system. If the pressure gage is not mounted on the vessel itself, it shall be ascertained

that the gage is installed on the system in such a manner that it correctly indicates actual pressure in the vessel. The inspector shall verify that the vessel is provided with a drain opening. The system shall have a pressure gage designed for at least the most severe condition of coincident pressure in normal operation. This gage shall be clearly visible to the person adjusting the setting of the pressure control valve. The graduation on the pressure gage shall be graduated to not less than one and a half (1.5) times the maximum allowable working pressure (MAWP) of the vessel. Provisions shall be made to calibrate pressure gages or to have them checked against a standard test gage. Any vents and exhausts shall be piped at least ten (10) feet from any air intake. Venting shall be provided at all high points of the piping system;

- (H) Inspection of view ports and windows. Each window shall be individually identified and be marked in accordance with PVHO-1. If there are any penetrations through windows, they must be circular. Windows must be free of crazing, cracks, and scratches. Windows and viewports have a maximum interval for seat or seal inspection and refurbishment. Documentation shall be checked to ensure compliance with PVHO-2, Table 2-4.3-1, Table 2-4.3-2 (see Exhibit 1); and
- (I) Inspection of pressure relief devices. Pressure relief devices must have a quick opening manual shutoff valve installed between the chamber and the pressure relief device, with a frangible seal in place, within easy access to the operator. The pressure relief device shall be constructed in accordance with

ASME BPVC Section VIII. The discharge from the pressure relief device must be piped outside to a safe point of discharge. Rupture disks may be used only if they are in series with a pressure relief valve, or when there is less than two (2) cubic feet of water volume. Verify that the safety valve is periodically tested either manually by raising the disk from the seat or by removing and testing the valve on a test stand. [Eff and comp 12/21/19; am and comp SEP - 4 2021] (Auth: HRS §397-4) (Imp: HRS §397-4)

§12-224.1-6 Installation of pressure vessels for human occupancy (PVHOs)

(a) Scope. This section provides general information and guidance for installation to help manufacturers, owners, users, and inspectors understand PVHO systems and their unique characteristics. The PVHO systems covered in this section include only monoplace (single human occupancy) medical systems used for Hyperbaric Oxygen Therapy (HBO). The PVHO system is comprised of one or more monoplace PVHOs each with pressurization and vent controls, monitoring, and communication supplied by facility medical gas systems or dedicated breathing gas systems, gas distribution, controls, and gas storage.

(b) General. A pressure vessel for human occupancy, as defined by ASME PVHO-1, is a pressure vessel that encloses one or more human beings within its pressure boundary while it is subject to internal or external pressure that exceeds a two (2) psi (15 kPa) differential pressure. PVHOs include, but are not limited to, submersibles, diving bells, personal transfer capsules, decompression chambers, recompression chambers, hyperbaric chambers, high-altitude chambers, and medical hyperbaric oxygenation facilities. Unique characteristics of PVHOs include:

- (1) Fire hazard due to oxygen enrich environment;

- (2) Fire hazard due to in-service hydrocarbon contamination;
 - (3) Rapid decompression hazard;
 - (4) Pressure boundary valves at PVHO penetrators;
 - (5) Cleanliness of gases inside the PVHO system;
 - (6) In-service life expectancy of flat disc acrylic windows in protected environments, including cylindrical windows, can be up to twenty years with periodic inspections;
 - (7) Manual or pneumatic control systems; and
 - (8) Heat, ultraviolet light, and solvents are harmful to acrylic windows.
- (c) Documentation, registration, and regulatory requirements. The following shall apply:
- (1) PVHO systems shall be designed and constructed in accordance with ASME PVHO-1. This code requires Section VIII for steel and other allowed vessel materials and therefore shall bear a "U" or "U2" ASME designator and forms. PVHO-1 also has several Code Cases that address PVHOs manufactured from non-Section VIII materials such as reinforced fabrics. PVHO Code Cases are subject to jurisdictional authority and shall have all the documentation required by the Code Case, but not necessarily Section VIII forms;
 - (2) Viewport acrylic windows shall be designed and constructed in accordance with PVHO-1 and maintained following the rules of PVHO-2. The owner and user should follow PVHO-2 and manufacturer manuals for in-service guidance;
 - (3) The manufacturer shall retain PVHO system documentation or submit and register with the NB; and
 - (4) The PVHO system owner shall have copies of the following documents on site:
 - (A) Manufacturer data report for a Section VIII vessel (FORM U1-A or U2-A);
 - (B) Manufacturer data report for PVHO-1 (Form GR-1);
 - (C) PVHO-1 Forms VP-1 to VP-5;
 - (D) PVHO system installation instructions;and

- (E) PVHO system operation and maintenance manuals.
- (d) Pressure vessels for human occupancy system configuration and installation. The following shall apply:
 - (1) PVHOs include the following pressure boundary components:
 - (A) Shells and heads of revolution;
 - (B) Openings and their reinforcements;
 - (C) Nozzles and other connections;
 - (D) Door seals and quick actuating closures; and
 - (E) Viewports including acrylic windows;
 - (2) Pressure vessels designed for human occupancy (such as decompression or hyperbaric chambers) shall be provided with a quick opening stop valve between the pressure vessel and its pressure relief valve. The stop valve shall be normally sealed open with a frangible seal and be readily accessible to the pressure relief attendant;
 - (3) A PVHO system, comprised of one or more monoplace PVHOs each with operational controls, should be supplied by a hospital or clinic medical gas system. Installers of medical gas systems that meet NFPA 99 Chapter 5 requirements should be qualified to, and hold third-party certification, in accordance with American Society of Safety Engineers 6010;
 - (4) Facility installation. The following shall apply to facility installation:
 - (A) PVHO systems installed and operated within buildings are subject to local building codes, NFPA 99, and the requirements of the department;
 - (B) The rooms designated for PVHO systems shall be adequately sized, allowing operation and inspection access to all sides of the PVHO

- system, and dedicated to only hyperbaric system operation;
- (C) PVHO system oxygen exhaust and ventilation lines shall be independently piped to the building exterior; and
- (D) Temperature in the PVHO room should be maintained for patient comfort;
- (5) Electrical. The following shall apply to electrical components of PVHOs:
 - (A) All electrical controls should be located externally;
 - (B) Electrically powered control equipment should be connected to grounded facility outlets matching the equipment power specifications;
 - (C) Electrical penetration connectors should be as specified by the manufacturer and checked for leak tightness;
 - (D) Electrical wiring should be supported to prevent obstruction or tripping hazard; and
 - (E) Electrical systems within the PVHO should protect low-voltage communication and monitoring equipment from being exposed to voltages greater than twenty-eight (28) volts alternative current and currents greater than 0.5 amps and should be grounded in accordance with NFPA 99 Chapter 14;
- (6) Controls. The following shall apply to PVHO controls:
 - (A) Medical PVHO controls, piping, hoses, connections, pressure gages, control valves, gas system should meet PVHO-1 Section 4-Piping Systems, and Section 5-Medical Hyperbaric Systems;
 - (B) Pressurization, ventilation, and depressurization controls should be manual or pneumatic;

- (C) The operator at the PVHO control station should be present and have visual sight and audio communication with PVHO occupant during operation;
 - (D) Separate oxygen and air supply to the PVHO and occupant should be from the facility medical gas systems or a standalone medical gas system;
 - (E) The gas system should be sized (both flow and volume) for normal and emergency PVHO operations in accordance with manufacturer's specification or manual. The owner shall have this information available on-site; and
 - (F) The facility gas system piping or tubing and controls shall be secured to the facility structure up to the adjacent PVHO wall connects. Hoses or tubing shall connect to these wall connections and supply the gases to the PVHO operational controls. Hoses or tubing shall be secured to prevent obstruction or tripping hazards;
- (7) Internal system cleanliness and toxicity. The following shall apply:
- (A) PVHO systems that include breathing gas systems with air and oxygen enriched gases (greater than 25 per cent oxygen) shall be cleaned and maintained to NFPA 99 Chapter 5; and national consensus standards (e.g., Compressed Gas Association);
 - (B) Manufacturer maintenance manuals shall be available on site and provide guidance for the owner or user to maintain system cleanliness, and prevent contamination during operation and maintenance; and
 - (C) Hoses shall be off-gas toxicity tested prior to installation;

- (8) Maintenance. The following shall apply to maintenance:
- (A) PVHO systems shall be maintained in accordance with PVHO-2 and the manufacturer's maintenance manual;
 - (B) Periodic window inspections shall be performed in accordance with PVHO-2; and
 - (C) Replacement windows shall meet PVHO manufacturer specifications (with new PVHO-1 VP-1 to VP-5 forms), and once installed checked for leak tightness. [Eff SEP - 8 2024]
(Auth: HRS §397-4) (Imp: HRS §397-4)