HAWAII ADMINISTRATIVE RULES

TITLE 12

DEPARTMENT OF LABOR AND INDUSTRIAL RELATIONS

SUBTITLE 8

HAWAII OCCUPATIONAL SAFETY AND HEALTH DIVISION

PART 10

BOILER AND PRESSURE VESSELS

CHAPTER 224.1

PRESSURE VESSELS

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 DEC 2 1 2019]

§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 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 DEC 21 2019] (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 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 DEC 21 2019] (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 DEC 21 2019] (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; and

(3) Pressure vessels used for the treatment of wood shall be scrubbed clean for close visual inspection every ten years.

[Eff and comp DEC 21 2019] (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

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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) The opening in the pressure vessel wall shall be designed to provide unobstructed flow between the vessel and its pressure relief device;

(C) 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

(D) 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;

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(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;

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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

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(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

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(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) The opening in the pressure vessel wall shall be designed to provide unobstructed flow between the vessel and its pressure relief device;

(C) 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

(D) 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) Pressure relief device discharges shall be arranged such that they are not a hazard to personnel or other equipment and, when necessary, lead to a safe location for disposal of fluids being relieved;

(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; and

(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.

(e) Supports. Each pressure vessel shall be safely supported. The potential for future hydrostatic 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 movement), and loadings (including the weight of water during a hydrostatic test) in accordance with jurisdictional

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) Safety relief devices. Each hot water storage tank shall be equipped with an ASME/NB certified temperature and pressure relieving device 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 relieving device shall meet the requirements of NBIC Part 1 4.5;

(2) Hot water storage tanks greater than 160 Psi maximum allowable working pressure shall be equipped with an ASME/NB certified temperature and pressure relieving device set at a pressure not to exceed the maximum allowable working pressure and 210 degrees Fahrenheit. In lieu of this requirement, such tanks may be equipped with incompressible fluid pressure rated relief valves with appropriate relieving capacity provided the hot water system is installed with an over-temperature protection that adequately prevent the generation of hot water in excess of 210 degrees Fahrenheit; and acceptable to the jurisdiction; Examples of system over-temperature protection:
    (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;
    (D) Solenoid operated dump valves with thermostat probe rated for 210 degrees Fahrenheit maximum scale range setting; and
    (E) Any other system of over-temperature protection controls to be demonstrated to function as designed and approved by the jurisdiction;

(3) Clearances. 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;

(4) Each 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 tank shall be equipped with stop valves in the water inlet piping and the outlet piping for the hot water storage tank to be removed from service without having to drain the complete system. Each hot water storage tank also shall be equipped with a bottom drain valve to provide for flushing and draining of the vessel.

(l) Additional requirements for pressure relief valves for steam to hot-water supply heat exchangers. When a hot-water supply is heated indirectly by steam in a coil or pipe within the service limitations set forth in the NBIC, the pressure of the steam used shall not exceed the safe working pressure of the hot water tank, and a safety relief valve of at least NPS 1 set to relieve at or below the maximum allowable working pressure of the tank, shall be applied on the tank.

(m) Description and concerns of specific types of pressure vessels.

(1) Compressed air vessels. The following applies to compressed air vessels:

(A) 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

(B) Inspections of compressed air vessels shall consist of the following:

(i) Welds. Inspect all welds for cracking or gouging, corrosion, and erosion. Particular attention shall be given to the welds that attach brackets supporting the compressor. These welds may fail due to vibration;

(ii) Shells and heads: externally, inspect the base material for environmental deterioration and impacts from objects. Hot spots and bulges are signs of overheating and shall be noted and evaluated for acceptability. Particular attention shall be paid to the lower half of the vessel for corrosion and leakage. For vessels with manways or inspection openings, an internal inspection shall be performed for corrosion, erosion, pitting, excessive deposit buildup, and leakage around inspection openings. Ultrasonic thickness testing (UT) may be used where internal inspection access is limited or to determine actual thickness when corrosion is suspected;

(iii) Fittings and attachments. Inspect all fittings and attachments for alignment, support, deterioration, damage, and leakage around threaded joints. Any internal attachments such as supports, brackets, or rings shall be visually examined for wear, corrosion, erosion, and cracks;

(iv) Operation. Check the vessel nameplate to determine the maximum allowed working pressure and temperature of the vessel. Ensure the set pressure of the safety valve does not exceed that allowed on the vessel nameplate and determine that the capacity of the safety valve is greater than the capacity of the compressor. Ensure there is a functioning manual or automatic condensate drain; and

(iv) Quick closure attachments. Filter-type vessels usually have one quick-type closure head for making filter changes, see NBIC Part 2, 2.3.6.5;

(2) The following shall apply to pressure vessels with quick-actuating closures:

(A) Due to the many different designs of quick-actuating closures, potential failures of components that are not specifically covered shall be considered. The scope of inspection shall include areas affected by abuse or lack of maintenance and a check for inoperable or bypassed safety and warning devices;

(B) Temperatures above that for which the quick-actuating closure was designed can have an adverse effect on the safe operation of the device. If parts are found damaged and excessive temperatures are suspected as the cause, the operating temperatures may have exceeded those temperatures recommended by the manufacturer. Rapid fluctuations in temperatures due to rapid start-up and shutdown may lead to cracks or yielding caused by excessive warping and high thermal stress. A careful observation shall be made of the condition of the complete installation, including maintenance and operation, as a guide in forming an opinion of the care the equipment receives. The history of the vessel shall be established, including: year built, materials of construction, extent of post weld heat treatment, previous inspection results, and repairs or alterations performed. Any leak shall be thoroughly investigated

and the necessary corrective action initiated;

(C) Inspection of parts and appurtenances. Seating surfaces of the closure device, including but not limited to the gaskets, O-rings, or any mechanical appurtenance to ensure proper alignment of the closure to the seating surface, shall be inspected. This inspection can be made by using powdered chalk or any substance that will indicate that the closure is properly striking the seating surface of the vessel flange. If this method is used, a check shall be made to ensure that:

(i) Material used shall not contaminate the gasket or material with which it comes into contact; and

(ii) The substance used shall be completely removed after the examination;

(D) The closure mechanism of the device shall be inspected for freedom of movement and proper contact with the locking elements. This inspection shall indicate that the movable portions of the locking mechanism are striking the locking element in such a manner that full stroke can be obtained. Inspection shall be made to ensure that the seating surface of the locking mechanism is free of metal burrs and deep scars, which would indicate misalignment or improper operation. A check shall be made for proper alignment of the door hinge mechanisms to ensure that adjustment screws and locking nuts are properly secured. When deficiencies are noted, the following corrective actions shall be initiated:

(i) If any deterioration of the gasket, O-ring, etc., is found, the gasket, O-ring, etc., shall be replaced immediately. Replacements shall be in accordance with the vessel manufacturer's specifications;

(ii) If any cracking or excessive wear is discovered on the closing mechanism, the owner or user shall contact the original manufacturer of the device for spare parts or repair information. If this cannot be accomplished, the owner or user shall contact an organization competent in quick-actuating closure design and construction prior to implementing any repairs;

(iii) Defective safety or warning devices shall be repaired or replaced prior to further operation of the vessel;

(iv) Deflections, wear, or warping of the sealing surfaces may cause out-of-roundness and misalignment. The manufacturer of the closure shall be contacted for acceptable tolerances for out-of-roundness and deflection; and

(v) The operation of the closure device through its normal operating cycle shall be observed while under control of the operator. This shall indicate if the operator is following posted procedures and if the operating procedures for the vessel are adequate;

(E) Gages, safety devices, and controls. The required pressure gage shall be installed so that it is visible from the operating area and located in such

a way that the operator can accurately determine the pressure in the vessel while it is in operation. The gage dial size shall be of such a diameter that it can be easily read by the operator. This gage shall have a pressure range of at least one and a half (1.5) times, but not more than four (4) times, the operating pressure of the vessel. There shall be no intervening valve between the vessel and gage;

(F) The pressure gage shall be of a type that will give accurate readings, especially when there is a rapid change in pressure. It shall be of rugged construction and capable of withstanding severe service conditions. Where necessary, the gage shall be protected by a siphon or trap;

(G) Pressure gages intended to measure the operating pressure in the vessel are not usually sensitive or easily read at low pressures approaching atmospheric. It may be advisable to install an auxiliary gage that reads inches of water and is intended to measure pressure from atmospheric through low pressures. This ensures that there is zero pressure in the vessel before opening. It would be necessary to protect the auxiliary low-pressure gage from the higher operating pressures;

(H) Provisions shall be made to calibrate pressure gages or to have them checked against a master gage as frequently as necessary;

(I) A check shall be made to ensure that the closure and its holding elements must be fully engaged in their intended operating position before pressure can be applied to the vessel. A safety interlock device shall be provided that

prevents the opening mechanism from operating unless the vessel is completely depressurized; and

(J) Quick-actuating closures held in position by manually operated locking devices or mechanisms, and which are subject to leakage of the vessel contents prior to disengagement of the locking elements and release of the closure, shall be provided with an audible and/or visible warning device to warn the operator if pressure is applied to the vessel before the closure and its holding elements are fully engaged, and to warn the operator if an attempt is made to operate the locking device before the pressure within the vessel is released. Pressure tending to force the closure clear of the vessel must be released before the closure can be opened for access; and

(3) Inspection of 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. This code adopts ASME BPV Section VIII and therefore the vessels shall bear a "U" or "U2" ASME designator. Inspections should be conducted using ASME PVHO-2 for reference;

(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 DEC 21 2019] (Auth: HRS §397-4) (Imp: HRS §397-4)

Table 2-4.3-1 Maximum Intervals for Maintenance Viewport Inspection

Actual Service Duration and/or Cycles	Protected	Typical	Severe Service
Less than design life	36 months	24 months	18 months
Greater than design life	24 months	18 months	12 months

GENERAL NOTES

(a) Window removal is not required unless deemed necessary by the Inspector.

(b) Because of the critical adjustments of tie rods, cylindrical window chambers should not normally be disassembled on a periodic basis for performance of maintenance viewport inspection.

Table 2-4.3-2 Maximum Intervals for Refurbishment

Type	Maximum Interval
Cylindrical window members	Completely refurbish at 10-year intervals regardless of usage
Metallic transition subassembly	Completely refurbish at 5-year intervals regardless of usage
Metallic closure ring subassembly	Completely refurbish at expiration of reference service life
All other metallic parts	Completely refurbish at expiration of reference service life

GENERAL NOTE: Each subassembly requires a more detailed breakdown of the viewport components and refurbishment procedures.

Table 2-4.3-1 Maximum Intervals for Maintenance Viewport Inspection

Actual Service Duration and/or Cycles	Protected	Typical	Severe Service
Less than design life	36 months	24 months	18 months
Greater than design life	24 months	18 months	12 months

GENERAL NOTES:

(a) Window removal is not required unless deemed necessary by the inspector.

(b) Because of the critical adjustments of tie rods, cylindrical window chambers should not normally be disassembled on a periodic basis for performance of maintenance viewport inspections.

Table 2-4.3-2 Maximum Intervals for Refurbishment

Type	Maximum Interval
Cylindrical window chambers	Completely refurbish at 10-yr intervals regardless of usage
Marine intermittent submersion	Completely refurbish at 10-yr intervals regardless of usage
Marine continuous submersion	Completely refurbish at expiration of extended service life
All other window types	Completely refurbish at expiration of extended service life

GENERAL NOTE: Refurbishment requires a more detailed (hands-on) inspection of the viewport components and requires the complete removal and refurbishment of all viewport components.