

**WAC 296-24-31505 Liquefied hydrogen systems. (1) Design.**

**(a) Containers.**

(i) You must ensure that hydrogen containers comply with the following: Storage containers be designed, constructed, and tested in accordance with appropriate requirements of the ASME Boiler and Pressure Vessel Code, Section VIII—Unfired Pressure Vessels (1968) or applicable provisions of API Standard 620, Recommended Rules for Design and Construction of Large, Welded, Low-Pressure Storage Tanks, Second Edition (June 1963) and Appendix R (April 1965).

(ii) You must ensure that portable containers are designed, constructed and tested in accordance with DOT specifications and regulations.

**(b) Supports.** You must provide permanently installed containers with substantial noncombustible supports securely anchored on firm noncombustible foundations. You must ensure that steel supports in excess of 18 inches in height are protected with a protective coating having a 2-hour fire-resistance rating.

**(c) Marking.** You must legibly mark each container to indicate "LIQUEFIED HYDROGEN—FLAMMABLE GAS."

**(d) Safety relief devices.**

(i) You must equip stationary liquefied hydrogen containers with safety relief devices sized in accordance with CGA Pamphlet S-1-1966, Part 3, Safety Relief Device Standards for Compressed Gas Storage Containers.

(A) Portable liquefied hydrogen containers complying with the U.S. Department of Transportation regulations must be equipped with safety relief devices as required in the U.S. Department of Transportation specifications and regulations. Safety relief devices must be sized in accordance with the requirements of CGA Pamphlet S-1-1966, Safety Relief Device Standards, Part 1, Compressed Gas Cylinders and Part 2, Cargo and Portable Tank Containers.

(ii) You must ensure that safety relief devices are arranged to discharge unobstructed to the outdoors and in such a manner as to prevent impingement of escaping liquid or gas upon the container, adjacent structures or personnel. See (2)(a)(vi) of this section for venting of safety relief devices in special locations.

(iii) You must design or locate relief devices or vent piping so that moisture cannot collect and freeze in a manner which would interfere with proper operation of the device.

(iv) You must provide safety relief devices in piping wherever liquefied hydrogen could be trapped between closures

**(e) Piping, tubing, and fittings.**

(i) Piping, tubing, and fittings and gasket and thread sealants must be suitable for hydrogen service at the pressures and temperatures involved. You must give consideration to the thermal expansion and contraction of piping systems when exposed to temperature fluctuations of ambient to liquefied hydrogen temperatures.

(ii) Gaseous hydrogen piping and tubing (above—20°F) must conform to the applicable sections of Pressure Piping Section 2—Industrial Gas and Air Piping, ANSI B31.1-1967 with addenda B31.1-1969. Design of liquefied hydrogen or cold (-20°F or below) gas piping must use Petroleum Refinery Piping ANSI B31.3-1966 or Refrigeration Piping ANSI B31.5-1966 with addenda B31.5a-1968 as a guide.

(iii) Joints in piping and tubing must preferably be made by welding or brazing; flanged, threaded, socket, or suitable compression fittings may be used.

(iv) You must provide means to minimize exposure of personnel to piping operating at low temperatures and to prevent air condensate from contacting piping, structural members, and surfaces not suitable for cryogenic temperatures. Only those insulating materials which are rated nonburning in accordance with ASTM Procedures D1692-68 may be used. Other protective means may be used to protect personnel. The insulation must be designed to have a vapor-tight seal in the outer covering to prevent the condensation of air and subsequent oxygen enrichment within the insulation. The insulation material and outside shield must also be of adequate design to prevent attrition of the insulation due to normal operating conditions.

(v) You must not install uninsulated piping and equipment which operate at liquefied-hydrogen temperature above asphalt surfaces or other combustible materials in order to prevent contact of liquid air with such materials. Drip pans may be installed under uninsulated piping and equipment to retain and vaporize condensed liquid air.

(f) **Equipment assembly.**

(i) Valves, gauges, regulators, and other accessories must be suitable for liquefied hydrogen service and for the pressures and temperatures involved.

(ii) Installation of liquefied hydrogen systems must be supervised by personnel familiar with proper practices and with reference to their construction and use.

(iii) You must ensure that storage containers, piping, valves, regulating equipment, and other accessories are readily accessible and protected against physical damage and against tampering. A shutoff valve must be located in liquid product withdrawal lines as close to the container as practical. On containers of over 2,000 gallons capacity, this shutoff valve shall be of the remote control type with no connections, flanges, or other appurtenances (other than a welded manual shutoff valve) allowed in the piping between the shutoff valve and its connection to the inner container.

(iv) Cabinets or housings containing hydrogen control equipment must be ventilated to prevent any accumulation of hydrogen gas.

(g) **Testing.**

(i) After installation, you must test all field-erected piping and prove it to be hydrogen gas-tight at operating pressure and temperature.

(ii) Containers if out of service in excess of one year must be inspected and tested as outlined in (1) of this section. You must check the safety relief devices to determine if they are operable and properly set.

(h) **Liquefied hydrogen vaporizers.**

(i) You must anchor the vaporizer and ensure that its connecting piping is sufficiently flexible to provide for the effect of expansion and contraction due to temperature changes.

(ii) You must ensure that the vaporizer and its piping are adequately protected on the hydrogen and heating media sections with safety relief devices.

(iii) You must indirectly supply heat used in a liquefied hydrogen vaporizer utilizing media such as air, steam, water, or water solutions.

(iv) You must provide a low temperature shutoff switch in the vaporizer discharge piping to prevent flow of liquefied hydrogen in the event of the loss of the heat source.

(i) **Electrical systems.**

(i) You must ensure that electrical wiring and equipment located within 3 feet of a point where connections are regularly made and disconnected, meet the requirements of chapter 296-24 WAC Part L for Class I, Division 1 locations.

(ii) You must ensure that except as provided in (1) of this section, electrical wiring, and equipment located within 25 feet of a point where connections are regularly made and disconnected or within 25 feet of a liquid hydrogen storage container, must meet the requirements of chapter 296-24 WAC Part L for Class I, Division 2 locations. When equipment approved for Class I, environments is not commercially available, the equipment may be:

(A) Purged or ventilated in accordance with NFPA No. 496-1967, Standard for Purged Enclosures for Electrical Equipment in Hazardous Locations,

(B) Intrinsically safe, or

(C) Approved for Class I, Group C atmospheres. This requirement does not apply to electrical equipment which is installed on mobile supply trucks or tank cars from which the storage container is filled.

(j) **Bonding and grounding.** You must electrically bond and ground the liquefied hydrogen container and associated piping.

(2) **Location of liquefied hydrogen storage.**

(a) **General requirements.**

(i) You must locate the storage containers so that they are readily accessible to mobile supply equipment at ground level and to authorized personnel.

(ii) You must ensure that the containers are not exposed by electric power lines, flammable liquid lines, flammable gas lines, or lines carrying oxidizing materials.

(iii) When locating liquefied hydrogen storage containers near above-ground flammable liquid storage or liquid oxygen storage, locate the liquefied hydrogen container on ground higher than flammable liquid storage or liquid oxygen storage.

(iv) Where it is necessary to locate the liquefied hydrogen container on ground that is level with or lower than adjacent flammable liquid storage or liquid oxygen storage, you must take suitable protective means (such as by diking, diversion, curbs, grading), with respect to the adjacent flammable liquid storage or liquid oxygen storage, to prevent accumulation of liquids within 50 feet of the liquefied hydrogen container.

(v) You must fence and post storage sites to prevent entrance by unauthorized personnel. You must also placard sites as follows: "Liquefied hydrogen—Flammable gas—No smoking—No open flames."

(vi) If liquefied hydrogen is located in (as specified in Table H-3) a separate building, in a special room, or inside buildings when not in a special room and exposed to other occupancies, you must ensure that containers have the safety relief devices vented unobstructed to the outdoors at a minimum elevation of 25 feet above grade to a safe location as required in (1)(d)(ii) of this section.

(b) **Specific requirements.**

(i) You must ensure that the location of liquefied hydrogen storage, as determined by the maximum total quantity of liquefied hydrogen, is in the order of preference as indicated by Roman numerals in the following Table H-3.

**TABLE H-3**

MAXIMUM TOTAL QUANTITY OF LIQUEFIED HYDROGEN STORAGE PERMITTED

Nature of location	Size of hydrogen storage (capacity in gallons)			
	39.63 (150 liters) to 50	51 to 300	301 to 600	In excess of 600
Outdoors	—	I —	I —	I —
In a separate building	—	II —	II —	II — Not permitted.
In a special room	—	III —	III —	Not permitted Not permitted.
Inside buildings not in a special room and exposed to other occupancies	—	IV —	Not permitted	Not permitted Not permitted.

Note: This table does not apply to the storage in dewars of the type generally used in laboratories for experimental purposes.

(ii) You must ensure that the minimum distance in feet from liquefied hydrogen systems of indicated storage capacity located outdoors, in a separate building, or in a special room to any specified exposure is in accordance with Table H-4.

**TABLE H-4**  
MINIMUM DISTANCE (FEET) FROM LIQUEFIED HYDROGEN SYSTEMS TO EXPOSURE

Type of exposure	Liquefied hydrogen storage (capacity in gallons)		
	39.63 (150 liters) to 3,500	3,501 to 15,000	15,001 to 30,000
1. Fire-resistive building and fire walls*	—	5	5
2. Noncombustible building*	—	25	50
3. Other buildings*	—	50	75
4. Wall openings, air-compressor intakes, inlets for air-conditioning or ventilating equipment -	—	75	75
5. Flammable liquids (above ground and vent or fill openings if below ground) (see 513 and 514)	—	50	75
6. Between stationary liquefied hydrogen containers	—	5	5
7. Flammable gas storage	—	50	75
8. Liquid oxygen storage and other oxidizers (see 513 and 514)	—	100	100
9. Combustible solids	—	50	75
10. Open flames, smoking, and welding	—	50	50
11. Concentrations of people**	—	75	75
12. Public ways, railroads, and property lines	—	25	50

\* Refer to standard types of building construction, NFPA No. 220-1969 for definitions of various types of construction.

\*\* In congested areas such as offices, lunchrooms, locker rooms, time-clock areas, and places of public assembly.

Note 1: The distance in Nos. 2, 3, 5, 7, 9, and 12 in Table H-4 may be reduced where protective structures, such as firewalls equal to height of top of the container, to safeguard the liquefied hydrogen storage system, are located between the liquefied hydrogen storage installation and the exposure.

Note 2: Where protective structures are provided, ventilation and confinement of product should be considered. The 5-foot distance in Nos. 1 and 6 facilitates maintenance and enhances ventilation.

(c) **Handling of liquefied hydrogen inside buildings other than separate buildings and special rooms.** You must ensure that portable liquefied hydrogen containers of 50 gallons or less capacity as permitted in Table H-3 and in compliance with (2)(a)(vi) of this section when housed inside buildings not located in a special room and exposed to other occupancies comply with the following minimum requirements:

(i) Be located 20 feet from flammable liquids and readily combustible materials such as excelsior or paper.

(ii) Be located 25 feet from ordinary electrical equipment and other sources of ignition including process or analytical equipment.

(iii) Be located 25 feet from concentrations of people.

(iv) Be located 50 feet from intakes of ventilation and air-conditioning equipment or intakes of compressors.

(v) Be located 50 feet from storage of other flammable-gases or storage of oxidizing gases.

(vi) Containers must be protected against damage or injury due to falling objects or work activity in the area.

(vii) Containers must be firmly secured and stored in an upright position.

(viii) Welding or cutting operations, and smoking must be prohibited while hydrogen is in the room.

(ix) The area must be adequately ventilated. Safety relief devices on the containers must be vented directly outdoors or to a suitable hood. See (1)(d)(ii) of this section and (2)(a)(vi) of this section.

(3) **Design at specific locations.**

(a) **Outdoor locations.**

(i) Outdoor location means outside of any building or structure, and includes locations under a weather shelter or canopy provided such locations are not enclosed by more than two walls set at right angles and are provided with vent-space between the walls and vented roof or canopy.

(ii) Roadways and yard surfaces located below liquefied hydrogen piping, from which liquid air may drop, must be constructed of noncombustible materials.

(iii) If protective walls are provided, they must be constructed of noncombustible materials and in accordance with the provisions of (3)(a)(i) of this section as applicable.

(iv) Electrical wiring and equipment must comply with chapter 296-24 WAC Part L.

(v) You must provide adequate lighting for nighttime transfer operation.

(b) **Separate buildings.**

(i) Separate buildings must be of light noncombustible construction on a substantial frame. Walls and roofs must be lightly fastened and designed to relieve at a maximum internal pressure of 25 pounds per square foot. Windows must be of shatterproof glass or plastic in

metal frames. Doors must be located in such a manner that they will be readily accessible to personnel in an emergency.

(ii) You must provide adequate ventilation to the outdoors. Inlet openings must be located near the floor level in exterior walls only. Outlet openings must be located at the high point of the room in exterior walls or roof. Both the inlet and outlet vent openings must have a minimum total area of 1 square foot per 1,000 cubic feet of room volume. Discharge from outlet openings must be directed or conducted to a safe location.

(iii) You must ensure that there are no sources of ignition.

(iv) Electrical wiring and equipment must comply with chapter 296-24 WAC Part L.

(v) Heating, if provided, must be by steam, hot water, or other indirect means.

(c) **Special rooms.**

(i) Floors, walls, and ceilings must have a fire resistance rating of at least 2 hours. Walls or partitions must be continuous from floor to ceiling and must be securely anchored. At least one wall must be an exterior wall. Openings to other parts of the building must not be permitted. Windows and doors must be in exterior walls and doors shall be located in such a manner that they will be accessible in an emergency. Windows must be of shatterproof glass or plastic in metal frames.

(ii) You must ensure that ventilation is as provided in (3)(b)(ii) of this section.

(iii) You must provide explosion venting in exterior walls or roof only. The venting area must be equal to not less than 1 square foot per 30 cubic feet of room volume and may consist of any one or any combination of the following: Walls of light noncombustible material; lightly fastened hatch covers; lightly fastened swinging doors opening outward in exterior walls; lightly fastened walls or roofs designed to relieve at a maximum pressure of 25 pounds per square foot.

(iv) You must ensure that there are no sources of ignition.

(v) Electrical wiring and equipment must comply with chapter 296-24 WAC Part L.

(vi) Heating, if provided, must be steam, hot water, or by other indirect means.

(4) **Operating instructions.**

(a) **Written instructions.** For installation which require any operation of equipment by the user, you must maintain legible instructions at operating locations.

(b) **Attendant.** A qualified person must be in attendance at all times while the mobile hydrogen supply unit is being unloaded.

(c) **Security.** You must adequately secure each mobile liquefied hydrogen supply unit used as part of a hydrogen system to prevent movement.

(d) **Grounding.** You must ground the mobile liquefied hydrogen supply unit for static electricity.

(5) **Maintenance.** The equipment and functioning of each charged liquefied hydrogen system shall be maintained in a safe operating condition in accordance with the requirements of this section. You must not permit weeds or similar combustibles within 25 feet of any liquefied hydrogen equipment.

[Statutory Authority: RCW 49.17.010, 49.17.040, 49.17.050, and 49.17.060. WSR 15-24-100, § 296-24-31505, filed 12/1/15, effective 1/5/16. Statutory Authority: Chapter 49.17 RCW. WSR 91-24-017 (Order

91-07), § 296-24-31505, filed 11/22/91, effective 12/24/91; WSR 88-23-054 (Order 88-25), § 296-24-31505, filed 11/14/88. Statutory Authority: RCW 49.17.040 and 49.17.050. WSR 85-10-004 (Order 85-09), § 296-24-31505, filed 4/19/85; Order 76-6, § 296-24-31505, filed 3/1/76; Order 73-5, § 296-24-31505, filed 5/9/73 and Order 73-4, § 296-24-31505, filed 5/7/73.]