

Addendum A

Standard for Safe Design of Closed-Circuit  
Ammonia Refrigeration Systems

Public Review Draft #3

Reviewers of Addendum A are welcome to comment on the *changes* in the standard, indicated by underline and strikethrough text. Original parts of the standard are provided for context only.

Please refrain from commenting on layout, formatting and punctuation issues.

Comments on informative appendices are welcome but might not be formally addressed.

**Flammable Liquid:** A liquid whose flashpoint is ~~greater~~less than 100°F when tested by closed-cup test methods.

**4.2.4 \*Public Assembly, Commercial, Residential, and Large Mercantile Occupancies.** Where approved, ammonia refrigeration machinery shall be permitted outside of a machinery room for applications in a public assembly occupancy, commercial occupancy, or large mercantile occupancy. The quantity of ammonia shall be limited such that a complete discharge from any independent refrigerant circuit will not result in an ammonia concentration exceeding 300 ppm in any room or area where equipment containing ammonia is located. The calculation procedure for determining the concentration level shall comply with Chapter 5, Section 5.3.

EXCEPTIONS:

1. ~~Listed P~~packaged vapor compression ~~or~~ absorption systems, with no refrigerant containing parts that are joined in the field by other than mating valves that permit sections of the system to be joined before opening the valves, installed in areas or rooms that are not public hallways or lobbies and with refrigerant quantities equal to or less than 6.6 lbs. (3 kg) are permitted for residential occupancies.
2. ~~Listed P~~packaged vapor compression or ~~or~~ absorption systems, with no refrigerant containing parts that are joined in the field by other than mating valves that permit sections of the system to be joined before opening the valves, installed in areas or rooms that are not public hallways or lobbies and with refrigerant quantities equal to or less than 22 lbs. (10 kg) are permitted for commercial occupancies.
3. ~~Listed, sealed P~~packaged vapor compression or absorption systems with no refrigerant containing parts that are joined in the field by other than mating valves that permit sections of the system to be joined before opening the valves, installed in public hallways or lobbies and with refrigerant quantities equal to or less than 3.3 lbs. (1.5 kg) are permitted for residential and commercial occupancies.

5.13.2.3 Equipment and piping designs based on the exception to Section 5.13.2 shall be required to comply with additional requirements in ASME B31.5 as applicable.

**6.7.2 Path of Travel.** The path of travel within the machinery room to at least one eyewash/safety shower unit shall be unobstructed and shall not include intervening doors. Additional eyewash/safety shower units shall be installed such that the path of travel in the machinery room is no more than 55 ft to an eyewash/safety shower unit. The path of travel to at least one eyewash/safety shower unit located outside of the machinery room shall be within 55 ft. of the principle machinery room door. The path of travel shall be unobstructed and shall not include intervening doors.

**6.15.1 NFPA 704 Placards.** A NFPA 704 placard shall be provided in accordance with Section 5.14.2 on or next to all doors through which a person can enter the machinery room, the principle machinery room door in accordance with Section 5.14.2.

**12.2.6\*** In applications where vessels are subject to external corrosion as determined by the owner or owner's designated agent, suitable means shall be used to address vessel protection. Carbon steel pressure vessels shall be designed and specified with a minimum of 1/16 in. (0.16 cm) external corrosion allowance. The external corrosion allowance is in addition to the minimum vessel thickness as required by ASME B&PVC, Section VIII, Division 1.

**EXCEPTIONS:**

1. ~~ASME stamped high side vessels, compressor oil separators and accompanying oil filters and oil coolers that are located indoors.~~
2. ~~The owner or the owner's designated agent specifies a different corrosion allowance.~~

15.2.3 Pressure relief devices shall not use cast iron seats or discs. ~~The design specifications of pressure relief devices shall limit the distortion of seats and discs such that distortion shall not cause a deviation greater than 5% of the set pressure within a span of 5 years.~~

**15.3.1 ASME Pressure vessels and ~~other types of Non-ASME E~~equipment**

**15.3.1.1** Pressure vessels and equipment built and stamped in accordance with ASME B&PVC, Section VIII, Division 1 shall be provided with pressure relief protection in accordance with the ASME B&PVC, Section VIII, Division 1.

**15.3.1.2** \*Equipment with an internal volume greater than 0.5 cubic feet that is not built in accordance ASME BPVC, Section VIII, Division 1 shall be provided with pressure relief protection that is in accordance with the ASME B&PVC Section VIII, Division 1.

EXCEPTION: This does not include compressors, pumps, controls, headers, piping, evaporators, condensers, and other types of equipment built in accordance with ASME B31.5.

**17.7 \*Detection and Alarm Levels.** Where this standard specifies an ammonia detection and alarm concentration, the operational criteria shall be as specified in this section.

**EXCEPTION:** Where approved, alternatives to fixed ammonia leak detectors shall be permitted for areas with high humidity or other harsh environmental conditions that are incompatible with detection devices.

**17.7.1 Level 1 Ammonia Detection and Alarm.** Level 1 ammonia detection and alarm shall have the following features:

1. At least one ammonia detector shall be provided in the room or area.

2. The detector shall activate an alarm that reports to a monitored location so that corrective action can be taken at an indicated concentration of 25 ppm or higher.

~~**17.7.2 Level 2 Ammonia Detection and Alarm.** Level 2 ammonia detection and alarm shall have the following features:~~

- ~~1. At least one ammonia detector shall be provided in the room or area.~~
- ~~1. The detector shall activate an alarm that reports to a monitored location so that corrective action can be taken at an indicated concentration of 25 ppm or higher.~~
- ~~2. Audible and visual alarms shall be provided inside the room to warn that, when the alarm has activated, access to the room is restricted to authorized personnel and emergency responders.~~

~~**17.7.3 Level 3 Ammonia Detection and Alarm.** Level 3 ammonia detection and alarm shall have the following features:~~

- ~~1. At least one ammonia detector shall be provided in the room or area.~~
- ~~1. The detector shall activate an alarm that reports to a monitored location so that corrective action can be taken at an indicated concentration of 25 ppm or higher.~~
- ~~2. Audible and visual alarms shall be provided inside the room to warn that, when the alarm has activated, access to the room is restricted to authorized personnel and emergency responders.~~
- ~~3. Upon activation of the alarm, control valves feeding liquid and hot gas to equipment in the affected area shall be closed. Refrigerant pumps, nonemergency fans, or other motors that are part of the ammonia refrigeration equipment in the room shall be de-energized.~~
- ~~4. Upon activation of the alarm, emergency exhaust systems, where required, shall be activated.~~

#### **(Informative) Explanatory Material.**

**A.5.17.4** The maximum volume of liquid in vessels has traditionally been considered 90% at a temperature of 90°F. Calculations can be done to determine other levels and worse case temperatures.

If hydrostatic relief is used to protect against overpressure due to hydraulic expansion, this does not eliminate the requirement for atmospheric relief if it is required elsewhere in this standard.

**A6.7.1** Eyewash/safety shower units should be located as closely as possible to the machinery room. The location and number of eyewash/safety showers should also be considered in a process hazard analyses.

**A12.2.6** ~~Pressure vessels used in ammonia refrigeration service are not generally subject to internal corrosion. There are however many of the low side vessels that have the potential to condense water on the outside of the vessel wherever the vessel temperature is consistently or intermittently below the dew point temperature of the surrounding air. For this reason 12.2.6 requires the addition of a 1/16 inch external corrosion allowance to all pressure vessels used in ammonia refrigeration systems that do not meet the requirements for the exceptions given. The exceptions cover vessels that are unlikely to corrode to any measurable extent, essentially warm painted vessels in machinery rooms. The second exception is to allow an owner's designated agent to specify a different, (either higher or lower) corrosion allowance if the owner chooses other methods to prevent corrosion; like painting, cathodic protection, corrosion control gel, or similar products, or determines that a greater corrosion allowance is required to meet the life expectation of a particular pressure vessel installation. In any location the requirements of the B&PV code Section VIII Division I specifies the minimum design thickness for vessels. For vessels specified without corrosion allowance, vessel fabricators, when requested, should provide buyers or their designated agents the ASME BPVC VIII-1 minimum thickness values (Tmin), for shell and heads. The Tmin values may exclude nozzle reinforcement locations but should account for~~

excess material used to satisfy impact test exemptions and other loadings including those listed in ASME BPVC VIII-1 paragraph UG-22. Unless provided by the manufacturer,  $T_{min}$  values within two diameters of an opening should be considered equal to the Manufacturer's Data Report U-1 or U-1A nominal material thickness value minus any ASME BPVC VIII-1 material tolerance. Plate ordered to a nominal value has a material under tolerance of the smaller of .01 inch (0.3 mm) or 6% of the nominal thickness<sup>1</sup>. Carbon and alloy steel welded and seamless pipe has a material under tolerance of 12.5% of nominal thickness.<sup>2</sup>  
ASME BPVC VIII-1 Paragraph UG-16(e) (2).

1.—ASME BPVC II-A SA-530 Table 1.

Metal thickness less than new construction limits should be reviewed based on local jurisdictional guidelines and procedures. These may include aspects of the National Board Inspection Code (NBIC) NB-23 or API RP 579-1 / ASME FFS-1 Fitness for Service.

Carbon steel pressure vessels used in closed-circuit ammonia refrigeration systems may be subject to external corrosion. Corrosion is more likely in applications where the surface temperature of an uninsulated vessel periodically cycles or operates continuously below the dew point temperature in the area where it is installed, when the vessel is inadequately insulated, or when installed outdoors and unprotected from the weather (e.g. Receivers, Accumulators, Recirculators, Oil Pots, Transfer Vessels).

Accordingly, the user or his designated agent who knows how the vessel will be applied, should consider corrosion preventive measures where necessary when specifying new vessels. Preventive measures include painting, insulation, cathodic protection, corrosion control gel, or similar products. The addition of a corrosion allowance may be required to meet the life expectancy of a particular pressure vessel installation.

ASME Section VIII Div. 1 permits the use of plate material with under-tolerance that is the smaller of 0.01 in. (0.3mm) or 6% of the nominal material thickness. Vessels constructed in accordance with the rules of ASME section VIII Div. 1 using plate materials that have under-tolerance within the allowed ranges are compliant even though the plate material thickness could be less than the nominal wall thickness or the calculated minimum wall thickness and may be used at full design pressure. In these cases, pitting or surface corrosion can reduce life expectancy. Determination of suitability for continued service should be based on vessel inspection guidelines in section 10.1 of IIAR6. When pitting or surface damage exceeds these guidelines, vessel derating, wall repair by an ASME R stamp holder, or vessel replacement is required.

#### **A.15.3.1.2**

Plate type heat exchangers, plate freezers or any assemblies, subassemblies, accessories, or components of a refrigeration system, with internal volumes greater than or equal to 0.5 cubic feet, that are not specifically designed to comply to ASME B31.5 should be provided with pressure relief protection per section 15.3.

#### **A.16.1.2**

For refrigeration systems with automatic monitoring, the monitoring system should report alarms to a monitored location. Automatic monitoring systems for critical operating parameters should acquire and store data in a manner and for a time period that is compatible with the owner's intended inspection methods. For refrigeration systems with automatic monitoring, the monitoring system should automatically report critical alarms to a monitored location. Examples of critical alarms may include discharge pressure greater than the compressor high pressure cut out setting; ammonia concentration greater than 300ppm within an enclosed area; or other criteria that indicates a refrigerant release has occurred. Automatic monitoring systems for critical

operating parameters should acquire and store data in a manner and for a time period that is compatible with the owner's intended inspection methods.

**A.17.7**

The normative parts of this standard do not require ammonia detection and alarm levels other than level 1. Some end-users may prefer to use a more stringent level of detection and response. The following detection and alarm levels are possible alternatives:

**Level 2 Ammonia Detection and Alarm.** Level 2 ammonia detection and alarm shall have the following features:

1. At least one ammonia detector shall be provided in the room or area.
2. The detector shall activate an alarm that reports to a monitored location so that corrective action can be taken at an indicated concentration of 25 ppm or higher.
3. Audible and visual alarms shall be provided inside the room to warn that, when the alarm has activated, access to the room is restricted to authorized personnel and emergency responders.

**Level 3 Ammonia Detection and Alarm.** Level 3 ammonia detection and alarm shall have the following features:

1. At least one ammonia detector shall be provided in the room or area.
2. The detector shall activate an alarm that reports to a monitored location so that corrective action can be taken at an indicated concentration of 25 ppm or higher.
3. Audible and visual alarms shall be provided inside the room to warn that, when the alarm has activated, access to the room is restricted to authorized personnel and emergency responders.
4. Upon activation of the alarm, control valves feeding liquid and hot gas to equipment in the affected area shall be closed. Refrigerant pumps, nonemergency fans, or other motors that are part of the ammonia refrigeration equipment in the room shall be de-energized.
5. Upon activation of the alarm, emergency exhaust systems, where required, shall be activated.