**Section 215.90 Refrigerated Storage**

a) This Section applies specifically to systems using tanks for storage of anhydrous ammonia under refrigerated conditions. Section 215.25 applies to this Section unless otherwise stated.

b) Tanks may be designed for any storage pressure desired as determined by economical design of the refrigerated system.

c) The design temperature shall be the minimum temperature to which the container will be refrigerated and shall be so designated.

d) Containers with a design pressure exceeding 15 psig shall be constructed in accordance with Section 215.25 and the material shall be selected from those listed in API Standard 620, Design and Construction of Large, Welded, Low-Pressure Storage Tanks, Tables 2.02, R.2.2, R.2.3, or R.2.4.

e) Tanks with a design pressure of 15 psig or less shall be constructed in accordance with the general requirements of API Standard 620, including Appendix R.

f) When austenitic stainless steels or nonferrous metals are used, the ASME Code shall be used as a guide in selection of materials for use at the design temperature.

g) Tanks shall be supported on suitable noncombustible foundations designed to accommodate the type of tank being used.

h) Adequate protection against flotation or other water damage shall be provided wherever high flood water might occur.

i) Tanks storing product at less than 32°F shall be supported in such a way, or heat shall be supplied, to prevent the effects of freezing and subsequent frost heaving of the soil.

j) The area surrounding a refrigerated tank, or group of such tanks, shall be provided with drainage, diked, or provided with other secondary containment systems to prevent accidental discharge of liquid from spreading to uncontrolled areas.

k) When drainage is employed, a slope of not less than 1% shall be provided. The drainage system shall terminate in an impounding basin having a capacity as large as the largest tank served.

l) Provision shall be made for the drainage of rain water from the dike or impounding area. Such drainage shall be provided with a positive means to stop the flow.

m) Where a dike is employed, the capacity of the diked enclosure shall be 110% of the capacity of the largest tank served. When computing the volume of the dike, allowance shall be made for the volume displaced by all other containers in the diked area.

n) The walls of a diked enclosure or the wall of an impounding basin used in a drainage system shall be of earth, steel, concrete, or other suitable material designed to be liquid tight and to withstand the hydrostatic pressure and temperature. Earth walls shall have a flat top at least 2 feet wide. The slope shall be stable and consistent with the angle of repose of the earth used.

o) The ground in an impounding basin or with a diked enclosure should be graded so that small spills or the early part of a large spill will accumulate at one side or corner, thereby contacting only a relatively small area of ground and exposing a relatively small area for heat gain. Shallow channels in the ground surface or low curbs of earth can help guide the liquid to these low areas without contacting a large ground area.

p) Each refrigerated container shall be marked with a nameplate on the outer covering in an accessible place as specified in the following:

1) With the name and address of the builder and the date of fabrication;

2) With the maximum volume or weight of the product, whichever is most meaningful to the user;

3) With the design pressure;

4) With the minimum temperatures in degrees Fahrenheit (°F) or degrees Celsius (°C) for which the container was designed;

5) With the maximum allowable water level to which the container may be filled for the test purposes;

6) With the density of the product in pounds per cubic foot or kilograms per cubic meter for which the container was designed; and

7) With the maximum level to which the container may be filled with liquid anhydrous ammonia.

q) Each refrigerated container shall be marked on two directly opposite sides at near eye level with the words ANHYDROUS AMMONIA or CAUTION – AMMONIA in sharply contrasting colors with letters not less than 4.0 inches high.

r) Each refrigerated container shall be conspicuously marked with a hazard warning label complying with 29 CFR 1910.1200.

s) Shutoff valves shall be:

1) Provided for all connections except those with a No. 54 (0.055 inches) drill size restriction, plugs, pressure relief valves, and thermometer wells; and

2) Located as close to the tank as practical.

t) A check valve shall be installed on the tank liquid fill connection if it is located below the maximum liquid level. A remotely operated shutoff valve shall be installed on other connections located below the maximum liquid level. See Section 215.65.

u) Each refrigerated container shall be equipped with an approved liquid level gauging device and high liquid level alarm.

v) The tank shall be provided with a system of one or more pressure relief valves that can limit the tank pressure below 115% (110% if only one pressure relief valve is used) of the design pressure during operational emergency conditions other than fire and below 121% of the design pressure during operational emergency conditions that include fire. One of the pressure relief valves shall be set to start to discharge at a pressure not in excess of the design pressure of the tank, and all other pressure relief valves needed to limit the tank pressure below 115% (110% if only one pressure relief valve is used) of the design pressure during operational emergency conditions other than fire shall be set to discharge at a pressure not in excess of 105% of the design pressure. All additional pressure relief valves needed to limit the tank pressure below 121% of the design pressure during operational emergency conditions, including fire, shall be set to start to discharge at a pressure not in excess of 110% of the design pressure.

w) The pressure relief valve set to discharge below 105% of the design pressure of the tank shall have a total relieving capacity in excess of the relieving capacity required to handle operating emergency conditions listed in subsection (x). The total relieving capacity of all the pressure relief valves in the system shall be the larger requirement of subsection (x) or (y).

x) Possible refrigeration system upsets are cooling water failure; power failure; instrument air or instrument failure; mechanical failure of any equipment; excessive pumping rates; and changing atmospheric conditions.

y) Use either of the following formulas for fire exposure. Relief valve sizing for fire protection may be adjusted to protect against the worst possible fire exposure.

1) For valve manufacturers who classify valves on the basis of the weight of the vapors to be relieved:

■



■

2) For valve manufacturers who classify valves on the basis of air flow:



3) Where:

|  |  |  |
| --- | --- | --- |
| W | = | weight of vapors to be relieved in pounds/hour at relieving conditions |
|  |  |  |
| Qa | = | air flow in cubic feet per minute at standard conditions 60°F and 14.7 psi |
|  |  |  |
| F | = | fireproofing credit. Use F = 1.0 except when an approved fireproofing material of recommended thickness is used, in which case use F = 0.2 |
|  |  |  |
| A | = | total surface area in square feet up to 25 feet above grade or to the equator of a sphere, whichever is greater |
|  |  |  |
| Z | = | compressibility factor of ammonia at relieving condition (if not known, use Z = 1.0) |
|  |  |  |
| T | = | temperature in degrees R (460 + temperature in °F of gas at relieving conditions) |
|  |  |  |
| M | = | molecular weight = 17 for ammonia |
|  |  |  |
| L | = | latent heat of ammonia at relieving conditions in Btu per pound |
|  |  |  |
| C | = | constant based on relation of specific heats (C may be obtained from the following table) |

(If K is not known, use C = 315)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| K | C | K | C | K | C |
| 1.00 | 315 | 1.26 | 343 | 1.52 | 366 |
| 1.02 | 318 | 1.28 | 345 | 1.54 | 368 |
| 1.04 | 320 | 1.30 | 347 | 1.56 | 369 |
| 1.06 | 322 | 1.32 | 349 | 1.58 | 371  |
| 1.08 | 324 | 1.34 | 351 | 1.60 | 372 |
| 1.10 | 327 | 1.36 | 352 | 1.62 | 374 |
| 1.12 | 329 | 1.38 | 354 | 1.64 | 376 |
| 1.14 | 331 | 1.40 | 356 | 1.66 | 377 |
| 1.16 | 333 | 1.42 | 358 | 1.68 | 379 |
| 1.18 | 335 | 1.44 | 359 | 1.70 | 380 |
| 1.20 | 337 | 1.46 | 361 | 2.00 | 400 |
| 1.22 | 339 | 1.48 | 363 | 2.20 | 412 |
| 1.24 | 341 | 1.50 | 364 |  |  |

4) Where

|  |  |  |
| --- | --- | --- |
| K | = | Cp at atmospheric conditions |
| Cv |
| Cp | = | specific heat of vapor at constant pressure |
| Cv | = | specific heat of vapor at constant volume |

z) Shutoff valves of adequate flow capacity may be provided and used to facilitate inspection and repair of pressure relief valves. When a shutoff valve is provided, it shall be so arranged that it can be locked or sealed open, and it shall not be closed except by an authorized person who shall remain stationed there while the valve remains closed and who shall again lock or seal the valve open when leaving the station.

aa) Pressure relief valves shall comply with the following:

1) If stacks are used they shall be suitably designed to prevent obstruction by rain, snow, ice, or condensate.

2) The outlet size shall not be smaller than the nominal size of the pressure relief valve outlet connection.

bb) Discharge lines may be used if desired. Multiple pressure relief valves on the same storage unit may be run into a common discharge header. The discharge line and header shall be designed to accommodate the maximum flow and a back pressure not exceeding 10% of the design pressure of the storage container. This back pressure shall be included to limit total tank pressure below 121% of the design pressure given in subsection (v). No other container or system shall exhaust into this discharge line or header. The vent lines shall be installed to prevent accumulation of liquid in the lines.

cc) The discharge from pressure relief valves shall be vented away from the container, upward and unobstructed to the open air to an area such that persons, property, and the environment will not be harmed. All pressure relief valves shall have suitable rain caps that will allow free discharge of the vapor and prevent the entrance of water. Suitable provision shall be made for draining condensate that may accumulate.

dd) Atmospheric storage shall be provided with vacuum breakers of adequate capacity to respond to anticipated rates of liquid withdrawal and to rapid atmospheric changes so as to avoid damage to the container. Ammonia gas may be used to provide a pad.

ee) Pressure relief valves used to protect other systems at refrigerated storage installations shall discharge to the open air unless connected to a control device as defined in Section 215.55.

ff) Because emergency venting for a double-wall refrigerated storage tank is complex, no calculation method is presented here. A thorough analysis of the fire relief for a double-wall refrigerated storage tank should be conducted.

gg) Refrigerated storage containers and appurtenances shall comply with the provisions of Section 215.40.

hh) Containers of such size as to require a field fabrication shall, when moved and reinstalled, be reconstructed and re-inspected in complete accordance with the original requirements under which they were constructed. The containers shall be subjected to a pressure retest, and if re-rating is necessary, it shall be done in accordance with the applicable pressure of the original requirements.

ii) The total refrigeration load shall be computed as the sum of the following:

1) Load imposed by heat flow into the container caused by the temperature differential between the ambient temperature and the storage temperature;

2) Load imposed by heat flow into the tank caused by maximum sun radiation; and

3) Maximum load imposed by filling the tank with ammonia warmer than the design storage temperature.

jj) More than one storage tank may be handled by the same refrigeration system.

kk) A minimum of two compressors shall be provided, either of which is of sufficient size to handle the loads listed in subsections (ii)(1) and (ii)(2), except as provided in subsection (mm). Where more than two compressors are provided, minimum standby equipment equal to the largest normally operating equipment shall be installed. Compressors required for subsection (ii)(3) may be used as standby equipment for compressors required in subsections (ii)(1) and (ii)(2).

ll) Compressors shall be sized to operate with a suction pressure at least 10% below the minimum setting of the pressure relief valves on the storage tank and shall withstand a suction pressure at least equal to 121% of the design pressure of the tank. Discharge pressure will be governed by condensing conditions.

mm) Where facilities are provided to safely dispose of vented vapor to an automatic flare or to a process unit, a single compressor of sufficient size to handle the load listed in subsections (ii)(1) and (ii)(2) shall be allowed.

nn) Each compressor shall have its own drive unit.

oo) Any standard drive consistent with good design may be used.

pp) An emergency source of power of sufficient capacity to handle the loads listed in subsections (ii)(1) and (ii)(2) shall be provided unless facilities are provided to safely dispose of vented vapors while the refrigeration system is not operating.

qq) The refrigeration system shall be arranged with suitable controls to govern the compressor operation in accordance with the load as evidenced by the pressure in the containers.

rr) An emergency alarm system shall be installed to function in the event the pressure in the containers rises to the maximum or falls to the minimum allowable operating pressure.

ss) An emergency alarm and shutoff shall be located in the condenser system to respond to excess discharge pressure caused by failure of the cooling medium.

tt) All automatic controls shall be installed in a manner to preclude operation of alternate compressors unless the controls will function with the alternate compressors.

uu) An entrainment separator of suitable size and design pressure shall be installed in the compressor suction line. The separator shall be equipped with a drain and gauging device. A maximum liquid level control with alarm should be installed.

vv) An oil separator of suitable size shall be installed in the compressor discharge line. It shall be designed for at least 250 psig and shall be equipped with a gauging device and drain valve. A maximum oil level control with alarm should be installed.

ww) A separator shall be equipped with a pressure relief valve if the separator can be isolated with shutoff valves.

xx) The condenser system may be cooled by air or water or both. The condenser shall be designed for at least 250 psig. Provision shall be made for purging noncondensibles either manually or automatically.

yy) The condenser shall be equipped with a pressure relief valve if the condenser can be isolated with shutoff valves.

zz) A condenser effluent receiver shall be provided that is equipped with automatic level controls and valving designed to discharge the liquid ammonia to storage, or with a high-pressure liquid drain trap of suitable capacity. The receiver shall be designed for at least 250 psig operating pressure and be equipped with the necessary connections, pressure relief valves, and gauging device.

aaa) Refrigerated containers and pipeline that are insulated shall be covered with a material of suitable quality and thickness for the temperatures encountered. Insulation shall be suitably supported and protected against the weather. Weatherproofing and insulation shall be of a type that will not support flame propagation and will not cause corrosion when wet.

bbb) Each refrigerated storage installation shall have on hand the minimum safety equipment required in Section 215.20.

ccc) In addition to the safety equipment requirement in Section 215.20, each refrigerated storage installation shall have on hand at least two independently supplied, positive-pressure SCBAs and at least two approved encapsulating corrosive chemical suits that are impervious to ammonia. Each shall be designed to accommodate an SCBA.

ddd) A sign with letters of a minimum height of two inches giving the name and telephone number, including area code, of owner, manager or agent of the anhydrous ammonia storage location shall appear at the site entrances to the property or apart from the storage tanks.

(Source: Amended at 27 Ill. Reg. 9922, effective July 1, 2003)