Ammonia Refrigeration *RAGAGEP*

Recognized and Generally Accepted Good Engineering Practice

Peter Thomas, P.E., CSP – Resource Compliance, Inc.

Introduction

- Where does the term ***RAGAGEP*** come from?

CalARP RAGAGEP

- Process Safety Information 2760.1(d)(2)
  - The owner or operator shall document that equipment complies with **recognized and generally accepted good engineering practices**.

CalARP RAGAGEP

- Mechanical Integrity 2760.5(d)(3) - (4)
  - Inspection and testing procedures shall follow **recognized and generally accepted good engineering practices**.
  - The frequency of inspections and tests of process equipment shall be consistent with applicable manufacturers' recommendations and **good engineering practices**, and more frequently if determined to be necessary by prior operating experience.

CalARP RAGAGEP

- Pre-Startup Safety Review 2760.7(b)(1)
  - Construction and equipment is **in accordance with design specifications**;

RAGAGEP Citations

Citation 1 Item 1 Type of Violation: **Serious**

29 CFR 1910.119(d)(3)(ii): The employer did not document that equipment complies with recognized and generally accepted good engineering practices.

On or about 20 July 2013, and at times prior thereto, the employer did not document that the ventilation system complies with recognized and generally accepted good engineering practices (RAGAGEP) within the Engine Room, when the electrical system for the room does not meet Class I, Group D, Division 2. Failure to verify and document that the system complies with the RAGAGEP in the Engine Room for both normal and emergency mechanical ventilation exposed the workers within to the hazard of anhydrous ammonia liquid or vapor.

ABATEMENT DOCUMENTATION REQUIRED FOR THIS ITEM

Date By Which Violation Must be Abated:	03/07/2014
Proposed Penalty:	$7000.00

RAGAGEP Citations

Citation 1 Item 4 Type of Violation: **Serious**

29 CFR 1910.119(d)(3)(ii): The employer did not document that equipment complies with recognized and generally accepted good engineering practices:

For the Commercial Warehousing ammonia refrigeration facility located at 101 and 102 Industrial Blvd. in Winter Haven, FL as observed on or about 1/15/2015:

a) Pressure vessels in the engine rooms such as, but not limited to, the T6-North were operated at temperatures below their minimum design metal temperature.

b) Ammonia detectors were not interlocked to ventilation fans in engine rooms, and ventilation fans in engine rooms did not have an interlocked supervisory alarm that would sound if the ventilation fans shut off.

c) Remote actuation of ventilation system, outside of engine room, was not available. The only way to turn on fans was from a breaker inside the engine rooms.

d) Ammonia relief vent discharge was located at a height of 19-20 ft. above ground and only 9-12 ft. from the T6 north engine room's ventilation intake while the employer's process safety information stated that the relief discharge shall not be within 20 feet of a ventilation intake. This location exposed employees working outside in the area around the high pressure receiver, the condensers, and at the engine room entrance door to potential ammonia concentrations above ammonia's IDLH, 300 ppm. The relief discharge's location also resulted in the potential for ammonia vapors to be pulled back into the engine room from the ventilation intake.

Date By Which Violation Must be Abated:	08/07/2015
Proposed Penalty:	$4500.00

RAGAGEP Citations

Citation 1 Item 3 Type of Violation: **Serious**

29 CFR 1910.119(d)(3)(ii): The employer did not document that equipment complies with recognized and generally accepted good engineering practices:

In the ammonia engine room, the engine room access door and a garage door leading into the engine room were not each equipped with a tight-fitting seal, exposing employees outside the room to potential leaks of ammonia. The doors did not comply with the employers accepted engineering practice, ANSI/ASHRAE Standard 15 requirements.

Date By Which Violation Must be Abated: Corrected During Inspection

Proposed Penalty: $ 6,300.00

Millard reaches $3 mil deal over ammonia release that sickened workers

Investing.com | Politics | Jun 02, 2015 11:25PM GMT | Add a Comment

64. COUNT 18 - 40 C.F.R. § 68.73(d)(2) required Defendant to follow recognized and generally accepted good engineering practices for its inspections and testing procedures in order to maintain the mechanical integrity of its process equipment. Defendant failed, in violation of 40 C.F.R. § 68.73(d)(2), in at least four ways to follow recognized and generally accepted good engineering practices: (a) Failed to show that it conducted the IIAR Bulletin No. 109 inspections for all pressure vessels to help identify cracked and damaged vessels; (b) Failed to mark/label its piping to meet the ammonia pipe labeling requirements of IIAR's Bulletin No. 14, Guidelines for Identification of Ammonia Refrigeration Piping and Safety Components; (c) Failed to show that it performed the annual test on its emergency ventilation system in July 2010 (just before the August 2010 Release). A testing schedule for the mechanical ventilation systems is required by IIAR 2 - 2008 Section 13.3.12.1; (d) Failed to provide material certification documents (U-1, U-1A, U-2) for all the screw compressor oil filter housings, screw compressor cooler thermosyphon oil coolers, intercoolers, accumulators, and oil pots.

Citation 1 Item 1 Type of Violation: **Serious**

29 CFR 1910.119(d)(3)(ii): The employer did not document that equipment complies with recognized and generally accepted good engineering practices:

Employees engaged in production activities throughout the facility were exposed to chemical hazards associated with the catastrophic release of ammonia in that the employer had not documented and implemented compliance with recognized and generally accepted good engineering practices for the marking of Ammonia refrigeration piping and system components to comply with IIAR Bulletin # 114 09/1991; and ANSI A13.1, 2007. Missing Valve Tag Identifications include but are not limited to 5 sets of the High Gas NH3 Valves; and 2 sets of the Defrost Release Valves.

29 CFR 1903.19(d)(1) requires certification and documentation that the abatement of the above violation is completed.

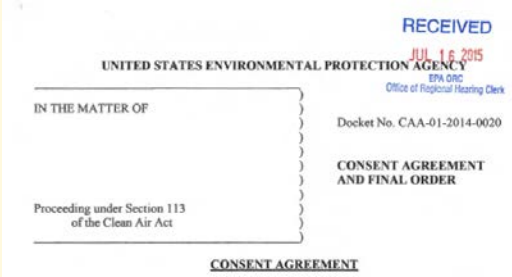
ABATEMENT DOCUMENTATION REQUIRED FOR THIS ITEM

Date By Which Violation Must be Abated:	09/25/2015
Proposed Penalty:	$5500.00

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

IN THE MATTER OF	Docket No. CAA-01-2014-0020
	CONSENT AGREEMENT AND FINAL ORDER
Proceeding under Section 113 of the Clean Air Act	

CONSENT AGREEMENT



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Office of Regional Hearing Clerk

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

IN THE MATTER OF

Docket No. CAA-01-2014-0020

CONSENT AGREEMENT AND FINAL ORDER

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CONSENT AGREEMENT

48. Pursuant to 40 C.F.R. § 68.65, the owner or operator of a Program 3 process is required, among other things, to compile written process safety information before completing the PHA, in order to perform an adequate PHA and to enable proper maintenance of process equipment. This includes documenting information pertaining to the hazards of the RMP chemical in the process; information pertaining to the technology and equipment of the process, including that the equipment complies with RAGAGEP; and information showing that any equipment that was designed according to outdated standards is designed, maintained, inspected, tested, and operated in a safe manner. This compilation enables appropriate identification and understanding of hazards posed by regulated substances in the process and the technology and equipment of the process.

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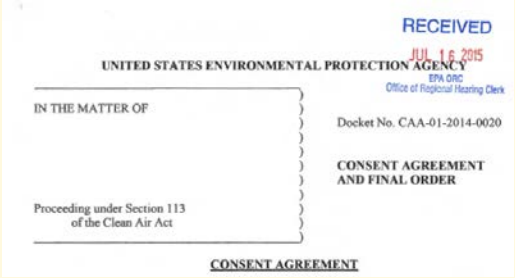
CONSENT AGREEMENT

57. By failing to compile the necessary information about the technology and equipment of the Processes, including by documenting that the Processes comply with RAGAGEP, Respondent violated 40 C.F.R. § 68.65 and Section 112(r)(7)(E) of the CAA, 42 U.S.C. § 7412(r)(7)(E).



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CONSENT AGREEMENT

STIPULATED PENALTIES

109. In the event that Respondent fails to satisfactorily complete the SEPs as outlined in Exhibit A, Respondent shall be liable for stipulated penalties in accordance with the provisions set forth below. The determination of whether the SEP has been satisfactorily completed shall be in the sole discretion of EPA.

a. If EPA determines that Respondent completely or substantially failed to implement the Safety Upgrade SEP in accordance with this CAFO, Respondent shall pay a stipulated penalty to the United States in the amount of $385,750, plus interest from the effective date of the CAFO;8

b. If EPA determines that Respondent completely or substantially failed to implement the Equipment Purchase SEP in accordance with this CAFO, Respondent shall pay a stipulated penalty to the United States in the amount of $16,875, plus interest from the effective date of the CAFO;9

c. If Respondent spends less than $322,100 on the two SEPs but EPA determines that Respondent otherwise satisfactorily completes each SEP, Respondent shall only be required to pay a stipulated penalty to the United States in the amount equal to the

OSHA General Duty Clause

- U.S. Code Title 29 Section 654 SEC. 5
  - Each employer shall furnish to each of his employees employment and a place of employment which are free from **recognized hazards** that are causing or are likely to cause death or serious physical harm to his employees...

OSHA RAGAGEP Memo

June 5, 2015

MEMORANDUM FOR: REGIONAL ADMINISTRATORS AND STATE PLAN DESIGNEES

THROUGH: DOROTHY DOUGHERTY
Deputy Assistant Secretary

FROM: THOMAS GALASSI Director
Directorate of Enforcement Programs

SUBJECT: RAGAGEP in Process Safety Management Enforcement

This memorandum provides guidance on the enforcement of the Process Safety Management (PSM) Standard's recognized and generally accepted good engineering practices (RAGAGEP) requirements, including how to interpret "shall" and "should" language in published codes, standards, published technical reports, recommended practices (RP) or similar documents, and on the use of internal employer documents as RAGAGEP. Enforcement activity, including the *Petroleum Refinery Process Safety Management National Emphasis Program* (Refinery NEP), and requests for assistance from the field, revealed the need for guidance on the PSM standard's RAGAGEP provisions.

OSHA RAGAGEP Memo

- *Shall* vs. *Should*
- *Normative* vs. *Informative*
- Primary Sources of RAGAGEPs
- Use of Internal Standards

Ammonia Refrigeration RAGAGEP

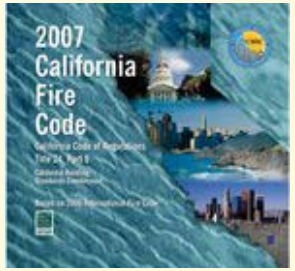
- American National Standards Institute (ANSI)
- International Code Council® (ICC)
- International Association of Plumbing and Mechanical Officials (IAPMO)
- California Building Standards Commission (CBSC)
- American Society of Mechanical Engineers
- ASHRAE (formerly American Society of Heating Refrigeration and Air-Conditioning Engineers)
- International Institute of Ammonia Refrigeration (IIAR)

IIAR

- **VISION**
  - IIAR's vision is to be globally recognized as the leading advocate for the safe, reliable and efficient use of ammonia and other natural refrigerants.
- **MISSION**
  - IIAR provides advocacy, education, and standards for the benefit of the global community in the safe and sustainable design, installation and operation of ammonia and other natural refrigerant systems.

Ammonia Refrig. RAGAGEP Documents

- California Mechanical Code (CMC)
- Uniform Mechanical Code (UMC)
- California Fire Code (CFC)
- Fire Code (NFPA 1)
- ANSI/ASHRAE 15 Safety Standard for Refrigeration Systems



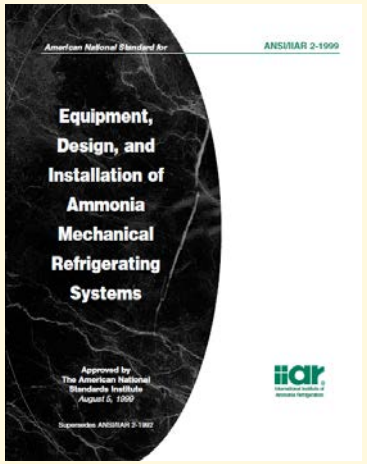
IIAR RAGAGEP Documents

- ANSI/IIAR 2 *Equipment, Design, and Installation of Closed-Circuit Ammonia Mechanical Refrigerating Systems*

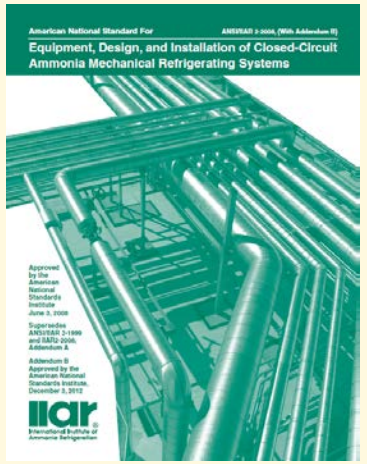
1974-78

1984

1999



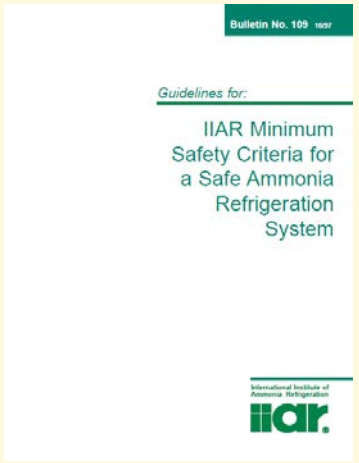
2008

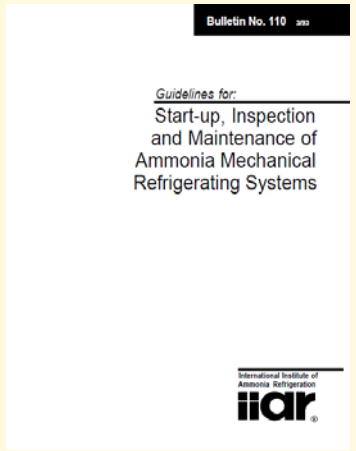


2014

IIAR RAGAGEP Documents

- IIAR Bulletin No. 109 *Guidelines for: IIAR Minimum Safety Criteria for a Safe Ammonia Refrigeration System*
- IIAR Bulletin No. 110 *Guidelines for: Start-up, Inspection and Maintenance of Ammonia Mechanical Refrigerating Systems*
  - Coming Soon → ANSI/IIAR 6





IIAR Literature

- Bulletins

NOTICE

The information contained in these guidelines has been obtained from sources believed to be reliable. However, it should not be assumed that all acceptable methods or procedures are contained in this document, or that additional measures may not be required under certain circumstances or conditions.

The International Institute of Ammonia Refrigeration makes no warranty or representation, and assumes no liability or responsibility, in connection with any information contained in this document.

While the Institute recommends use of and reference to this document by private industry, government agencies and others, this publication is intended to be voluntary and not binding.

The Institute does not "approve" or "endorse" any products, services or methods. This document should not be used or referenced in any way which would imply such approval or endorsement.

IIAR Literature

- Standards

This document is intended to serve as a standard for equipment, design and installation of closed-circuit ammonia refrigerating systems. Additional requirements may be necessary because of particular circumstances, project specifications or other jurisdictional considerations. Note that this standard does not constitute a comprehensive detailed technical design manual and should not be used as such.

The Status of IIAR Standards

- **ANSI/IIAR 1** Definitions and Terminology Used in IIAR Standards
- **ANSI/IIAR 2** Equipment, Design, and Installation of Closed-Circuit Ammonia Mechanical Refrigerating Systems
- **ANSI/IIAR 3** Ammonia Refrigeration Valves
- **ANSI/IIAR 4** Installation of Closed-Circuit Ammonia Mechanical Refrigeration Systems
- **ANSI/IIAR 5** Start-up and Commissioning of Closed-Circuit Ammonia Refrigeration Systems
- **ANSI/IIAR 6** Maintenance and Inspection of Closed-Circuit Ammonia Mechanical Refrigeration Systems
- **ANSI/IIAR 7** Developing Operating Procedures for Closed-Circuit Ammonia Mechanical Refrigerating Systems
- **ANSI/IIAR 8** Decommissioning of Closed-Circuit Ammonia Mechanical Refrigeration Systems

RAGAGEP Confusion

- 2013 CMC §1102.1
  - Except as modified by this code, refrigeration system shall comply with **ASHRAE 15.** In addition, ammonia refrigeration systems shall comply with **IIAR 2**.
- ANSI/IIAR 2-2014 §5.7.2.1
  - Cast iron, malleable iron, nodular iron, steel, cast steel, and alloy steel shall be permitted in accordance with **ASME B31.5** or **ASME B&PVC, Section VIII, Division 1**. Other metallic materials, including but not limited to aluminum, aluminum alloys, lead, tin, and lead-tin alloys shall be permitted in accordance with Section 5.7.1. Where tin and tin-lead alloys are used, the alloy composition shall be verified as suitable for temperature exposures, as specified in Section 5.6.

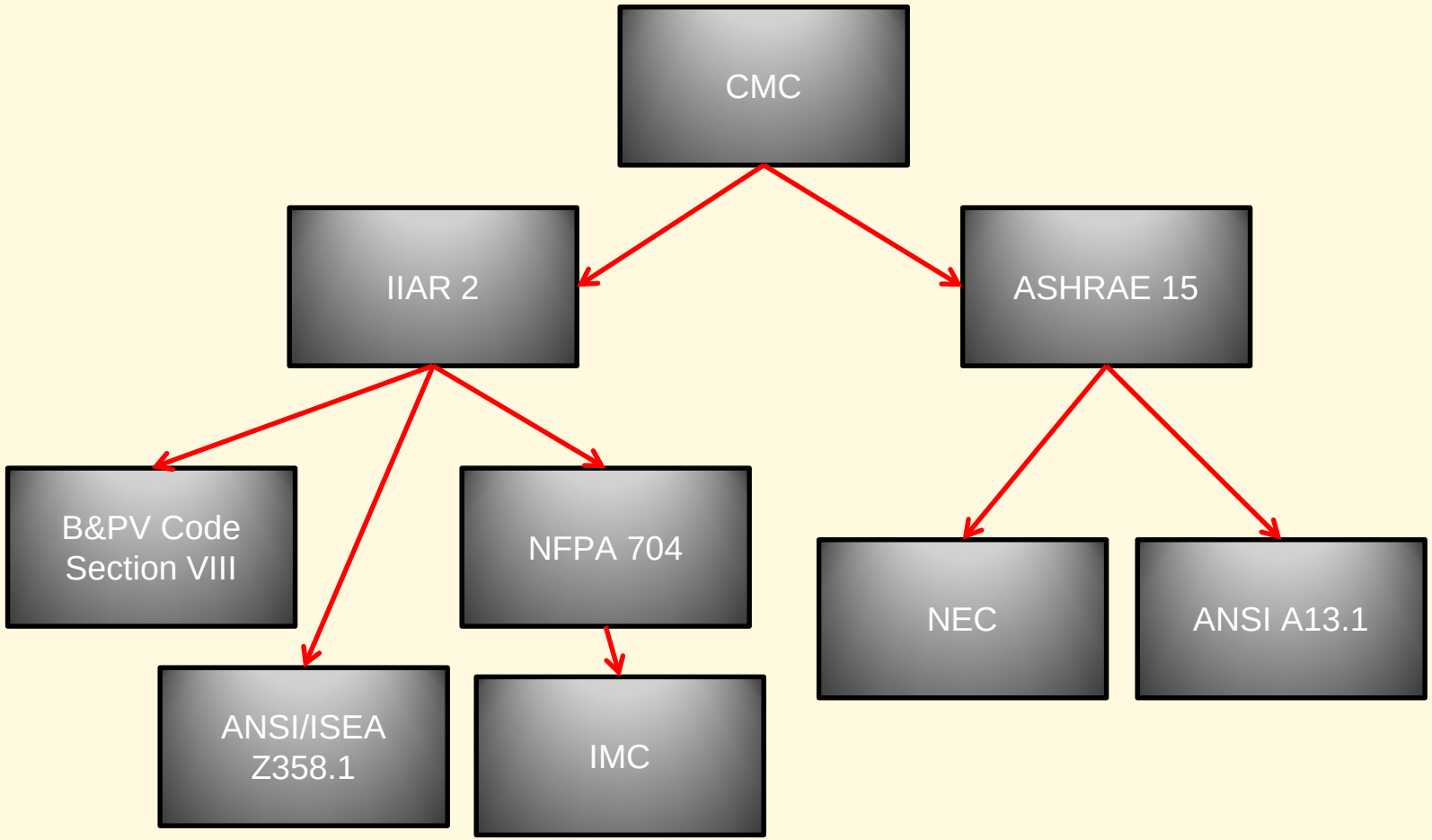
RAGAGEP Confusion

- ANSI/IIAR 2-2014 §6.7.3
  - Emergency eyewash/safety shower unit installations shall comply with **ANSI/ISEA Z358.1**.
- ANSI/IIAR 2-2014 §6.15.1
  - Buildings and facilities with refrigeration systems shall be provided with placards accordance with **NFPA 704** and the **Mechanical Code**.

RAGAGEP Confusion

- ANSI/ASHRAE 15-2013 §11.2.2
  - the kind of refrigerant or secondary coolant contained in exposed piping outside the machinery room. Valves or piping adjacent to valves shall be identified in accordance with **ANSI A13.1, Scheme for Identification of Piping Systems**.
- ANSI/ASHRAE 15-2013 §8.5
  - Electrical Safety. Electrical equipment and wiring shall be installed in accordance with the **National Electrical Code** and the requirements of the AHJ.

RAGAGEP Confusion



Implications of RAGAGEP

Safe Access

- **Equipment**
  - An unobstructed readily accessible opening and passageway not less than 36 inches in width and 80 inches in height shall be provided and maintained to the compressor, valves required by this chapter, or other portions of the system requiring routine maintenance. [2013 CMC §1106.3]
  - Equipment shall be accessible for maintenance, as required by the Mechanical Code. [ANSI/IIAR 2-2014 §5.12.1]
  - Operational and maintenance service egress shall be provided by access panels or doors, or the design shall provide for remote service by removal of the enclosure or the contents from the installed location. [ANSI/IIAR 2-2014 §5.12.1]

Service Provision

- **Maintenance Accommodation**
  - Shell and Tube Condenser [ANSI/IIAR 2-2014 §10.4.4]
  - Plate Heat Exchanger Condenser [ANSI/IIAR 2-2014 §10.5.4]
  - Double-Pipe Condenser [ANSI/IIAR 2-2014 §10.6.4.1]
  - Shell and Tube Evaporator [ANSI/IIAR 2-2014 §11.3.1.4, ANSI/IIAR 2-2014 §11.3.2.4]
  - Plate Heat Exchanger Evaporator [ANSI/IIAR 2-2014 §11.4.4]
  - Scraped Surface Heat Exchanger [ANSI/IIAR 2-2014 §11.5.4]
  - Pressure Vessels [ANSI/IIAR 2-2014 §12.6.1]

Safe Access

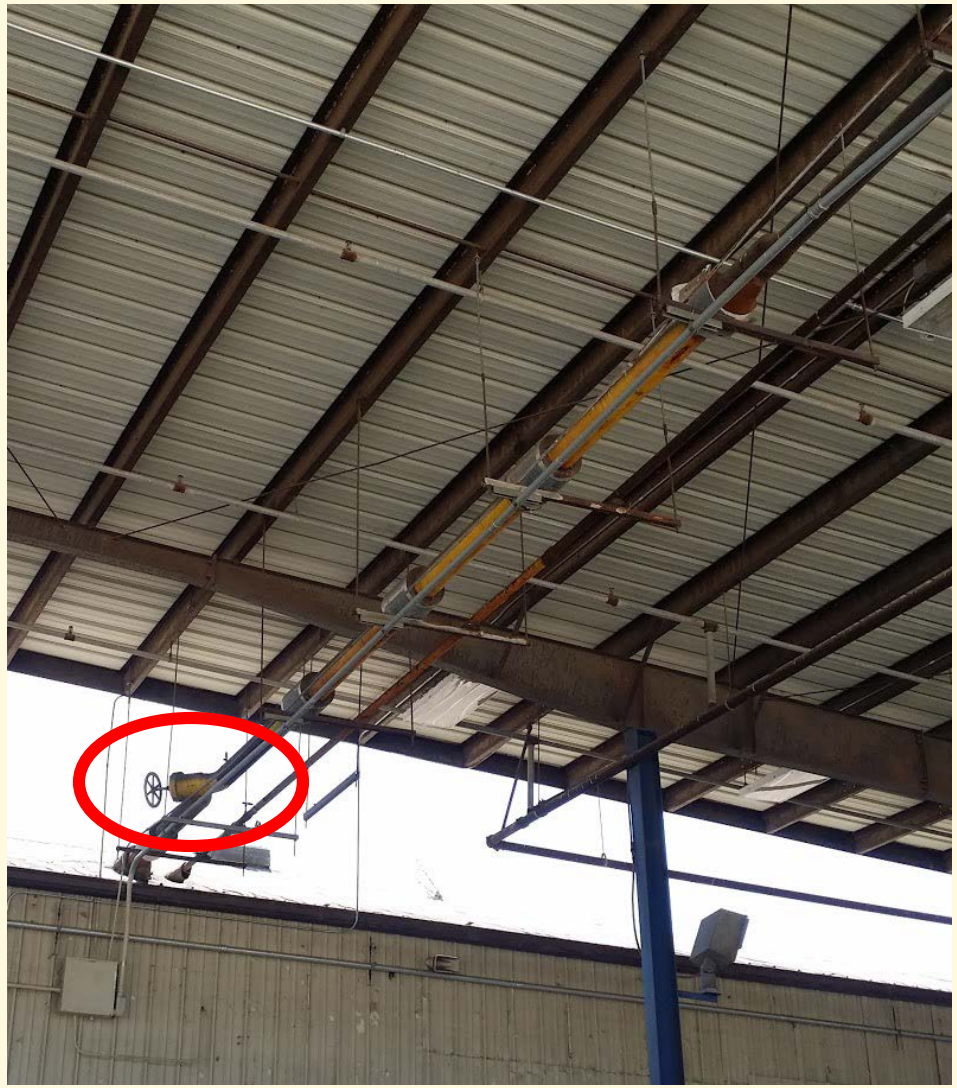
Safe Access

Safe Access

- **Valves**
  - Stop valves shall be readily accessible from the machinery room floor or a level platform [2013 CMC §1112.3]
  - Manually operated valves that are inaccessible from floor level shall be operable from portable platforms, fixed platforms, ladders, or shall be chain operated. [ANSI/IIAR 2-2014 §6.3.3.1]
  - Manually operated isolation valves identified as being part of the system emergency shutdown procedure shall be directly operable from the floor or chain operated from a permanent work surface. [ANSI/IIAR 2-2014 §6.3.3.2, §13.3.7]
  - Relief device arrangements shall be configured to allow access for inspection, maintenance, and repair. [ANSI/IIAR 2-2014 §15.2.3]
  - Similar requirement dating back to 1978

Safe Access

Safe Access

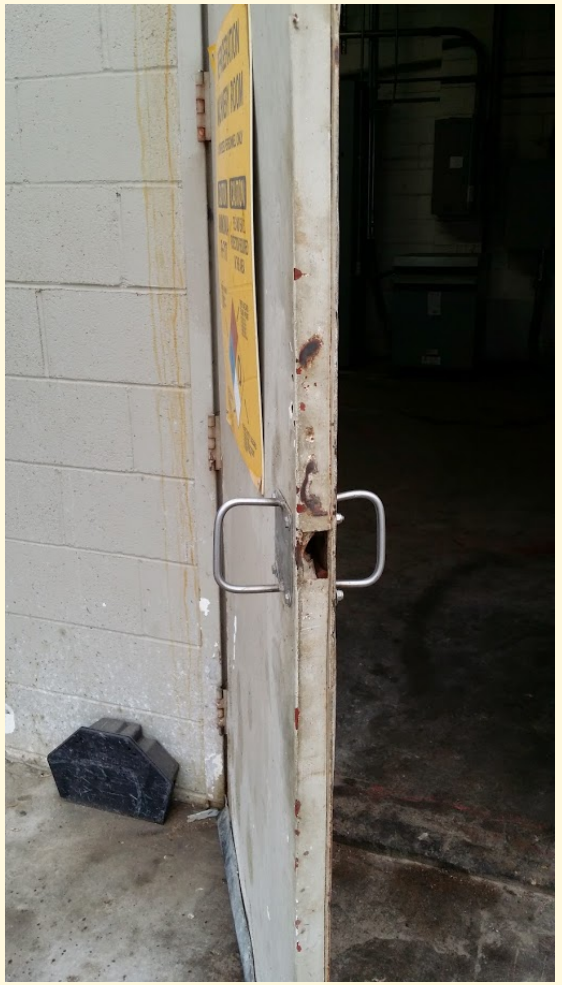


Restricted Access

- **Machinery Room**
  - Access to a machinery room shall be restricted to authorized personnel. Signage on machinery room doors shall comply with Section 6.15. [ANSI/IIAR 2-2014 §6.3.4]
  - Each machinery room entrance door shall be marked with a permanent sign to indicate that only authorized personnel are permitted to enter the room. [ANSI/IIAR 2-2014 §6.15.3]
  - Changing of safety settings shall be limited to authorized personnel only. Changing of system operational settings shall not permit or affect changes to safety settings. [ANSI/IIAR 2-2014 §16.1.5]

Restricted Access

Restricted Access



Nameplates

- Equipment shall have a nameplate with minimum data that describes or defines the manufacturer's information and design limits and purpose as specified in Chapter 8 through Chapter 16. [ANSI/IIAR 2-2014 §5.14.4.1]
- Sections 8.4.1, 9.4, 10.2.3, 11.2.3, 12.4.1, 12.5, 15.2.7, and 16.3.2 address nameplate requirements for various types of equipment.

Nameplates

- The nameplate shall be attached to the vessel or to a pad, bracket, or structure that is welded, brazed, soldered, or attached with mechanical fasteners directly to the vessel. Mechanical fasteners shall be of a material and design that is compatible with the vessel, bracket materials, and the vessel service. After installation of the pad, bracket, or structure, the heads of the fasteners shall be welded, brazed, or soldered to the pad, bracket, or structure that supports the nameplate. The nameplate shall be located within 30 in. (760 mm) of the vessel. Removal shall require the willful destruction of the nameplate, or its attachment system. [2013 B&PV Code Section VIII UG-119(e)]

Nameplates


S/N
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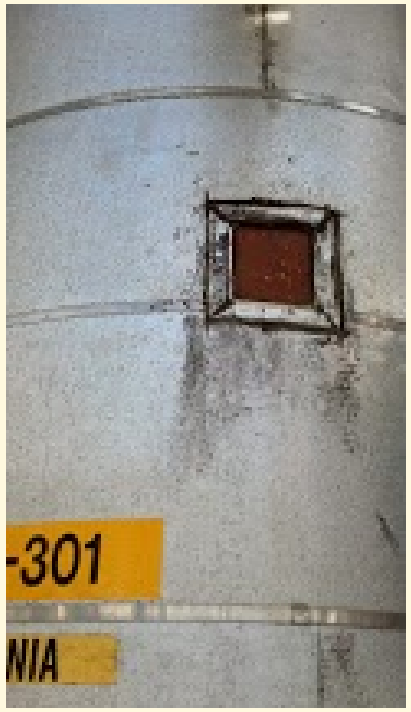
SHELL THK
HEAD THK
U.S. GAL
SQ. FT. SURF
RVS
evapco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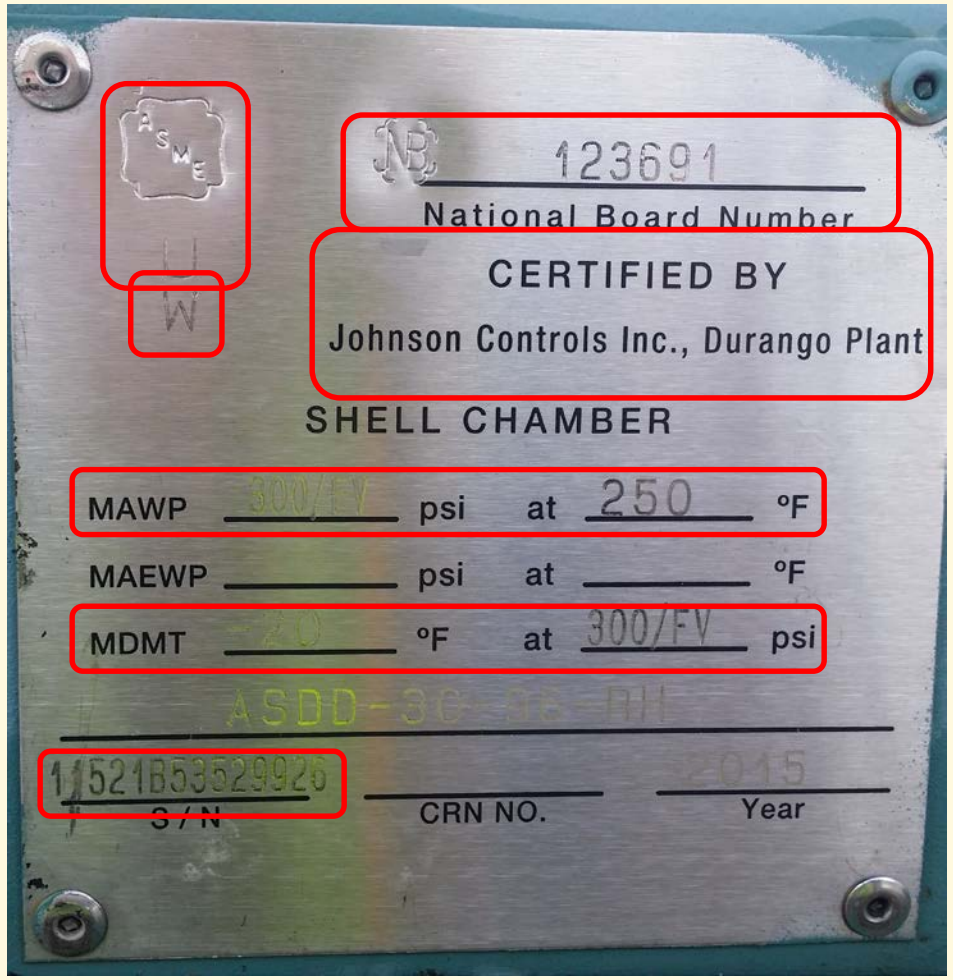
Nameplates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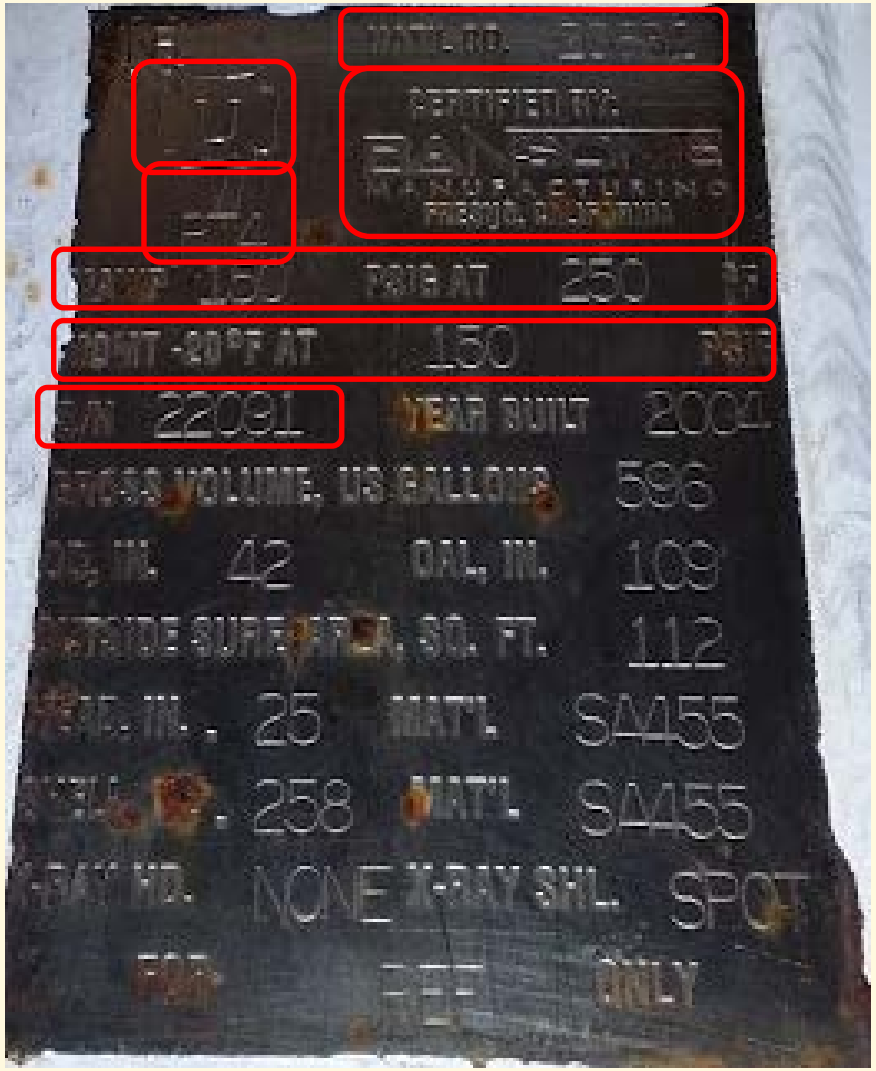
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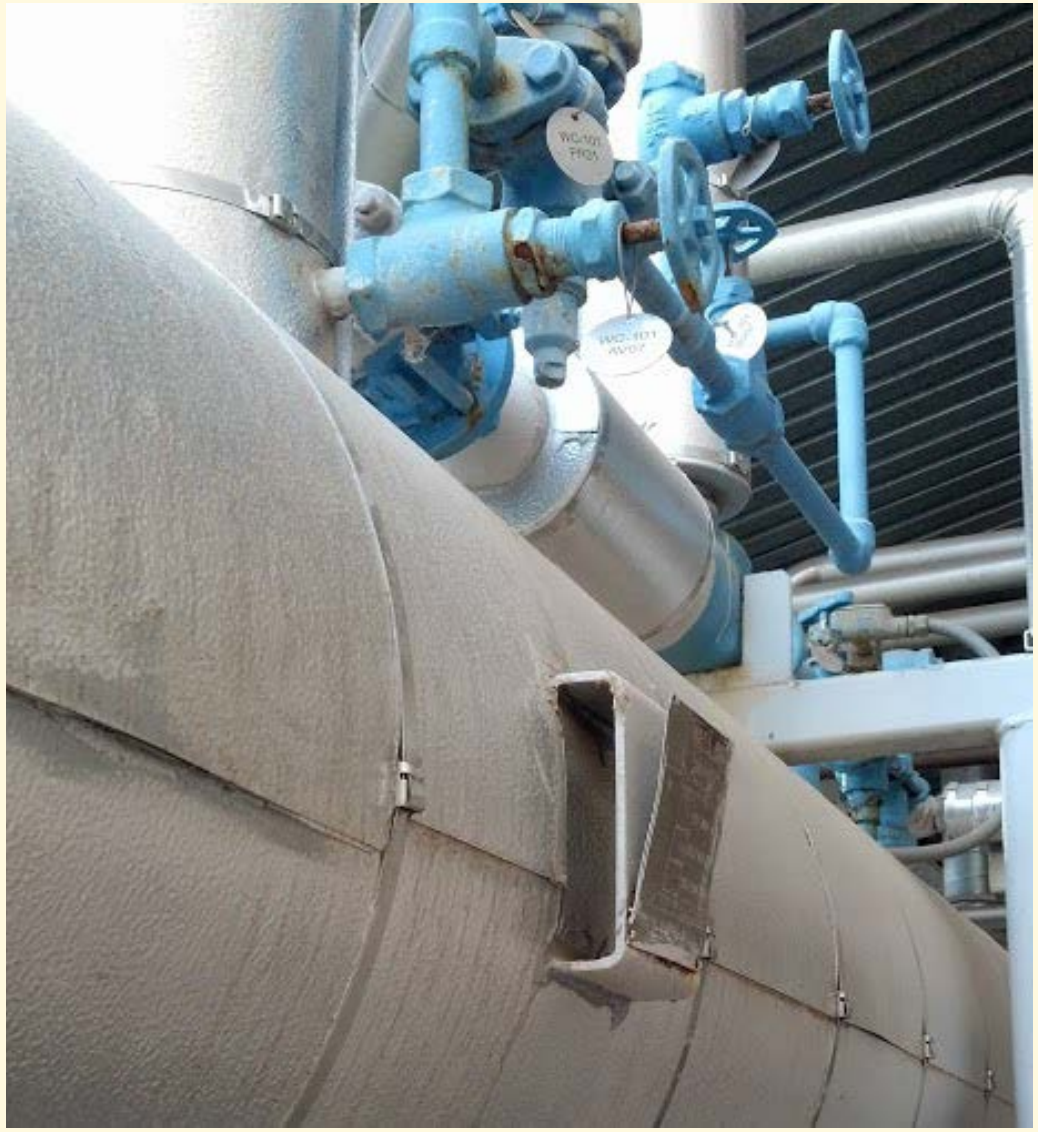
Nameplates

Nameplates



Relief Valves

- **Areas Required**
  - *Positive-Displacement Compressors* [2013 CMC §1114.2, ANSI/IIAR 2-2014 §8.2.2]
  - *Liquid-Containing Portions of Systems* [2013 CMC §1114.3, ANSI/IIAR 2-2014 §15.6]
  - *Evaporators* (located within 18 inches of a heating element) [2013 CMC §1114.4]
  - *Pressure Vessels* (exceeding 6” diameter) 2013 CMC §1114.5, ANSI/IIAR 2-2014 §15.3.1]
  - *ASME Equipment* [2013 B&PV Code Section VIII UG-125, ANSI/IIAR 2-2014 §15.3.1]

Relief Valve Installation

- **Areas Required**

Relief Valve Installation

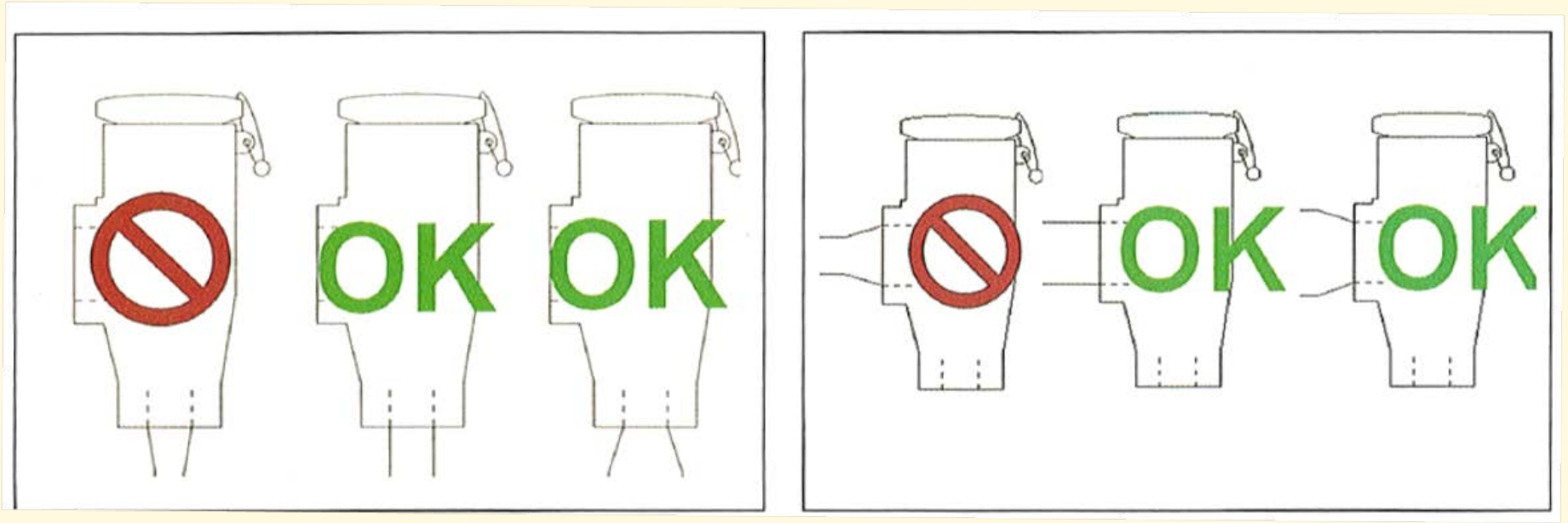
- **Single vs. Dual [2013 CMC §1117.2, ANSI/IIAR 2-2014 §15.3.4-§15.3.5]**
  - Pressure vessels between 3ft^3 and 10ft^3 are permitted to use a single relief valve
  - Pressure vessels greater than 10ft^3 must use a dual relief assembly

Relief Valve Installation

- **Piping [ANSI/IIAR 2-2014 §15.4]**
  - No stop valves on inlet or outlet piping
  - The size of inlet piping must be greater than or equal to the inlet connection size of the relief valve
  - The size of the discharge pipe must not be less than the outlet size of the relief valve

Relief Valve Installation

- **Piping [ANSI/IIAR 2-2014 §15.4]**



Relief Valve Installation

- **Piping [ANSI/IIAR 2-2014 §15.4]**

Relief Valve Installation

- **Piping [ANSI/IIAR 2-2014 §15.4]**

Relief Valve Installation

- **Other Requirements**
  - ASME equipment must be protected by relief devices with ASME nameplates [2013 B&PV Code Section VIII UG-129]
  - 5-Year replacement [IIAR Bulletin No. 109 §4.9.7]

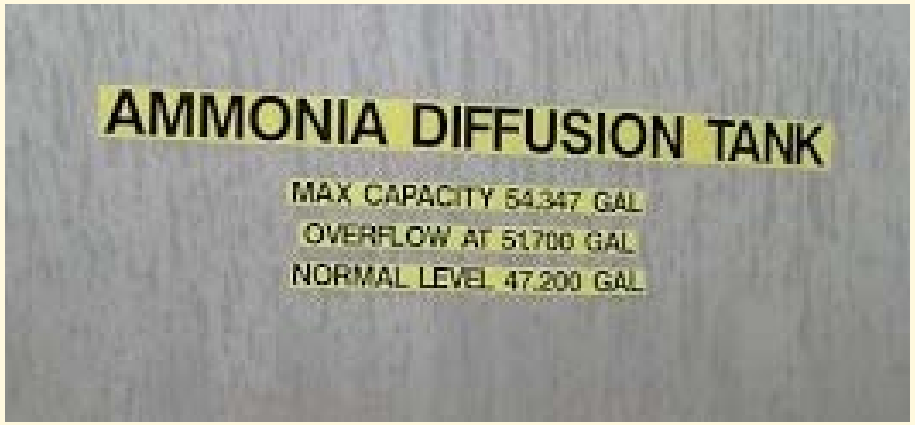



Relief Valve Termination

- **Ammonia Discharge [2013 CMC §1120.1]**
  - Ammonia shall discharge into a tank of water that shall be used for no purpose except ammonia absorption. Not less than 1 gallon (4 L) of fresh water shall be provided for each pound (kg) of ammonia that will be released in 1 hour from the largest relief device connected to the discharge pipe…

Relief Valve Termination

- **Ammonia Discharge [2013 CMC §1120.1]**

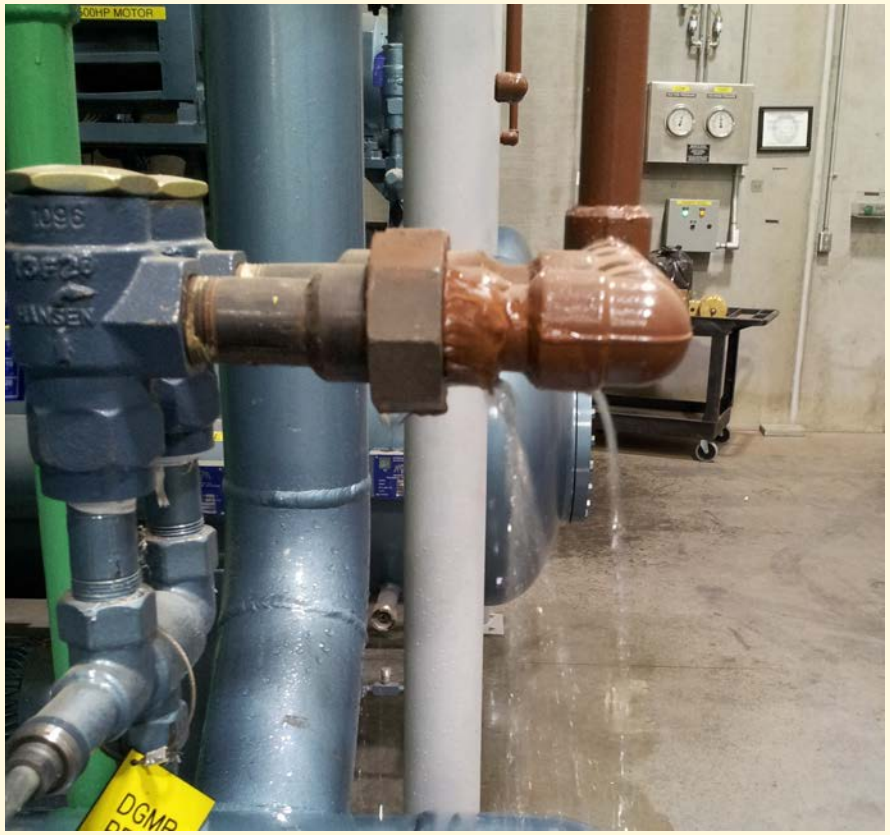


Relief Valve Termination

- **Ammonia Discharge [2013 CMC §1120.1]**

Relief Valve Termination

- **Ammonia Discharge [2013 CMC §1120.1]**

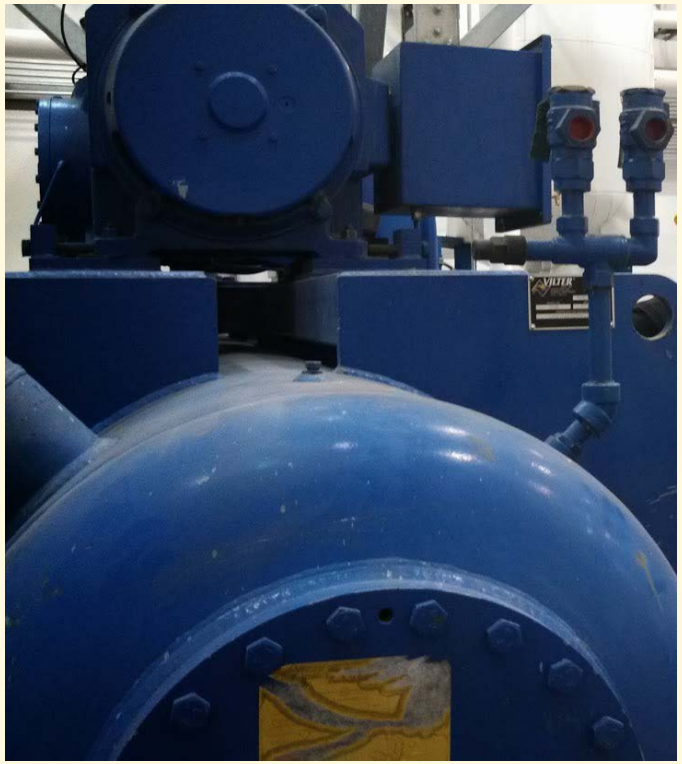


Relief Valve Termination

- **Atmospheric Discharge [ANSI/IIAR 2-2014 §15.5.1]**
  - Pipe sizing requirements [ANSI/IIAR 2-2014 §15.5.1.1.1]
  - Provision of draining moisture [ANSI/IIAR 2-2014 §15.5.1.6]
  - 20 ft from any window, ventilation intake, or personnel exit [ANSI/IIAR 2-2014 §15.5.1.2]
  - Not less than 15 feet above grade [ANSI/IIAR 2-2014 §15.5.1.2]
  - Not less than 7.25 feet above roof/platform [ANSI/IIAR 2-2014 §15.5.1.4, §15.5.1.5]
  - Arranged to avoid spraying ammonia on persons in the vicinity [ANSI/IIAR 2-2014 §15.5.1.5]
- ***2015 Uniform Mechanical Code does not require diffusion tanks for ammonia refrigeration systems.***

Relief Valve Termination

- **Atmospheric Discharge [ANSI/IIAR 2-2014 §15.5.1]**



Relief Valve Termination

- **Atmospheric Discharge [ANSI/IIAR 2-2014 §15.5.1]**

Relief Valve Termination

- **Atmospheric Discharge [ANSI/IIAR 2-2014 §15.5.1]**

Relief Valve Termination

Relief Valve Discharge Piping

Relief Valve Discharge Piping

Relief Valve Discharge Piping

200	20	7.5	15.2	27.5	53.2	77	138	207	337	614	1005	1485
200			.9	24.3	49.5	72	130	197	322	592	967	1447
200			.9	23.6	46.5	67.9	123	188	309	572	949	1412
200			.4	21.1	41.8	61.4	113	173	287	538	901	1349
200			.6	17.7	35.5	52.5	97.7	151	254	484	823	1245
200	100	3.6	7.5	14.1	28.5	42.4	79.9	125	212	413	714	1094
200	160	2.9	6	11.3	23	34.4	65.2	103	176	347	610	944
200	250	2.3	4.9	9.1	18.6	27.9	53.3	84.1	145	290	514	802
Set Pressure (psig)	Length (ft)	Nominal Pipe Size, NPS, DN										
		½	¾	1	1¼	1½	2	2½	3	4	5	6
		15	20	25	32	40	50	65	80	100	125	150
250	2	16.5	30.4	50.7	89.9	124	207	298	463	803	1268	1836
250	3	15.5	28.8	48.6	87.2	121	203	293	457	796	1260	1826
250	4	14.6	27.5	46.9	84.7	118	199	289	452	789	1251	1815
250	5	13.8	26.4	45.2	82.4	115	196	284	446	782	1243	1805
250	6	13.2	25.4	43.8	80.3	113	192	280	441	775	1234	1795
250	8	12.2	23.6	41.3	76.6	108	186	273	431	762	1219	1776
250	10	11.3	22.2	39.1	73.3	104	180	265	422	750	1203	1757
250	15	9.8	19.6	35	66.7	95.4	168	250	401	721	1167	1713
250	20	8.8	17.7	31.9	61.5	88.7	158	237	383	696	1135	1672
250	25	8	16.3	29.5	57.5	83.3	150	226	368	673	1104	1634
250	30	7.4	15.1	27.6	54.1	78.7	143	216	354	652	1076	1598
250	40	6.5	13.4	24.7	48.8	71.5	131	200	330	616	1026	1533
250	60	5.4	11.3	20.9	41.7	61.5	114	176	294	558	944	1423
250	100	4.3	8.9	16.6	33.6	49.9	93.7	146	248	479	826	1261
250	160	3.4	7.1	13.4	27.2	40.6	76.8	121	207	406	710	1096
250	250	2.7	5.8	10.8	22.1	33	62.9	99.2	171	340	602	937

OP-1 RV has a capacity of 57 lb/min and uses 1" outlet pipe. Not allowed.

LPR-1 and HPR-1 RV has a capacity of 118 lb/min and uses 1-1/2" outlet pipe. Only 4' is allowable.

$$L = \frac{0.2146 d^5 \left(P_0^2 - P_2^2\right)}{f C_r^2} - \frac{d \times \ln\left(P_o / P_2\right)}{6f}$$

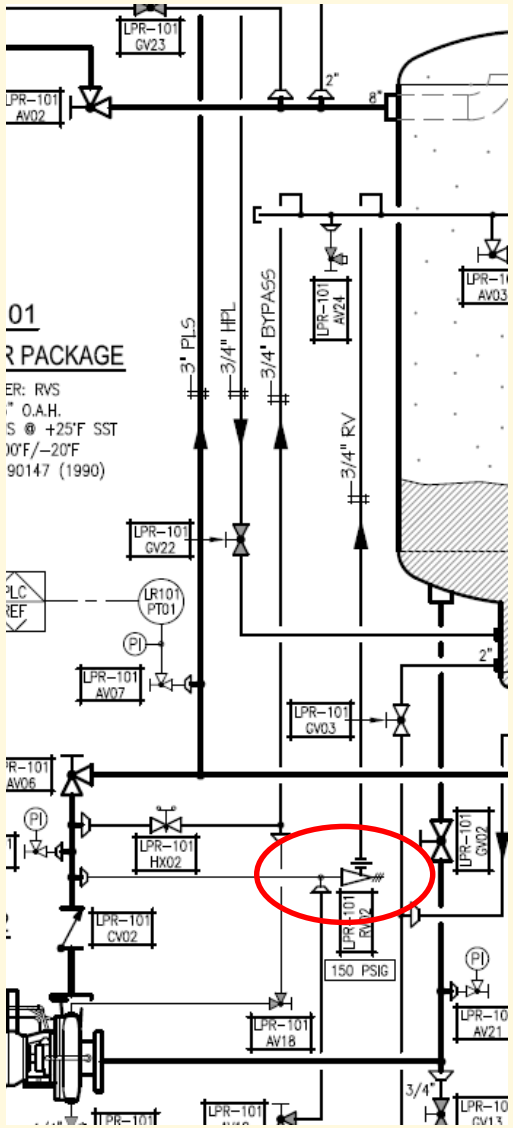
Hydrostatic Protection

- Protection against overpressure due to thermal hydrostatic expansion of trapped liquid ammonia shall be provided for equipment and piping sections that can be isolated and can trap liquid ammonia in an isolated section in any of the following situations:
    1. Automatically during normal operation.
    2. Automatically during shutdown by any means, including alarm or power failure.
    3. During planned isolation for standby or seasonal conditions.
    4. Due to an equipment or device fault.

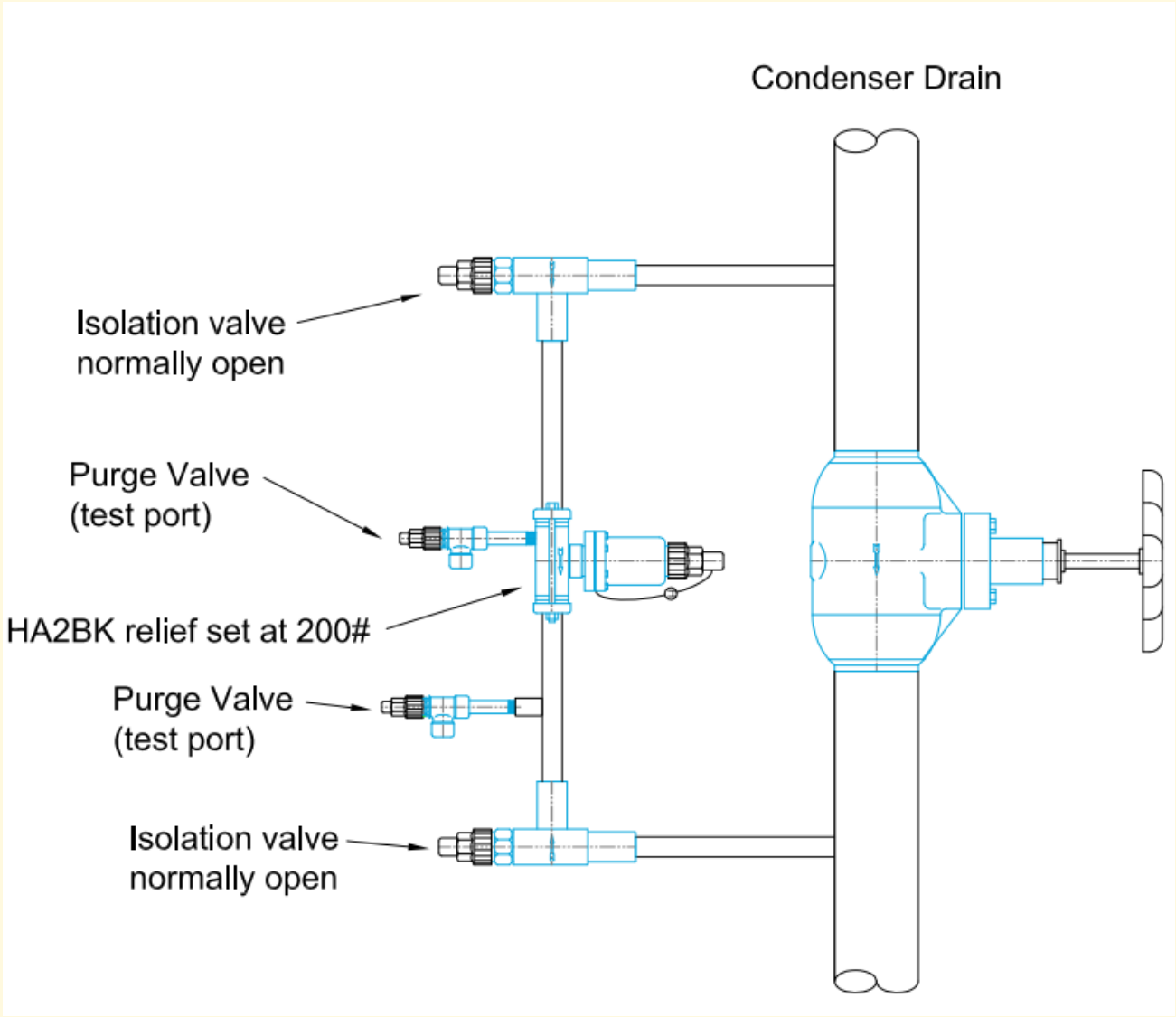
    EXCEPTION: If trapping of liquid with subsequent thermal hydrostatic expansion is only possible during maintenance or service operations, engineering or administrative controls, or both, shall be permitted as the means of relieving or preventing overpressure.

    [ANSI/IIAR 2-2014 §15.6]

Hydrostatic Protection



Hydrostatic Protection



Ammonia Detection

Ammonia Detection

- **Machinery Rooms -** 2013 CMC §1107.4, 2015 UMC §1106.4, 2015 IMC §1105.3
- **“Other Than Machinery Rooms” -** 2013 CMC §1105.3.1, 2015 UMC §1104.4(4), 2015 IMC §1104.2.2(4)
- **Interlocked with Ventilation -** 2013 CMC §1108.5, 2015 UMC §1107.6, 2015 IMC §1106.3
- **Emergency Shutdown -** 2013 CMC §1109.4, 2015 UMC §1108.3, 2015 IMC §1106.5.1
- **Alarms/Testing -** 2013 CMC §1121.0, 2015 UMC §1108.4, 2015 IMC §1109.1

Ammonia Detection – Historical References

- The room shall be provided with an independent mechanical ventilation system actuated automatically by vapor detector(s) when concentration of ammonia in the room exceeds 40,000 parts per million…[ANSI/IIAR 74-2 - 1978 §4.3.3.2]


AMERICAN NATIONAL STANDARD
FOR
EQUIPMENT, DESIGN, AND
INSTALLATION
OF AMMONIA MECHANICAL
REFRIGERATION SYSTEMS

ANSI/IIAR 74-2 - 1978

iiar

Sponsor
INTERNATIONAL INSTITUTE OF AMMONIA REFRIGERATION

Approved by
The American National Standards Institute
March 16, 1978

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Ammonia Detection – Level 1

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.

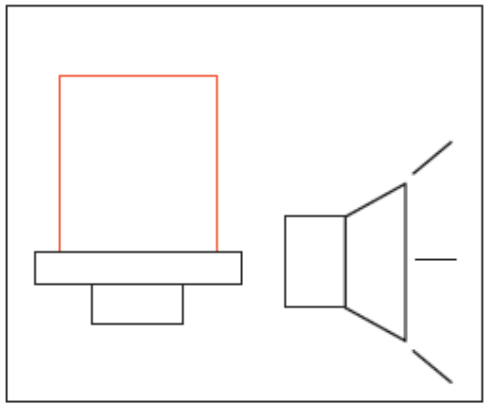
[ANSI/IIAR 2-2014 §17.7.1]

Ammonia Detection – Level 2

1. Must meet all Level 1 Detection requirements
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.

[ANSI/IIAR 2-2014 §17.7.2]

Ammonia Detection – Alarms

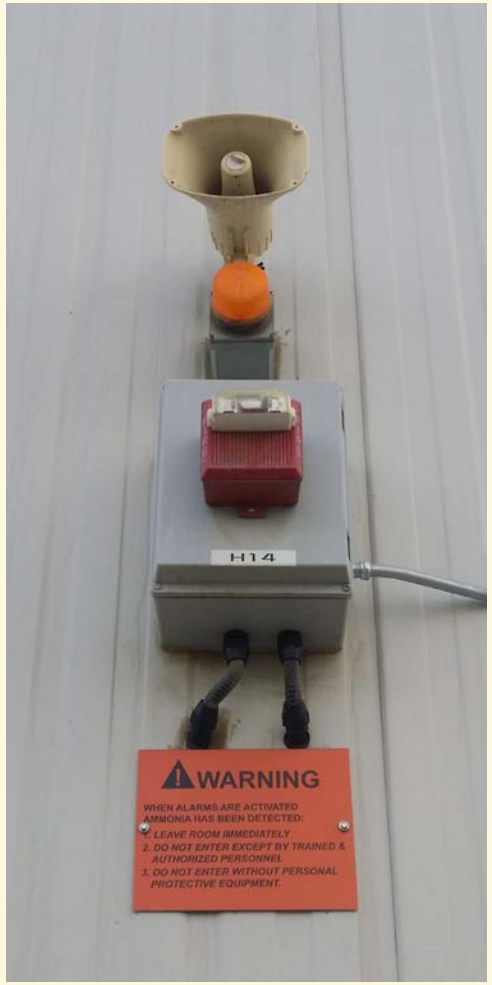


⚠ WARNING

WHEN ALARMS ARE ACTIVATED AMMONIA HAS BEEN DETECTED:

1. LEAVE ROOM IMMEDIATELY
2. DO NOT ENTER EXCEPT BY TRAINED & AUTHORIZED PERSONNEL.
3. DO NOT ENTER WITHOUT PERSONAL PROTECTIVE EQUIPMENT.

Ammonia Detection – Alarms



Ammonia Detection – Level 3

1. Must meet all Level 2 Detection requirements
2. Additional audible and visual alarms shall be located outside of each entrance to the machinery room.
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

[ANSI/IIAR 2-2014 §17.7.3]

Ammonia Detection – Machinery Rooms

- Variation of Level 3
- At least one ammonia detector inside the room
- 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.
- Audible and visual alarms shall be provided inside the room to warn that access to the room is restricted to authorized personnel and emergency responders when the alarm has activated. Additional audible and visual alarms shall be located outside of each entrance to the machinery room.

[ANSI/IIAR 2-2014 §6.13.1]

Ammonia Detection – Machinery Rooms

- Detection of ammonia concentrations less than **25 ppm** requires no alarm.
- Detection of **150 ppm** must activate emergency ventilation with manual reset required.
- Detection of **40,000 ppm** or vapor detector's upper limit must cause the following equipment to automatically de-energize:
  - Refrigerant compressors.
  - Refrigerant pumps.
  - Normally closed automatic refrigerant valves that are not part of an emergency control system

[ANSI/IIAR 2-2014 §6.13.2]

Ammonia Detection – Other Than Machinery Rooms

- Level 1 Detection
  - Exceptions:
  - 1. Unoccupied areas with continuous piping that does not include valves, valve assemblies, equipment, or equipment connections.
  - 2. Where approved, rooms or areas in industrial occupancies that are always occupied and are provided with an alternative to fixed detection and alarm equipment, such as an emergency action plan.

[ANSI/IIAR 2-2014 §7.2.3]

Ammonia Detection – Packaged Systems

1. Package systems located in machinery rooms shall be included as machinery room equipment. Detection and alarms shall comply with Section 6.13.
2. Package systems located indoors and outside of a machinery room, shall be provided with Level 2 detection and alarms
3. Package systems located outdoors that are not intended for human occupancy shall not require ammonia detection or alarms.

[ANSI/IIAR 2-2014 §14.4]

Ammonia Detection – Other Requirements

- Dedicated power circuit
- Failure of detection system must send a signal to a monitored location
- Tests must be performed per manufacturer's recommendation or at least annually
- Must be located where a leak is likely to occur
- Must be located so that it can be serviced

[ANSI/IIAR 2-2014 §17.2-17.4]

Ammonia Detection – Other Requirements

Dräger

DrägerSensor® NH_3 LC – 68 09 680

Calibration interval	
default	6 months
Adjustment range min/max	1 day/12 months
Warm-up time	
ready for operation after max.	120 minutes
ready for calibration after max.	660 minutes
when using SensorReady®	<5 minutes
Measurement accuracy *	
measurement uncertainly (of meas. value) or	≤ ±5 %
minimum (whichever is the greater value)	≤ ±1.5 ppm
Loss of sensitivity, per year	≤ -15 %
Expected service life, in ambient air	>24 months
Environmental conditions	
Temperature, min./max.	-40/65 °C (-40/149 °F)
Rel. humidity, min./max.	15/95 %
Ambient pressure	±3 %
Storage conditions	
packed, min./max.	0/40 °C (32/104 °F)
Cross-sensitivities	existing, for information contact Dräger
Order Nos.:	
DrägerSensor NH_3 LC	68 09 680
Dust filter	68 09 595
Calibration adapter V	68 10 536
Calibration cylinder for ampoule calibr.	68 03 407
Test gas ampoule 50 ppm NH_3	68 07 924

Ammonia Detection – Other Requirements

- Alarms must provide a sound level of 15 dBA above average ambient noise. 5 dBA above maximum noise.
- Signage must be installed adjacent to each visual/audible alarm.
- 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.

[ANSI/IIAR 2-2014 §17.5-17.7]

Ammonia Detection – Other Requirements

- A means shall be provided for monitoring the concentration of an ammonia release in the event of a power failure.

[ANSI/IIAR 2-2014 §16.1.4]

Ammonia Detection – Implications

- Machinery rooms shall be designated Ordinary Locations, as described in the Electrical Code, where the machinery room is provided with emergency ventilation in accordance with Section 6.14.7 and ammonia detection in accordance with Section 6.13.

[ANSI/IIAR 2-2014 §6.8.2]

Ventilation

- Every machinery room shall be provided with means of ventilation to the outer air. [1982 UMC §1508]
- Machinery room ventilation required in IIAR 2 (1974, 1978, 1984, 1999, 2008, 2014)
  - Normal Ventilation: 20 ACH
  - Emergency Ventilation: 30 ACH
- Machinery room ventilation required in ASHRAE 15

Ventilation

Ventilation

Ventilation

Ventilation

Citation 1 Item 5 Type of Violation: **Serious**

29 CFR 1910.119(j)(4)(i): Inspections and tests were not performed on process equipment.

On or about 20 July 2013, and at times prior thereto, the employer did not conduct testing of the ventilation system for the Engine Room to ensure it was still performing at the rated capacity from the original install in 1999. The system was designed to meet the requirements of ANSI/IIAR 2-1992, which has been superseded by ANSI/IIAR 2-1999 and currently with ANSI/IIAR 2-2008, Addendum A. Failure to ensure the ventilation system performs to the rated capacity exposed the workers within the Engine Room to the hazard of anhydrous ammonia liquid or vapor.

ABATEMENT DOCUMENTATION REQUIRED FOR THIS ITEM

Date By Which Violation Must be Abated:	03/07/2014
Proposed Penalty:	$7000.00

Emergency Shutoff

- A clearly identified switch of the break-glass type or with an approved tamper-resistant cover shall provide off-only control of refrigerant compressors, refrigerant pumps and normally closed automatic refrigerant valves located in the machinery room. Additionally, this equipment shall be automatically shut off whenever the refrigerant vapor concentration in the machinery room exceeds the vapor detector's upper detection limit or 25 percent of the LEL, whichever is lower. [2013 CFC §606.9.1]
- Similar requirement in 2013 CMC §1109.4, ANSI/IIAR 2-2014 §6.12.1

Emergency Shutoff

- Remote control of the mechanical equipment in the refrigerating machinery room shall be provided immediately outside the machinery room door solely for the purpose of shutting down the equipment in an emergency. Ventilation fans shall be on a separate electrical circuit and have a control switch located immediately outside the machinery room door. [ANSI/ASHRAE 15-2013 §8.12(i)]
- Similar requirement has existed since 1982 UMC

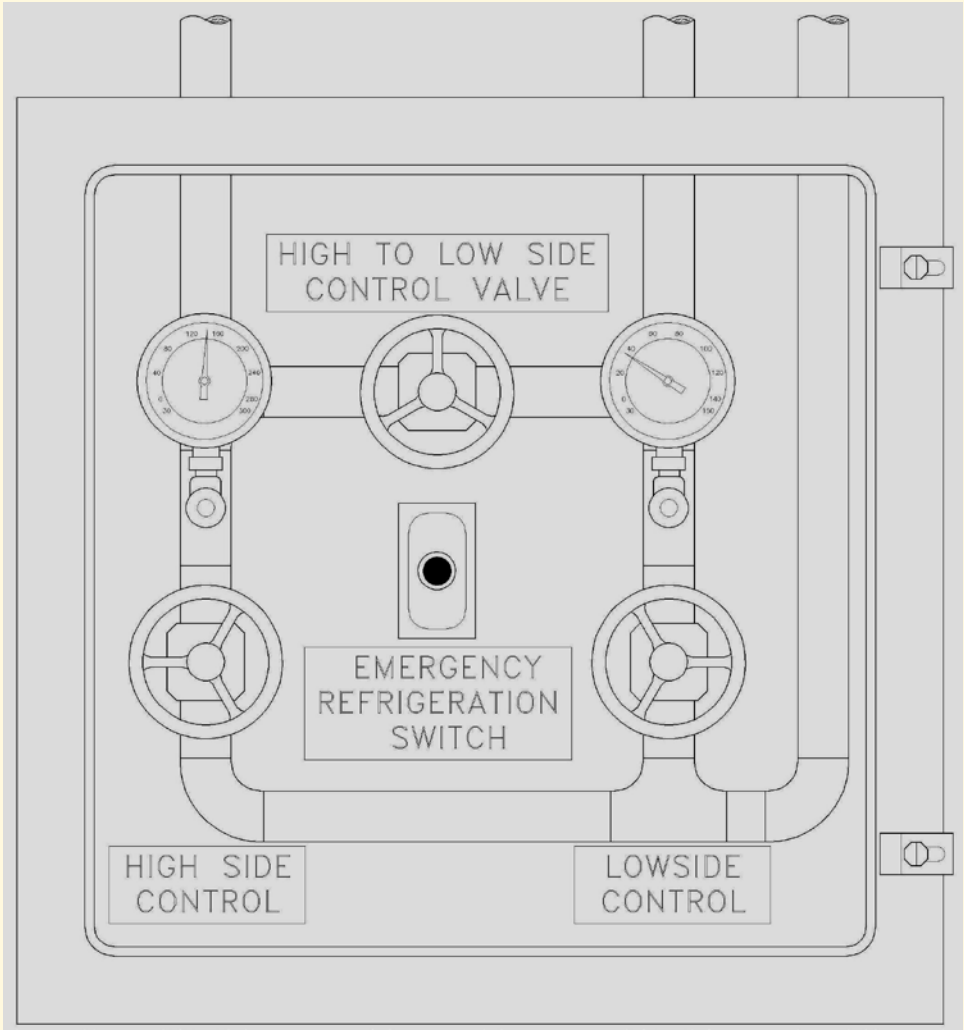
Emergency Shutoff

Emergency Shutoff

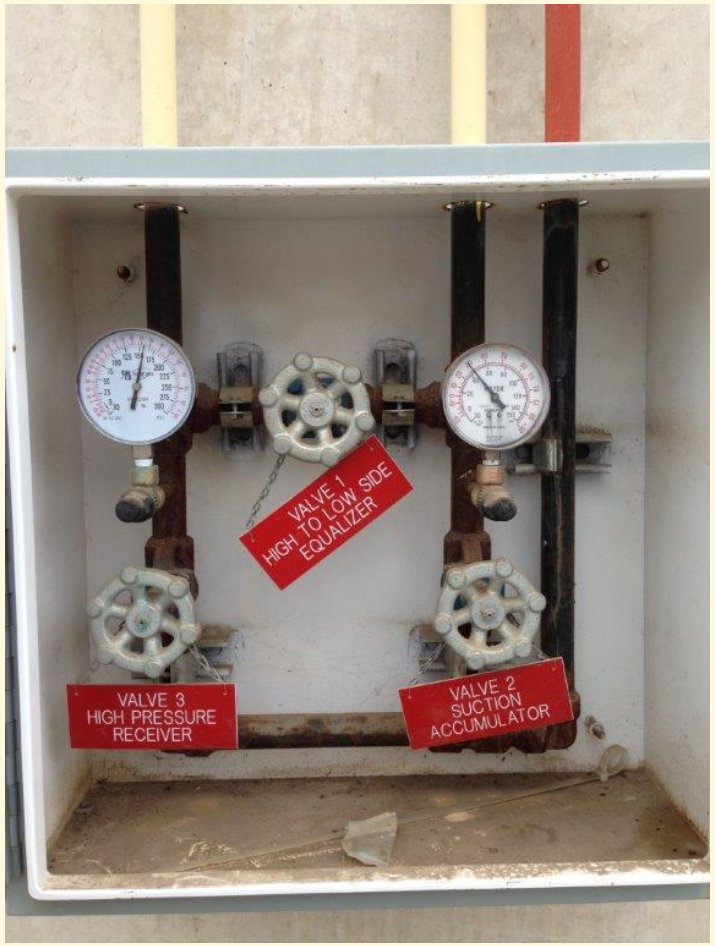
Emergency Shutoff

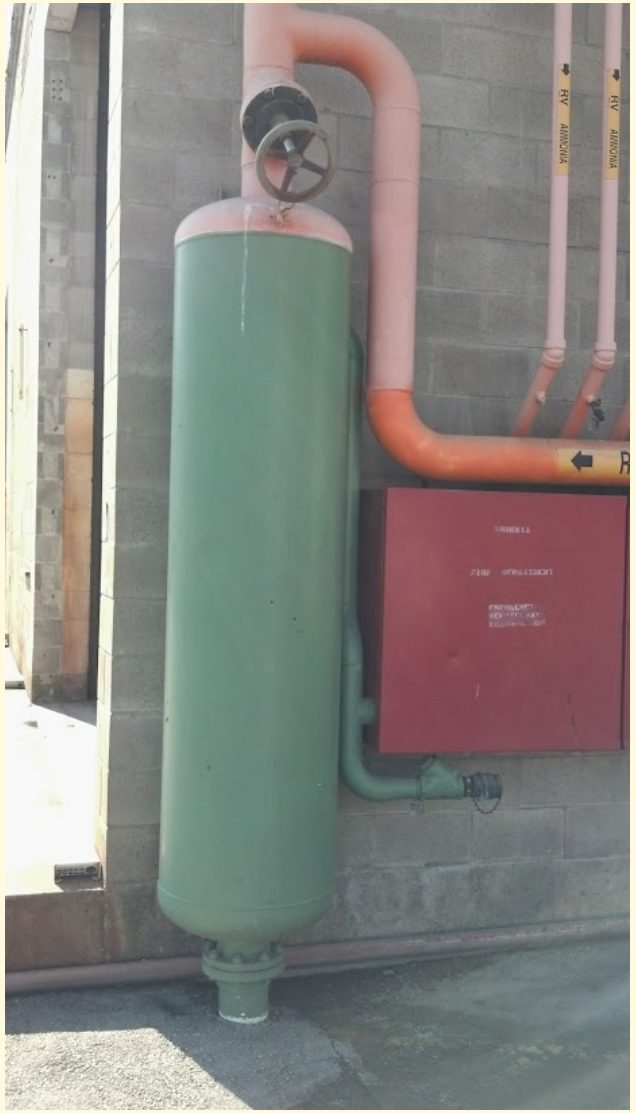
Emergency Control Box

- Fire/Mechanical Code requirement since 1967. Last instance in a model code was 2003.
- Some mechanical codes and fire codes require manual emergency discharge or diffusion arrangements for refrigerants. While these provisions are not recommended nor required by this Standard, Appendix B has been included to aid in the safe accomplishment of this purpose when required. [ANSI/ASHRAE 15-1989 §10.15]



Emergency Control Box





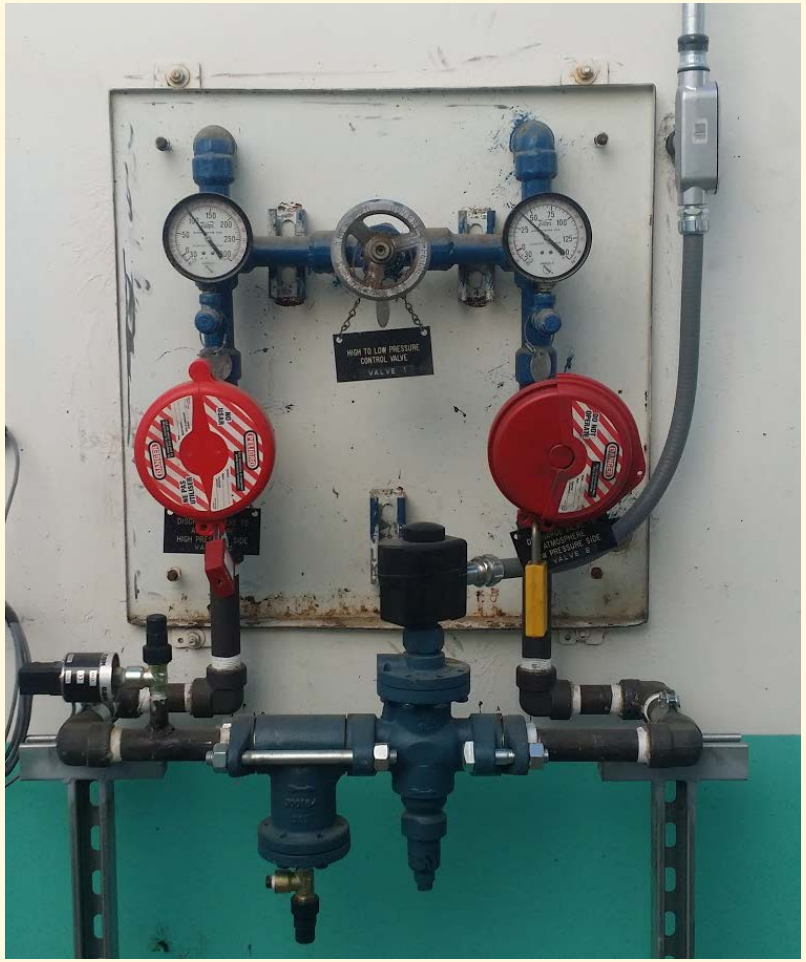
Emergency Control Box

Emergency Pressure Control System

- Refrigeration systems containing more than 6.6 pounds (3 kg) of flammable, toxic or highly toxic refrigerant or ammonia shall be provided with an emergency pressure control system in accordance with Sections 606.10.1 and 606.10.2. [2013 CFC §606.10]
- ANSI/IIAR 2-2014 Appendix I

Emergency Pressure Control System

Emergency Pressure Control System



Labeling

- **NFPA 704 Placards**
  - Buildings and facilities with refrigeration systems shall be provided with placards accordance with NFPA 704 and the Mechanical Code. [ANSI/IIAR 2-2014 §6.15.1]
  - Refrigeration units or systems having a refrigerant circuit containing more than 220 pounds (100 kg) of Group A 1 or 30 pounds (14 kg) of any other group refrigerant shall be provided with approved emergency signs, charts and labels in accordance with NFPA 704. Hazard signs shall be in accordance with the California Mechanical Code for the classification of refrigerants listed therein. [2013 CFC §606.7]

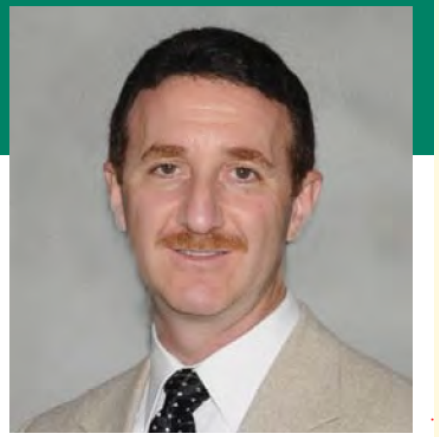
Labeling

- **NFPA 704 Placards**

Labeling

- **NFPA 704 Placards**

IIAR Code Advocacy Update



By Jeffrey M. Shapiro, PE., FSFPE

Understanding NFPA 704 Placards and Their Use at Ammonia Refrigeration Facilities

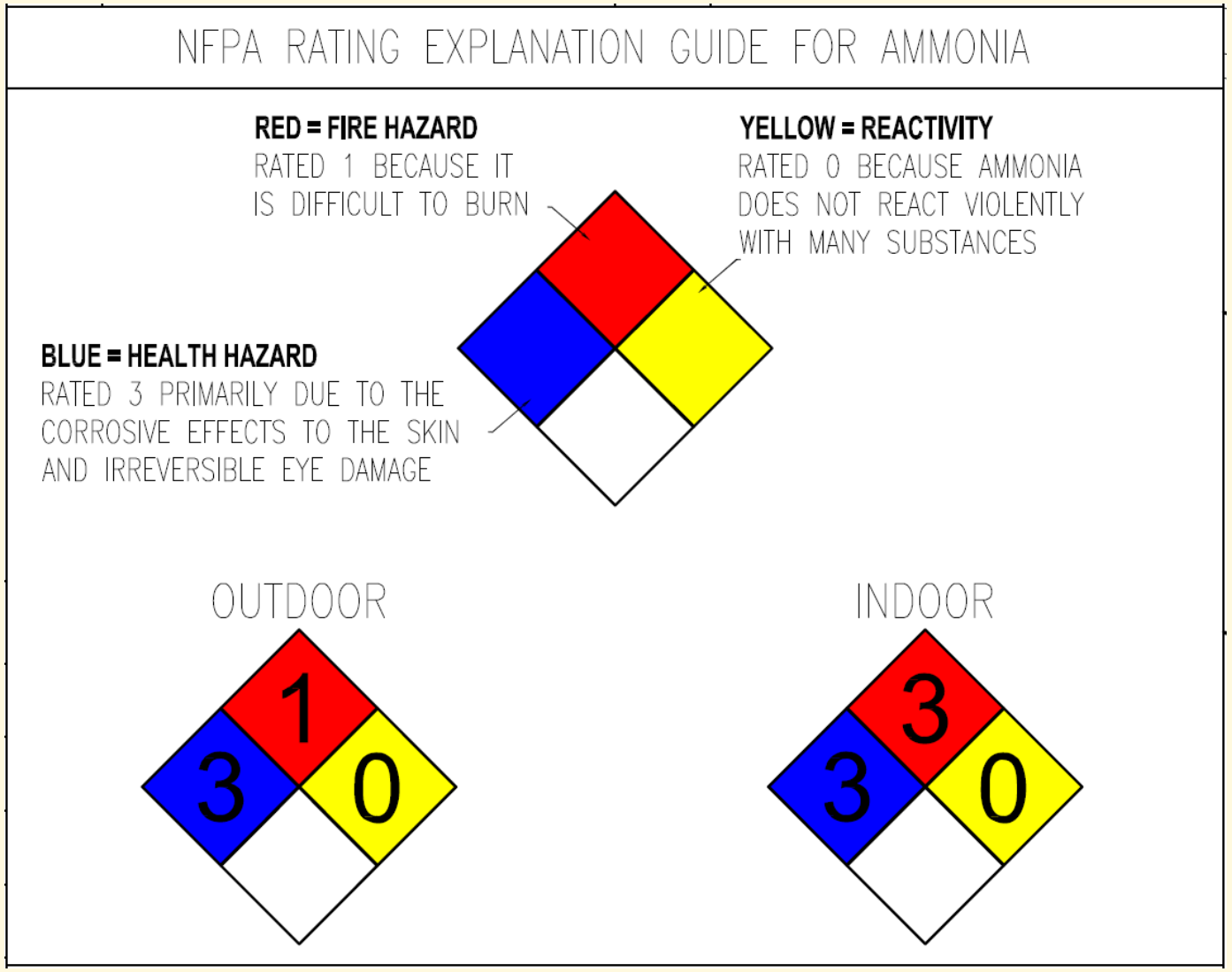
Put yourself in the position of a firefighter. You've been

The purpose statement is enhanced by several stated objectives, two of which are:

(1) To provide an appropriate signal or

Labeling

- **NFPA 704 Placards**



Labeling

- **Piping**
  - Ammonia piping mains, headers, and branches shall be identified with the following information:
    1. “AMMONIA.”
    2. Physical state of the ammonia.
    3. Relative pressure level of ammonia, being low or high as applicable.
    4. Pipe service, which shall be permitted to be abbreviated.
    5. Direction of flow.

  The marking system shall either be one established by a recognized model code or standard or one described and documented by the facility owner. [ANSI/IIAR 2-2014 §5.14.5]
  - IIAR Bulletin No. 114 §4.1
  - Similar requirements in 2013 CMC §1111.8 and ANSI/ASHRAE 15-2013 §11.2.2.

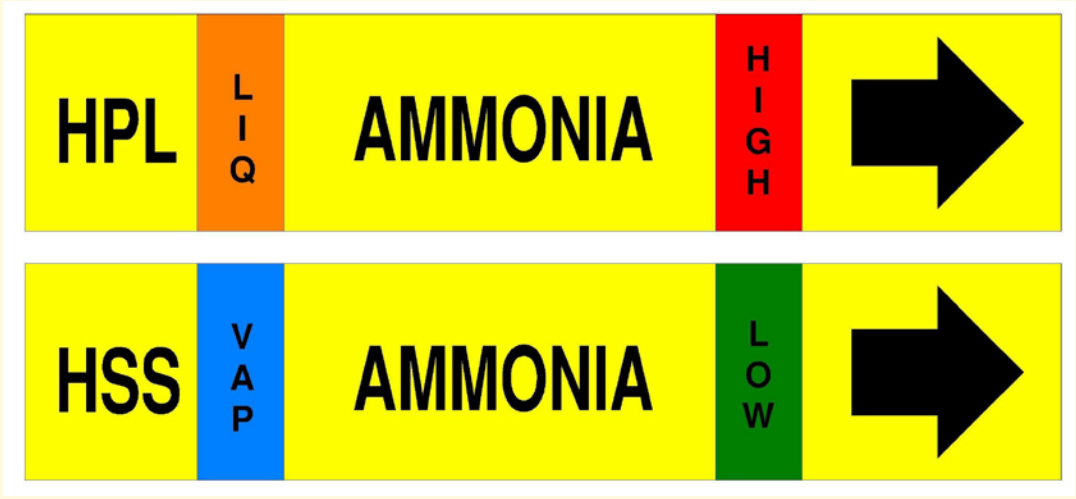
Labeling

- **Piping**

Labeling

- **Piping**

Pre-March 2014



Post-March 2014

Labeling

- **Piping**

Labeling

- **Piping**

A Guide to Bulletin 114: Piping Colors

In its updated form, IIAR Bulletin 114 will provide a method for expanding color identification guidelines, and will serve as a recommendation for an expanded piping color scheme.

The guideline will address: un-insulated line finishes; insulated lines with insulation jacketing; and intermittent markers. The colors specified by the guideline have been designated by Pantone color numbers, from the Pantone Color Matching System, and are identified by the document as "targets" for shade, tone, and color.

The bulletin makes an allowance for slight variations that are expected as a result of variance in manufacturing, UV deterioration, dust and other unforeseen factors that may alter the appearance of color either at installation or after the jacketing or markers have been in service.

According to the draft bulletin, facilities may select an alternate color scheme as long as that color scheme is consistent throughout a facility. Regardless of the color scheme selected, Bulletin 114 specifies that a legend or key to the meaning of the colors should be posted in a conspicuous area. Listed below are the eight Pantone colors recommended under IIAR's piping color scheme, which is slated for release as an update to IIAR Bulletin 114 early next year.

High Pressure Liquid Piping

Ammonia high pressure liquid piping should be **Ammonia Refrigeration Orange (PANTONE® Color 152 C)** for services > 70 psig as follows:

- High Pressure Liquid (HPL)
- Sub Cooled Liquid (SCL)
- Thermosyphon Supply (TSS)
- Thermosyphon Return (TSR)
- Condenser Drain (CD)
- Liquid Injection Cooling (LIC)
- Intermediate Pressure Liquid (IPL)

Ammonia High Pressure Vapor Piping

Ammonia high pressure vapor piping should be **Ammonia Refrigeration Yellow (PANTONE® Color 109 C)** for services > 70 psig as follows:

- Booster Discharge (BD)
- High Stage Discharge (HSD)
- Hot Gas Defrost (HGD)
- Foul Gas (FG)

Low Pressure, High Temperature Liquid and Vapor Piping

Low pressure, high temperature liquid and vapor piping should be **Ammonia Refrigeration Light Blue (PANTONE® Color 298C)** for the services within the 0°F to +45°F range (saturated pressure 66.3 psig>P>15.7 psig).

If more than one temperature or pressure level exists within this range, additional colors can be selected to further distinguish these subsystems. Note that any alternate colors can be selected if they are easily distinguishable, do not duplicate defined uses within this guideline and are identified in an accessible legend. The services for the low pressure, high temperature range are as follows:

- High Temperature Recirculated Liquid (HTRL)
- Booster Suction (BS)
- Economizer Suction (ES)
- High Stage Suction (HSS)
- Medium Temperature Suction (MTS)
- Medium Temperature Recirculated Suction (MTRS)
- High Temperature Suction (HTS)
- High Temperature Recirculated Suction (HTRS)
- Defrost Relief (DR)

Low Pressure, Low Temperature Liquid and Vapor Piping

Low pressure, low temperature liquid and vapor piping should be **Ammonia Refrigeration Dark Blue (PANTONE® Color 3015c)** for the services within the -1°F to -20°F range (saturated pressure 15.7 psig>P>3.6 psig).

If more than one temperature or pressure level exists within this range, additional colors can be selected to further distinguish these subsystems. Note that any alternate colors can be selected if they are easily distinguishable, do not duplicate defined uses within this guideline and are identified in an accessible legend. The services for the low pressure, low temperature range are as follows:

- Low Temperature Recirculated Suction (LTRS)
- Low Temperature Suction (LTS)
- Low Temperature Recirculated Liquid (LTRL)
- Low Temperature Liquid(LTL)

Low Pressure, Low-Low Temperature Liquid and Vapor Piping

Low pressure, low-low temperature liquid and vapor piping should be **Ammonia Refrigeration Purple (PANTONE® Color 2617 C)** for the services within the -21°F to -60°F range (saturated pressure P< 3.6 psig).

If more than one temperature or pressure level exists within this range, additional colors can be selected to further distinguish these subsystems. Note that any alternate colors can be selected if they are easily distinguishable, do not duplicate defined uses within this guideline and are identified in an accessible legend. The services for the low Pressure, low-low temperature range are as follows:

- Low-Low Temperature Recirculated Suction (LLTRS)
- Low-Low Temperature Suction (LLTS)
- Low-Low Temperature Recirculated Liquid (LLTRL)
- Low-Low Temperature Liquid(LLTL)

Non-Pressurized Refrigeration Piping and Related Process Piping:

Pressure Relief Vent Grey (PANTONE® Color 430 C) for:

- Pressure Relief Vent Piping (RV)

Water Green (PANTONE® Color 3415 C) for:

- Water Piping

Sprinkler Red (PANTONE® 485 C) for:

- Fire Sprinkler Piping

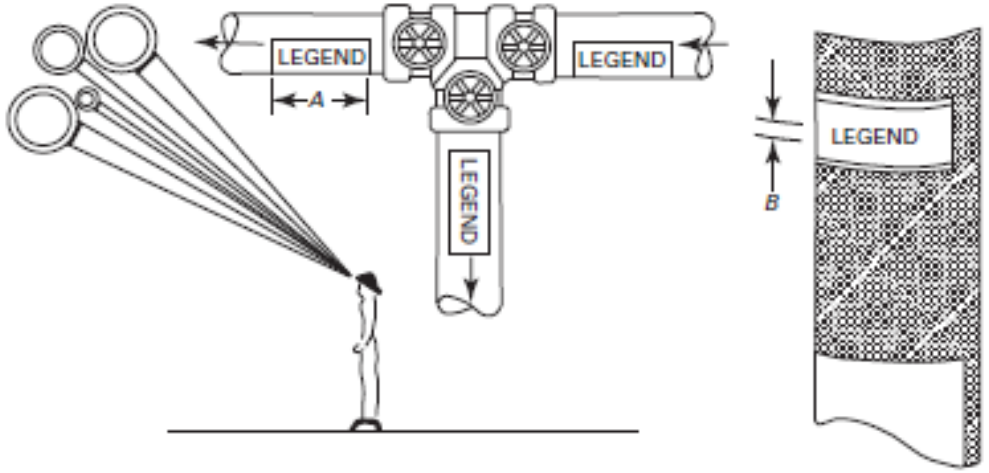
Labeling

- **ASME A13.1-2015**

Table 2 Designation of Colors

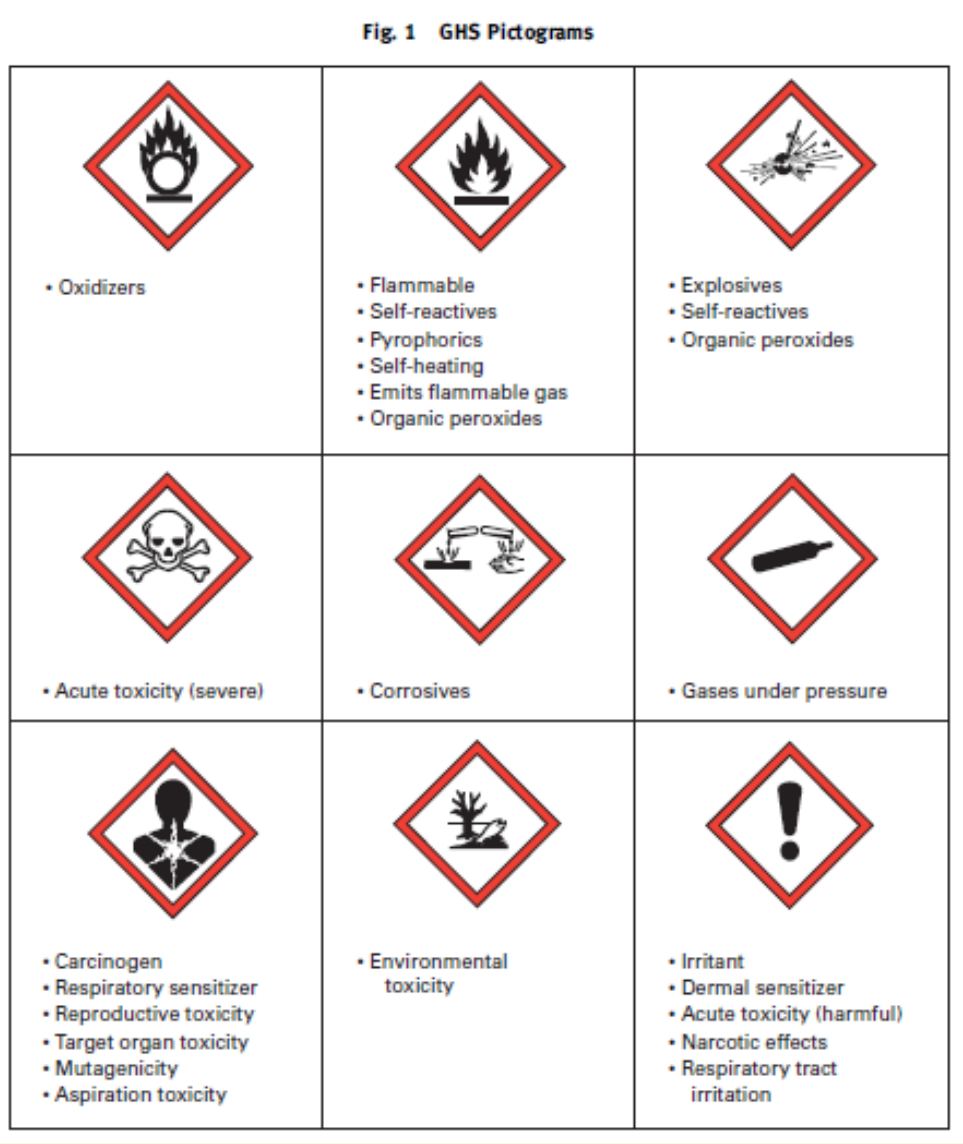
Fluid Service	Background Color	Letter Color	Color and Letter Sample
Fire quenching fluids	Safety red	White	Letters
Toxic and corrosive fluids	Safety orange	Black	Letters
Flammable and oxidizing fluids	Safety yellow	Black	Letters
Combustible fluids	Safety brown	White	Letters
Potable, cooling, boiler feed, and other water	Safety green	White	Letters
Compressed air	Safety blue	White	Letters
To be defined by the user	Safety purple	White	Letters
To be defined by the user	Safety white	Black	Letters
To be defined by the user	Safety gray	White	Letters
To be defined by the user	Safety black	White	Letters

Fig. 2 Location of Identification Markers



Labeling

- **ASME A13.1-2015 §3.1**
  - Where piping is connected to containers that are labeled in accordance with GHS requirements, a corresponding label on the piping may be provided. The corresponding label should contain at least the product name or identifier, the pictogram, the signal word, and the physical, health, and environmental hazard statement(s).

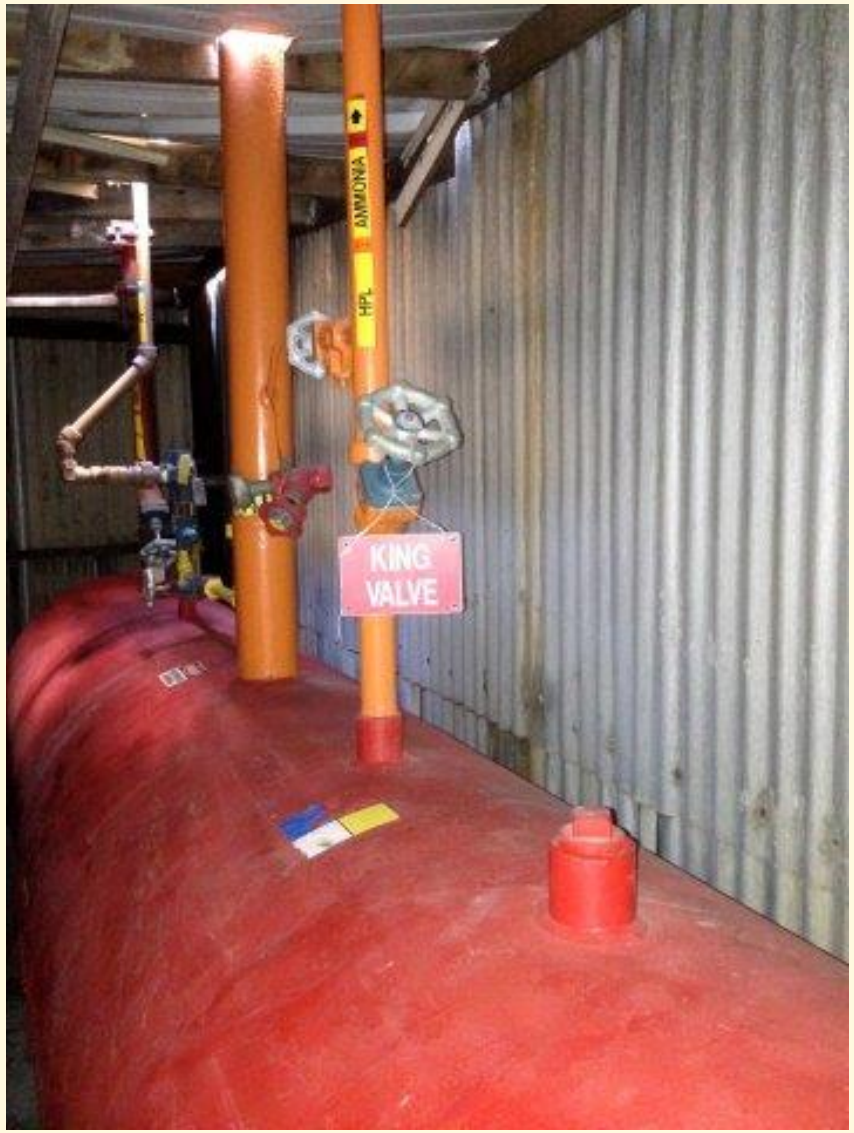


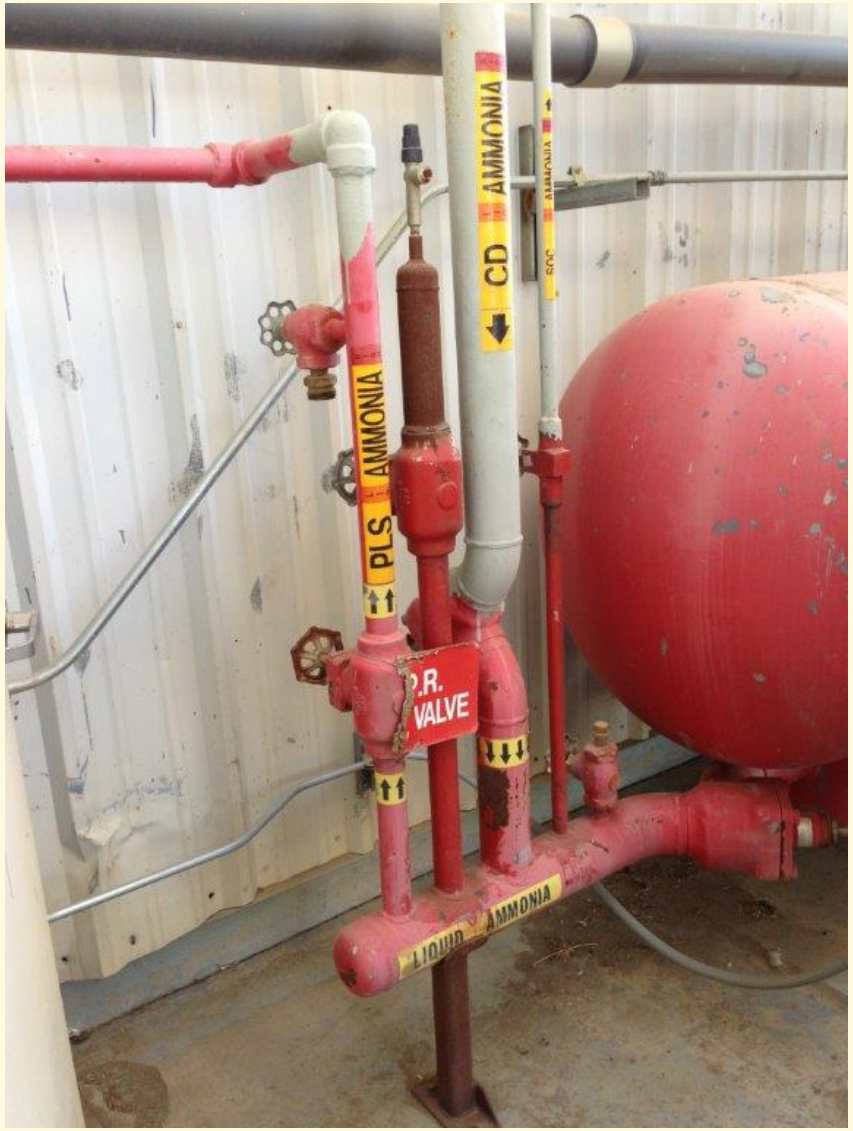
Labeling

- **Valves**
  - Valves required for emergency shutdown of the system shall be clearly and uniquely identified at the valve itself and in the system schematic drawings. [ANSI/IIAR 2-2014 §5.14.3]
  - Stop valves shall be suitably labeled if the components to and from which the valve regulates flow are not in view at the valve location. Valves or piping adjacent to the valves shall be identified in accordance with ANSI A13.1 When numbers are used to label the valves, there shall be a key to the numbers located within sight of the valves with letters at least 0.5 in. (12.7 mm) high. [ANSI/ASHRAE 15-2013 §9.12.6]
  - Stop valves shall be identified by tagging in accordance with the reference standard for identification. A valve chart shall be mounted under glass at an approved location near the principal entrance to the machinery room. [2013 CMC §1112.4]

Labeling

- **Valves**





Labeling

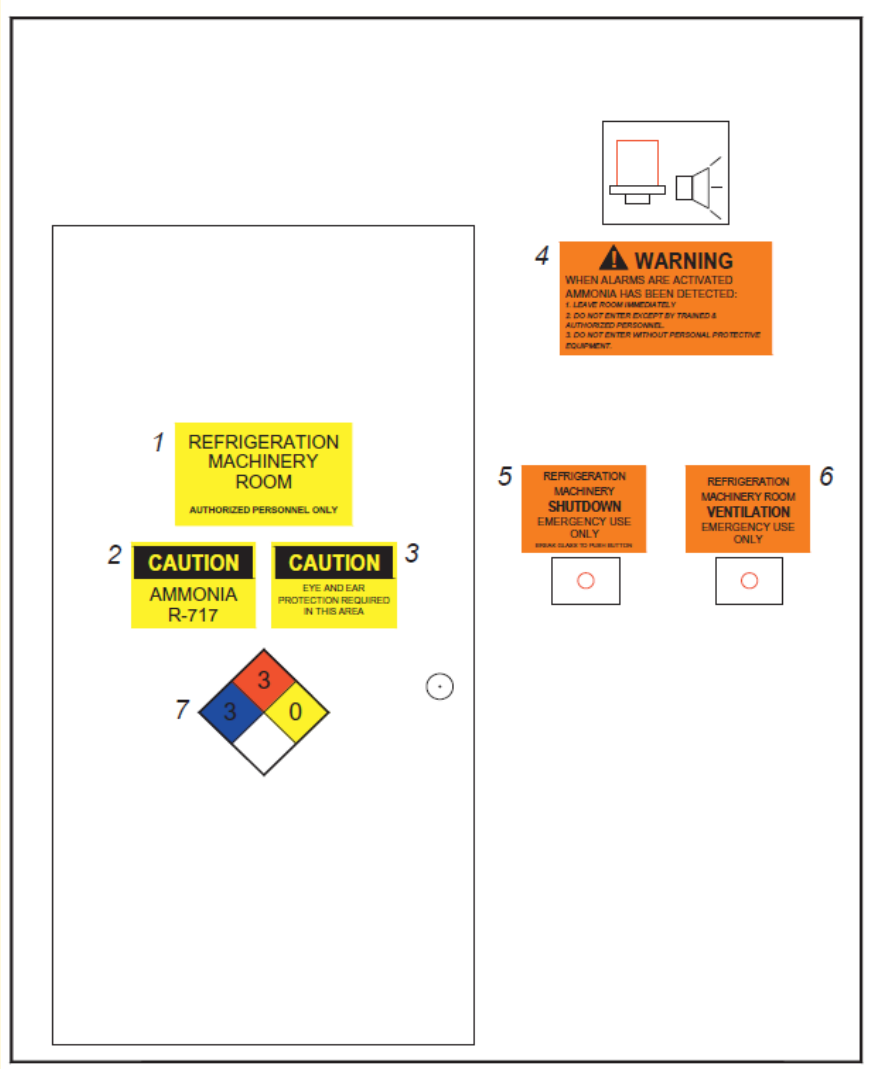
- **Valves**

Labeling

- **Machinery Room**
  - Each refrigerating system erected on the premises shall be provided with a legible permanent sign, securely attached and easily accessible, indicating
    - a. the name and address of the installer,
    - b. the refrigerant number and amount of refrigerant,
    - c. the lubricant identity and amount, and
    - d. the field test pressure applied.
      [2013 CMC §1123.3, ANSI/IIAR 2-2014 §15.15]
  - ANSI/IIAR 2-2014 Appendix J

Labeling

- **Machinery Room**



Principal Machinery Room Door

Labeling

- **Machinery Room**

Pipe Supports

- …piping and tubing shall be securely fastened to a permanent support within 6 feet (1829 mm) following the first bend in such tubing from the compressor and within 2 feet (610 mm) of each subsequent bend or angle. Piping and tubing shall be supported at points not more than 15 feet (4572 mm) apart. [2013 CMC §1111.2]

Pipe Supports

- ANSI/IIAR 2-2014 Appendix F

Nominal Pipe Size	Maximum Span	Minimum Rod Diameter
Up to 1	7	1/8
1-¼ - 1-1/2	9	3/8
2	10	3/8
2-1/2	10	1/2
3	12	1/2
4	14	5/8
5	16	5/8
6	17	3/4
8	19	7/8
10	22	7/8
12	23	7/8

Pipe Supports

Pipe Supports

Pipe Supports

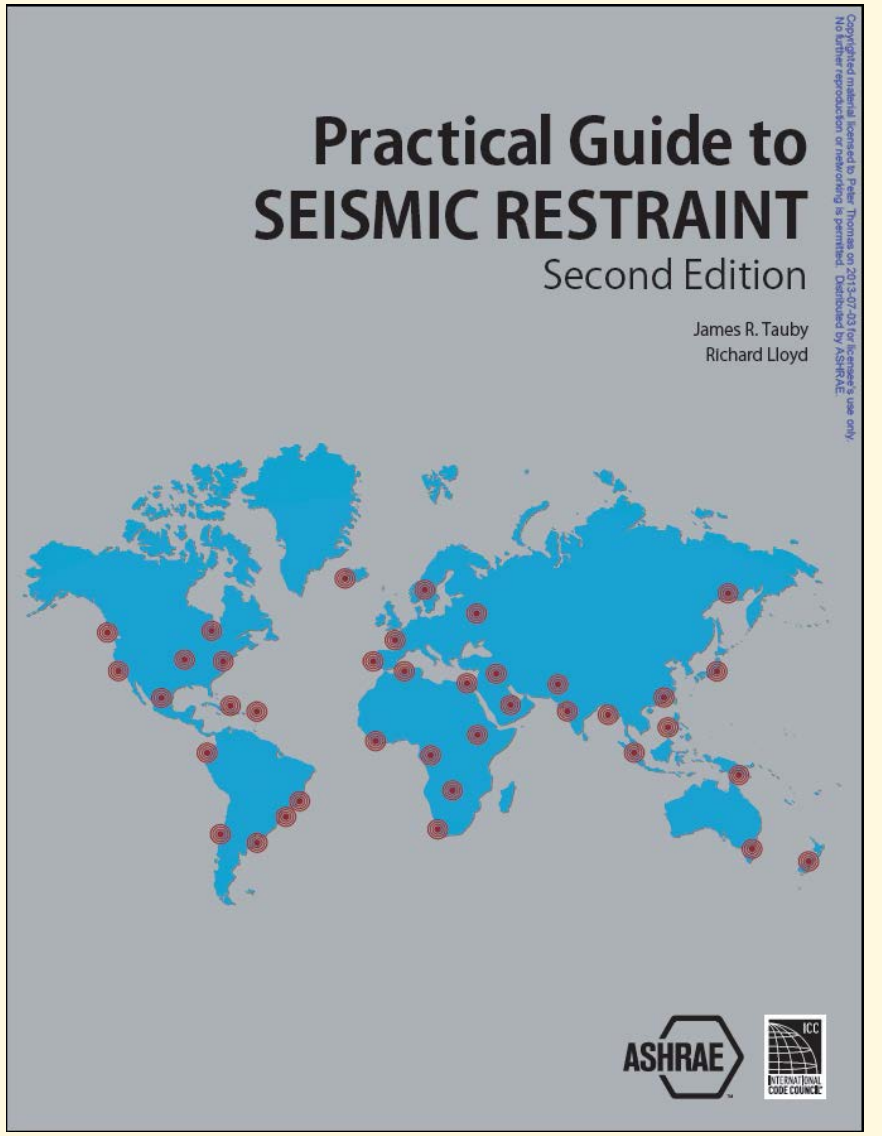
Pipe Supports

Pipe Supports

Supports and Anchorage

- …A compressor or portion of a condensing unit supported from the ground shall rest on a concrete or other approved base extending not less than 3 inches (76 mm) above the adjoining ground level. [2013 CMC §1106.2]

Supports and Anchorage



Anchorage

Anchorage

Trapeze Supports

Ammonia Detection

Emergency Eyewash/Shower

- Be in accessible locations that require no more than 10 seconds to reach [Title 8 CCR §5162, ANSI/ISEA Z358.1-2009 §7.4.2]
- Each machinery room shall have access to a minimum of two eyewash/safety shower units, one located inside the machinery room and one located outside of the machinery room, each meeting the requirements in Section 6.7.3. 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. [ANSI/IIAR 2-2014 §6.7.1
- An emergency eye wash station and deluge body shower shall be located just outside the machine room exit door. An additional emergency eye wash station and deluge body shower should be readily accessible inside the machinery room. [IIAR Bulletin No. 109 §4.10.10]

Emergency Eyewash/Shower

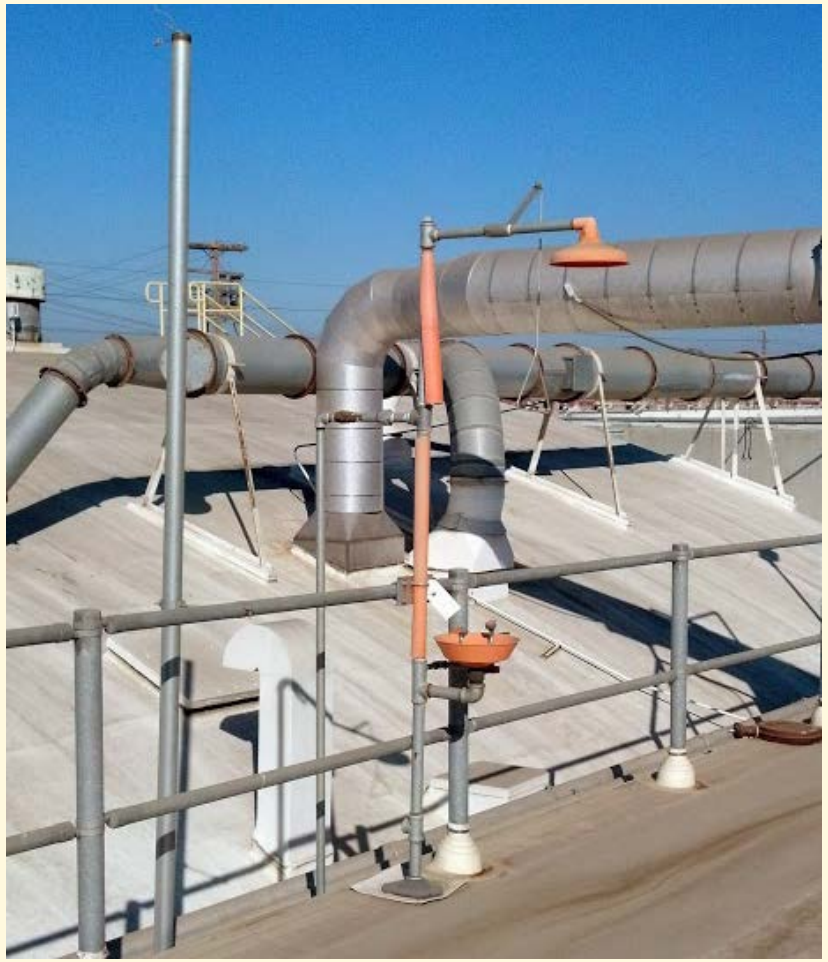
- Be located in an area identified with a highly visible sign positioned so the sign shall be visible within the area served by the combination unit. The area around the combination unit shall be well-lit. [ANSI/ISEA Z358.1-2009 §7.4.3]
- Plumbed eyewash and shower equipment shall be activated at least monthly to flush the line and to verify proper operation. Other units shall be maintained in accordance with the manufacturer's instructions. [Title 8 CCR §5162(e)]

Emergency Eyewash/Shower

- Deliver tepid flushing fluid. In circumstances where chemical reaction is accelerated by flushing fluid temperature, a facilities safety/health advisor should be consulted for the optimum temperature for each application. (See Appendix B6). [ANSI/ISEA Z358.1-2009 §7.4.5]
- Temperatures in excess of 38°C (100°F) have proven to be harmful to the eyes and can enhance chemical interaction with the skin and eye tissue…Colder ambient temperature might require an enclosure for added protection…[ANSI/ISEA Z358.1-2009 §B6]

Emergency Eyewash/Shower

Emergency Eyewash/Shower



Emergency Instructions

- It shall be the duty of the person in charge of the premises at which the refrigeration system is installed to provide directions for the emergency shutdown of the system at a location that is readily accessible to trained refrigeration system staff and trained emergency responders. Schematic drawings or signage shall include the following:
    1. Instructions with details and steps for shutting down the system in an emergency.
    2. The name and telephone numbers of the refrigeration operating, maintenance, and management staff, emergency responders, and safety personnel.
    3. The names and telephone numbers of all corporate, local, state, and federal agencies to be contacted as required in the event of a reportable incident.
    4. Quantity of ammonia in the system.
    5. Type and quantity of refrigerant oil in the system.
    6. Field test pressures applied.

[ANSI/IIAR 2-2014 §15.15]

Emergency Instructions

General Safety

- **Access Ports**
  - Air conditioning refrigerant circuit access ports located outdoors shall be protected from unauthorized access with locking-type tamper resistant caps or in a manner approved by the Authority Having Jurisdiction. [2013 CMC §1106.14]
  - Stop valves connecting refrigerant containing parts to atmosphere during shipping, testing, operating, servicing, or standby conditions shall be capped, plugged, blanked, or locked closed when not in use. [ANSI/ASHRAE 15-2013 §11.6.1]

Restricted Access

- **Access Ports**

Restricted Access

- **Access Ports**

Electrical

- Electrically energized components of refrigeration systems shall comply with the electrical code. [2013 CMC §1106.6]
- Electrical equipment and wiring shall be installed in accordance with the National Electrical Code and the requirements of the AHJ. [ANSI/ASHRAE 15-2013 §8.5]

Electrical

- ANSI/IIAR 2-2014 §6.8 Electrical Safety
  - Electrical equipment and wiring shall be installed in accordance with the Electrical Code.
  - Machinery rooms shall be designated Ordinary Locations, as described in the Electrical Code, where the machinery room is provided with emergency ventilation in accordance with Section 6.14.7 and ammonia detection in accordance with Section 6.13.
  - Machinery rooms not provided with emergency ventilation shall be designated as not less than a Class 1, Division 2, Group D Hazardous (Classified) Location, and electrical equipment installed in the machinery room shall be designed to meet this requirement.

Electrical

Housekeeping

- Refrigerating systems shall be maintained by the user in a clean condition, free from accumulations of oily dirt, waste, and other debris, and shall be kept accessible at all times. [ANSI/ASHRAE 15-2013 §11.6]
- Machinery room floor clean of oil, grease and water? [IIAR Bulletin No. 109 General Safety Checklist Item L]
- Mechanical refrigeration systems shall be maintained in proper operating condition, free from accumulations of oil dirt, waste, excessive corrosion, other debris and leaks. [2015 IMC §1101.7]

Housekeeping

Housekeeping

Corrosion

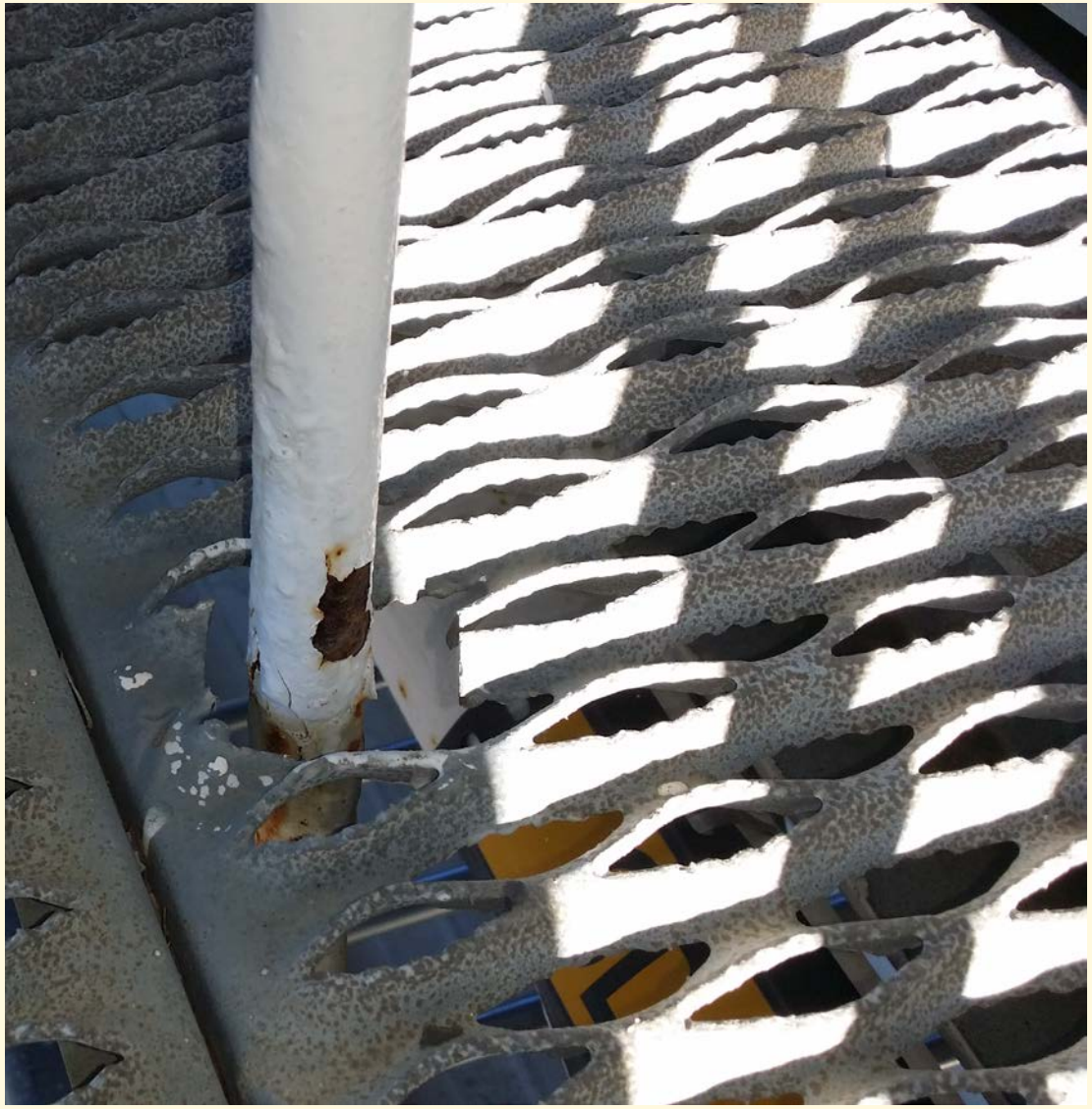
- Uninsulated refrigerant piping should be examined for signs of corrosion. If corrosion exists, the pipe should be cleaned down to bare metal and painted with a rust preventive paint. Badly corroded pipe should be replaced. [IIAR Bulletin No. 109 §4.7.4]

Corrosion

Corrosion

Corrosion

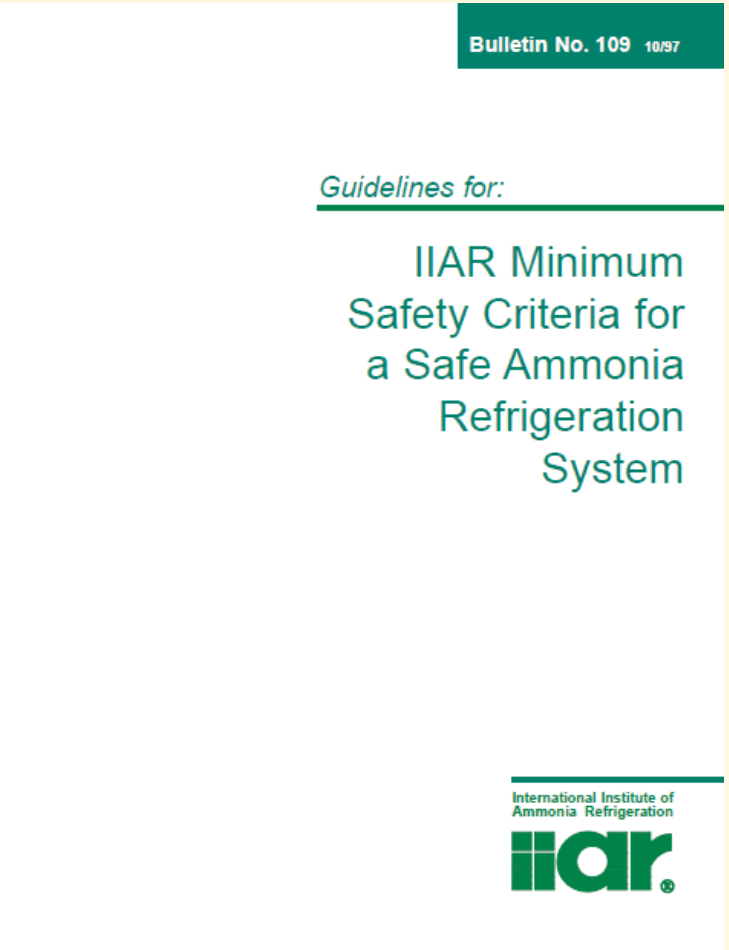
Corrosion

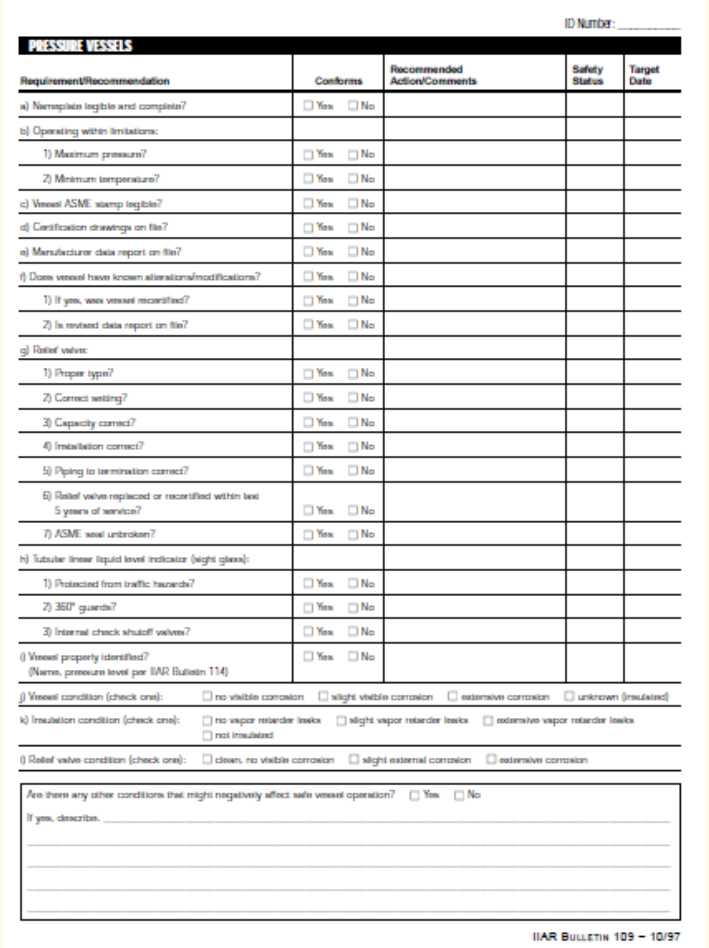


5-Year Independent Inspection

- At least every five years, the annual inspection of the vessels and heat exchangers shall be carried out by a competent person independent of immediate commercial and production pressures for that installation, who shall carry out whatever examinations and tests he may consider necessary in order to determine that the equipment is safe for further use or in order to specify such repairs that may be necessary. [IIAR Bulletin No. 110 §6.4.4.1]

5-Year Independent Inspection





ID Number: _____

PRESSURE VESSELS

Requirement/Recommendation	Conforms	Recommended Action/Comments	Safety Status	Target Date
a) Nameplate legible and complete?	☐ Yes ☐ No			
b) Operating within limitations:				
1) Maximum pressure?	☐ Yes ☐ No			
2) Minimum temperature?	☐ Yes ☐ No			
c) Vessel ASME stamp legible?	☐ Yes ☐ No			
d) Certification drawings on file?	☐ Yes ☐ No			
e) Manufacturer data report on file?	☐ Yes ☐ No			
f) Does vessel have known alterations/modifications?	☐ Yes ☐ No			
1) If yes, was vessel recertified?	☐ Yes ☐ No			
2) Is revised data report on file?	☐ Yes ☐ No			
g) Relief valves:				
1) Proper type?	☐ Yes ☐ No			
2) Correct setting?	☐ Yes ☐ No			
3) Capacity correct?	☐ Yes ☐ No			
4) Installation correct?	☐ Yes ☐ No			
5) Piping to termination correct?	☐ Yes ☐ No			
6) Relief valve replaced or recertified within last 5 years of service?	☐ Yes ☐ No			
7) ASME seal unbroken?	☐ Yes ☐ No			
h) Tubular linear liquid level indicator (sight glass):				
1) Protected from traffic hazards?	☐ Yes ☐ No			
2) 360° guards?	☐ Yes ☐ No			
3) Internal check shutoff valves?	☐ Yes ☐ No			
i) Vessel properly identified? (Name, pressure level per IIAR Bulletin 114)	☐ Yes ☐ No			

j) Vessel condition (check one): ☐ no visible corrosion ☐ slight visible corrosion ☐ extensive corrosion ☐ unknown (insulated)

k) Insulation condition (check one): ☐ no vapor retarder leaks ☐ slight vapor retarder leaks ☐ extensive vapor retarder leaks ☐ not insulated

l) Relief valve condition (check one): ☐ clean, no visible corrosion ☐ slight external corrosion ☐ extensive corrosion

Are there any other conditions that might negatively affect safe vessel operation? ☐ Yes ☐ No

If yes, describe. _____

Insulation

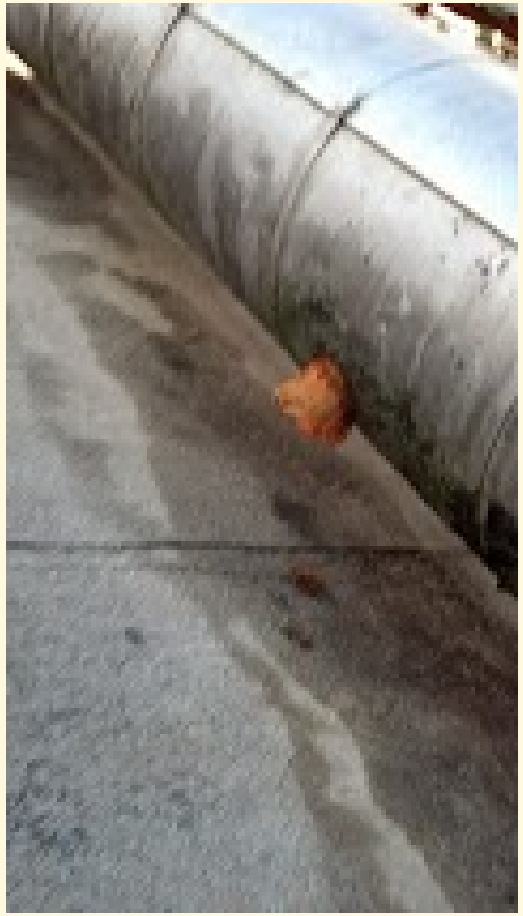
- Piping and equipment surfaces not intended for heat exchange shall be insulated, treated, or otherwise protected to mitigate condensation and excessive frost buildup where the surface temperature is below the dew point of the surrounding air during normal operation and in an area where condensation and frost could develop and become a hazard to occupants or cause damage to the structure, electrical equipment, or refrigeration system. [ANSI/IIAR 2-2014 §5.10.1]
- Refrigerant piping with an external surface temperature of 140°F (60°C) or higher and located outside the machinery room at a height less than 7.25 ft (2.2 m) above the floor, or located adjacent to passageways, aisles, walkover stairs, or landings, shall be provided with one of the following: 1. caution signs, 2. insulation, or 3. guards to prevent contact. [ANSI/IIAR 2-2014 §5.17.8]

Insulation

- Insulated piping showing signs of vapor barrier failure should have the insulation removed and the pipe inspected. [IIAR Bulletin No. 109 §4.7.5]

Insulation

Insulation



Insulation

Compatibility

- Materials used in the construction and installation of refrigeration systems shall be compatible for the refrigerant, refrigerant oil, or brine in the system. Material or equipment that will deteriorate due to the chemical action of the refrigerant, the oil, or combination of both, shall not be installed. [2013 CMC §1110.1]
- Similar requirements in 2012 UMC §1110.1, 2013 ASHRAE 15-2013 §9.1.1, ANSI/IIAR 2-2014 §5.7.1.1

Compatibility

Q&A | Ammonia Rated Hoses

Home » News » Q&A | Ammonia Rated Hoses

April 16th, 2013 | ammonia, Hose, OSHA

Question: Do I have to use an ammonia rated hose when draining or transferring ammonia from a refrigeration system?

Answer: The short answer is "**ABSOLUTELY**". OSHA has been far from silent on this issue and has made it clear that ammonia rated hose must be used for any anhydrous ammonia activity that requires a hose, including but not limited to…transferring, purging, venting, draining, and moving ammonia. Here are some of the major points to keep in mind:

- Ammonia hoses must be incorporated into the overall process safety management program;
- Ammonia hoses must be designed in accordance with RAGAGEP (recognized and generally accepted good engineering practice). To learn more about RAGAGEP for ammonia hoses you would need to get a copy of *Specifications for Anhydrous Ammonia Hose*, Rubber Manufacturer's Association (RMA) Publication IP-14;
- Ammonia hoses should inspected as part of the larger mechanical integrity program. Look for kinks, evidence that the hose has been driven over, soft spots, and loose covers;
- Ammonia hoses should be marked every five (5) feet with the manufacturer's name, the words "Anhydrous Ammonia", the working pressure, and the year of manufacture;
- Ammonia hoses must be replaced according to manufacturer's recommendations. If this reminds you of the five (5) year replacement of pressure relief valves…then you are on the right track. Most manufacturer's recommend replacing ammonia hoses on three (3) or five (5) year intervals.
- Employees must be trained to use ammonia rated hoses.

This is just a quick summary of the requirements for ammonia hoses. If you are looking for more detail, check out OSHA's perspective on their website.

Testing Safety Devices

- Detection and alarm systems shall be installed, maintained, and tested in accordance with the Fire Code and with equipment manufacturers' specifications [2013 CMC §1121.4]
- The following emergency devices or systems shall be periodically tested… [2013 CFC §606.1]
  - 1. Treatment and flaring systems.
  - 2. Valves and appurtenances necessary to the operation of emergency refrigeration control boxes.
  - 3. Fans and associated equipment intended to operate emergency ventilation systems.
  - 4. Detection and alarm systems.

Testing Safety Devices

- Detector(s), alarm(s), and mechanical ventilating systems shall be tested in accordance with manufacturers' specifications and the requirements of the jurisdiction having authority. [ANSI/ASHRAE 15-2013 §11.6.3]
- A schedule for testing ammonia detectors and alarms shall be established based on manufacturers' recommendations, unless modified based on documented experience. [ANSI/IIAR 2-2014 §17.3.1]

Testing Safety Devices

Dräger

DrägerSensor® NH_3 LC – 68 09 680

Calibration interval	
default	6 months
Adjustment range min/max	1 day/12 months
Warm-up time	
ready for operation after max.	120 minutes
ready for calibration after max.	660 minutes
when using SensorReady®	<5 minutes
Measurement accuracy *	
measurement uncertainly (of meas. value) or	≤ ±5 %
minimum (whichever is the greater value)	≤ ±1.5 ppm
Loss of sensitivity, per year	≤ -15 %
Expected service life, in ambient air	>24 months
Environmental conditions	
Temperature, min./max.	-40/65 °C (-40/149 °F)
Rel. humidity, min./max.	15/95 %
Ambient pressure	±3 %
Storage conditions	
packed, min./max.	0/40 °C (32/104 °F)
Cross-sensitivities	existing, for information contact Dräger
Order Nos.:	
DrägerSensor NH_3 LC	68 09 680
Dust filter	68 09 595
Calibration adapter V	68 10 536
Calibration cylinder for ampoule calibr.	68 03 407
Test gas ampoule 50 ppm NH_3	68 07 924

Testing Safety Devices

- Ventilation
  - A schedule for testing the mechanical ventilation system shall be established based on manufacturers' recommendations, unless modified based on documented experience. Testing shall include operation of the ventilation system based on ammonia detection at the concentration set forth in Section 6.13.2 and by a manual control switch required by Section 6.12.2.
  - Where manufacturers' recommendations are not provided, the mechanical ventilation system shall be tested at least twice per year. [ANSI/IIAR 2-2014 §6.14.8]

Testing Safety Devices

- Liquid Level Control
  - Accumulators or interstage coolers should be equipped with high level float switches which should actuate a high level alarm, and where practical, should cause the associated compressor(s) to shut down when a high refrigerant level is detected. [IIAR Bulletin No. 109 §4.10.2]

Testing Safety Devices

- Each compressor shall be equipped with the following operable safety controls as a minimum: [IIAR Bulletin No. 109 §4.1.7]
  - a) Low pressure cutout switch
  - b) High pressure cutout switch
  - c) Low oil pressure cutout switch (if the compressor uses forced feed lubrication)

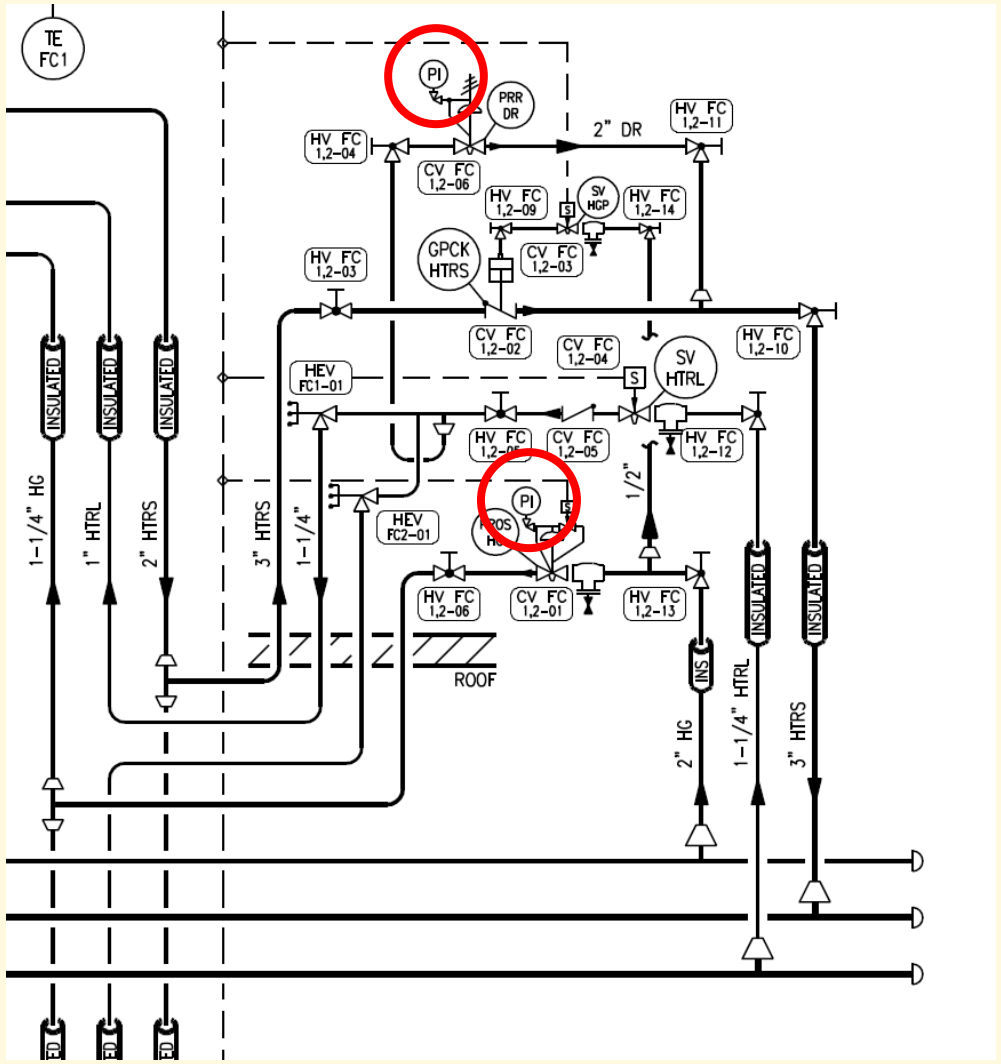
Testing Safety Devices

Gauges and Instruments

- ***IIAR Bulletin No. 109 §4.10.1***
  - All installed instruments should be in working order. Inaccurate or broken instruments should be replaced

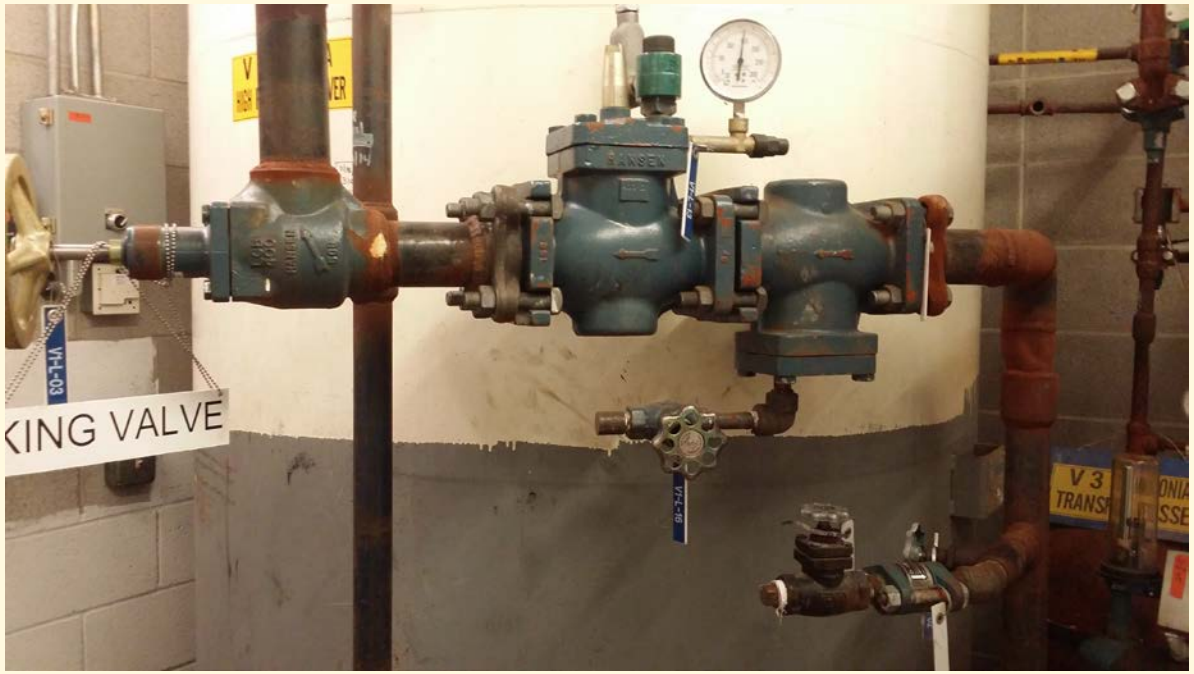
Pressure Gauges

Pressure Gauges



Provision for Refrigerant Removal

- **ANSI/IIAR 2-2014 §13.3.4**
  - Valve groups shall be fitted with a provision for ammonia removal to facilitate maintenance of strainers.



Provision for Refrigerant Removal

Questions?

Peter Thomas, P.E.
Resource Compliance
www.resourcecompliance.com
(559) 591-8898
pthomas@resourcecompliance.com