Introduction
PSM RAGAGEP References

Title 29 §1910.119(d)(3)(ii) Process Safety Information
• The employer shall document that equipment complies with recognized and generally accepted good engineering practices.

Title 29 §1910.119(j)(4)(ii) Mechanical Integrity
• Inspection and testing procedures shall follow recognized and generally accepted good engineering practices.

Title 29 §1910.119(j)(4)(iii) Mechanical Integrity
• 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.
RAGAGEP Citations

Citation 1  Item 2  Type of Violation: Serious


On or about i, the employer did not document that is complied with recognized and generally accepted good engineering practices (RAGAGEP) exposing employees to the hazards of inhalation of toxic ammonia and/or fire/explosion in the following instances, see A through E:

A. The employer failed to document compliance with RAGAGEP, such as "Identification of Ammonia Refrigeration Piping and System Components" Section 4.1 "Piping Markers" and Section 5.0 (a-d) "Marker Location," March 2014, as the employer failed to mark and/or label ammonia refrigeration equipment, including:

1. Engine Room 5, Evaporating Condenser, tower EC-1
2. Engine Room 6, Evaporating Condenser, tower EC-2
3. Engine Room 7, Evaporating Condenser, towers EC-1 and EC-2
4. Engine Room 8, Evaporating Condenser, towers EC-1, EC-2 and EC-3
5. Engine Room 11, Evaporating Condenser, tower EC-1, EC-2 and EC-3

B. Failure to document compliance with RAGAGEP, such as "Guidelines for: Startup, Inspection and Maintenance of Ammonia Mechanical Refrigerating Systems" Section 6.6 Valves and Sensing Devices Subsection 6.6.1 Shut-off Valves, as the employer failed to change out ammonia refrigeration system safety relief valves prior to their 5 year due dates from the date of installation, including:

1. Engine Room 6, Heat Exchangers 1, 2 and 3. These are dual relief systems using Hansen Valves.

ABATEMENT DOCUMENTATION REQUIRED FOR THIS ITEM

Date By Which Violation Must be Abated: 07/29/2016
Proposed Penalty: $7000.00

IIAR Bulletin 114  IIAR Bulletin 110
Ammonia Refrigeration Code Organizations

- International Institute of Ammonia Refrigeration (IIAR)
- American National Standards Institute (ANSI)
- International Code Council (ICC)
- International Association of Plumbing and Mechanical Officials (IAPMO)
- American Society of Mechanical Engineers (ASME)
- American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
IIAR Literature

- IIAR Bulletin No. 110 Guidelines for: Start-up, Inspection and Maintenance of Ammonia Mechanical Refrigerating Systems
- IIAR Bulletin No. 111 Guidelines for: Ammonia Machinery Room Ventilation
- IIAR Bulletin No. 112 Guidelines for: Ammonia Machinery Room Design
- IIAR Bulletin No. 116 Guidelines for: Avoiding Component Failure in Industrial Refrigeration Systems Caked by Abnormal Pressure or Shock
IIAR Bulletin No. 110 §6.4.2 [emphasis mine]:

The system **should** be checked regularly for the presence of non-condensable gases which **should** be purged as necessary from the receiver(s) and/or condenser(s), **preferably** into a noncondensable gas remover or purger but **alternatively** into water. Where an automatic purger is fitted, its correct operation **should** be monitored. If there is a large accumulation of noncondensable gases the reason **should** be investigated and the cause **should** be corrected.
IIAR Suite of Standards

- **ANSI/IIAR 1** Definitions and Terminology Used in IIAR Standards
- **ANSI/IIAR 2** Standard for Safe Design of Closed-Circuit Ammonia Refrigeration 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
- **IIAR 6** Standard for Inspection, Testing, and Maintenance of Safe Closed-Circuit Ammonia 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
- **IIAR 9** RAGAGEP Standard
Standard for Definitions and Terminology Used in IIAR Standards
Definitions – IIAR 1

- **owner**: The employer or designated facility representative who is legally responsible for the refrigeration system.
- **piping**: The interconnecting parts of a closed-circuit refrigeration system that contain and convey the refrigerant. Piping includes pipe; flanges; bolting; gaskets; valves; fittings; the pressure-containing parts of other components such as heat transfer components; expansion joints; strainers; filters; and devices that serve such purposes as mixing, separating, snubbing, distributing, metering or controlling flow; pipe hangers; supporting fixtures; and structural attachments.
Definitions – IIAR 1

• **pressure vessel**: Any *refrigerant* containing receptacle in a *closed circuit mechanical refrigerating system* designed and manufactured under the rules of ASME Section VIII, Division 1, Boiler and Pressure Vessel Code. See also *receiver: receiver* and *controlled-pressure receiver*. EXCEPTIONS per ASME Section VIII, Division 1, Boiler and Pressure Vessel Code:
  a. *Compressors*
  b. Pumps
  c. Controls
Definitions – IIAR 1

- **Machinery Room**: An enclosed space that, where required by this standard to contain *equipment*, must comply with the requirements set forth in Chapter 6.

- **Trained Operator**: An individual having training and experience that qualify that individual to operate and perform basic system inspections on a closed-circuit refrigeration system with which he or she has become familiar.
IIAR Standard 2

• ANSI/IIAR 2 Standard for Safe Design of Closed-Circuit Ammonia Refrigeration Systems
Overview

- **Part 1** – General (Chapters 1-3)
- **Part 2** – Design and Installation Considerations (Chapters 4-7)
- **Part 3** – Equipment (Chapters 8-17)
- **Part 4** – Appendices (Appendix A – Appendix N)
Outline

• Part 1
  o Chapter 1 – Purpose, Scope, and Applicability
  o Chapter 2 – Definitions
  o Chapter 3 – Reference Standards

• Part 2
  o Chapter 4 – Location of Ammonia Refrigeration Machinery
  o Chapter 5 – General System Design Requirements
  o Chapter 6 – Machinery Rooms
  o Chapter 7 – Refrigeration Equipment in Areas Other Than Machinery Rooms
Outline

• Part 3
  o Chapter 8 – Compressors
  o Chapter 9 – Refrigerant Pumps
  o Chapter 10 – Condensers
  o Chapter 11 – Evaporators
  o Chapter 12 – Pressure Vessels
  o Chapter 13 – Piping
  o Chapter 14 – Packaged Systems and Equipment

• Part 4 (Informative Appendices)
  o Chapter 15 – Overpressure Protection Devices
  o Chapter 16 – Instrumentation and Controls
  o Chapter 17 – Ammonia Detection and Alarms
# Normative vs. Informative

<table>
<thead>
<tr>
<th>Normative</th>
<th>Informative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parts 1-3 (Chapters 1-17)</td>
<td>Part 4 (Appendices)</td>
</tr>
<tr>
<td>Prescriptive</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Required</td>
<td>Supplemental</td>
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<tr>
<td>Shall</td>
<td>Should</td>
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<tr>
<td>Must</td>
<td>May</td>
</tr>
<tr>
<td>Will</td>
<td>Could/Can</td>
</tr>
</tbody>
</table>
IIAR 2 vs. ASHRAE 15
IIAR 5

American National Standard

Standard for Start-up and Commissioning of Closed-Circuit Ammonia Refrigeration Systems

Approved by the American National Standards Institute July 31, 2013
Category 1 - To be completed before ammonia is brought on site

1. Was the system designed by, and installed under the supervision of, persons who by reason of knowledge, training and experience are competent for the tasks? [ANSI/IIAR 5.2013 §6.1.1]

2. Has a system component inventory list been prepared? [ANSI/IIAR 5.2013 §6.2.1]

3. For each system component included on the inventory list, have the specifications and details from the following list been included? [ANSIIAR 5.2013 §6.2.1]

4. Does the inventory list contain a record of the maximum working pressure(s) and minimum temperatures? [ANSIIAR 5.2013 §6.2.2]
IIAR 7

American National Standard

Standard for Developing Operating Procedures for Closed-Circuit Ammonia Mechanical Refrigerating Systems

Approved by the American National Standards Institute August 21, 2013
IIAR 8

Category 1 - Preparation

1. Has the reason or reasons that the system or parts thereof are to be decommissioned been clearly stated and found adequate? [ANSI/IIAR 8-2015 §5.1.1.1]

2. Has a competent person been designated for coordination of all decommissioning activities? [ANSI/IIAR 8-2015 §5.1.1.2]

3. Has an initial plan been developed for the decommissioning activities? [ANSI/IIAR 8-2015 §5.1.1]

4. Have documents relevant to the decommissioning activities been obtained and made available to all necessary personnel involved in decommissioning? [ANSI/IIAR 8-2015 §5.2.1]
Guidelines for:
IIAR Minimum Safety Criteria for a Safe Ammonia Refrigeration System
Ammonia Refrigeration Safety Inspection Checklist

PRESSURE VESSELS

ID Number: ________________________

PLANT OWNER:

Address: __________________________

Contact: __________________________

Inspector: __________________________

Identification Mark/No.: ______________

APPLICATION:

- High Pressure Receiver
- Intercooler
- Accumulator
- Receiver
- Pump Receiver: Low Temp
- Pump Receiver: High Temp
- Other: (Describe)

APPLICATION DATA:

- Normal Operating Pressure (psig)
- Design Temperature (F)
- Vessel Size (Gallons) x (LPS)
- Normal Liquid Level (ft)
- Normal Ammonia Inventory (Pounds)
- Design Capacity (Specify: Pounds Per Hour, etc.)

VESSEL NAMEPLATE DATA:

- Manufacturer, Name, Model, Serial No.
- Year Manufactured
- Maximum Allowable Pressure (psig)
- Minimum Design or Max Temperature (F)
- Test Pressure (psig)
- National Board No.
- ASME Certification Stamp: Yes/No

SAFETY RELIEF VALVE DATA:

- Type: Burst, Single, None
- Manufacturer, Name, Model, Serial No.
- Year Manufactured or Reconditioned
- ASME Seat Unknown: Yes/No
- Pressure Settings (psig): Capacity (psig), Design (psig)
- Valve Connections: Inlet, Outlet
- Pipe Size: Inlet, Outlet
- Valve Properly Insulated and Piped to Termination: Yes/No
- Valve Properly Insulated: Yes/No
- Valve Location: Tube, Pipe, High Pressure Intercooler

VISUAL LIQUID LEVEL INDICATOR:

- Type: Tube, Pipe, High Pressure Intercooler

MINIMUM SAFETY CRITERIA FOR A SAFE AMMONIA REFRIGERATION SYSTEM:

- Are there any other conditions that might negatively affect safe vessel operation? Yes/No
- If yes, describe: __________________________

PRESSURE VESSELS

<table>
<thead>
<tr>
<th>Requirement/Recommendation</th>
<th>Conforms</th>
<th>Recommended Action/Comments</th>
<th>Safety Status</th>
<th>Target Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Valve leak test and repair?</td>
<td>Yes/No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) Operating within insulations?</td>
<td>Yes/No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c) Maximum pressure?</td>
<td>Yes/No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d) Minimum temperature?</td>
<td>Yes/No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e) Visual ASME stamp legible?</td>
<td>Yes/No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f) Certification drawings on file?</td>
<td>Yes/No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g) Manufacturer data report on file?</td>
<td>Yes/No</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>h) Does vessel have known internal modifications?</td>
<td>Yes/No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i) If yes, vessel reconditioned?</td>
<td>Yes/No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>j) Is arrow data report on file?</td>
<td>Yes/No</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>k) Relief valve:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>l) Proper type?</td>
<td>Yes/No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>m) Correct setting?</td>
<td>Yes/No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n) Capacity correct?</td>
<td>Yes/No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>o) Inlet correct?</td>
<td>Yes/No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>p) Spring correct?</td>
<td>Yes/No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>q) Insides check normal valves?</td>
<td>Yes/No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>r) Valve properly terminated?</td>
<td>Yes/No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>s) Blowdown valve properly terminated?</td>
<td>Yes/No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>t) Insides check normal valves?</td>
<td>Yes/No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>u) Relief valve replaced or reconditioned within last 5 years of service?</td>
<td>Yes/No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>v) ASME seal unknown?</td>
<td>Yes/No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>w) Valve operating properly?</td>
<td>Yes/No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>x) Insulation condition (check one): no visible corrosion, slight visible corrosion, extensive visible corrosion, unknown (insulated)</td>
<td>Yes/No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>y) Valve properly insulated?</td>
<td>Yes/No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>z) Valve proper operation?</td>
<td>Yes/No</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

IIAR BULLETIN 189 – 10/97
Guidelines for:  
Start-up, Inspection and Maintenance of Ammonia Mechanical Refrigerating Systems
A Guide to Bulletin 114: Piping Colors

In its updated form, IAR Bulletin 114 will provide a method for expanding color designations for piping systems, and will serve as an enhancement for an expanded piping color chart. This guide will address color designations, insulations, tables, and recommendations for enabling a better, more consistent implementation of a color-coded system. The guide will be provided as an electronic document and will be updated as needed.

Low Pressure, Low Temperature Liquid and Vapor Piping

Low pressure, low temperature liquid and vapor piping should be Ammonia Refrigeration Light Blue (PANTONE® Color 3015C) for the services within the -5°F to 45°F range (saturated pressure P<15 psig).

Low Pressure, Low Temperature Liquid and Vapor Piping

For low pressure, low temperature liquid and vapor piping, color designations should be Ammonia Refrigeration Dark Blue (PANTONE® Color 19-3916C) for the services within the -17°F to 29°F range (saturated pressure P<15 psig).

Low Pressure, Low-Low Temperature Liquid and Vapor Piping

For low pressure, low temperature liquid and vapor piping, color designations should be Ammonia Refrigeration Dark Blue (PANTONE® Color 19-3916C) for the services within the -17°F to 29°F range (saturated pressure P<15 psig).

Non-Pressurized Refrigeration Piping and Related Process Piping:

Pressure Relief Valve (PANTONE® Color 400C) for:
- Pressure Relief Valve Piping (PRV)
- Water Supply (PANTONE® Color 315C) for:
- Water Piping
- Sprinkler Red (PANTONE® Color 415C) for:
- Fire Sprinkler Piping
### Table 2  Designation of Colors

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

### Fig. 2  Location of Identification Markers

[Diagram of location of identification markers]
PSM/RMP Guidebook
ARM-LC Guidebook
Figure 1-6
Double Vertical Return Riser

F = SMALL TRAP
E = LARGE TRAP
D = LARGE RISER
C = SMALL RISER
A = EVAPORATOR UNIT OUTLET
B = SECTION MAIN
V = HEIGHT OF VERTICAL RISE

LTRS
IIAR and Model Codes

- **2018 IFC §605.1.2 Ammonia refrigeration.** Refrigeration systems using ammonia refrigerant and the buildings in which such systems are installed shall comply with **IIAR-2** for system design and installation and **IIAR-7** for operating procedures. Decommissioning of ammonia refrigeration systems shall comply with **IIAR-8**.

- **2018 NFPA 1 §53.1.3 Reference Codes and Standards.** Refrigeration systems shall be in accordance with ASHRAE 15 and the mechanical code. Refrigeration systems using ammonia as a refrigerant shall also comply with **ANSI/IIAR 2**, Standard for Equipment, Design and Installation of Closed-Circuit Ammonia Mechanical Refrigerating Systems.
IIAR and Model Codes

- **2018 UMC §1102.2 Ammonia Refrigeration Systems.** Refrigeration systems using ammonia as the refrigerant shall comply with IIAR 2, IIAR 3, IIAR 4, and IIAR 5 and shall not be required to comply with this chapter.

- **2018 IMC §1101.6 General.** Refrigeration systems shall comply with the requirements of this code and, except as modified by this code, ASHRAE 15. Ammonia-refrigerating systems shall comply with this code and, except as modified by this code, ASHRAE 15, IIAR 2, IIAR 3, IIAR 4 and IIAR 5.
IIAR and Model Codes

- **NFPA 70-2017 §505.5** Refrigerant machinery rooms that contain ammonia refrigeration systems and are equipped with adequate mechanical ventilation that operates continuously or is initiated by a detection system at a concentration not exceeding 150 ppm shall be permitted to be classified as “unclassified” locations. Informational Note: For further information regarding classification and ventilation of areas involving closed-circuit ammonia refrigeration systems, see ANSI/ASHRAE 15-2013, Safety Standard for Refrigeration Systems, and **ANSI/IIAR 2-2014**, Standard for Safe Design of Closed-Circuit Ammonia Refrigeration Systems.
Questions?

Peter Thomas, P.E.
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