

US EPA ARCHIVE DOCUMENT

ACCIDENT PREVENTION AND RESPONSE MANUAL

For
Anhydrous Ammonia Refrigeration
System Operators



U.S. Environmental Protection Agency Region 7



June 2015

(Fourth Edition)
EPA-907-B-1-9001

<http://www2.epa.gov/rmp/accident-prevention-and-response-manual-anhydrous-ammonia-refrigeration-system-operators>

What's this Manual All About?

There are many laws and regulations in place to protect operators, other employees, and surrounding communities from the potential hazards of working with toxic chemicals like anhydrous ammonia.

This manual summarizes the requirements of environmental and safety laws for anhydrous ammonia refrigeration system operators. A list of the federal laws and regulations related to process safety, accident prevention, emergency planning, and release reporting may be found in Appendix C.



Many anhydrous ammonia system operators know their systems inside and out. If you are already familiar with the environmental laws and regulations that pertain to your system, then you are invited to test your knowledge by taking the quiz in Appendix E. If you score 100% - CONGRATULATIONS and you may not need this manual. If you score less than 100%, this manual will help you update your knowledge base. Good luck!

Test your ammonia refrigeration knowledge in Appendix E.

This manual has been prepared by the Environmental Protection Agency Region 7 (Iowa, Kansas, Missouri & Nebraska). Region 7 thanks all who contributed their time and expertise to the development of this manual. A special thanks to the final editor, Patricia Reitz, of EPA Region 7.

Notes about this Fourth Edition:

The third edition was published March 2006. Since then several new recognized and generally accepted good engineering practices (RAGAGEPS) have been embraced as industry standards. This fourth edition is updated to reflect these new standards.

Disclaimers:

- This manual provides guidance to assist regulated entities in understanding their obligations in accordance with environmental laws. For a complete understanding of all legal requirements, the reader must refer to applicable federal and state statutes and regulations. This manual is not a substitute for regulations, nor is it a regulation itself. Thus, it cannot impose legally binding requirements of EPA, states, or the regulated community.
- This guidance does not represent final agency action and may change in the future, as appropriate.
- This guidance does not limit the otherwise lawful prerogatives of regulating agencies. Agencies may act at variance with this guidance based on facility specific circumstances.
- Mention of trade names, commercial products, industry references, and technical resources does not constitute an endorsement or recommendation for use.

Table of Contents

CHAPTER 1 – WHAT’S THE BIG EMERGENCY?	1.1
1.1 Accidents Happen	1.1
1.2 Why is Anhydrous Ammonia so Dangerous?	1.2
CHAPTER 2 – IS MY FACILITY A SAFETY RISK?	2.1
2.1 Determine Your Responsibility	2.1
2.1.1 OSHA Requirements	2.1
2.1.2 EPA Requirements	2.1
2.1.3 DHS Requirements	2.3
CHAPTER 3 – PREVENTING ACCIDENTS	3.1
3.1 Work Safely	3.1
3.1.1 Worker and System Protection	3.2
3.1.2 System Operations and Maintenance	3.13
3.1.3 System Inspections	3.18
3.1.4 Training	3.19
3.2 Property Security	3.20
3.3 Other RAGAGEP	3.22
CHAPTER 4 – WHAT TO DO WHEN THERE IS AN ACCIDENT	4.1
4.1 Be Prepared	4.1
4.2 Report the Accident	4.2
4.3 Investigations	4.5

APPENDIX A – CLEAN AIR ACT (CAA) PREVENTION PROGRAM REQUIREMENTS	A.1
A.1 Risk Management Program Level	A.1
A.2 Program 3 Requirements.....	A.1
A.2.1 Management System.....	A.1
A.2.2 Hazard Assessment	A.2
A.2.3 Prevention Program.....	A.2
A.2.4 Emergency Response.....	A.3
A.2.5 Risk Management Plan	A.4
A.3 Compliance	A.5
A.4 Deregistration	A.6
 APPENDIX B – EMERGENCY PLANNING	B.1
B.1 Emergency Response Planning	B.1
B.2 Emergency Response Program	B.2
B.2.1 Emergency Response Plan (ERP).....	B.2
B.2.2 Emergency Response Equipment	B.5
B.2.3 Train All Employees.....	B.5
B.2.4 Review and Update ERP.....	B.5
B.3 Practice Your Plan	B.5
B.4 Emergency Planning and Response Guidance	B.8
 APPENDIX C – GOVERNMENT REQUIREMENTS.....	C.1
C.1 Federal Requirements.....	C.1
C.2 State and Local Requirements	C.7
 APPENDIX D – EDUCATION AND INFORMATION RESOURCES.....	D.1
 APPENDIX E – ANHYDROUS AMMONIA HANDLING QUIZ	E.1

CHAPTER 1 – WHAT’S THE BIG EMERGENCY?

1.1 Accidents Happen

Ammonia is used as a refrigerant at a large number of industrial facilities, such as:

- Cold storage warehouses and ice plants,
- Meat, poultry, or fish processing plants,
- Dairy and ice cream plants,
- Wineries and breweries,
- Fruit/vegetable juice and soft drink processing facilities, and
- Chemical manufacturing facilities



72% of all reported chemical accidents in Iowa, Kansas, Missouri, and Nebraska involve anhydrous ammonia. Up to 96% of them are preventable through increased operator training, improved procedures, and better communication of lessons learned.

(Based on chemical accidents required by EPA to be reported by industry from 2004-2014.)

Accidental ammonia releases cause injuries and death to employees, emergency response personnel, and people in surrounding communities.

Here are some examples:

Two Workers Killed in Cold Storage Accident

In May 2009, a leak of anhydrous ammonia killed 2 maintenance workers at a cold storage facility in Kentucky. Plant employees described the vapors as too thick to see through.

Thirty-Two Hospitalized after Rupture of Refrigeration Piping

In August 2010, 32 offsite workers were hospitalized after a cold storage facility in Alabama released more than 32,000 pounds of anhydrous ammonia. The refrigeration system experienced a sudden, localized pressure surge called “hydraulic shock”, causing catastrophic failure of piping, valves, and other system components.

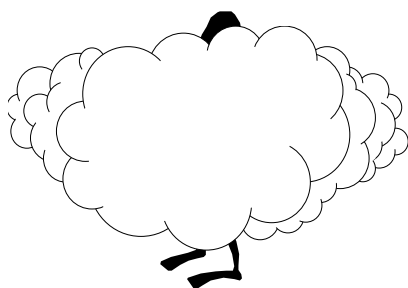
Seven in Intensive Care Following Ammonia Leak

In March 2011, a poultry plant in Alabama accidentally released 32,000 pounds of anhydrous ammonia resulting in \$4 million in product losses. Approximately 150 people were taken to the hospital. The leak prompted road closures and the evacuation of workers and neighboring residents. Factors contributing to the accident include an early termination to the defrost cycle causing hydraulic thermal shock, too many evaporators going into defrost at the same time, and equipment and operator error.

1.2 Why Is Anhydrous Ammonia So Dangerous?

Anhydrous ammonia and ammonium hydroxide are two types of ammonia commonly used in industry. This manual will focus on the “anhydrous” type, which means, “without water.” (Ammonium hydroxide is formed when ammonia gas is dissolved in water.)

Anhydrous ammonia is very corrosive, and exposure to it may result in chemical-type burns to skin, eyes, and lungs. It may also result in frostbite, since its boiling point is -28°F. Ammonia is *hygroscopic*, which means it has a high affinity for water, and migrates to moist areas like the eyes, nose, mouth, throat, and moist skin.

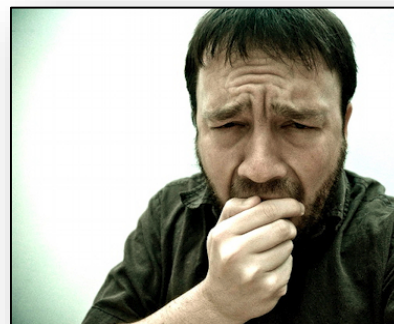


Released anhydrous ammonia will rapidly absorb moisture from air and form a dense, visible white cloud. This dense cloud tends to travel along the ground on a cool day. **Do not enter a visible cloud of ammonia. It will damage your lungs!**

If there is no visible cloud, you can still detect an ammonia release by its pungent odor when it is present in the concentration of 5 to 50 parts per million by volume (ppm*). Exposure to anhydrous ammonia between 5 and 50 ppm can cause **headaches, loss of the sense of smell, nausea, and vomiting.**

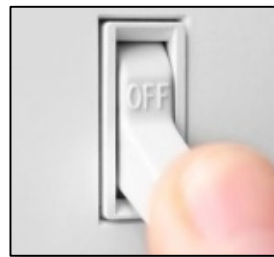
Concentrations above 50 ppm result in **irritation to the nose, mouth, and throat causing coughing and wheezing.** Concentrations of 300 to 500 ppm are immediately dangerous to life. People will generally leave the area due to **lung irritation, coughing, and shortness of breath.** Higher exposures can cause **fluid in the lungs** (pulmonary edema), and severe shortness of breath, which may possibly lead to death.

Inhaling anhydrous ammonia can cause severe coughing.



*An example of parts per million (ppm) is one (1) needle in a 2000 pound haystack.

Ammonia is also flammable and explosive at the right concentrations, which is more likely to happen when released in a confined space, such as inside a building. It can be ignited by something as common as the electric flash from a switch.



The best first aid is to prevent the injury in the first place. Preventing accidents not only keeps employees healthier and more productive, it saves a lot of wasted time and money from having to repair equipment, pay for injured employees' medical expenses, lost product, and having to clean up the mess. Chapter 3 discusses how to prevent accidents.

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CHAPTER 2 - IS MY FACILITY A SAFETY RISK?

2.1 Determine Your Responsibility

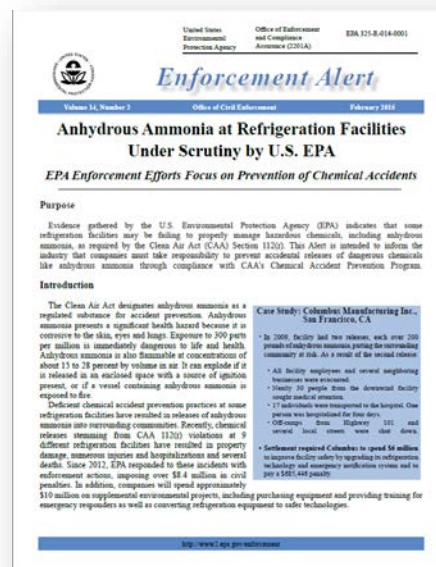
Keeping employees, emergency workers, and the surrounding community safe is of utmost importance. Therefore, Congress has enacted laws requiring facilities who handle hazardous chemicals to have a plan in place to prevent accidents and a plan on how to respond to emergencies that might occur. The provisions of some of these laws are summarized below.

2.1.1 OSHA Requirements

Ammonia refrigeration systems with 10,000 pounds (approximately 2000 gallons) or more of ammonia are a covered process subject to the requirements of the Occupational Safety and Health Administration (OSHA) Process Safety Management (PSM) Standard [29 CFR 1910.119]. If the ammonia refrigeration system has less than 10,000 pounds, the facility is subject to the requirements of the General Duty Clause (see Section 3.1). More information about OSHA's PSM program may be found at <https://www.osha.gov/SLTC/processsafetymanagement/>.

2.1.2 EPA Requirements

EPA published a document, "Anhydrous Ammonia at Refrigeration Facilities Under Scrutiny by U.S. EPA" to help make aware anhydrous ammonia refrigeration operators' responsibility to prevent accidental ammonia releases and manage their process safely. This document may be accessed at: <http://www2.epa.gov/enforcement/enforcement-alert-epa-enforcement-efforts-focus-prevention-chemical-accidents>.



Under Section **112(r) of the Clean Air Act (CAA)** and Title 40 of the Code of Federal Regulations (CFR), Part 68, owners and operators of stationary sources are required to develop Risk Management Programs **for each regulated substance** in a process http://www.ecfr.gov/cgi-bin/text-idx?tpl=/ecfrbrowse/Title40/40cfr68_main_02.tpl.

The goal of EPA's Risk Management Program is to prevent or minimize consequences of accidental releases of certain hazardous substances.



Compliance with 40 CFR 68 is required if the facility has more than the **threshold quantity** of a regulated substance in a process (including storage) at any given time. **The threshold quantity for anhydrous ammonia (CAS#7664-41-7) is 10,000 pounds.** To help determine if your process is subject to the Risk Management Program, EPA developed a guidance for refrigeration facilities: <http://www2.epa.gov/rmp/general-rmp-guidance-appendix-e-supplemental-risk-management-program-guidance-ammonia>.

Ammonia refrigeration systems under 10,000 pounds are subject to CAA 112(r)(1); General Duty Clause. You may find more information about the General Duty Clause at <http://www2.epa.gov/rmp/general-duty-clause-fact-sheet>.

If you find that one or more of your processes are subject to this rule, you will need to determine whether each process is subject to Program 1, Program 2, or Program 3. If your facility is subject to OSHA PSM, then you are subject to Program 3 of the EPA Risk Management Program. For more information and guidance concerning the Risk Management Program, please visit <http://www2.epa.gov/rmp>. For assistance in filing a Risk Management Plan, which is accepted only electronically, please visit <http://www2.epa.gov/rmp/rmpesubmit>.

EPA also administers the **Emergency Planning and Community Right to Know Act (EPCRA)**. Facilities that handle and/or store extremely hazardous substances (EHSs) above a 500 pound threshold are required to report these chemicals under EPCRA Section 312 (Tier II Report). If an ammonia refrigeration facility has 10,000 pounds or more in its system during any calendar year, they are subject to EPCRA Section 313 reporting (Toxic Release Inventory Form A or Form R). EPCRA also requires that facilities which are subject to Section 312 and/or Section 313 coordinate with their Local Emergency Planning Committee and their State Emergency Response

Commission. For additional information on these reporting requirements, please visit <http://www2.epa.gov/epcra>.

2.1.3 DHS Requirements

The Department of Homeland Security (DHS) regulates chemical facilities that “present high levels of security risk.” In Section 550 of the Homeland Security Appropriations Act of 2007 (P.L. 109-295) (Act), Congress gave the DHS regulatory authority over security at high-risk chemical facilities. In the Act, Congress instructed DHS to require all “high-risk” chemical facilities to complete:

- * Security vulnerability assessments,
- * Develop site security plans, and
- * Implement protective measures necessary to meet DHS-defined risk-based performance standards.

In April 2007, DHS promulgated the Chemical Facilities Anti-Terrorism Standards (CFATS) regulation. To determine which chemical facilities meet the CFATS criteria for “high-risk” chemical facilities, the Department developed the Chemical Security Assessment Tool (CSAT) Top-Screen, an easy-to-use on-line questionnaire that must be completed by facilities that possess any chemical on the CFATS [DHS Chemicals of Interest List](#) at or above the listed Screening Threshold Quantity (STQ) for each chemical. The STQ for anhydrous ammonia is 10,000 pounds, which is the same threshold quantity as the OSHA PSM and EPA Risk Management

CSAT Top-Screen Questions
OMB PRA # 1670-0007
Expires: 9/31/2011

Facility Description

Choose the facility type that best describes your facility
[0.1.1-65]

☐ Chemical manufacturing, usage, storage, and distribution

☐ Petroleum refining

☐ Liquefied natural gas storage

Facility Regulatory Mandates

Is the facility regulated pursuant to the Maritime Transportation Security Act of 2002, Public Law 107-295, as amended?
[0.1.2-65]

☐ Yes, the facility is regulated pursuant to MTSA.

☐ No, the facility is not regulated pursuant to MTSA.

☐ Partially: The site includes both a facility regulated pursuant to MTSA and a facility not regulated pursuant to MTSA.

▲ If the site includes both a facility regulated pursuant to the Maritime Transportation Security Act of 2002, Public Law 107-295, as amended, and a facility not regulated pursuant to the Maritime Transportation Security Act, select "Partially" and continue to fill out the screen for the facility not subject to the Maritime Transportation Security Act.

Is the facility a Public Water System, as defined by section 1401 of the Safe Drinking Water Act, Public Law 93-523, as amended?
[0.1.3-65]

☐ Yes, the facility is a Public Water System.

☐ No, the facility is not a Public Water System.

☐ Partially: the facility contains a Public Water System regulated under the Safe Drinking Water Act, but also contains components that are not so regulated.

▲ If the facility contains a Public Water System as defined by the Safe Drinking Water Act, but also contains components that are not covered by that definition, select "Partially" and continue to fill out the screen for the portion of the facility not so defined under the Safe Drinking Water Act.

DHS Form 9007 Page 7 of 167 Version 2.8

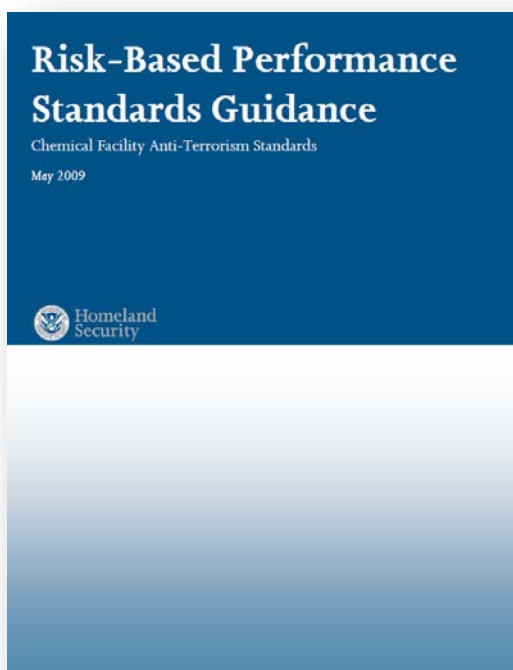
Program thresholds. (See Table 2.1 for more anhydrous ammonia thresholds.)

Visit <http://www.dhs.gov/publication/csat-ts-questions> to review the CSAT Top Screen Questions Guide.

DHS has defined “risk-based performance standards for chemical facilities.”

A performance standard specifies the outcome required, and allows the company to determine how the outcome is achieved. There are eighteen (18) Risk-Based Performance Standards that covered chemical facilities must meet to be in compliance with CFATS.

- 1) Restrict Area Perimeter
- 2) Secure Site Assets
- 3) Screen and Control Access
- 4) Deter, Detect, and Delay
- 5) Shipping, Receipt, and Storage
- 6) Theft and Diversion
- 7) Sabotage
- 8) Cyber
- 9) Response
- 10) Monitoring
- 11) Training
- 12) Personnel Surety
- 13) Elevated Threats
- 14) Specific Threats, Vulnerabilities, or Risks
- 15) Reporting of Significant Security Incidents
- 16) Significant Security Incidents and Suspicious Activities
- 17) Officials and Organization
- 18) Records



For more information, see Risk-Based Performance Standards Guidance; Chemical Facility Anti-Terrorism Standards; May 2009

at <http://www.dhs.gov/sites/default/files/publications/CFATS-Risk-Based-Performance-Standards-508.pdf> .

Table 2.1. Threshold/Reportable Quantities for Anhydrous Ammonia

Agency/Program (Code of Federal Register)	Threshold Quantity (TQ) Reportable Quantity (RQ) (pounds)
OSHA PSM (29 CFR 1910.119)	TQ 10,000
EPA Risk Management Program (40 CFR Part 68)	TQ 10,000
EPA General Duty Clause [CAA 112(r)(1)]	Less than TQ of 10,000
EPA EPCRA* 313, Toxic Release Inventory (40 CFR 372)	“Otherwise Used” TQ 10,000
EPA EPCRA* 302 & 312, Hazardous Chemical Notification and Inventory Reporting (40 CFR 355.10 & 40 CFR 370)	TQ 500
EPA EPCRA* 304 Emergency Notification Release Reporting (40 CFR 355.30)	RQ 100
EPA CERCLA** 103 Emergency Notification Release Reporting (40 CFR 302.6)	RQ 100
DHS CFATS (6 CFR 27.210(1)(i & d))	TQ 10,000

* EPCRA is the Emergency Planning Community Right to Know Act.

** CERCLA is the Comprehensive Environmental Response, Compensation, and Liability Act, also known as Superfund.

For additional information on Federal, State, and local requirements, please visit Appendix C of this manual.

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CHAPTER 3 - PREVENTING ACCIDENTS

3.1 Work Safely

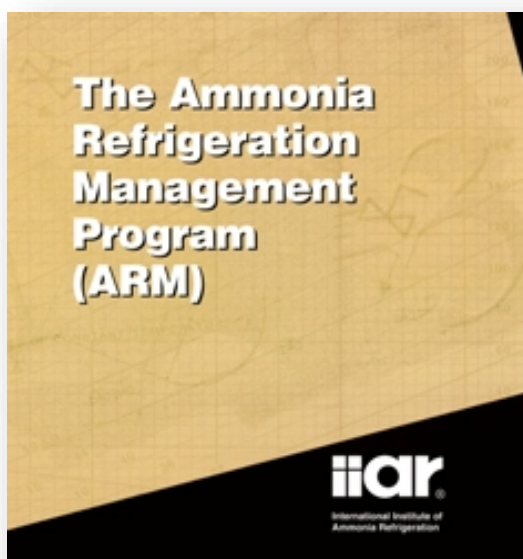
As mentioned in Chapter 1, ninety six (96) percent of accidents are preventable through increased operator training, improved procedures, and better communication of lessons learned.

A major component of working safely is to develop and implement recognized and generally accepted good engineering practices (RAGAGEP) at your facility. RAGAGEP can include regulations, code, standards, guidelines, engineering documents, and/or safety data sheets.



No matter the amount of anhydrous ammonia in your refrigeration system, it is important to adhere to RAGAGEP. If your refrigeration facility has an inventory of 10,000 pounds or more of anhydrous ammonia, your facility is subject to the OSHA Process Safety Management and the EPA Risk Management Program regulations.

RAGAGEP for refrigeration facilities with any amount of anhydrous ammonia is IIAR Ammonia Refrigeration Management (ARM) Program.



All facilities that have anhydrous ammonia in the refrigeration system (even if less than 10,000 pounds) are subject to the General Duty Clause. The General Duty Clause requires RAGAGEP such as adherence to a program like the International Institute of Ammonia Refrigeration (IIAR) Ammonia Refrigeration Management (ARM). You may find more information about the General Duty Clause at <http://www2.epa.gov/rmp/general-duty-clause-fact-sheet>.

3.1.1 Worker and System Protection

Personnel at ammonia refrigeration facilities should be aware of the hazards associated with anhydrous ammonia releases and the measures that can be taken to prevent such releases.

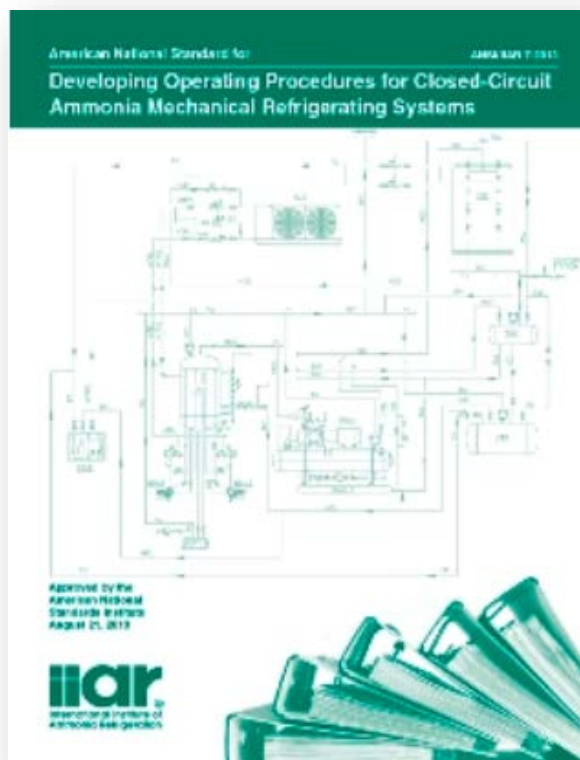
*The best and most simple rule of thumb is to
“Keep the ammonia in the system”.*

Safety practices where EPA inspectors frequently note deficiencies are described, as follows:

Develop Operating Procedures

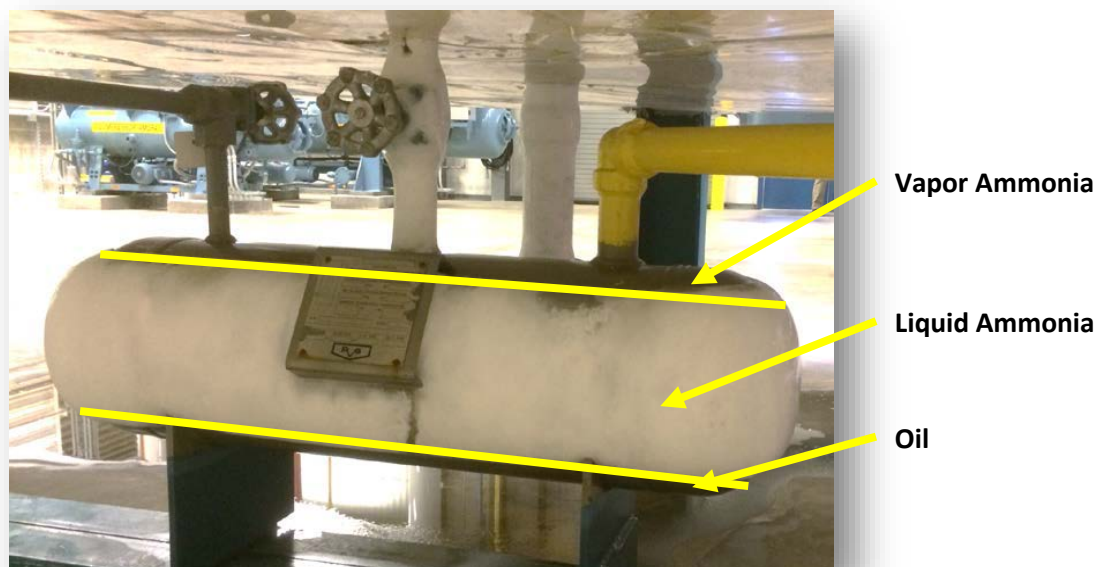
Operating procedures must be developed and implemented in accordance to 40 CFR 68.69. The safety of refrigeration operators and maintenance personnel is enhanced by their training in and understanding of the facility’s operating and maintenance procedures before performing routine tasks (e.g., adding ammonia, removing oil, replacing a valve, etc.).

The primary RAGAGEP for developing operating procedures is ANSI/IIAR Standard 7-2013 Developing Operating Procedures for Closed-Circuit Ammonia Mechanical Refrigerating Systems.



Oil Removal

For proper system maintenance, refrigeration oil should be removed from the refrigeration system as needed. The majority of plants with industrial ammonia refrigeration systems utilize an oil pot which is a vessel equipped with an oil drain valve in series with either a self-closing or manual quick-closing emergency stop valve connected to the oil drain point, a vent line, a vent line isolation valve, and an approved pressure relief device. It is common to tell if an oil pot needs draining by the frost-line.



The RAGAGEP for removing oil is IIAR 2.

Using a spring-loaded 1/4 turn ball or globe valve with an oil drain container is considered a RAGAGEP. A “self-closing,” also called “deadman valve,” functions as an emergency stop valve to prevent an ammonia release if the operator draining oil is overcome or must abandon his work station.





Operator with plant-required personal protective equipment donned performing an oil drain. Note the oil pot is not frosted during the actual oil draining. Also note the second operator in the background behind the oil pot serving as a backup.

For more detailed information on oil management, please refer to “The Cold Front” Newsletter Vol. 14 No. 3, 2014 by the Industrial Refrigeration Consortium, which may be found at <http://www.irc.wisc.edu/?/download>, under “Publications” in the right column.

Protect Equipment, Tanks, Piping

Forklifts, hand trucks, and other maintenance vehicles can and have caused ammonia releases after damaging unprotected components of ammonia refrigeration systems. It is good practice to provide barriers or establish safety procedures to protect refrigeration equipment (e.g., pipes, valves, evaporator coils, tanks, vessels, etc.) likely to be damaged.



Example of structural horizontal barriers (yellow) which help prevent forklifts or other objects from damaging ammonia piping.

Examples of how facilities are physically protecting refrigeration equipment include:

- Installing horizontal and vertical structural members to prevent products on pallets from falling against refrigeration equipment;
- Blocking access to storage bins immediately adjacent to and below refrigeration equipment; and
- Installing concrete curbs, barriers, bollards, or aprons to prevent wheeled equipment from impacting equipment.



Bollards (yellow) to protect tanks, pipe, valves, and coils from forklift impact.

Install, Maintain, and Inspect Ammonia Detector Systems

IIAR 2 requires at least two (2) ammonia detectors in the machinery room to monitor for leaks. In addition, consider installing detectors in areas where a leak could occur or an area which is not manned 24 hours per day and 7 days a week. IIAR-2 requires notification be sent to a “monitored location” when the ammonia detection system is activated, so that corrective action can be taken. A “monitored location” is defined as a means of continual oversight such as pagers, on-site staff, third-party alarm service, or responsible party.



Example of an ammonia detection device.

Operation of ammonia sensors and alarms must be tested and calibrated regularly to ensure the alarms are functioning properly and are set to alert personnel of a release.

The following are examples of detector problems that have been noted during EPA inspections:

- o Ammonia detectors were calibrated to alarm at 600 ppm, twice the IDLH (immediately dangerous to life and health) level;
- o Ammonia detectors did not function properly.



Facilities also have used ammonia detectors to activate ventilation fans in compressor rooms and to trigger remote alarms to notify facility security personnel about accidental releases of ammonia. Each alarm activates a call down system that alerts key ammonia refrigeration personnel. IIAR 2 requires the machinery room ventilation system to be actuated by detection systems (as well as manually).

There are numerous codes and standards that have requirements related to ammonia detection system design, including IIAR 2 (Addendum B), ASHRAE 15, NFPA-1, UMC, IFC, and IMC. In addition to these, many insurance carriers impose their own requirements to mitigate the risk of loss of life and product in a facility. The table, below, is an illustration of locations and concentration thresholds with corresponding actions based on the lowest levels identified in the above-mentioned codes and standards.

ROOM	ACTION
Compressor Room (minimum 2)	25 ppm – Alarm to monitored location 25 ppm – Horn Strobe outside each entrance and inside room 25 ppm – Normal Ventilation 150 ppm – Emergency Ventilation
Compressor Room (minimum 1)	10,000 ppm – Redundant Emergency Ventilation 20,000 ppm – Electrical Shunt trip OR De-energize pumps, compressors, normally closed valves
Vent Line	1% - Alarm to monitored location
Freezer	25 ppm – Alarm to monitored location 25 ppm – Horn Strobe 35 ppm – Close liquid Solenoid valves
Cooler	25 ppm – Alarm to monitored location 25 ppm – Horn Strobe 35 ppm – Close liquid Solenoid valves
Dock	25 ppm – Alarm to monitored location 25 ppm – Horn Strobe 35 ppm – Close liquid Solenoid valves
Process Area	25 ppm – Alarm to monitored location 25 ppm – Horn Strobe 35 ppm – Close liquid Solenoid valves
Production	25 ppm – Alarm to monitored location 25 ppm – Horn Strobe 35 ppm – Close liquid Solenoid valves

The following table specifies ammonia alarm system requirements per code.

	IIAR-2B 2012	ASHRAE 15 2013	NFPA 1 2012	UMC 2012 Preprint	IFC 2012	IMC 2012	NFPA 72 2010
General				Comply with IIAR2, ASHRAE 15	Comply with IMC - 2012	Comply with IIAR2, ASHRAE 15, IFC-2012	Any gas detection systems installed on a fire alarm system shall comply with ... (same requirements as fire alarm)
Machinery Room De-energize compressors, pumps, NC valves	40,000 PPM		40,000 PPM or upper limit of detector	40,000 PPM or upper limit of detector	40,000 PPM or upper limit of detector		
Machinery Room De-energize all electrical			40,000 PPM				
Machinery Room Audio Visual Alarms inside room and outside each entrance	25 PPM	1,000 PPM Manual reset inside machine room	1,000 PPM	25 PPM Manual reset inside machine room	25 PPM* "Approved locations"		
Machinery Room Activate normal ventilation	25 PPM	1000 PPM		25 PPM			
Machinery Room Activate emergency ventilation	1,000 PPM		1,000 PPM	1,000 PPM Manual reset only		1,000 PPM	
Power and Supervision			Per NFPA 72	Per NFPA 72			Dedicated branch circuit, 24 hour UPS or backup generator, trouble signal indicating fault in system.
Alarm signal to monitored location	Yes		Yes	Yes per NFPA 1	"approved location"		
Machinery Room Concentration Display		Suggested					
Refrigerated Areas Audio Visual		1,000 PPM		50 PPM			

Constant ventilation in a machinery room is an option available in place of ammonia detection devices per the American National Standards Institute/American Society of Heating, Refrigerating and Air-Conditioning Engineers (ANSI/ASHRAE) 15-2014 Safety Standard for Refrigeration Systems. When ammonia is used, the machinery room is required to meet Class I, Division 2, of the National Electric Code (NEC), unless:

- The mechanical ventilation system in the machinery room is run continuously and failure of the mechanical ventilation system actuates an alarm; or
- The machinery room is equipped with a vapor detector that will automatically start the mechanical ventilation system and actuate an alarm at a detection level not to exceed 1000 ppm.



Install Emergency Ventilation Switches

Some facilities have installed manual switches to remotely activate ventilation fans. Others have their ammonia detectors activate the fans at a certain parts per million (ppm) level, and some facilities use continuous ventilation. It is recommended to have the remote switches located near, yet at a safe distance from, the compressor room.



RAGAGEP recommends one set of switches directly outside the primary external exit and one at a remote location per IIAR 2. Identify the switches with signage for use in an emergency.



Install Check Valves in Ammonia Charging Line

Facilities should consider installing a manual check valve in the ammonia charging line in a location close to the main control valve. This check valve can be used to isolate any problems associated with the main control valve and prevent release or removal of ammonia through the charging line.

Configure Remote Operation of Solenoid Valve on King Valve Line

It is best to install a solenoid valve in the King Valve line near the receiver vessel and configure its operation by a manual switch located outside of the compressor/recycle room. The system's manual emergency stop (estop) switch should also be clearly recognizable by all facility personnel and emergency responders.

Install Dual Pressure Relief Valves

Facilities are replacing single pressure relief valves (PRVs) with dual relief valves to facilitate the maintenance of relief valves. Installation of a dual relief valve consists of one three-way manifold or selector valve and two pressure safety release valves. The American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)'s Standard 15, *Safety Standard for Refrigeration Systems*, as well as IIAR 2 outlines the required use of dual PRVs.



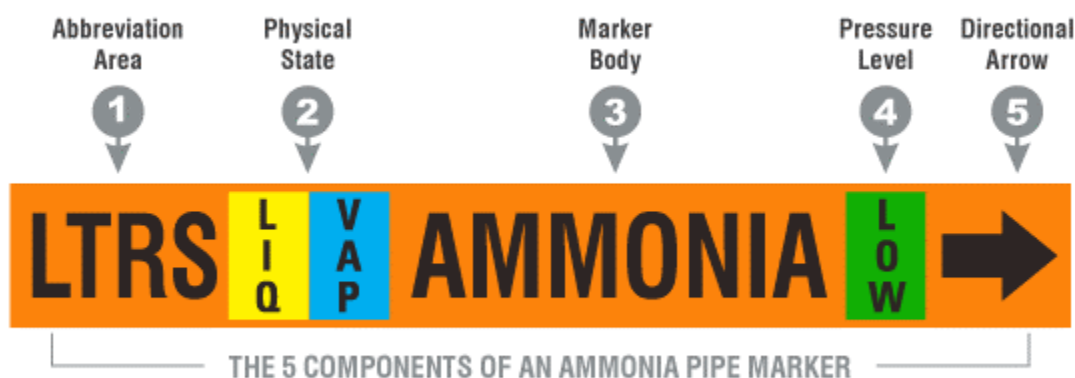
Refrigeration PRVs are recommended for replacement every five (5) years.

Use of dual PRVs and a three-way valve allows one relief valve to be serviced, tested, or replaced, while the other PRV remains on-line to protect the refrigeration equipment. This configuration enables the operator to keep the refrigeration system operational rather than needing to pump down the equipment each time a relief valve is serviced or replaced. Each valve must be of adequate size to protect the refrigeration equipment.

Color Coding, Labeling, and Signage

Using a color-coding and/or a labeling system helps to ensure the facility's engineering drawings or piping and instrumentation diagrams (P&IDs) are up-to-date and reduces the chances of errors in the facility's operating procedures.

The RAGAGEP for labeling ammonia piping is IIAR B114, as depicted below.



1. Use piping abbreviations to properly identify system components.
2. Indicate the physical state of the refrigerant (liquid, vapor, or both).
 - o Yellow color band indicates liquid state
 - o Blue color band indicates vapor state
 - o Use both color bands to indicate both states are present
3. Print "Ammonia" in black letters on orange background.
4. Indicate whether the internal pipe pressure is high or low.
 - o Red color band indicates high pressure
 - o Green color band indicates low pressure
5. Use arrows to indicate the direction of ammonia flow.

**Facilities that lack clear and comprehensive labeling are
"accidents waiting to happen."**

Uniquely label all pipes, valves, and instrumentation.

Some examples include:

- o Identify the king valve and all other emergency isolation valves with large, easily identifiable placards to be used in an emergency.
- o Clearly and consistently indicate the king valve and all other emergency isolation valves on the P&IDs and any process flow or control logic diagrams.
- o Post ammonia placards (i.e., National Fire Protection Association 704 anhydrous ammonia diamond) and warning signs in areas where ammonia is being used as a refrigerant or is being stored (e.g., compressor room doors).



Anhydrous Ammonia

HEALTH HAZARD
4 Deadly
3 Extreme Danger
2 Hazardous
1 Slightly Hazardous
0 Normal Material

FIRE HAZARD Flash Points:
4 Below 73°F
3 Below 100°F
2 Below 200°F
1 Above 200°F
0 Will Not Burn

INSTABILITY
4 May Detonate
3 Shock + Heat may Detonate
2 Violent Chemical Change
1 Unstable if Heated
0 Stable

SPECIFIC HAZARD
OX Oxidizer ACID Acid
ALK Alkaline COR Corrosive
W Use No Water ☢ Radioactive
SA Simple Asphyxiant

PROTECTIVE EQUIPMENT FOR HANDLING MATERIALS
 Apron  Boots  Face Shield  Gloves  Goggles

Precautionary Measures:
Avoid inhalation and exposure to skin. Keep container closed. Use only with adequate ventilation to maintain airborne concentrations below hazardous levels. Wear appropriate gloves, goggles, and personal protective clothing.

Emergency Overview:
Colorless gas/liquid with a strong, suffocating odor. Causes skin, eye and respiratory tract burns. May cause blindness. Exposure to high levels may be fatal. Potential explosion hazard in confined space. Use sufficient ventilation to prevent vapor build-up.

First Aid Procedures:
Inhalation: Remove to fresh air. Eyes/Skin: Flush with flooding amounts of water for at least 15 min. Ingestion: Ingestion of gas is unlikely. For aqueous solutions, do not induce vomiting. If conscious, give large amounts of water to drink. If unconscious, do not give anything by mouth.

There are two different NFPA designations for anhydrous ammonia - one for the machinery room and one for all other locations.



Distinguish and label storage cabinets used for emergency response equipment, supplies, and reference materials.

Consider whether signs should be posted in other languages in addition to English.

3.1.2 System Operations and Maintenance

In accordance with 40 CFR 68.73, “Mechanical Integrity” procedures must be written and implemented to maintain the ongoing integrity of process equipment. A preventative maintenance program and schedule, based on the manufacturer’s recommendations and RAGAGEP, is part of a mechanical integrity program for each component of a refrigeration system.

RAGAGEP for Mechanical Integrity for refrigeration systems is IIAR 109/110

Monitor Refrigeration System Operating Parameters

Routinely monitor ammonia refrigeration system’s operating state. Many facilities use a daily engine (compressor) room log for recording the refrigeration system’s various process temperatures, volumes, vibrations, lubrication levels, and pressures at least once per operating shift. Startup, shutdown, and pump-down operations, as well as the results of any work or testing, should be recorded in the daily log.

Operators regularly should review these logs to watch for trends that may indicate system problems (e.g., increasing system temperatures and pressures, decreases in oil pressure, or releases of ammonia through PRVs). Some facilities have the chief engineer, the plant manager, and a refrigeration technician sign the daily logs to help initiate early, proactive problem resolution.

During design of new systems or retrofitting of existing systems, most facilities are using computer controls to monitor, record, and alarm process parameter conditions 24 hours per day. This does not replace essential operator duties of conducting rounds at least daily, which includes walking the system to observe the operation and detect any abnormalities by seeing, hearing, smelling, etc.

Equipment manufacturers and equipment operating manuals should be consulted to develop and expand operating logs to ensure their usefulness at each facility. RAGAGEP within an operating log recommends including a column to document operating conditions. Record whether conditions are normal or not. If conditions are not normal, indicate levels and trends that should be addressed through maintenance or emergency actions.

Maintain Good Housekeeping Practices

Flammables and/or combustibles must not be stored in the machinery room. In addition, there must be a clear and unobstructed approach and space to the machinery for inspection, service, and emergency shutdown.

Anhydrous ammonia is very corrosive to copper, brass, and galvanized surfaces and materials.

Do not use copper, brass, zinc, and galvanized components in any part of an anhydrous ammonia refrigeration system.

Support structure components should be readily visible such that they can be inspected for deterioration and replaced before a failure event can occur. All refrigeration piping should be periodically inspected for failed insulation/vapor barrier, rust, and corrosion. Ammonia piping underneath failed insulation should be carefully inspected for corrosion. Damaged and deteriorated ammonia piping should be replaced. All uninsulated piping should be cleaned, primed, and painted with an appropriate coating to protect the pipe from corrosion as well as being consistent with the color coding scheme.



Track Ammonia Purchases and Distribution of Ammonia in Your System

Keep an accurate record of the initial amount of ammonia purchased and any additional replacement charges of ammonia. This data is not only critical for trend and operations analysis, but it also is necessary to determine if system-wide ammonia releases are occurring. If your facility adds more than 10,000 pounds of ammonia in a calendar year, you may be required to report it in accordance with 40 CFR 372 (Toxic Release Inventory). Here is an example spreadsheet for tracking ammonia distribution in a system:

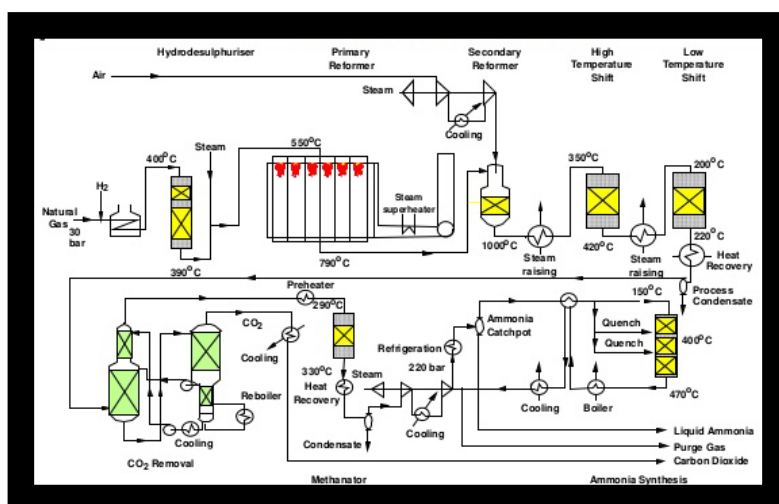
Component/ Unit	HP NH ₃ Receiver V-1	Pilot Receiver V-2	Low Temperature Suction Trap V-3	Intercooler V-4	Accumulator for #1 V-5	Recirculator Vessel V-6
Orientation	Horizontal	Horizontal	Vertical	Horizontal	Horizontal	Horizontal
Diameter (ft)	3.50	1.67	4.00	4.00	3.00	4.00
Length (ft)	18	10.75	8.5	8.0	14.83	12.33
Volume (ft ³)	165.44	23.45	102.04	100.53	104.83	154.98
Liquid Level (%)	35.71%	93.02%	11.76%	22.92%	44.44%	56.25%
Temp. (°F)	95	95	-31	17	17	-31
Liquid (ft ³)	59.09	21.82	12.00	23.04	46.60	87.18
Liquid (lbs/ft ³)	36.67	36.67	42.69	40.57	40.57	42.69
NH ₃ Liquid (lbs)	2,167	800	512	935	1,891	3,722
Vapor (ft ³)	106.35	1.64	90.04	77.49	58.25	67.80
Vapor (lbs/ft ³)	0.6517	0.6517	0.05134	0.159	0.159	0.05134
NH ₃ Vapor (lbs)	69	1	5	12	9	3
Total NH ₃ (lbs)	2,236	801	517	947	1,900	3,725

If you need assistance in determining how much ammonia is in your refrigeration system, the Industrial Refrigeration Consortium, having a collaborative effort between the University of Wisconsin Madison and industry, has made tools available for calculating the inventory of pressure vessels and heat exchangers. <http://www.irc.wisc.edu/?/download>.

Piping and Instrumentation Diagrams

Facilities must maintain complete and accurate **piping and instrumentation diagrams** (P&IDs) of the ammonia refrigeration system and the equipment manufacturer's documentation. A P&ID is a set of drawings or detailed schematics that illustrate all components (e.g., vessels, valves, pumps, and piping) of the refrigeration system. Operating procedures, operation and maintenance checklists, daily logs, facility management plan, and emergency response materials should all relate to the information found in the manufacturer's documentation and on the facility's P&IDs.

Unfortunately, many facilities have P&IDs that lack critical elements, or do not represent the currently installed configuration and system components. These defects cause operating errors, delay efforts to minimize an ammonia release, and further increase the risks to emergency responders.



Many facilities find that P&ID verification coupled with a line-and-valve-labeling project is a very cost effective housekeeping project.

P&IDs periodically should be verified by tracing ammonia equipment throughout a facility. Construction changes, system renovations and repairs, and draftsman errors all contribute to inaccuracies in P&IDs. Ladder/logic diagrams should be prepared from the verified P&IDs and electrical drawings for all system components.

Conduct a Periodic Process Hazard Analysis

A Process Hazard Analysis (PHA) is used to identify, evaluate, and control hazards that exist within the facility. These hazards have the potential to lead to the release of ammonia with the further prospect of causing on-site injury, infrastructure damage, or offsite consequences. Routinely performing a PHA will help minimize releases, helps facility prioritize resources, and provides a forum for ammonia system operators to share critical operating knowledge.

A PHA is required every five (5) years or sooner if the facility incurs a major change [40 CFR 68.67(f) and 29 CFR 1910.119]. A well-designed PHA aims to identify all hazards that could lead to significant ammonia exposure of workers, the public, or the environment. It also establishes dates for resolving recommendations and assigns personnel to complete each recommendation. The facility must keep all PHAs for the life of the process. Here's an example worksheet:

What if	Hazard	Consequences	Safeguards	Recommendations	Target and Actual dates for completion	Completed By
Drain valve open/leaking on lowest vessel	Potential release of ammonia from leak point	Significant volume of ammonia release into engine room	Log vessel operating parameters every 4 hours. Ammonia alarm starts ventilation fans.	Ensure operator monthly checks that caps and plugs are placed on system and protected from damage	First check on July 15, 2015	John Smith
Manual valve closed in pump discharge line	Potential for high pump discharge pressures	Over pressurize system, which could lead to ammonia release in engine room	Pressure regulator (vented back to ultra-low vessel) is in pump discharge line. Logs of pressure every 4 hours.	Consider providing a PRV on the discharge of pump	September 23, 2015	Jane Doe
Pump stops (due to mechanical failure or low level switch)	Loss of ammonia flow to evaporators	No safety or environmental consequences (operation issue)	Preventative maintenance program and operator attention during ammonia system operations.	No recommendations	N/A	N/A
Oil lubrication system fails	Ammonia discharge temperatures increase	Compressor bearings or seals could be damaged	Compressor parameters and oil pressure logged every 4 hours. Compressors equipped with low oil pressure alarms and cutouts.	No recommendations	N/A	N/A
Excessive vibration of compressor or pumps	Damage to compressor or pumps	Potential for catastrophic ammonia leak	Ammonia detector in engine room will alarm and start ventilation fans at 100 ppm set point	Consider conducting quarterly vibration analysis of the compressors and pumps.	First analysis on August 1, 2015	Charlie Brown

3.1.3 System Inspections

Conducting inspections is one of the system operator's most valuable tools for preventing unnecessary accidents due to equipment failure.

Conduct Visual Testing

Visual inspections are relatively inexpensive and provide a great deal of valuable information to the system operator. To monitor the condition of the ammonia refrigeration system, the person inspecting the system should note any corrosion of piping, valves, seals, flanges, and other pertinent equipment. In addition, the insulation should be visually

inspected for breeches in its integrity. The person conducting the visual test should keep a log, including photographs, of all findings. Taking corrective action of all findings is essential to avoid unexpected equipment failure.



Conduct Leak Testing

All ammonia refrigeration system operators should try to maintain a leak-free ammonia system. Recommended practice involves leak testing all piping, valves, seals, flanges, and other pertinent equipment at least four times a year. Some methods that can be used for leak testing are sulfur sticks, litmus paper, or a portable meter equipped with a flexible probe.



Operators, maintenance personnel, and other facility workers should be encouraged to **immediately report ammonia odors.**

Facilities should immediately investigate all reports of ammonia leaks, and take corrective actions without delay.

Conduct Vibration Testing

Depending on the nature of equipment at the site, some facility operators may elect to perform vibration testing on rotating equipment (i.e., compressors and pumps). These usually are performed to supplement the maintenance practices to indicate when equipment overhauls should be performed. Vibration levels on certain equipment can be logged and analyzed to determine if abnormal trends are developing or if further inspections are warranted. Excessive vibration can lead to potential equipment damage which could increase the probability of an ammonia release. The equipment manufacturer should be consulted to provide guidance on the usefulness of vibration monitoring for their particular equipment.

Conduct Thermal Imaging

A growing trend in preventive maintenance is the use of infrared (thermal) imaging. Infrared thermography helps locate many problems in their early stages often before they can be seen or found in any other way. A temperature difference, usually an abnormal hot spot, is typically associated with these problems due to high electrical resistance or excessive friction.



3.1.4 Training

Only fully trained and qualified operators are permitted to operate ammonia systems. Training is available through a number of trade organizations and professional societies. Some organizations that provide ammonia refrigeration education and training are listed in Appendix D, “Education and Information Resources”.

In accordance with 40 CFR 68.71, the owner or operator of your facility must provide initial training to each employee presently operating a process **BEFORE** they are involved with newly assigned process. They must also be trained in an overview of the process and in the operating procedures. The operator is required to take refresher training at least every 3 years to ensure the employee understands and adheres to the current operating procedures related to the process. In addition, after a major change in operations, the operator is required to be trained in any updated or new procedures prior to startup. For Program 3 facilities, the owner or operator must record the operator’s identity, date of training and the method used to verify the operator understood the training.

Facilities should also provide awareness training to other facility personnel who work within ammonia refrigerated areas. Awareness training of the hazards associated with ammonia accidents should be conducted in a manner that encourages immediate reporting of ammonia system damage and releases. Immediate awareness of a problem, or potential problem, can help ammonia operators quickly minimize and control any accidental releases as well as get employees to a safe location should a release occur.



3.2 Property Security

Many accidents can be prevented by taking proper site safety precautions. Ammonia theft and vandalism have resulted in death, injuries, property damage, and chemical releases from ammonia storage facilities and refrigeration systems.

The following site security should be considered at existing facilities as well as at new sites. Some of these recommendations will depend on the type and size of your facility. Appurtenances containing anhydrous ammonia that are readily accessible to the general public tend to provide the most serious security risk.

- o First and foremost, determine if your facility is subject to the Department of Homeland Security Risk-Based Performance Standards. See pages 2.3 – 2.4 of this manual.
- o Educate employees about potential theft and problems. You may find more information about preventing ammonia theft at <http://www2.epa.gov/sites/production/files/2013-11/documents/csalert.pdf>.
- o Ensure that all outside ammonia vessels and storage areas are well lit.
- o Know ammonia inventory to quickly identify missing quantities.
- o Visually inspect all outside vessels and cylinders each morning (especially after weekends or other periods when the facility has been unoccupied).

- o Consider setting up a valve protection program for critical valves that would cause a significant release if opened by mistake. For example, install a check valve in the ammonia charging line close to the main control valve. In addition, evaluate the benefits of installing lockable, quarter-turn ball or globe valves, or spring-loaded ball or globe valves in series with a manual valve in critical areas (e.g., ammonia supply connection).
- o Consider installing valve locks, fencing, bollards, or other barriers especially for unattended outside vessels or cylinders.
- o Consider installing other theft deterrent measures such as bilingual or multilingual warning signs, walls, motion detector lights, motion detector alarms, security patrols, and/or video surveillance.
- o Report thefts, signs of tampering, leaks, or any unusual activity to local law enforcement officials.
- o For more information on site security, please visit <http://www2.epa.gov/sites/production/files/2013-11/documents/secale.pdf>.



To assist in developing your Safety and Security Plans, you may want to look at the standards and recommended practices from other organizations. Listed below is a partial list of some resources that can provide information for developing security procedures or practices.

- o *Standard for Site Security Services for Fire Loss Prevention*, National Fire Protection Assoc. (NFPA) - 601.
- o *Responsible Care Employee Health and Safety Code Site Security Management Practice*, Chemical Manufacturers Association.
- o The Agency for Toxic Substances and Disease Registry www.atsdr.cdc.gov provides a 10-step procedure to analyze, mitigate, and prevent public health hazards resulting from terrorism involving industrial chemicals.
- o The American Society for Industrial Security www.securitymanagement.com develops educational programs and materials that address security concerns, including an online version of its magazine.

- o The Center for Chemical Process Safety (www.aiche.org/ccps) develops engineering and management practices to prevent and mitigate consequences of catastrophic events involving chemical releases.
- o The National Safety Council (www.nsc.org) provides general safety information on chemical and environmental issues.
- o The Energy Security Council (www.energysecuritycouncil.org) is a national industry association that assists law enforcement agencies and energy companies in combating all types of criminal activity.

3.3 Other RAGAGEP

In addition to the recognized and generally accepted good engineering practices “RAGAGEP” described earlier in this chapter, there are many other useful resources:

American Society of Mechanical Engineers (ASME)

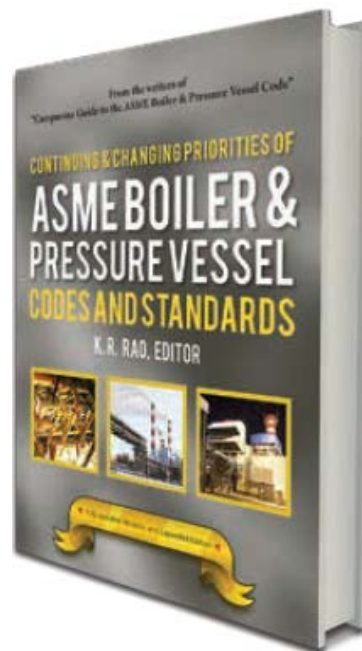
ASME Boiler & Pressure Vessel Code Section VIII

“Rules for Construction of Pressure Vessels” Division 1 provides requirements applicable to the design, fabrication, inspection, testing, and certification of pressure vessels operating at either internal or external pressures exceeding 15 psig.

ASME B31.5-2013 “Refrigeration Piping and Heat Transfer Components” contains requirements for the materials, design, fabrication, assembly, erection, test, and inspection of refrigerant, heat transfer components, and secondary coolant piping for temperatures as low as -320°F, whether erected on the premises or factory assembled.

ASME Section IX “Welding and Brazing Qualifications”

including welding procedure qualifications, welding performance qualifications, standard welding procedure specifications, and brazing qualifications.



American Society of Heating Refrigerating and Air-Conditioning Engineers (ASHRAE)

ASHRAE Standard 15-2013 “Safety Standard for Refrigeration Systems” clarifies location requirements for machinery room mechanical ventilation, harmonizes Standard 15 with the 2012 International Mechanical Code (IMC) section 1101.10.

ASHRAE Standard 34-2013 “Designation and Classification of Refrigerants” clarifies and modifies definitions; adds one new single-compound refrigerant and 14 new refrigerant blends; clarifies section 7.3, Requirements for Data Calculations, and 9.6, Toxicity Information, for consistency; changes the flammability safety classification of refrigerants 32, 143a, 717 and 1234yf from Class 2 to Class 2L based on the optional burning velocity measurement; modifies the definition of Workplace Environmental Exposure Level (WEEL) and adds a reference to the American Industrial Hygiene Association (AIHA) WEEL; clarifies the conditions for bubble point in Sections B2.4.1 and B2.4.2 of Normative Appendix B.2, Fractionation Analysis; and better defines experimental verification of models used to identify the worst case of fractionation for flammability (WCFF) compositions, and allows vapor liquid equilibrium (VLE) data only to be used for experimental verification



Factory Mutual Global Property Loss Prevention Data Sheet 12-61; Pressure Vessels, Mechanical Refrigeration (May 2002)

This data sheet applies to mechanical (compression type) refrigeration systems found in food processing and storage, chemical processes, biomedical applications and office buildings.

This data sheet provides loss prevention recommendations, support for those recommendations and inspection guidelines.

These recommendations are intended to supplement, not supersede, those of the equipment manufacturers and/or jurisdictional authorities.



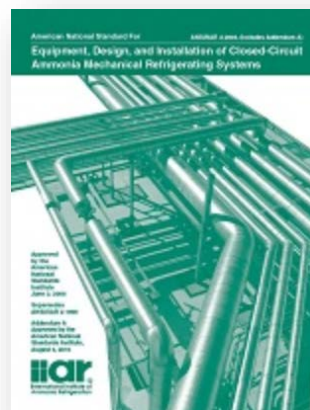
The image shows the Table of Contents for the FM Global Property Loss Prevention Data Sheet 12-61. The title is 'Table of Contents' and it lists various sections and their corresponding page numbers. The sections include: 1.0 SCOPE, 2.0 General Information, 3.0 Equipment and Piping, 4.0 Equipment and Piping, 5.0 Equipment and Piping, 6.0 Equipment and Piping, 7.0 Equipment and Piping, 8.0 Equipment and Piping, 9.0 Equipment and Piping, 10.0 Equipment and Piping, 11.0 Equipment and Piping, 12.0 Equipment and Piping, 13.0 Equipment and Piping, 14.0 Equipment and Piping, 15.0 Equipment and Piping, 16.0 Equipment and Piping, 17.0 Equipment and Piping, 18.0 Equipment and Piping, 19.0 Equipment and Piping, 20.0 Equipment and Piping, 21.0 Equipment and Piping, 22.0 Equipment and Piping, 23.0 Equipment and Piping, 24.0 Equipment and Piping, 25.0 Equipment and Piping, 26.0 Equipment and Piping, 27.0 Equipment and Piping, 28.0 Equipment and Piping, 29.0 Equipment and Piping, 30.0 Equipment and Piping, 31.0 Equipment and Piping, 32.0 Equipment and Piping, 33.0 Equipment and Piping, 34.0 Equipment and Piping, 35.0 Equipment and Piping, 36.0 Equipment and Piping, 37.0 Equipment and Piping, 38.0 Equipment and Piping, 39.0 Equipment and Piping, 40.0 Equipment and Piping, 41.0 Equipment and Piping, 42.0 Equipment and Piping, 43.0 Equipment and Piping, 44.0 Equipment and Piping, 45.0 Equipment and Piping, 46.0 Equipment and Piping, 47.0 Equipment and Piping, 48.0 Equipment and Piping, 49.0 Equipment and Piping, 50.0 Equipment and Piping, 51.0 Equipment and Piping, 52.0 Equipment and Piping, 53.0 Equipment and Piping, 54.0 Equipment and Piping, 55.0 Equipment and Piping, 56.0 Equipment and Piping, 57.0 Equipment and Piping, 58.0 Equipment and Piping, 59.0 Equipment and Piping, 60.0 Equipment and Piping, 61.0 Equipment and Piping, 62.0 Equipment and Piping, 63.0 Equipment and Piping, 64.0 Equipment and Piping, 65.0 Equipment and Piping, 66.0 Equipment and Piping, 67.0 Equipment and Piping, 68.0 Equipment and Piping, 69.0 Equipment and Piping, 70.0 Equipment and Piping, 71.0 Equipment and Piping, 72.0 Equipment and Piping, 73.0 Equipment and Piping, 74.0 Equipment and Piping, 75.0 Equipment and Piping, 76.0 Equipment and Piping, 77.0 Equipment and Piping, 78.0 Equipment and Piping, 79.0 Equipment and Piping, 80.0 Equipment and Piping, 81.0 Equipment and Piping, 82.0 Equipment and Piping, 83.0 Equipment and Piping, 84.0 Equipment and Piping, 85.0 Equipment and Piping, 86.0 Equipment and Piping, 87.0 Equipment and Piping, 88.0 Equipment and Piping, 89.0 Equipment and Piping, 90.0 Equipment and Piping, 91.0 Equipment and Piping, 92.0 Equipment and Piping, 93.0 Equipment and Piping, 94.0 Equipment and Piping, 95.0 Equipment and Piping, 96.0 Equipment and Piping, 97.0 Equipment and Piping, 98.0 Equipment and Piping, 99.0 Equipment and Piping, 100.0 Equipment and Piping.

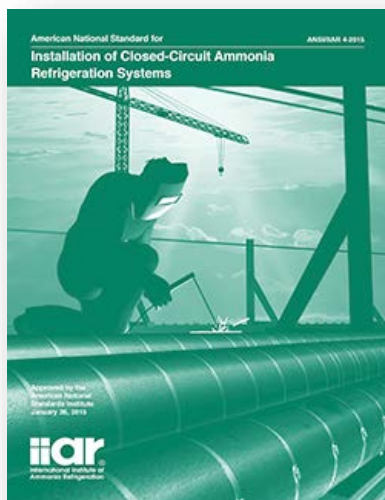
International Institute of Ammonia Refrigeration (IIAR)

ANSI/IIAR Standard 1-2012 “American National Standard for Definitions and Terminology Used in IIAR Standards” provides a unified set of definitions for use in the IIAR Standards. All IIAR standards may be found at http://www.iiar.org/iiar/WCM/Store/Standards/WCM/IIAR_Publications/Standards.aspx.

ANSI/IIAR 2-2008 (Addendum B) “American National Standard for Equipment, Design and Installation of Closed-Circuit Ammonia Mechanical Refrigerating Systems” has been written to serve as a standard for equipment, design and installation of closed-circuit ammonia refrigeration systems.

ANSI/IIAR Standard 3-2012 “American National Standard for Ammonia Refrigeration Valves” specifies criteria for materials, design parameters, marking and testing of valves and strainers used in closed circuit ammonia refrigeration systems.



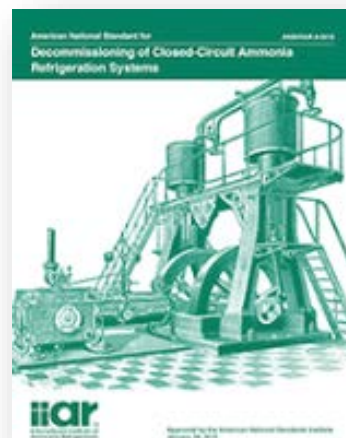


ANSI/IIAR Standard 4-2015 “Installation of Closed-Circuit Ammonia Refrigeration Systems” serves as a standard for the installation of closed-circuit ammonia mechanical refrigeration systems and overpressure protection relief piping systems.

ANSI/IIAR Standard 5-2013 “Start-up and Commissioning of Closed-Circuit Ammonia Refrigeration Systems” specifies criteria and procedures of the startup and commissioning of closed-circuit ammonia mechanical refrigeration systems.

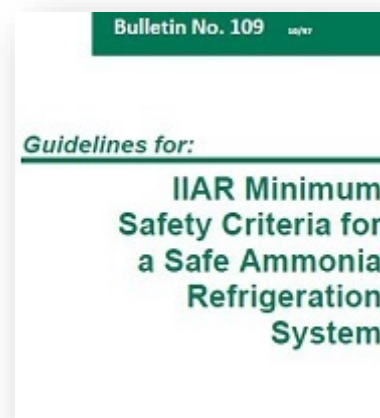
ANSI/IIAR Standard 7-2013 “Developing Operating Procedures for Closed-Circuit Ammonia Mechanical Refrigerating Systems” defines the minimum requirements for developing operating procedures for closed-circuit ammonia mechanical refrigerating systems.

ANSI/IIAR Standard 8-2015 “Decommissioning of Closed-Circuit Ammonia Refrigeration Systems” specifies the minimum criteria for removing the ammonia charge in conjunction with the decommissioning of closed-circuit ammonia refrigeration systems.



IIAR Bulletins

- IIAR Bulletins may be found at http://www.iiar.org/iiar/WCM/Store/Bulletins/WCM/IIAR_Publications/Bulletins.aspx?hkey=edfd130e-9f58-43c9-979a-1f18dc8c8a9a.
- **IIAR B108** “Water Contamination in Ammonia Refrigeration Systems”
- **IIAR B109** “Minimum Safety Criteria for a Safe Ammonia Refrigeration System”
- **IIAR B110** “Start-up, Inspection and Maintenance of Ammonia Mechanical Refrigerating Systems”
- **IIAR B114** “Identification of Ammonia Refrigeration Piping and System Components”
- **IIAR B116** “Avoiding Component Failure in Industrial Refrigeration Systems Caused by Abnormal Pressure or Shock”



CHAPTER 4 - WHAT TO DO WHEN THERE IS AN ACCIDENT

4.1 Be Prepared

Not knowing how to respond in an emergency often makes the situation worse. It is important to develop a suitable plan for emergency response, meet the local emergency responders, and to practice your plan.

Facilities whose employees do not respond to chemical emergencies, would merely take steps to safely shut down the process and evacuate personnel. This would not include donning PPE. These facilities are also required to develop an emergency action plan in accordance with OSHA regulations. Your facility is required to be included in the community

emergency response plan and facility personnel are required to know who to contact if there is an emergency.

If your employees will be responding to an anhydrous ammonia emergency, then you are required to have an EPA emergency response program and plan in accordance with 40 CFR 68.95. Many responding facilities may also be subject to OSHA's Hazardous Waste Operations and Emergency Response (HAZWOPER) Standard (29 CFR 1910.120). For further guidance on actions a responding facility would take, please see Appendix B.1 of this manual.



Plan ahead by meeting your local emergency responders before an emergency occurs.

The risk management emergency response **program** requires the following elements:

- o **An emergency response plan.** Your emergency response plan must be specific to the operations and layout of your facility and must be maintained and kept at your facility. Each emergency response plan is to include:
 - ✓ Procedures for informing the public and local emergency response agencies about accidental releases.
 - ✓ Documentation of proper first-aid and emergency medical treatment for accidental human exposure.
 - ✓ Procedures and measures for emergency response after an accidental release.
- o **Procedures for using and maintaining emergency response equipment.**
- o **Training for employees in their emergency responsibilities.**
- o **Procedures to review and update the emergency response plan.**



For more detailed information on EPA's emergency response program, see Chapter 8 – Emergency Response Program of the EPA “General Risk Management Program Guidance”.

<http://www2.epa.gov/rmp/quidance-facilities-risk-management-programs-rmp#general>

4.2 Report the Accident

No matter how well you implement best practices, planning, and security, accidents still may happen. Having a **well-rehearsed** emergency response/action plan in place will help alleviate much of the stress if an accident occurs.

When an accident does occur, it is essential that you notify the appropriate authorities immediately so they can initiate a response if necessary to insure the protection of the public and the environment. Most companies will post a list of who to call to respond to an emergency and a list of who to call to report an emergency.

Notification, reporting, and response requirements are summarized in the following table. The first notification should be made to the local responders, since they are needed immediately*. The next notification should be made to the state, followed by the National Response Center.

Subject	Law and Regulation	Who to Notify	When
EPCRA Release Notification (≥ 100 pounds of anhydrous ammonia)	EPCRA 40 CFR 355	Local Emergency Planning Committee (LEPC) State Emergency Response Commission (SERC)	Immediately*
CERCLA Release Notification (≥ 100 pounds of anhydrous ammonia) & Clean Water Act Release Notification (≥ 100 pounds of anhydrous ammonia over a 24-hour period that enter "waters of the U.S.")	CERCLA 40 CFR 300 and 302 & Clean Water Act 40 CFR 117	National Response Center 1-800-424-8802	Immediately*
Risk Management Program Release Notification (No threshold quantity. Any quantity that causes a "reportable accident"**)	Clean Air Act 112(r)(7)	Update Risk Management Plan	Within six (6) months of accident.
Notification of Slug Loading to POTW	Clean Water Act 40 CFR 403	POTW, State Hazardous Waste Authority, EPA Regional Waste Management Division Director	Immediately*
Notification of Hazardous Waste Discharge to Septic System	Clean Water Act 40 CFR 144	EPA Regional Underground Injection Control (UIC) Well Program, and state UIC Program	Immediately*
State Statutes	State Laws	State Environmental Agency	Varies

* "Immediately" is interpreted as "not to exceed 15 minutes after the person in charge has knowledge of the release." This interpretation is documented in [A Legislative History of the Superfund Amendments and Reauthorization Act of 1986, Volume 2, October 1990](#).

** "Reportable Accident" – an accident is reportable in the Risk Management Program if the chemical release causes: On-site deaths, injuries, or significant property damage; or Off-site deaths, injuries, property damage, environmental damage, evacuations, or sheltering in place.

Immediate Accident Reporting

In accordance with 40 CFR 355.40, a facility is to immediately report ammonia releases producing potential offsite exposure exceeding 100 pounds to all Local Emergency Planning Committee (LEPCs) and State Emergency Response Commission (SERCs) of the area likely to be affected. The release report is to include:

- o Chemical name or identity of all substances involved in the accident;
- o Time and duration of release; and
- o Estimate of quantity of substances released to the environment.

☒	Chemical name or identity of all substances involved in the accident;
☐	Time and duration of release.
☐	Estimate of quantity of substances released to the environment;



Initial notifications of a release can be made by telephone, radio, or in person. In accordance with 40 CFR 302.6(a), a facility is to immediately report releases ≥ 100 pounds of ammonia to the National Response Center at (800) 424-8802.

Reporting should include the following:

- o Chemical name or identity of the released substance;
- o Indication of whether the substance is on the CERCLA Section 302(a) list;
- o Estimated quantity of release;
- o Time and duration of release;
- o Medium or media into which the release occurred; and
- o Whether release threatens waterways (reporting requirement of the Clean Water Act contained in 40 CFR 117.21).



The facility owner or operator also is required to provide a **written Follow-up Emergency Notice** as soon as possible (and within 30 calendar days) to their LEPC and SERC after a release that requires notification.

The written follow-up notice should include the following:

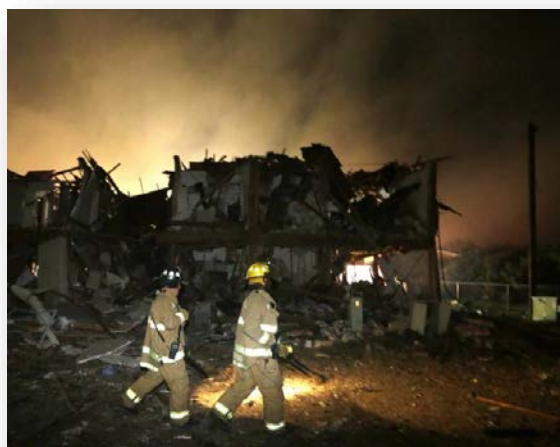
- o An update of all previously provided information;
- o Actions taken to respond to the release;
- o Known or anticipated acute or chronic health risks associated with a release; and
- o Advice regarding medical attention necessary for exposed individuals.

4.3 Investigations

An incident investigation is a requirement of EPA's Risk Management Program, as contained in 40 CFR 68.60 and 68.81. (Note that these requirements are nearly identical to those under OSHA's Process Safety Management.)

For processes categorized as a Program 2 or Program 3 process, each incident that results in (or could reasonably have resulted in) a catastrophic release must be investigated. The resulting investigation report should include the following information:

- o Date of incident;
- o Date investigation began ($\leq$ 48 hours after the incident);
- o Description of incident;
- o Factors that contributed to incident; and
- o Recommendations resulting from the investigation.





The goal of an accident investigation is to determine the root causes or management system failures that ultimately caused the ammonia release. Efforts to determine the facts, conditions, circumstances, and probable causes of ammonia releases can help to reduce the likelihood of their recurrence. They also can minimize the consequences associated with future releases and make anhydrous ammonia refrigeration systems and operations safer for everyone.

Section 112(r)(6) of the Clean Air Act established an independent safety board known as the Chemical Safety and Hazard Investigation Board (the “Chemical Safety Board”). One of the objectives of the Chemical Safety Board is to investigate, determine, and report the facts, conditions, circumstances, and probable causes of an accidental release that results in a fatality, serious injury, or substantial property damage.

*The Chemical Safety Board investigates chemical accidents.
Visit their page at <http://www.csb.gov/>.*

APPENDIX A - CLEAN AIR ACT (CAA) PREVENTION PROGRAM REQUIREMENTS

This appendix highlights the basic CAA 112(r) Risk Management Program requirements. For a detailed description of all requirements under this program, please visit:

<http://www2.epa.gov/rmp/guidance-facilities-risk-management-programs-rmp>

A.1 Risk Management Program Level

Most ammonia refrigeration processes are Program 3, because they are covered by OSHA Process Safety Management (PSM) standard codified at 29 CFR 1910.119 and their worst case scenario has public receptors in the circle of influence, which means it's not eligible for Program 1.

For detailed information on determining Program level, visit:

<http://www2.epa.gov/sites/production/files/2013-10/documents/chap-02-final.pdf>

A.2 Program 3 Requirements

Since most ammonia refrigeration facilities are Program 3, they are subject to the following requirements:

- Management System
- Hazard Assessment
- Prevention Program
- Emergency Response
- Risk Management Plan

A.2.1 MANAGEMENT SYSTEM

A written Management System is a document which specifies who is responsible for implementing each of the requirements of their Risk Management Program. In accordance with 40 CFR 68.15, the management system is to include the following:

- Develop a management system to oversee implementation of the risk management program elements;
- Designate a qualified person or position with the overall responsibility of developing, implementing, and ensuring integration of the Risk Management Program elements; and

- o Document names of people or positions and define lines of authority through an organizational chart or other similar document.

A.2.2 HAZARD ASSESSMENT

A Hazard Assessment must include an offsite consequence analysis (OCA) for each covered process as follows:

- o For worst-case and alternative release scenarios, potential exposures to human populations must be quantified and potential environmental damage must be identified;
- o In accordance with 40 CFR 68.36, revised analyses and a revised Risk Management Plan is required within six months of changes in processes or any changes that increase or decrease the distance to an endpoint by a factor of two or more; and
- o Worst-case and alternative release scenarios must be reviewed and updated at least once every five years.

Although not required, many facilities provide an accurate map showing these scenario distances to the Local Emergency Planning Committee (LEPC) for their planning purposes. For free tools and more information on developing an OCA, please visit <http://www2.epa.gov/rmp/rmpcomp>.

A.2.3 PREVENTION PROGRAM

The Prevention Program is the foundation of the Risk Management Program. The Program 3 prevention program includes each of the following requirements:

Section	Program 3
68.65	Process Safety Information
68.67	Processes Hazard Analysis
68.69	Operating Procedures
68.71	Training
68.73	Mechanical Integrity
68.75	Management of Change

Section	Program 3
68.77	Pre-Startup Review
68.79	Compliance Audits
68.81	Incident Investigation
68.83	Employee Participation
68.85	Hot Work Permit
68.87	Contractors

Ammonia refrigeration facilities are also subject to OSHA's PSM standards. Many of OSHA's PSM requirements are very similar to the EPA Risk Management Program requirements as demonstrated in the following table:

Risk Management Plan (EPA)	Process Safety Management (OSHA)
Process safety information	Process safety information
Process Hazard Analysis	Hazard evaluation
Operating Procedures	Standard operating procedures
Employee participation	(No equivalence)
Training	Training
Contractors	(No equivalence)
Pre-Startup Safety Review	Pre-start up review
Mechanical Integrity	Maintenance
Hot Work permit	(No equivalence)
Management of Change	Management of change
Incident Investigation	Accident investigations
Emergency Planning and Response	Emergency response
Compliance Audits	Safety audits
Trade Secret	(No equivalence)
(No equivalence)	Risk assessment

A.2.4 EMERGENCY RESPONSE

A facility has the option to respond to their own emergencies or not. If **facility employees will not be responding to an accidental release** they must meet the requirements of [40 CFR 68.90(b)] and have an OSHA emergency action plan in place. If the facility employees will be responding to the emergency, they must meet the requirements of the EPA emergency response program (40 CFR 68.95).

*For more information on emergency response,
see Appendix B.*

A.2.5 RISK MANAGEMENT PLAN

A Risk Management Plan (RMP) is a document which reflects the status of a facility's Risk Management Program. In addition to including a summary of general facility information, the hazard assessment, the prevention program, and the emergency response program, the RMP includes an executive summary. Guidance on preparing and electronically submitting an RMP may be found at <http://www2.epa.gov/rmp>.

Executive Summary

The RMP requires an Executive Summary including a description of the following six (6) elements:

- The facility's accidental release prevention and emergency response policies;
- The facility and the regulated substances;
- The general accidental release prevention program and chemical-specific prevention steps;
- The five-year accident history;
- The emergency response program; and
- Planned changes to improve safety.

Five-year accident history

One of the elements that is often overlooked, not reported correctly, or not reported timely is the five-year accident history. In accordance with 40 CFR 68.42 and 68.168, a five-year accident history must be completed and included within a facility's RMP if the release caused at least one of the following consequences:

- o **On-site** deaths, injuries, or significant property damage; or
- o Known **off-site** deaths, injuries, property damage, environmental damage, evacuations, or sheltering in place.

There is no reportable quantity for this reporting requirement. If any amount of the regulated substance causes any of the above consequences, then the facility's RMP must be corrected to add a reportable accident **within six (6) months** of its occurrence.

RMP Corrections and Updates

In accordance with 40 CFR 68.190, a facility is required to electronically **update** their RMP:

- o At least every five (5) years from the date of the initial submission;
- o No later than the date a regulated substance is present at or above the threshold quantity;
- o Within six (6) months of a change that requires a revised off-site consequence analysis;
- o Within six (6) months of a change that requires a revised PHA or hazard review;
- o Within six (6) months of a change that results in a change in program level of a covered process.

RMPs must be revised and resubmitted at least once every five years.

A facility must electronically **correct** its RMP **within one (1) month** of a change of the **emergency contact information** and within **six (6) months** of a **reportable accident**.

A.3 Compliance

EPA conducts inspections at facilities to determine if the facility is in compliance with the requirements of the Risk Management Program. Typical examples of preliminary determinations found during EPA inspections include:

- o Mount NFPA placards on doors to compressor rooms and condenser/receiver areas;
- o Install bollards at ammonia fill station to improve protection against vehicular traffic;
- o Physically protect coils, valves, and pipes against fork lifts;



- o Identify and correct corrosion on ammonia vessels, piping, and structural supports;
- o Retest, calibrate, and replace ammonia sensors found inoperable;
- o Stock spill booms (specific for ammonia) to limit flow of released ammonia;
- o Perform vibration testing and trend analysis on all motor/compressors every six (6) months;
- o Replace pressure safety valves after they have been activated or every 5 years, whichever comes first;
- o Install check valves in charging line; and
- o Add audible or strobe alarms tied into ammonia sensors to improve notification to workers.

A.4 Deregistration

A facility which is no longer covered under the Risk Management Program, must submit a “de-registration” to EPA **within six (6) months** of not being subject in accordance with the provisions of 40 CFR 68.190(c).

APPENDIX B - EMERGENCY PLANNING

B.1 Emergency Response Planning

Effective emergency response planning is proactive and ongoing. EPA interprets “response” to be consistent with OSHA’s Hazardous Waste Operations and Emergency Response (HAZWOPER) Standard (29 CFR 1910.120). OSHA defines emergency response as, “a response effort by employees from outside the immediate release area or by other designated responders...to an occurrence which results, or is likely to result, in an uncontrolled release of a hazardous substance.”

An OSHA emergency action plan (EAP) is a written document required by 29 CFR 1910.38(a). The purpose of an EAP is to facilitate and organize employer and employee actions during workplace emergencies.

An EPA Risk Management Program Emergency Response Plan (ERP) outlines the action and equipment necessary for effective proactive emergency response in accordance with 40 CFR Subpart E, “Emergency Response” as it relates to the regulated substance.

A facility may have one plan as long as it meets all of the OSHA and EPA emergency plan requirements. For more information, visit

<http://www.epa.gov/region1/enforcement/epcra/oneplan.html>.

All facilities are required to have mechanisms in place to notify emergency responders when there is a release. Any facility whose employees will **not** respond to accidental releases are not required to develop and implement an EPA ERP. In accordance with 40 CFR 68.90, these facilities have the responsibility to contact the Local Emergency Planning Committees LEPC(s) which may be affected by a release of a **toxic** substance to ensure the facility is included in the community emergency response plan. In addition, facilities are required to coordinate with the local fire department concerning a potential release of their **flammable** substances.



Any spill of anhydrous ammonia, regardless of quantity, will require a “response” effort due to immediate ammonia volatilization, the hazardous nature of ammonia gas dispersing into the environment, and human health risks to on-site and off-site people.

B.2 Emergency Response Program

Any facility whose employees will respond to an accidental release is required to develop and implement an EPA Emergency Response Program in accordance with 40 CFR 68.95. The Emergency Response Program includes, at a minimum:

1. An Emergency Response Plan
2. Procedures for the use of emergency response equipment and for its inspection, testing, and maintenance
3. Training for all employees in relevant procedures
4. Procedures to review and update, as appropriate, the emergency response plan to reflect changes at the stationary source and ensure that employees are informed of changes

B.2.1 EMERGENCY RESPONSE PLAN (ERP)

The ERP must contain, at a minimum:

- Public Communication Plan;
- Emergency Medical Treatment; and
- Emergency Response Procedures.

o Public Communication Plan

The ERP must contain procedures for informing the public and local emergency response agencies about accidental releases. Facilities should get to know their local emergency planners and responders in order to develop an effective communication plan. At a minimum, this should involve the LEPC and local Fire Department.

o Emergency Medical Treatment

The ERP must include a procedure to document proper first-aid and emergency medical treatment necessary to treat accidental human exposures.

O Emergency Response Procedures

The ERP must contain procedures and measures for emergency response after an accidental release of a regulated substance. Some of these procedures and measures may include:

* Emergency Contact Information

Prepare an easily accessible list of Emergency contact information including, at a minimum:

- The National Response Center
- State Emergency Response Commission
- LEPC
- Local Emergency Responders
- Company Emergency Contact

National Response Center
800-424-8802

The National Response Center (NRC) is the sole Federal point of contact for reporting chemical spills/releases, including anhydrous ammonia.

Your State Emergency Response Commission (SERC) and your LEPC play extremely important roles in Emergency Response Planning. For planning purposes and in accordance with 40 CFR 355.20, **facilities that use or store more than 500 pounds of anhydrous ammonia are required to notify the SERC and LEPC.** These facilities must appoint a liaison from the facility and work with the LEPC to include facility-specific emergency response information into the comprehensive emergency response plan.

* Identify Chain of Command

An ERP should clearly define chain of command responsibilities in an event. The plan should indicate how response functions change if an emergency occurs as the result of a known or suspected terrorist event. For example, an Incident Command System will likely transition to a Unified Command structure. The change in response leadership is typically necessary to accommodate emergency response efforts that involve mutual-aid partners, State, and Federal responders.

* Mitigation Procedures

Procedures included in an ERP should involve mitigation activities to protect workers and the public from further exposure to hazards. In general, public health officials, EMS personnel, and criminal investigators should work together to identify and mitigate hazards following an event. The ERP could include a list of basic questions to ask victims, impacted emergency responders, and other individuals in the affected population.

Active and passive mitigation systems should be considered. Passive mitigation means equipment, devices, or technology that function without human, mechanical, or other energy input. Examples of passive mitigation include dikes and enclosed systems. Active mitigation means equipment, devices, or technologies that need human, mechanical, or other energy input to function. Examples of active mitigation include interlocks, shutdown systems, pressure-relieving devices, flares, emergency isolation systems, and fire protection systems.

*A fire protection system is an example of
Active Mitigation*



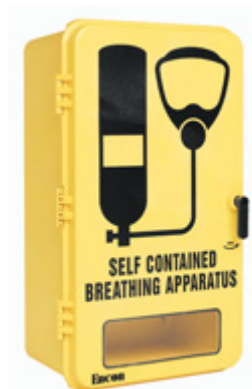
The system design, location, operating procedures, and emergency response procedures should be taken into consideration when determining the mitigation system to use. The design of the mitigation system should consider the different factors that would influence the system operation and potential release scenarios.

* Establish Emergency Shutdown Procedures

The ERP should establish emergency shutdown procedures and instructions on what to do during and after a power failure.

B.2.2 EMERGENCY RESPONSE EQUIPMENT

The Emergency Response Program must include procedures for inspecting, testing, and maintaining emergency response equipment. Emergency equipment should be inspected and tested regularly to ensure respirators and other equipment are maintained, available, and accessible. Air-purifying respirators must have appropriate and unexpired cartridges. They must only be used in an ammonia atmosphere less than 300 ppm. Self-contained breathing apparatus (SCBA) air should be suitable for the temperature in which the SCBA will be worn. Facilities should also periodically verify that onsite response personnel are trained and fit tested for the proper use of the emergency equipment.



B.2.3 TRAIN ALL EMPLOYEES

The Emergency Response Program must provide training to all employees in relevant emergency response procedures.

B.2.4 REVIEW AND UPDATE ERP

The Emergency Response Program must include procedures for updating the emergency response plan when relevant changes are made at the facility and to ensure that employees are informed of changes.

B.3 Practice Your Plan



Response actions during the first few minutes of an ammonia release are the most critical. They should not only be planned, but also well-rehearsed to minimize the impact of a release. Facilities that take a comprehensive approach in developing a facility-specific emergency response program are better prepared to respond in a release event.

A facility must conduct training, evaluate its program, maintain emergency equipment, and regularly coordinate with local agencies in order for an EAP/ERP to be useful in an emergency.

Include Local Emergency Medical Service (EMS) Personnel in your Planning and Practice

In an emergency, an integrated EMS response is critical. People seriously injured by a hazardous material have a greater chance of recovery when:

- Appropriate emergency treatment is provided by prepared EMS personnel at the scene;
- The patient is transported to a facility having the most appropriate personnel and technical resources; and
- Communication with the medical facility is open to relay information regarding the material impacting the patient.



EMS agencies are a crucial link in the community response system that responds to a facility incident. EMS personnel are often the first to arrive at an incident scene. They must be able to assess the nature of the hazard while attending to the immediate needs of victims.

The absence of EMS personnel in emergency response planning has resulted in the following types of problems:

- o Poorly managed incidents by facility personnel and first responders;
- o Ineffective and/or redundant communication channels between private and public sectors;
- o Medical facilities inadequately prepared to treat or manage incoming patients involved in hazardous materials incidents; and
- o Medical staff uninformed as to the lethal effects of a chemical release.

EMS personnel reinforce the importance of defining safe response scenarios, medical practices, and transportation guidelines in the event of an emergency. They are a critical link in the collaboration with other response agencies (e.g., police and fire departments) and hospitals.



EMS personnel should also participate in annual disaster drills and emergency plan reviews, helping to ensure that each ERP is effective and benefits from lessons learned during other emergency events.

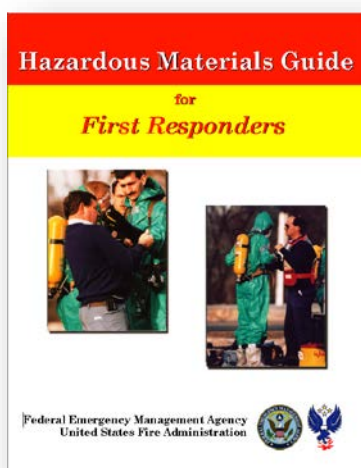
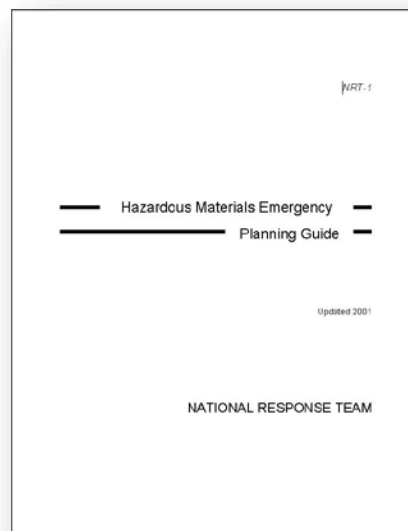
B.4 Emergency Planning and Response Guidance

Assistance in developing an emergency response program may be found at the US National Response Team (NRT) home page:

<http://www.nrt.org/production/nrt/nrtweb.nsf/PagesByLevelCat/Level3GeneralNRTPublications?Opendocument>

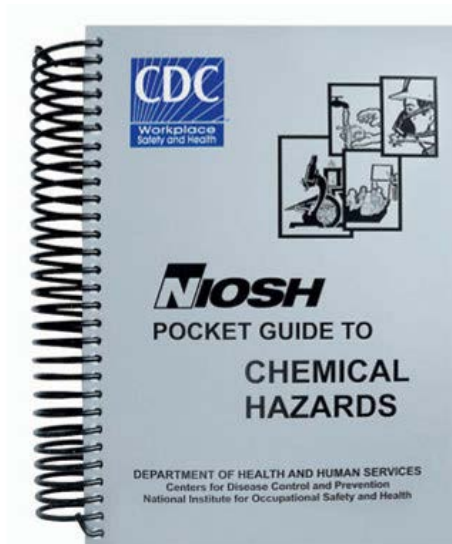
The NRT home page provides links to several guidance documents, including:

- o **Update of Hazardous Materials Emergency Planning Guide** (NRT-1 Update, 2001). Addresses outdated information of the 1987 Hazardous Materials Emergency Planning Guide.
- o **Criteria for Review of Hazardous Materials Emergency Plans** (NRT1a, 1998). Supplements NRT-1. Recommends criteria to RRTs for reviewing their emergency plans. Criteria is also useful for SERCs and LEPCs during plan revision.
- o **Integrated Contingency Plan**, 61 FR 28642, June 5, 1996. Guidance on consolidating multiple plans into a single, functional emergency response plan that complies with various federal regulations.



Hazardous Materials Guide for First Responders, Federal Emergency Management Association and U.S. Fire Administration, 1998. Includes specific emergency response procedures for anhydrous ammonia releases.

<http://www.d.umn.edu/ehso/hazguide.pdf>



NIOSH Pocket Guide to Chemical Hazards,

United States Centers for Disease Control and Prevention. Provides ten relevant databases, including recommendations for chemical protective clothing, toxicologic chemical reviews, and the Emergency Response Guidebook. For the most up to date information, view the pocket guide electronically at: <http://www.cdc.gov/niosh/npg/>

An NIOSH app may be downloaded for your phone or tablet and/or hard copies may be ordered or downloaded free at the above web address.

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APPENDIX C – GOVERNMENT REQUIREMENTS

C.1 Federal Requirements

When it comes to managing your facility in accordance to environmental laws, the Environmental Protection Agency’s laws and regulations are not the only ones to consider. Federal statutes and regulations relevant to anhydrous ammonia process safety, accident prevention, emergency planning, and release reporting are summarized in the table below. Facilities are encouraged to review this information before a release occurs.

Statute and Regulation	Description	Source(s)
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, “Superfund”) 40 CFR 302.6(a)	Hazardous Substance Release Reporting Releases equal to or greater than the reportable quantity of 100 pounds of ammonia must be immediately reported to the National Response Center (NRC).	National Response Center: (800) 424-8802
Clean Air Act (CAA) Section 112(r)(1) 40 CFR 68	General Duty Clause is applicable to facilities that store or use any amount of extremely hazardous substances, including anhydrous ammonia. The General Duty clause indicates facilities “ have a general duty... to identify hazards which may result from releases using appropriate hazard assessment techniques, to design and maintain a safe facility taking such steps as are necessary to prevent releases, and to minimize the consequences of accidental releases, which do occur. ”	EPA Hotline: (800) 424-9346 or (703) 412-9810 or (800) 553-7672 (TDD) http://www2.epa.gov/rmp/general-duty-clause-fact-sheet
Clean Air Act (CAA) Section 112(r)(7) 40 CFR 68	Risk Management Program Facilities having more than 10,000 pounds of anhydrous ammonia must develop a hazard assessment, a prevention program, an emergency response program, and submit a risk management plan to EPA.	EPA Hotline: (800) 424-9346 or (703) 412-9810 or (800) 553-7672 (TDD) http://www2.epa.gov/rmp

Statute and Regulation	Description	Source(s)
CAA 40 CFR 608	Regulates the use, recycling, and disposal of certain ozone-depleting substances (ODS) in applications including industrial processes and commercial refrigeration systems. The rules apply to systems that contain chlorofluorocarbon (CFC) or hydrochlorofluorocarbon (HCFC) refrigerants or refrigerant mixtures containing a CFC or HCFC. (Referenced here to emphasize that 40 CFR 608 is not applicable to anhydrous ammonia refrigeration systems.)	(800) 296-1996 http://www2.epa.gov/compliance/clean-air-act-caa-compliance-monitoring
Clean Water Act (CWA) 40 CFR 112	The CWA regulates the discharge of contaminants to surface water bodies from a point source. If a facility releases or discharges aqueous ammonia, then the CWA does apply and discharges of ammonia effluent would be regulated under state-specific NPDES permit programs. EPA's published ambient water quality criteria for ammonia is in EPA 822-R-99-014 (December 1999).	http://www2.epa.gov/compliance/clean-water-act-cwa-compliance-monitoring
CWA 40 CFR 117.21	Discharges equal to or greater than the reportable quantity of 100 pounds of ammonia (that threaten waterways) must be reported to National Response Center (NRC). Reporting should be by the person in charge of the source vessel or facility.	National Response Center (800) 424-8802
CWA 40 CFR 122.26	Storm water Regulations Regulates runoff from activities that take place at industrial facilities, such as material handling and storage that discharges industrial pollutants into nearby storm sewer systems and water bodies. This may adversely impact water quality and a permit may be required for this runoff.	http://water.epa.gov/polwaste/npdes/stormwater/Stormwater-Regulations.cfm

Statute and Regulation	Description	Source(s)
EPCRA 40 CFR 355.10	Community Emergency Planning Facilities that have ammonia equal to or greater than the threshold planning quantity (TPQ) of 500 pounds must report to their Local Emergency Planning Committee (LEPC) and State Emergency Response Commission (SERC), and comply with EPCRA Section 302 requirements. LEPC and SERC notification must be within 60 days of the date of exceedance of the TPQ and include information for the community emergency response plan. Facility must also appoint a liaison from the facility to the LEPC.	EPA Hotline: (800) 424-9346 or (703) 412-9810 or (800) 553-7672 (TDD) http://www2.epa.gov/epcra
EPCRA 40 CFR 355.40	Emergency Release Notification Releases equal to or greater than the reportable quantity of 100 pounds of ammonia must be immediately reported to the LEPC, SERC, or local emergency response personnel (911 in the case of transportation-related release) in accordance with EPCRA Section 304. Written follow-up is required within 30 calendar days.	National Response Center: (800) 424-8802 http://www2.epa.gov/epcra/epcra-section-304
EPCRA 40 CFR 370.20	Hazardous Chemical Reporting Facilities that have ammonia equal to or greater than 500 pounds must submit a Material Safety Data Sheet (MSDS) or chemicals list to their LEPC, SERC, and local fire department in accordance with EPCRA Section 311. Facilities must also comply with EPCRA Section 312's Tier I (aggregate) or Tier II (chemical specific) annual, March 1 st , inventory reporting requirements (e.g., quantity, location, hazards, reactive). MSDSs or chemicals list must be provided within 3 months of chemical presence on-site, and then updated with any significant changes to quantity or process.	General EPCRA: http://www2.epa.gov/epcra SERCs: http://www2.epa.gov/epcra/state-emergency-response-commissions-contacts LEPCs: http://www2.epa.gov/epcra/local-emergency-planning-committees

Statute and Regulation	Description	Source(s)
EPCRA 40 CFR 372	Toxic Chemicals Release Inventory Manufacturing businesses with certain NAIC codes and ten or more employees that manufacture, process, or otherwise use ammonia above an applicable threshold quantity of 10,000 pounds must file annually a Toxic Chemical Release form with EPA and the state by July 1st. If more than 10,000 pounds of ammonia is added to a refrigeration system during a calendar year it will trip the “otherwise used” criteria for filing. In accordance with Section 313, Annual Form A and Form R (unusual) reports are due July 1st of each year.	EPA Hotline: (800) 424-9346 or (703) 412-9810 or (800) 553-7672 (TDD) http://www2.epa.gov/toxics-release-inventory-tri-program
Occupational Safety and Health Act (OSHA) 29 CFR 1910.38a	Employee Emergency Action Plans and Fire Prevention Plans Ammonia incidents should be covered by these plans. This generally applies to facilities which plan to rely on off-site services for emergency response personnel and equipment. Anyone not part of the Incident Command system should evacuate the facility.	OSHA Public Information: 1-800-321-OSHA (6742) https://www.osha.gov/SLTC/etools/ammonia_refrigeration/emergency/index.html
OSHA 29 CFR 1910.111	Storage and Handling of Anhydrous Ammonia This standard does not apply to refrigeration plants that use ammonia solely as a refrigerant. This standard does apply to the design, construction, location, installation, and operation of any part of an ammonia distribution system (e.g., bulk storage facilities, distributors) including its associated pipelines and is typically applicable to ammonia retailers. This standard also does apply to other non-mechanical refrigeration systems users of ammonia (e.g., anhydrous ammonia used in the metal treating or reproduction industries).	OSHA Public Information: 1-800-321-OSHA (6742) https://www.osha.gov/SLTC/ammoniarefrigeration/index.html

Statute and Regulation	Description	Source(s)
OSHA 29 CFR 1910.119	Process Safety Management (PSM) Standard Facilities that have ammonia equal to or greater than the threshold quantity of 10,000 pounds are subject to a number of requirements for management of hazards, including process hazards analysis and maintaining mechanical integrity of equipment. Note that external threats must be considered when conducting a process hazard analysis. The PSM standard is applicable to ammonia manufacturers and facilities with large ammonia refrigeration systems, but not applicable to retail facilities.	OSHA Public Information: 1-800-321-OSHA (6742) https://www.osha.gov/SLTC/processsafetymanagement/
OSHA 29 CFR 1910.120(q)	Hazardous Waste Operations and Emergency Response Planning Generally these requirements apply to employers who use anhydrous ammonia refrigeration systems. Requirements include personal protective equipment testing, levels of protective gear, compliance guidelines, and training curriculum guidelines. Generally applies to facilities that establish capability to proactively respond to an ammonia release as first responders.	OSHA Public Information: 1-800-321-OSHA (6742) https://www.osha.gov/SLTC/hazardouswaste/index.html
OSHA 29 CFR 1910.132, 1910.133, 1910.134, 1910.138, & 1910.156	Personal Protective Equipment Employers are required to provide personal protective equipment to employees who may be exposed to ammonia. Employees who wear a respirator during the course of their job, or who are expected to wear one during an emergency response situation, must follow the requirements of the respiratory protection standard.	OSHA Public Information: 1-800-321-OSHA (6742) https://www.osha.gov/SLTC/personalprotectiveequipment/index.html
OSHA 29 CFR 1910.1200	Hazard Communication Requires facilities using toxic and hazardous chemicals to evaluate potential hazards and communicate this information to the employees.	OSHA Public Information: 1-800-321-OSHA (6742) https://www.osha.gov/dsg/hazcom/index.html

Statute and Regulation	Description	Source(s)
Oil Pollution Act (OPA) of 1990 40 CFR 112, 33 CFR 154, 49 CFR 194, 30 CFR 254	Spill Prevention, Control, and Countermeasure (SPCC) Facilities storing oil above 1,320 aggregate gallons in containers larger than 50 gallons must prepare and implement SPCC plans. These plans need to address security elements such as locks, guards, access, lighting, and vandalism.	http://www2.epa.gov/region8/spill-prevention-control-and-countermeasure-spcc
Resource Conservation and Recovery Act (RCRA) 40 CFR 264, 265, and 279.52	Anhydrous ammonia is not a listed hazardous waste (40 CFR 261). However, disposal of anhydrous ammonia requires hazardous waste characterization. Provided that a facility does not treat, store (> 90 days), or dispose of hazardous waste from anhydrous ammonia systems, the facility does not have to have a RCRA permit.	EPA Hotline: (800) 424-9346 or (703) 412-9810 or (800) 553-7672 (TDD) http://www.epa.gov/epawast/infocenters/online/
Department of Homeland Security Chemical Facilities Anti-Terrorism Standards (CFATS) CFATS Act of 2014	Facilities that possess any chemical on the CFATS Appendix A: DHS Chemicals of Interest List at or above the listed Screening Threshold Quantity (STQ) for each chemical. The STQ for anhydrous ammonia is 10,000 pounds.	Report a possible security concern involving the CFATS regulation. CFATS Chemical Facility Security Tip Line: 877-394-4347

C.2 State and Local Requirements

The federal statutes and regulations discussed above are the primary requirements. However, state and local governmental agencies may have their own (possibly more strict) requirements that are based on the federal laws. Therefore, be sure to check applicable state and local government industrial, agricultural, chemical, and environmental requirements, including, but not limited to the following:

- o Department of Agriculture
- o Fire Marshal
- o Environmental Division
- o Local Building/Electrical Codes
- o Boiler/pressure vessel inspector
- o Department of Health
- o State OSHA programs

Your State Emergency Response Commission (SERC) also will be able to help you determine any applicable state and local requirements. Locate your state's SERC at: <http://www2.epa.gov/epcra/state-emergency-response-commissions-contacts>.

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APPENDIX D - EDUCATION AND INFORMATION RESOURCES

For further training about anhydrous ammonia refrigeration, visit the following websites. *(Please note: The listings in this Appendix are not all-inclusive and do not constitute EPA endorsement.)*

- o **Refrigerating Engineers & Technicians Association (RETA)** provides online training which meets OSHA documenting requirements. Visit www.reta.com for additional information.
- o **Industrial Refrigeration Consortium (IRC) at the University of Wisconsin-Madison** offers several different educational opportunities. Visit <http://www.irc.wisc.edu/> for additional information.
- o **International Institute of Ammonia Refrigeration (IIAR)** offers ammonia refrigeration-related educational videos, short courses, technical publications, and an annual conference. Visit www.iiar.org for additional information.
- o **Georgia Ammonia Refrigeration Program (GARP) at the Lanier Technical College** offers hands-on training oriented toward operators of industrial ammonia refrigeration systems, and PSM/RMP implementation classes. Visit <http://www.laniertech.edu/EcoDev/Ammonia-Refrigeration.aspx> for additional information.
- o **Garden City Community College** offers hands-on credit courses for refrigeration engineers and technicians. Visit www.nh3gccc.com for additional information.
- o **Garden City Ammonia Program** provides hands-on training for the industrial ammonia refrigeration operators for PSM/RMP safety, compliance, and efficiency. Visit <http://www.ammoniaintraining.com/> for additional information.

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APPENDIX E - ANHYDROUS AMMONIA HANDLING QUIZ

The following ten (10) questions can help an individual begin to realize the range of information and knowledge required to safely handle anhydrous ammonia systems and releases. Answers follow the quiz.

1. At what concentration is a person able to smell the presence of anhydrous ammonia?
 - a) 0-4ppm
 - b) 5-50ppm
 - c) 51-100ppm
 - d) 101-150ppm
2. In accordance with 40 CFR 68, what is the threshold quantity for anhydrous ammonia?
 - a) 10 pounds
 - b) 100 pounds
 - c) 1,000 pounds
 - d) 10,000 pounds
3. Refrigeration facilities are subject to the General Duty Clause if they:
 - a) Have $\geq$ 1,000 pounds of ammonia in their refrigeration system.
 - b) Have $<$ 10,000 pounds of ammonia in their refrigeration system.
 - c) Have $<$ 100,000 pounds of ammonia in their refrigeration system.
 - d) All of the above are correct.
4. If your facility is subject to OSHA PSM standards, it is automatically Program 2 Risk Management Program facility under the Clean Air Act.
True or False?
5. The primary RAGAGEP for developing operating procedures is ANSI/IIAR Standard 7.
True or False?

6. Which of the following information is the owner or operator of a Program 3 facility required to provide when verifying the completion of the operator's training?
- a) the operator's identity
 - b) the method used to verify the operator understood the training
 - c) the date of training
 - d) a) thru c) are all correct
7. Your facility is required to notify the appropriate emergency response authorities _____ when _____ pounds of anhydrous ammonia is released from your facility.
- a) ≥ 1
 - b) ≥ 10
 - c) ≥ 100
 - d) $\geq 1,000$
8. An accident must be reported in the Risk Management Plan Accident History section if it causes:
- a) Known off-site evacuations
 - b) On-site sheltering in place
 - c) Reporters to show up on or off-site
 - d) On-site environmental damage
9. All anhydrous ammonia facilities are required to develop a Risk Management Program Emergency Response Plan.
- True or False?
10. For emergency planning purposes, a facility must notify their LEPC and SERC if they use or store more than _____ pounds of anhydrous ammonia.
- a) 100
 - b) 500
 - c) 1,000
 - d) 10,000

ANSWERS TO QUIZ

1. At what concentration is a person able to smell the presence of anhydrous ammonia?
b) 5-50ppm (Page 1.2)
2. In accordance with 40 CFR 68, what is the threshold quantity for anhydrous ammonia?
d) 10,000 pounds (Page 2.2)
3. Refrigeration facilities are subject to the General Duty Clause if they:
d) All of the above are correct. (Page 3.1)
4. If your facility is subject to OSHA PSM standards, it is automatically Program 2 Risk Management Program facility under the Clean Air Act.
False (Page A.1)
5. The primary RAGAGEP for developing operating procedures is ANSI/IIAR Standard 7.
True (Page 3.2)
6. Which of the following information is the owner or operator of a Program 3 facility required to provide when verifying the completion of the operator's training?
d) a) thru c) are all correct (Page 3.18)
7. Your facility is required to notify the appropriate authorities when _____ pounds of anhydrous ammonia is released from your facility.
c) ≥ 100 (Page 4.3)
8. An accident must be reported in the Risk Management Plan Accident History section if it causes:
a) Known off-site evacuations (Page A.4)
9. All anhydrous ammonia facilities are required to develop a Risk Management Program Emergency Response Plan.
False (Page B.1)
10. For emergency planning purposes, a facility must notify their LEPC and SERC if they use or store more than _____ pounds of anhydrous ammonia.
b) 500 (Page B.3)