IIAR 5-202x

Startup of Closed-Circuit Ammonia Refrigeration Systems

IIAR 5

Public Review #1 Draft

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Notes on the Standard Text

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Foreword
(Informative)

This standard specifies minimum requirements for the startup of closed-circuit ammonia refrigeration systems. This standard reflects the consensus reached by ammonia refrigeration industry representatives and is not a comprehensive task list for startup and should not be used in that manner.

For the purpose of this standard, it is assumed that the refrigeration system has been designed for the duty that it is to perform, that all piping and electrical equipment has been installed, and that adequate connections for the startup and test instruments have been provided. Since this document defines the minimum requirements for the startup of ammonia refrigeration systems, it may not be sufficient to meet other standards and/or regulations that are applicable to each specific refrigeration system. Accordingly, precautions and additional requirements may be necessary because of particular circumstances, project specifications, or other jurisdictional considerations. The IIAR Process Safety Management & Risk Management Program Guidelines address United States regulatory requirements for facilities with systems containing 10,000 pounds or more of ammonia and the IIAR Ammonia Refrigeration Management Program (ARM) addresses United States regulatory requirements for facilities with less than 10,000 pounds of ammonia. Note that this standard does not constitute a comprehensive, detailed technical manual and should not be used as such.

Experience shows that ammonia is very stable under normal conditions and rarely ignites when a release occurs because the flammability range in air is narrow and the minimum flammable concentration in air is very high as compared with other ignitable gases. Ammonia has a published flammability range of 160,000 ppm to 250,000 ppm. This concentration far exceeds ammonia's odor detection threshold and the 50-ppm permissible exposure limit (PEL) published by the Occupational Health and Safety Administration (OSHA).

Ammonia's strong odor alerts those nearby to its presence at levels well below those that present either flammability or health hazards. This "self-alarming" odor is so strong that a person is unlikely to voluntarily remain in an area where ammonia concentrations are hazardous.

The principal hazard to persons is ammonia vapor, because exposure occurs more readily by inhalation than by other routes. As with any hazardous vapor, adequate ventilation will dilute the vapor and greatly reduce exposure risk. Ammonia in vapor form is lighter than air. Typically, ammonia vapor rises and diffuses simultaneously when released into the atmosphere. It is biodegradable and, when released, combines readily with water and/or carbon dioxide to form relatively harmless compounds. Ammonia may also neutralize acidic pollutants in the atmosphere. Additional information regarding the properties of ammonia is published in the *IIAR Ammonia Data Book.*

ANSI/IIAR 5-202x was approved by ANSI on Month, Day, 202x which supersedes ANSI/IIAR 5-2019.

This revised standard was prepared using the ANSI consensus method, whereby organizations and individuals having interest in the subject of the standard were contacted prior to the approval of this revision for participation on the Consensus Body and in public reviews. The standard was prepared and approved for submittal to ANSI by the IIAR Standards Committee and the IIAR Board of Directors.

Informative Appendix A was added to provide explanatory information related to provisions in the standard. Sections of the standard with associated explanatory information are marked as an asterisk “*” after the section number, and the associated appendix information is located in Appendix A with a corresponding section number preceded by “A”.

At the time of publication of this new standard, the IIAR Standards Committee included the following members:

The subcommittee responsible for writing this standard had the following members at the time of publication:

Contents

Part 1 General

Chapter 1. Purpose, Scope, and Applicability

1.1 Purpose.

This standard specifies minimum requirements for the startup of new or additions or modifications to a closed-circuit ammonia refrigeration systems or additions or modifications thereto.

1.2 Scope.

*Startup of stationary closed-circuit ammonia refrigeration systems shall comply with this standard.

1.2.1

This standard shall not apply to portable refrigeration systems that are listed N manufactured in accordance with other ANSI standards.

1.2.2

Where a conflict exists between this standard and the Building Code, Fire Code, Mechanical Code, or Electrical Code, the requirements of these codes shall take precedence over this standard unless otherwise stated in such code.

1.2.3

Where approved, the use of devices, materials, or methods not prescribed by this standard is permissible as an alternative means of compliance, provided that any such alternative has been shown to be equivalent in quality, strength, effectiveness, durability, and safety. The alternative to the requirements of this standard shall be documented in the facility records.

1.2.4

Applicable Nationally Recognized Standards. For installations outside the United States, applicable nationally-recognized standards shall be permitted to be used in the place of those provided in this standard.

1.2.5

*A replacement in-kind of a component for maintenance reasons shall be in accordance with the applicable sections of this standard.

Chapter 2. Definitions

2.1 General.

Definitions shall be in accordance with ANSI/IIAR 1-2022.

Chapter 3. Normative References

3.1 American Society of Mechanical Engineers (ASME).

Standard as follows:

1. ASME B31.5-2022, *Refrigeration Piping and Heat Transfer Components*.

3.2 Environmental Protection Agency (EPA).

Regulations as follows:

1. Risk Management Plan (RMP).

3.3 International Institute of All-Natural Refrigeration (IIAR).

Standards as follows:

1. ANSI/IIAR 1-2022, *Definitions and Terminology Used in IIAR Standards*.
2. ANSI/IIAR 7-202x, *Developing Operating Procedures for Closed-Circuit Ammonia Refrigeration Systems.*
3. *Ammonia Refrigeration Management Program* (ARM) (2018).

3.4 Occupational Safety and Health Administration (OSHA).

Regulations as follows:

1. 29 CFR 1910.119, *Process Safety Management of Highly Hazardous Chemicals*.
2. 29 CFR 1910.132, *General Requirements, Personal Protective Equipment.*
3. U.S. Department of Labor, General Duty Clause in Section 5(a)(1) of the Occupational Safety and Health Act [29 U.S.C. § 654(a)(1)].

3.5 National Fire Protection Agency (NFPA).

Regulation as follows:

1. NFPA 70 (2023), National Electrical Code (NEC).

3.6 International Safety Equipment Association (ISEA).

Regulation as follows:

1. ANSI/ISEA Z358.1-2014 (R2020), *World Safety Standard for Emergency Eyewash and Shower Equipment*.

Chapter 4. Ammonia Specifications

4.1 Purity.

4.1.1
*Ammonia used for the initial and subsequent charging of ammonia refrigeration systems using mechanical compression shall meet the purity requirements in Table 4.1.1.

Table 4.1.1
Purity Requirements

Ammonia Content	99.5% minimum
Water	50 ppm minimum 5000 ppm maximum
Oil	50 ppm maximum
Salt (Calculated as NaCl)	None
Pyridine, Hydrogen Sulfide, Naphthalene	None

Part 2 Startup of New Systems and Additions or Modifications to Existing Systems

Chapter 5. Pre-Charging Activities and Requirements

5.1 Startup Team

5.1.1
A startup team shall be organized to perform the startup of the new system or additions or modifications to an existing system.

5.1.1.1
*At a minimum, the startup team shall include:

1. Owner or Owner's Designated Representative.
2. Startup team leader.
3. Trained startup technician(s).
4. Qualified contractor(s), where applicable.
5. Operating and maintenance personnel.

5.2 Startup Plan

5.2.1
A plan shall be prepared. The plan shall be application specific to execute the startup phase for a new ammonia refrigeration system or additions or modifications to an existing ammonia refrigeration system.

5.2.2
The startup plan shall address all pre-charging activities, charging, and post-charging activities.

5.2.3
The startup plan shall specifically apply to the scope of the work, equipment, location, and operational duty of the ammonia refrigeration system.

5.2.4
The startup plan shall address timing, roles and responsibilities, and ensure sufficient heat load for functional testing.

5.3 Design Documentation and Installation Records

5.3.1
*All system documentation from the planning, design, and installation phases of the project shall be assembled and readily available. This includes:

1. Design documentation.
2. Equipment and component documentation.
3. Test reports.

5.4 **Hazard Analysis**

5.4.1
*In the United States, ammonia refrigeration systems that are subject to either OSHA's Process Safety Management (PSM) standard, EPA's Risk Management Plan (RMP) Program 3 regulation, or both are required to conduct a Pre-Startup Safety Review (PSSR) to ensure that safety and design issues are addressed before ammonia is added to a new facility or to an existing facility which has been modified. New ammonia refrigeration facilities shall be analyzed by performing a formalized Process Hazard Analysis (PHA) prior to the introduction of ammonia refrigerant into a new system. Existing ammonia refrigeration systems shall be analyzed by performing a Hazard Review on the portion of the system that is being modified prior to the startup of the modified portion of the system.

5.4.2
*Ammonia refrigeration systems that are not subject to either OSHA's PSM standard or EPA's RMP Program 3 regulation shall be analyzed by performing a Hazard Review prior to the introduction of ammonia refrigerant into a new or modified system.

5.4.3
Standard Operating Procedures (SOP's) shall be in accordance with IIAR 7.

5.4.4
Standard Operating Procedures shall be readily accessible to all members of the startup team and the employees or contractors who work on or with the ammonia refrigeration system.

5.5 **Pressure Tests, Leak Tests, and Evacuation**

5.5.1 General.

5.5.1.1
*The ammonia refrigeration system if new, or its subsections if additions or modifications are made, shall be pressure tested, subsequently leak tested for tightness, and evacuated.

5.5.1.1.1
Where closure welds are used, the integrity of the closure weld shall be verified prior to placing the system back into service.

5.5.1.2
All pressure-envelope portions of the system, excluding factory-tested equipment and components, shall be pressure tested.

5.5.1.3
All pressure-envelope portions of the system, including factory-tested equipment and components, shall be leak tested and evacuated.

5.5.2 Test Preparation.

5.5.2.1
A pre-test inspection shall be performed to verify that all equipment and components of the new, added, or modified portions of the ammonia refrigeration systems under

examination have a pressure rating appropriate for the system design pressure(s) prior to testing. The following preparations shall be made:

5.5.2.1.1
All joints shall remain uninsulated, unpainted, and exposed until leak testing has been completed.

5.5.2.1.2
Valve off and isolate refrigeration equipment and components containing internal pressure-envelope portions that have already been factory tested to avoid or prevent damage from the test pressure when applied to other portions of the refrigeration system.

5.5.2.1.3
Remove all atmospheric pressure relief devices and cap or plug the openings.

5.5.2.1.4
Manually open all manually-operable control valves and devices.

5.5.2.1.5
Open all other valves except those leading to the atmosphere.

5.5.2.1.6
Cap, plug, or lock shut all valves and devices leading to the atmosphere.

5.5.2.1.7
The means used to furnish the test pressure shall have either a pressure-limiting device or a pressure-reducing device and an atmospheric pressure relief device and gauge on the outlet side. The atmospheric pressure relief device shall be set above the test pressure, but low enough to prevent permanent deformation of any of the system components.

5.5.3 Testing Procedure.

5.5.3.1
The test gas shall be introduced into the system gradually through the charging valve, or other suitable injection point, installed with a stop valve.

5.5.3.2
The test pressure shall be verified using a calibrated pressure gauge located on the portion of the system being tested.

5.5.3.3
The following fluids shall not be used for pressure and leak testing of a closed-circuit ammonia refrigeration system:

1. Oxygen or any combustible gas or combustible mixture of gases.
2. Carbon dioxide.
3. Halocarbon refrigerants.
4. Water or water solutions.

5.5.3.4
A supply regulator or an equivalent safe alternative method shall be used to control test pressure.

5.5.4 Pressure Testing

5.5.4.1
*Pressure testing of the closed-circuit piping system shall be in accordance with Section 538 of ASME B31.5, *Refrigeration Piping and Heating Transfer Components*.

5.5.5 Leak Testing

5.5.5.1
The minimum pressure used for leak testing shall be either the design pressure or a pressure specified in the engineering design.

5.5.5.2
*A leak test procedure shall be developed for system tie-ins in accordance with ASME B31.5.

5.5.5.3
The system shall be held under pressure until proven tight after accounting for temperature effects.

5.5.5.4
All leaks on newly installed piping and devices shall be repaired, all defective material shall be replaced, and the leak testing procedure shall be repeated until the closed-circuit refrigeration system or the pressure-envelope portion of the closed-circuit ammonia refrigeration system being leak tested is proven tight.

5.5.5.5
Upon completion of the leak test, reinstall the atmospheric pressure relief devices that were removed. Check the inlet threaded connection of the pressure relief device for tightness after installation.

5.5.6 Evacuation

5.5.6.1
*The system shall be evacuated to a pressure of 125,000 microns [25” Hg (gauge)]. For systems not equipped with a means to purge non-condensables, evacuation to at least 5000 microns [29.7” Hg (gauge)] is required. The evacuation pressure level shall be maintained for one (1) hour after the level of vacuum has been achieved and the system has been isolated from the vacuum pump(s). The effects of ambient temperature changes affecting gauge pressure shall be considered when determining if the system has held the vacuum.

5.6 Mechanical System Inspections and Verification

5.6.1
The entire ammonia refrigeration system and associated safety systems shall be visually inspected to ensure compliance with the system design documentation.

5.6.2
The machinery room and any other spaces containing portions of the ammonia refrigeration system and associated safety systems shall be visually inspected and design specifications confirmed to ensure compliance with the system design documentation.

5.6.3
Manufacturer's instructions shall be referenced to prepare equipment for operation.

5.6.4
Ensure all valves or piping connecting pressure-envelope portions of the ammonia refrigeration system to atmosphere are capped, plugged, blanked, or locked closed.

5.6.5
Ensure that all machine guarding is secured in place.

5.7 Electrical System Inspections and Verification

5.7.1
Electrical inspection and verification requirements shall apply to the ammonia refrigeration system and the associated safety systems.

5.7.2
Electrical power and electrical control systems shall be visually inspected to ensure compliance with the system design documentation.

5.7.3
The continuity of all electrical power, control wiring, and connections shall be tested and confirmed as safe circuitry before any electrical supply is connected.

5.7.4
All electronic controls shall be functionally verified to operate as intended per the design.

5.7.5
Open drive compressor motors shall be mechanically disconnected from the equipment and checked for correct direction of rotation.

5.7.6
All other drive motors shall be checked for correct direction of rotation and operation and the overloads shall be set in accordance with NFPA 70 *National Electrical Code* (NEC).

5.8 Safety Systems Inspections and Verification

5.8.1
The following shall be inspected, verified, tested, proven to function as designed, and put into operation by trained startup personnel prior to charging the system with ammonia refrigerant:

1. Ventilation system - temperature control and emergency.
2. Refrigerant detection and alarms.
3. Emergency eyewash and shower stations.
4. Emergency shutdown.
5. Emergency Pressure Control System (EPCS).

6. Compressor limiting devices and cutouts.

5.8.2
Startup personnel shall have the appropriate equipment, and where necessary, be fit-tested and trained on the use of personal protective equipment (PPE).

5.8.3
PPE and required First Aid equipment shall be readily available in a clearly identified location.

5.8.4
Offsite emergency response authorities and the authority having jurisdiction (AHJ) shall be advised of the startup plan.

5.8.5
All site personnel shall be advised of the time, date, and location of the ammonia refrigeration system charging activities.

5.8.6
Ensure that emergency egress is free from obstructions.

5.9 Water and Secondary Coolant System Inspections and Verification

5.9.1
Systems where water is used for condensing, compressor cooling or oil cooling shall be inspected, verified, tested, and put into operation prior to charging the refrigeration system with ammonia refrigerant.

5.9.2
Where secondary systems are employed, they shall be inspected, verified, tested, and made operational prior to charging that portion of the system with ammonia refrigerant.

5.10 Overview Training

5.10.1
*Employees involved in operating the ammonia refrigeration system shall be trained in an overview of the process and the operating procedures. The training shall include safety and health hazards, emergency operations, and safe work practices.

5.10.2
*An emergency action and/or response plan shall be in place.

5.10.3
Training shall be documented in accordance with the owner's PSM/RMP, ARM, or equivalent program.

5.11 Documentation/Pre-Startup Safety Review

5.11.1
All startup data from the pre-charging activities shall be recorded and provided to the owner.

5.11.2
*All state and federal regulatory documentation shall be completed and filed for future reference.

5.11.3
*Where required, all state and federal regulatory documentation shall be submitted to the respective government agency.

5.11.4
The Process Hazard Analysis (PHA), Safety and Health Review, and/or Hazard Review, where required, shall be confirmed completed. The confirmation shall verify that all recommendations identified during these reviews have been addressed.

5.11.5
The pre-charging checklist shall be filled out confirming that all items are completed. The owner or owner's designated representative shall sign off on this document.

Chapter 6. Charging

6.1 Pre-Charging Review

6.1.1
The completion of all pre-charging requirements and activities shall be confirmed prior to charging the ammonia refrigeration system or the additions or modifications with ammonia refrigerant.

6.2 Refrigerant Delivery, Transfer Hose(s), and Charging Location

6.2.1
Where additional ammonia refrigerant is required, ammonia refrigerant delivery shall be provided by cylinder(s) or by bulk truck(s) connected to the closed-circuit ammonia refrigeration system with an ammonia transfer hose(s).

6.2.2
*Ammonia transfer hose(s) used for charging a closed-circuit ammonia refrigeration system system shall be:

1. Certified for ammonia service.
2. Rated for design with a minimum working pressure of 350 psig and a minimum burst pressure of 1750 psig.
3. Visually inspected for damage or defects.
4. Within the manufacturer's service date stamped on the transfer hose.

6.2.3
Ammonia transfer hose(s) used for charging shall be connected to the closed-circuit ammonia refrigeration system at a location that will not result in liquid ammonia refrigerant entering a compressor. The charging connection shall include an inline shut-off valve and a check valve that is in accordance with IIAR 2.

6.3 Precautions

6.3.1
Site personnel shall be notified of the charging activity.

6.3.2
*An emergency eyewash and shower unit(s) shall be available in accordance with ISEA Z358.1. The path to the eyewash and shower unit(s) shall be free of obstructions.

6.3.3
The charging area shall have restricted access.

6.3.4
Storm drainage shall be secured to prevent threat of contamination from an accidental release, where applicable.

6.3.5
All operating refrigeration equipment and associated operating components shall be continually monitored.

6.3.6
The charging or transfer process shall be attended at all times by an individual designated by the startup team.

6.4 **Charging Activities**

6.4.1
A charging standard operating procedure (SOP) shall be utilized.

6.4.2
Ammonia vapor shall be introduced into the new, added, or modified portions of the closed-circuit refrigeration system that has been held in a vacuum. After the introduction, the pressure shall be raised to greater than zero (0) psig.

6.4.3
*A final leak check shall be conducted using ammonia vapor.

6.4.4
All identified leaks shall be repaired and retested.

6.4.5
After successful completion of the final leak test, the closed-circuit ammonia refrigeration system shall be charged with ammonia refrigerant.

6.4.6
The quantity of ammonia charged shall be recorded.

6.4.7
Once the closed-circuit ammonia refrigeration system is charged, all previously adjusted valves or other control devices shall be returned to their normal operating position.

Chapter 7. Startup Process

7.1 Equipment/System/Addition/Modification Startup

7.1.1
The new equipment/system shall be made operational in accordance with:

1. Initial Startup Procedure(s).
2. Manufacturer’s instruction(s).

7.2 Testing of Protection Devices

7.2.1
All safety devices in the system/addition/modification shall be tested to prove correct functionality. Testing shall be done by a trained startup technician having the training and experience that qualify that individual to startup the designated closed-circuit ammonia refrigeration with which he or she has already become familiar.

7.2.2
*The protection devices to be tested for startup include, but are not limited to:

1. Compressor High Discharge Pressure Cutout.
2. Compressor Low Suction Pressure Cutout.
3. Compressor High Discharge Temperature Cutout.
4. Compressor Oil Differential Pressure Cutout.
5. Refrigerant Liquid Level Protection Devices.

7.2.3
The following safety relief devices do not need to be tested:

1. Internal relief devices.
2. Hydrostatic relief devices.
3. Liquid relief devices.
4. Atmospheric relief devices.

7.3 Inspection of Operating System

7.3.1
*When operating the closed-circuit ammonia refrigeration system at design temperatures during the initial startup, the closed-circuit ammonia refrigeration system shall be inspected for leaks and abnormalities.

7.4 Verification

7.4.1
*Verify the functions and performance of the closed-circuit ammonia refrigeration system and confirm that it operates as intended by the design.

7.4.2
*The system shall be operated to demonstrate correct functionality:

1. Pressures and temperatures shall be recorded.
2. Refrigerant Liquid level controls shall be checked.

7.4.3
The manufacturer’s instructions on oil, strainers, and filter changes during startup shall be observed.

7.4.4
Verify the functions of all new control systems including:
1. Eltro-mechanical devices
2. Digital/Analog Inputs and Outputs (I/O)
3. Software and Human-Machine Interfaces (HMI)

7.5 **Deviation Resolution**

7.5.1
*Deviations from manufacturer and design specifications identified during the startup phase shall be resolved or an acceptable plan shall be developed to resolve identified deviations in a safe and timely manner.

7.6 **Operational Training**

7.6.1
*Operating and maintenance personnel shall be trained on the operating system. Operating system training shall be documented and provided to the owner.

7.6.2
Operating and maintenance personnel shall participate and work with the startup team throughout the startup phase of the project.

7.7 **System Monitoring**
Change

7.7.1
*Once the monitoring is completed, the system shall be turned over to the owner.

7.8 **Startup Documentation**

7.8.1
Startup documentation shall be provided to the owner or owner’s designated representative.

7.8.2
Startup documentation, at a minimum, shall include applicable:

1. Startup checklists.
2. Leak testing, pressure testing, and evacuation records.
3. Setpoints.
4. Updated design documents.

5. Issue resolution documentation.
6. Results of the functional verification of the controls.
7. Standard Operating Procedures.
8. Training Documentation.
10. Refrigerant Charge. (if applicable)
11. Results of testing for ventilation, including emergency air volumes.
12. Results of testing for safeties and protection devices.

Part 3 Appendices

Appendix A. (Informative) Explanatory Material

This informative appendix is not a part of the standard. It provides explanatory information related to provisions in the standard. Sections of the standard that have associated explanatory information in this appendix are marked with an asterisk "*" after the section number, and the associated appendix information is located in a corresponding section number preceded by "A".

A.1.2
The specific requirements for a particular system shall be considered when applying the general recommendations expressed in this standard.

Additions and Modifications are described as either:

1. Any new attachment to an existing operating system, or system which has been in operation, which did not exist prior to the attachment; or
2. Any reconfiguration of any portion of an existing operating system, or system which has been in operation, to service a new or converted area which does not function in the same manner as before the conversion.
3. Any activity which requires pipe to be replaced due to non-wear-and-tear issues, pipe cut to fit, pipe welded, or pipe threaded to reconnect sections of a closed-circuit ammonia refrigeration system.

A.1.2.5
Examples of replacement in-kind components for maintenance reasons include replacement of a solenoid valve or replacement of corroded pipe.

A.4.1.1
Refer to IIAR 2, Appendix B and the Ammonia Data Book, Appendix A for more information on ammonia properties and hazards.

A.5.1.1.1
Depending on the project size of a new ammonia refrigeration system or addition or modification to an existing ammonia refrigeration system, some of the startup team members might provide multiple positional responsible duties as listed. For example, the installing and/or startup contractor, the system designer, and the startup technician could all be the same person. The owner or owner's designated representative should stay engaged throughout the entire process (onsite and/or remotely) and is ultimately responsible for ensuring that the project is installed, and functions as intended. The designated team leader directs, coordinates, and records all startup activities. The startup technician(s) provide(s) the technical expertise and experience. There could be a startup technician for the mechanical portion of the system and a separate startup technician for the power and control portion of the system. A system designer(s) can advise and assist in resolving issues and provide training. There may be separate designers for different disciplines.

The contractor may help with functional testing, recording results, support for resolving issues, and provide training. Operational and maintenance personnel are involved to be trained so they can operate and maintain the system, once it is turned over to them. Often, an equipment manufacturer's startup technician(s) is/are included on the startup team, such as providing the support and service for the startup of compressor packages. Sometimes, other supplier support is needed, such as to set up control valves.

A.5.3.1

Regarding Section 5.3.1, Item 1. Design documentation & Item 2. Equipment and component documentation: System design documents, including those for equipment, provide the information necessary to safely and successfully startup and an ammonia refrigeration system. System design documents may include but are not limited to system specifications, performance specifications, P&IDs, as-built installation drawings, safety systems, regulatory documents, standard operating procedures (SOPs), refrigeration equipment lists, valve lists, relief valve data and relief system design basis, and manufacturer's instruction manuals. System specifications include, but are not limited to those for piping, fittings, valves, equipment, design pressures and temperatures, and insulation. Performance specifications may include a description of the system, process information, operating parameters, and setpoints. P&IDs and flow diagrams should be a system schematic showing every system component. As-built drawings should show system changes as installed and identify and locate all components. Safety system documents include process information or for larger regulated systems, Process Safety Information, as well as information on refrigerant detection, alarms, ventilation, emergency eyewash and showers, and PPE. Regulatory documents may include a process hazard analysis (PHA) or a risk management plan (RMP). SOPs will provide system specific instructions on how to operate the entire system or portions of the system. Equipment and valve lists will uniquely identify each of these components, as well as, provide design, operating, and performance data. Manufacturer's instruction manuals will provide information to startup, operate, and maintain the equipment and components. See the IIAR Process Safety Management & Risk Management Program Guidelines and the IIAR Ammonia Refrigeration Piping Handbook.

Regarding Section 5.3.1, Item 3. Test reports: Test records and reports may include but are not limited to system pressure tests, system and/or equipment leak tests, equipment manufacturer tests, and evacuation. System pressure and leak tests and the evacuation would have been performed as necessary at the conclusion of the installation. The equipment manufacturer's tests would have been performed at the manufacturer's factory or test facility.

Several owners keep an inventory list for their ammonia refrigeration system management records that have specification details for each system's equipment and components. The inventory list may include the following:

1. Physical description.
2. Nameplate data in accordance with IIAR 2.
3. Test and fabrication certificates, where applicable.
4. Pressure relief devices, type and set pressure, date of installation or replacement (if externally installed).
5. Manufacturer's instruction manuals.
6. Materials of construction.
7. Electrical classification.
8. Piping and Instrumentation Diagrams (P&ID's).
9. Pressure relief discharge piping system design and design basis.
10. Design codes and standards employed.
11. Safety systems, including safety devices, interlocks, switches, and refrigerant detectors.

12. Design operating pressures.
13. Design operating temperatures.
14. Ammonia machinery room ventilation system(s).
    a. Ventilation air flow diagram(s).
    b. Ventilation control system description(s).
15. Control and safety devices.
    a. Ammonia refrigerant vapor detection system.
    b. Initial calibration record(s).
16. Ammonia charge (i.e., Operating Intended Inventory and/or Threshold Quantity).

A.5.4.1
Facilities subject to OSHA's Process Safety Management (PSM) and EPA's Risk Management Plan (RMP), that are modifying a portion of their ammonia refrigeration system, should evaluate if the change warrants a formal Process Hazard Analysis (PHA) as part of Management of Change (MOC). If a PHA is determined to not be warranted, a less formalized technique, such as a questionnaire, may be utilized. This is often referred to as a Safety & Health Assessment.

A.5.4.2
For facilities not subject to OSHA's Process Safety Management (PSM) and EPA's Risk Management Plan (RMP), the Hazard Review may utilize one of the PHA techniques listed in those regulations. Alternatively, the Hazard Review may utilize a different technique, such as a questionnaire, often referred to as a Safety & Health Assessment.

A.5.5.1.1
The pressure test and the leak test are typically performed in conjunction with each other, with the leak test following a successful pressure test.

A.5.5.4.1
Pressure testing and associated testing documentation for equipment and components is the responsibility of the manufacturer. The manufacturer should provide this documentation with the delivery of the equipment and/or components.

A.5.5.5.2
A suitable inert dry gas such as nitrogen, argon, ammonia refrigerant vapor, or dry (dehydrated) compressed air, should be used as the medium for leak testing.

For system tie-ins, see (Informative) Appendix D of this standard.

A.5.5.6.1
After the piping has been leak tested and proven tight, the entire system should be evacuated with a vacuum pump to remove air and moisture.

Pressure switches should be valved off or disconnected since some switches may not have vacuum protection. All manual valves except those open to atmosphere should be opened and all control valves, such as solenoid valves, should be jacked open or electrically energized (if normally closed). Air or motor operated valves should also be open.

All seal volumes and other components requiring an oil charge for sealing should be charged with the specified oil and any rotating devices should be turned over by hand to assure distribution of this seal oil, etc. to the seal faces. Refer to the manufacturer's recommendations for any special considerations to be followed during pressure testing and/or evacuation.

All reasonable measures should be taken to drain or blow out any free-standing water in the system.

Connect a suitably sized vacuum pump to appropriately located valves. Start the pump and evacuate until a pressure of 125,000 microns is attained. Evacuation to this point should be rather rapid but if free water is present the process will be slowed as evaporation of the water takes place. Check low points, traps, etc. for cold spots indicating the presence of water and apply heat as needed to speed up the evaporation of water.

Some applications (such as direct expansion systems or self-contained packaged systems) can be sensitive to moisture and non-condensables. For these applications, it may be advisable to evacuate to a deeper vacuum to eliminate startup or performance issues. Manufacturers or design recommendations should be consulted in these cases.

A.5.10.1

The system overview training should provide a system description to develop understanding of the ammonia refrigeration system, equipment, and components and their function(s). In addition, the operator should be trained on the use of the control system and operation manuals.

Awareness training and emergency action training should be provided for the designers, engineers, contractors.

Regulatory training (e.g., General Duty Clauses & PSM and RMP, where applicable), as how it applies to the ammonia refrigeration system, should be provided for all affected employees, designers, engineers, and contractors.

A.5.10.2

An in-place plan should include, but not be limited to, reporting protocols, evacuation procedures, rescue and medical duties for employees, and procedures for operating personnel in an emergency.

A.5.11.2

The regulatory documentation may include documents for OSHA's Process Safety Management (PSM) or General Duty Clause, including a Management of Change (MOC), EPA's Risk Management Plan (RMP) or General Duty Clause, or any state specific regulation requirement.

A.5.11.3

The submission of the Risk Management Plan (RMP) to the EPA when the ammonia inventory meets or exceeds the regulatory threshold is an example of a required document submittal.

EPA also requires Tier 1 and Tier 2 reporting of ammonia refrigeration systems inventory that contain minimum established threshold quantities that are less than the PSM and RMP threshold.

A.6.2.2

For inspection, testing, and maintenance (ITM) tasks of ammonia transfer hoses, refer to ANSI/IIAR 6-2019, Chapter 11, Section 11.1.3, Ammonia Transfer Hoses.

A.6.4.3
Using ammonia vapor often identifies leaks that may not show up when using nitrogen or compressed air as the leak testing medium.

A.7.2.2
Item 1. Compressor High Discharge Pressure Cutout:

The Compressor High Discharge Pressure Cutout is also known as a compressor High Pressure Cutout (HPCO).

Compressor High Discharge Pressure Cutouts are a special case and require a specific testing method. Refer to ANSI/IIAR 6 for permitted functional testing methods of a Compressor High Discharge Pressure Cutout.

Item 4. Refrigerant Level Protection Devices:

Refrigerant Level Protection Devices may include, but are not limited to:

1. High level cutouts.
2. High level alarms.
3. Low level cutouts.
4. Low level alarms.

A.7.3.1
The reduction in temperature will cause materials to contract and shrink, possibly resulting in a refrigerant leak. Items such as valve stem packing nuts or flanges may require tightening to compensate.

Abnormalities may include piping movement or vibration that may require identifying the source and rectifying the root cause. This may require installing support modifications or adjustments.

A.7.4.1
Verification does not necessarily require full performance operation. During verification, the system should be operated with the available heat load.

A.7.4.2
Verification should be undertaken that the following items are operating safely, correctly, and as intended by design, where applicable:

1. Refrigeration system equipment, components, and devices.
2. Control set point adjustments for area space temperatures, process fluid temperatures, discharge pressures, suction pressures, refrigerant liquid levels, and refrigerant oil liquid levels.
3. Sequence of operation for compressor staging, discharge pressure control, evaporator defrosting, ventilation control, and pro-active detection and alarm systems.
4. All operator interface(s).

A.7.5.1

Deviations could include vibration, wiring, software/programming, defective components and devices, poor sensing location, valves that leak through, or components that do not perform to design specifications.

A.7.6.1
This training for the startup team is usually a continuation of the initial required training that was completed prior to charging the system with ammonia refrigerant. This startup training includes the same initial required elements, only this time, it is hands-on.

A.7.7.1
The duration of this monitoring period should be determined by the startup team. This monitoring will allow performance verification under a wider range of operating conditions and demands. It will also provide time to confirm component integrity.

Appendix B. (Informative) Pre-Startup & Startup Checklists

The Pre-Startup Check List shown below covers the equipment and component checks required for a typical system Component Group.

Examples of system Component Groups include:

Compressor Package(s)
Condenser(s)
High Pressure Vessel(s)
Intermediate and Low-Pressure Vessel(s)
Piping Mains
Piping Branches
Evaporator(s)
Non-condensable Gas Purgers

Typical Pre-Startup Checklist

- ☐ *Ammonia Safety Training Complete*
- ☐ *Hazard Review Complete*
- ☐ *Ventilation System Operational*
- ☐ *Alarms Operational*
- ☐ *Adequate Water Supply Available*
- ☐ *Emergency Eyewash and Shower Operational*
- ☐ *Ammonia Detection System Operational*
- ☐ *Emergency Shutdown Operational*
- ☐ *Visual and Audible Alarms Operational*
- ☐ *Evacuation and Pressure Testing Complete*
- ☐ *Appropriate State and Federal Registration Forms Submitted*
- ☐ *Condenser Passivation Completed*
- ☐ *High Level Cut-Outs Operational*
- ☐ *Condenser Operational*
- ☐ *Ammonia Inventory Recorded*
- ☐ *Water Treatment System Operational*
- ☐ *Note all temporary conditions or settings*

The checklists in this appendix may be used as examples of typical system startup checklists. They are not suitable for every system, and custom checklists are often generated based on equipment, components, and configuration of an individual refrigeration system, as well as safety program requirements (ARM/PSM/RMP). Additional copies of these forms within Appendix B can be made and used where a system has multiple various equipment, such as more than one compressor, condenser, evaporator, pressure vessel, etc.

Ammonia Refrigeration Startup Checklist
Compressor

Location:		**ID / Tag No.:**	
Facility Owner:			
Address:			
Startup Technician:		**Date:**	

Package Data

Manufacturer:		Model:	
Serial No:		Year Mfg.:	

Type (Rotary Screw, Reciprocating, etc.):

Application / Duty (Single Stage, Booster, Swing):

Oil Cooling Type (Liquid Injection, Water, Thermosyphon, etc.):

Designed Suction (Pressure / Temperature):

Designed Discharge (Pressure / Temperature):

Motor Data

Manufacturer:		Model:	
Serial No.:		HP:	
FLA:		RPM:	
Volts / Phase / Hz:		Svc Factor:	

Stater Data

Manufacturer:		Model:	
Serial No.:		Type:	

Safety Cutouts

Controller Type (Electro-Mechanical, Processor, etc.):

Low Suction Pressure Alarm		Psig/HG	Low Oil Temp Alarm		°F
Low Suction Pressure Cutout		Psig/HG	Low Oil Temp Cutout		°F
Low Suction Temp Alarm		°F	High Oil Temp Alarm		°F
Low Suction Temp Cutout		°F	High Oil Temp Cutout		°F
High Discharge Pressure Alarm		Psig/HG	Low Oil Pressure Alarm		Psig
High Discharge Pressure Cutout		Psig/HG	Low Oil Pressure Cutout		Psig
High Discharge Temp Alarm		°F	High Discharge Temp Cutout		°F

Ammonia Refrigeration Startup Checklist
Compressor

Location:		ID / Tag No.:	

Item		Notes or Comments
All anchors and fasteners tight and adequate?	Yes ☐ No ☐ N/A ☐	
Free of ammonia & oil leaks?	Yes ☐ No ☐ N/A ☐	
Correct compressor rotation verified?	Yes ☐ No ☐ N/A ☐	
Oil level verified?	Yes ☐ No ☐ N/A ☐	
Safety cutouts functioning correctly?	Yes ☐ No ☐ N/A ☐	
Control setpoints verified and correct?	Yes ☐ No ☐ N/A ☐	
Compressor / motor alignment preformed and correct?	Yes ☐ No ☐ N/A ☐	
All guards and covers installed?	Yes ☐ No ☐ N/A ☐	
Free of abnomaroal sounds and vibration?	Yes ☐ No ☐ N/A ☐	
Verified all valves are in proper positions and orientation?	Yes ☐ No ☐ N/A ☐	
High level shutdown verified and operational?	Yes ☐ No ☐ N/A ☐	

Notes or comments:

Ammonia Refrigeration Startup Checklist
Condenser

Location:		**ID / Tag No.:**	
Facility Owner:			
Address:			
Startup Technician:		**Date:**	

Unit Data

Manufacturer:		Model:	
Serial No:		Year Mfg.:	

Type (Evaporative, Air-cooled, Adiabatic, etc.): ____

Water Treatment type (Chemical, ozone, etc.): ____

Designed Condensing (Pressure / Temperature): ____

Designed Wet/ Dry Bulb Temp: ____

Motor Data

Manufacturer:		Model:	
Serial No:		HP:	
FLA:		RPM:	
Volts/ Phase/ Hz:		Svc Factor:	
Belt Size:		Belt Qty:	

Pump

Manufacturer:		Model:	
Serial No.:		HP:	
FLA:		RPM:	
Volts/ Phase/ Hz:		Svc Factor:	

Purge Point

Purger Type (Automatic, Manual, etc.): ____

Purge Point location (CD, HSD, EQ, etc.): ____

Controller

Controller type (Electro-Mechanical, Processor, etc.): ____

Discharge Pressure Setpoint: ____

Control strategy (Pressure, Wet bulb, etc.): ____

Ammonia Refrigeration Startup Checklist
Condenser

Location:		**ID / Tag No.:**	

Item		**Notes or Comments**
All anchors and fasteners tight and adequate?	Yes ☐ No ☐ N/A ☐	
Free of ammonia?	Yes ☐ No ☐ N/A ☐	
Correct fan and pump rotation verified?	Yes ☐ No ☐ N/A ☐	
Water level in sump set and correct?	Yes ☐ No ☐ N/A ☐	
Free of water leaks?	Yes ☐ No ☐ N/A ☐	
All mist eliminators and or louvers installed correctly?	Yes ☐ No ☐ N/A ☐	
Fans, pump, and motor alignment performed and correct?	Yes ☐ No ☐ N/A ☐	
All guards and covers installed?	Yes ☐ No ☐ N/A ☐	
Free of abnormal sounds and vibration?	Yes ☐ No ☐ N/A ☐	
Verified all valves are in proper positions and orientation?	Yes ☐ No ☐ N/A ☐	
Belt tension checked and correct?	Yes ☐ No ☐ N/A ☐	

Notes or comments:

Ammonia Refrigeration Startup Checklist
Evaporator

Location:		**ID / Tag No.:**	
Facility Owner:			
Address:			
Startup Technician:		**Date:**	

Unit Data

Manufacturer:		Model:	
Serial No:		Year Mfg.:	
Type (Direct Expeansion, Flooded, Recriculated, etc.):			
Applications (Freezer, Cooler, Process, Dock, etc.):			
Defrost Type (Air, Hot Gas, Water):			
Designed Room Air Temperature:			
Suction (Psig / °F):			

Motor Data

Manufacturer:		Model:	
Serial No:		HP:	
FLA:		RPM:	
Volts/ Phase/ Hz:		Svc Factor:	
Quanity of fans:			

Controller

Controller type (Processor, Time clock, T-stat etc.):	
Temperatue setpoint:	
Defrost strategy (Time, Liq counterm, Defrost termination, etc.):	

Ammonia Refrigeration Startup Checklist
Evaporator

Location:		ID / Tag No.:	

Item		Notes or Comments
All anchors and fasteners tight and adequate?	Yes ☐ No ☐ N/A ☐	
Free of ammonia & oil leaks?	Yes ☐ No ☐ N/A ☐	
Correct fan rotation verified?	Yes ☐ No ☐ N/A ☐	
Defrost set, operational, and verfied?	Yes ☐ No ☐ N/A ☐	
Pan free of water leaks?	Yes ☐ No ☐ N/A ☐	
Heat trace working?	Yes ☐ No ☐ N/A ☐	
Fan drive alignment correct?	Yes ☐ No ☐ N/A ☐	
All guards and covers installed?	Yes ☐ No ☐ N/A ☐	
Free of abnormal sounds and vibration?	Yes ☐ No ☐ N/A ☐	
Verified all valves are in proper positions and orientation?	Yes ☐ No ☐ N/A ☐	
Free of ice build up?	Yes ☐ No ☐ N/A ☐	

Notes or comments:

Ammonia Refrigeration Startup Checklist
Pressure Vessel

Location: ____________________ **ID / Tag No.:** __________

Facility Owner: ____________________

Address: ____________________

Startup Technician: ____________________ **Date:** __________

Unit Data

Manufacturer: __________ Model: __________

Serial No: __________ Year Mfg.: __________

National Board No.: __________

MAWP: __________ MDMT __________

Vessel Diameter: __________ Length: __________

Applications (Accumulator, Recirculator, Separator, etc.): __________

Level Indicator Type (Bulls eyes, Probe, Armored glass, etc.): __________

Designed Operation Pressure & Temperature (Psig / ºF): __________

Designed Liquid/ Oil level: __________

Relief Valve:

Manufacturer: __________ Model: __________

Set Pressure: __________

Installation Year: __________

Type - Internal or External: __________

Assembly(Dual, Single, etc.): __________

Controller

Controller type (Processor, Electro-Mechanical, Float, etc.): __________

Level Setpoint: __________

Ammonia Refrigeration Startup Checklist
Pressure Vessel

Location:		**ID / Tag No.:**	

Item		Notes or Comments
All anchors and fasteners tight and adequate?	Yes ☐ No ☐ N/A ☐	
Free of ammonia & oil leaks?	Yes ☐ No ☐ N/A ☐	
Free of abnormal ice build up?	Yes ☐ No ☐ N/A ☐	
Free of abnormal sounds and vibration?	Yes ☐ No ☐ N/A ☐	
All guards and covers in place?	Yes ☐ No ☐ N/A ☐	
Verified all valves are in proper positions and orientation?	Yes ☐ No ☐ N/A ☐	
Level control operational and correct?	Yes ☐ No ☐ N/A ☐	
High level protection installed and functional?	Yes ☐ No ☐ N/A ☐	
Low level protection installed and functional?	Yes ☐ No ☐ N/A ☐	

Notes and Comments:

Appendix C. (Informative) Purging

A noncondensable gas separator (purger) separates, collects, and removes air and other gases from the closed-circuit ammonia refrigerating system. It is useful in most refrigeration plants.

Noncondensable gases occur in systems from many causes. In systems operating below atmospheric pressure, air may be drawn through leaking packing, gaskets, rotary seals, or piping. Purging should be considered during startup of a new system or an addition or modification to an existing system. Improper charging or draining of ammonia or oil can introduce air into a closed-circuit ammonia refrigerating system. In all systems, noncondensable gases may remain after an inadequate evacuation of pressure test gas. Air may be introduced when the system has been opened for service or repair. Also, noncondensable gases can occur from the breakdown of ammonia into nitrogen and hydrogen or water, or through the breakdown of oil into hydrocarbon gases and other salts, acids, and sludge.

The result of noncondensable gases in the system is an increase in discharge pressure above normal. Higher discharge pressures cause a loss of system capacity concurrent with an increase in operating energy costs.

The use of automatic purgers is highly recommended. Manual purging can be wasteful, inefficient and hazardous. Manual purging is most effective when the system is in operation and noncondensable gases are concentrated and trapped at the condenser outlets. However, manual purging while in operation at the condenser outlets carries the risk of releasing liquid ammonia. Manual purging while not in operation is safer but less effective. Refer to the condenser manufacturer's published recommendations for purge locations and procedures.

Appendix D. (Informative) Considerations and Planning for Closed-Circuit Ammonia Refrigeration System Tie-Ins

Tie-ins represent a special case in Startup of Closed-Circuit Ammonia Refrigerating Systems. For purposes of this section, tie-ins are defined as the connection point between an existing Closed-Circuit Ammonia Refrigerating System and a new sub-system. The sub-system can range from simple to complex, adding one minor component or an extensive network of piping and components. In either case, the tie-in to an existing system presents challenges with regard to conformance with the pressure testing and evacuation portions of this Standard. The purpose of this Informative section is to provide guidance as to how to safely and effectively make a tie-in given the time constraints that operating refrigeration systems impose.

Under no circumstances is the sub-system itself – the piping, equipment, and valves leading up to the tie-in – exempt from the requirements of this document. The sub-system should be completely pressure tested prior to making the tie-in. This section refers only to the weld or welds immediately adjacent to the point of tie-in.

A Tie-in Procedure should include/address the following:

a) An Equipment - and Piping - -Opening Procedure (refer to IIAR 7-202x – Section 14.3).
b) A Leak Test and Evacuation Procedure (refer to Section 5.5).
c) A Change Management Procedure (that includes training) of the entire tie-in installation/project [refer to your company's procedure and/or the Process Safety Management (PSM) Management of Change (MOC) element if subject to OSHA and EPA regulations for compliance].
d) Modifications to the Startup Procedure for the specific tie-in (refer to IIAR 7-202x, Chapter 4).

Where no or few provisions have been made to facilitate tie-ins, and as these refrigeration systems are in service, the time required to make a tie-in can impact the operation the refrigeration system it is serving. The tie-ins can impact production schedules, temperature levels, etc. All tie-in periods should then recognize their total impact. While adhering to all jurisdictional regulations and safety requirements, a practical component to tie-ins should be acknowledged.

Due to these practical concerns, the procedures listed here, while considered best- practice, may require modification to accept the realities of the existing situation. These modifications could include eliminating a deep evacuation of a sub-system after a pressure test or accepting the introduction of moisture into a refrigeration system. It may not be possible to keep the entire sub-system in a vacuum, if an evacuation is required, when tying-in to an existing system. A portion of the piping should remain open to atmosphere while certain welds are being made. If the owner or the owners' representative requires an evacuation of the system or sub-system, there should be an allowance for the downtime required to execute the evacuation. Individual systems will have unique requirements.

Modifications to the Startup procedure outlined in these documents for tie-ins should be discussed with all the interested parties in the planning phase of the tie-ins.

Agreement on which aspects of Startup will be adhered to and which tenets will be omitted should be thoroughly discussed.

Appendix E. (Informative) Temperature Reduction Procedure for Newly Constructed Freezers

For any new holding freezer, storage freezer, or blast freezers, lower the room temperature according to the following recommendations for temperature reduction control, or follow guidelines of room material supplier(s), including the facility's expected material shrinkage (e.g., caulking, walls, floors, etc.):

Leave doors slightly open (ajar) or wall mounted check type vents to prevent negative pressure damage to the facility during the Phase I and Phase III pull downs. Close doors during Phase II to prevent moisture intrusion into the cold space.

Before lowering the temperature in the freezer, have the concrete contractor or engineer verify that the concrete has cured enough, and it is permitted to start the temperature reduction procedure.

Phase I – Pull Down from Ambient Temperature to 35 °F.

Lower temperatures with the following recommended time schedule unless directed differently by others. The installing floor contractor may have specific guidelines and failure to follow those guidelines could adversely impact the floors' warranty.

Time	Maximum Room Reduction	Minimum Room Temperature
24 Hours	15 °F	60 °F
24 Hours	15 °F	45 °F
24 Hours	5 °F	40 °F
24 Hours	5 °F	35 °F

Phase II – Hold at 35 °F for Moisture Removal.

35 °F should be maintained in rooms that will operate below freezing until the concrete contractor or engineer verifies that the moisture in the concrete has been removed, and it is safe to proceed with Phase III. In lieu of this verification, the following can be used to indicate that the concrete has cured:

- Verification that doors have remained closed and other sources of moisture have not been present;
- Room humidity has stabilized; and,
- The evaporator unit(s) have cycled through at least two (2) defrost cycles and the evaporator coils have remained dry and reasonably free of frost for at least 24 hours.

Phase III – Pull Down from 35 °F to Room Operating Temperature.

Lower temperatures with the following time schedule

Time	Maximum Room Reduction	Minimum Room Temperature
24 Hours	5 °F	30 °F
24 Hours	10 °F	20 °F
24 Hours	10 °F	10 °F
24 Hours	10 °F	0 °F
24 Hours	10 °F	-10 °F
24 Hours	10 °F	-20 °F
24 Hours	10 °F	-40 °F

Appendix F. (Informative) References and Sources of References

F.1 Informative References

F.1.1 Environmental Protection Agency (EPA), *Risk Management Plan (RMP).*

F.1.2 International Institute of All-Natural Refrigeration (IIAR), *Ammonia Data Book.*

F.1.3 International Institute of All-Natural Refrigeration (IIAR), *Ammonia Refrigeration Management Program* (ARM) (2018).

F.1.4 International Institute of All-Natural Refrigeration (IIAR), ANSI/IIAR 2-2021, *Standard for Design of Safe Closed-Circuit Ammonia Refrigeration Systems.*

F.1.5 International Institute of All-Natural Refrigeration (IIAR), ANSI/IIAR 6-202x, *Inspection, Testing, and Maintenance of Closed-Circuit Ammonia Refrigeration Systems.*

F.1.6 International Institute of All-Natural Refrigeration (IIAR), ANSI/IIAR 7-202x, *Developing Operating Procedures for Closed-Circuit Ammonia Refrigeration Systems.*

F.1.7 International Institute of All-Natural Refrigeration (IIAR), *Process Safety Management & Risk Management Program Guidelines* (2020).

F.1.8 Occupational Safety and Health Administration (OSHA), 29 CFR 1910.119, *Process Safety Management of Highly Hazardous Chemicals*.

F.1.9 Occupational Safety and Health Administration (OSHA), 29 CFR 132, *General Requirements, Personal Protective Equipment.*

F.1.10 Occupational Safety and Health Administration (OSHA), U.S. Department of Labor, General Duty Clause in Section 5(a)(1) of the Occupational Safety and Health Act [29 U.S.C. § 654(a)(1)].

G.2 Sources of References

G.2.1 American National Standards Institute (ANSI)
11 West 42nd Street
New York, NY 10036, USA
www.ansi.org

G.2.2 American Society of Mechanical Engineers (ASME)
ASME International
Two Park Avenue
New York, NY 10016-5990, USA
www.asme.org

G.2.3 International Institute of All-Natural Refrigeration (IIAR)
1001 North Fairfax Street
Suite 503
Alexandria, VA 22314, USA
www.iiar.org

G.2.4 International Safety Equipment Association (ISEA)
1901 North Moore Street
Suite 808
Arlington, VA 22209-1762, USA
www.safetyequipment.org

G.2.5 Occupational Safety and Health Administration (OSHA)
United States Department of Labor
Washington, DC 20210, USA
www.osha.gov
www.dol.gov
www.osha.gov/tdc

G.2.6 United States Environmental Protection Agency (EPA)
Ariel Rios Building
1200 Pennsylvania Avenue, NW
Washington, DC 20460, USA
www.epa.gov