American National Standard for

ANSI/IIAR 4-2015

Installation of Closed-Circuit Ammonia Refrigeration Systems

Approved by the
American National
Standards Institute
January 26, 2015

International Institute of
Ammonia Refrigeration

ANSI/IIAR 4-2015

Installation of Closed-Circuit Ammonia Refrigeration Systems

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Notes on the Standard Text

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Foreword (Informative)

This document is a standard for the installation of closed-circuit ammonia mechanical refrigeration systems and overpressure protection relief piping systems. Additional precautions may be necessary because of particular circumstances, project specifications or other jurisdictional considerations. This standard does not constitute a comprehensive detailed technical installation 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 to other 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 level published by 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, since 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 it 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.

At the time of publication of this revision of the standard, the IIAR Standards Review Committee had the following members:

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SECTION 1

Purpose

This standard specifies minimum requirements for the safe installation of closed-circuit ammonia mechanical refrigeration systems and overpressure device piping when used in conjunction with a closed-circuit ammonia refrigeration system.

SECTION 2

Scope

Closed-circuit refrigeration systems utilizing ammonia as the refrigerant and overpressure device piping when used in conjunction with a closed-circuit ammonia mechanical refrigeration system shall comply with this standard.

2.1 This is a standard for the installation of closed-circuit ammonia mechanical refrigeration systems and is not intended to supplant existing safety codes. In cases where the jurisdictional authority has specific code requirements that are more stringent than those herein, that authority shall prevail.

2.2 This standard applies to:

2.2.1 Equipment and systems installed subsequent to adoption of this standard;

2.2.2 Parts or components installed after adoption of this standard.

2.3 This standard does not apply to:
- (a) Ammonia absorption refrigeration systems.
- (b) Replacement of parts with functionally equivalent parts.
- (c) Equipment and systems installed prior to the effective date of this standard established by the authority having jurisdiction. Such systems shall be maintained in accordance with regulations that applied at the time of installation.

2.4 Alternate Means and Methods

The provisions of this standard are not intended to prevent the installation of any material or to prohibit any method of construction not specifically prescribed in this standard, provided that any such alternative has been approved by the authority having jurisdiction. An alternate material or method of construction shall be approved where the authority having jurisdiction finds that the proposed design is satisfactory and complies with the intent of the provisions of this standard, and the material, method or work offered is, for the purpose intended, at least equivalent of that prescribed in this standard in quality, strength, effectiveness, fire resistance, durability and safety.

SECTION 3

Definitions

Definitions shall be in accordance with ANSI/IIAR 1-2012.

SECTION 4

Normative References

4.1 Reference Standards

4.1.1 American Society of Mechanical Engineers (ASME), Editions as shown below:

4.1.1.1 ASME Section VIII, Division 1, 2013, *ASME Boiler and Pressure Vessel Code*, Pressure Vessels, (S-VIII, D-1, 2013, ASME B&PVC).

4.1.1.2 ASME B31.5, 2013, *Refrigeration Piping and Heat Transfer Components*.

4.1.1.3 ASME Boiler and Pressure Vessel Code Section IX, 2013, *Welding and Brazing Qualifications.*

4.1.2 American Society of Testing and Materials (ASTM), Editions as shown below:

4.1.2.1 ASTM A53/A53M-04a, *Standard Specification for Pipe*, *Steel*, *Black and Hot-Dipped*, *Zinc-Coated*, *Welded and Seamless*;

4.1.2.4 ASTM A120-84, *Specification for Pipe*, *Steel*, *Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless for Ordinary Uses* (Withdrawn 1987, replaced by ASTM A53 ref.4.1.2.1]);

4.1.2.3 ASTM A197A197M-00 (2011), *Standard Specification for Cupola Malleable Iron;*

4.1.2.4 ASTM A575-96, *Standard Specification of Steel Bars*, *Carbon*, *Merchant Quality, M Grades*;

4.1.3 National Fire Protection Association (NFPA), NFPA Standard 70, *National Electric Code* (NEC), 2013.

4.1.4 International Institute of Ammonia Refrigeration (IIAR):

4.1.4.1 ANSI/IIAR 1-2012, *Definitions and Terminology Used in IIAR Standards*;

4.1.4.2 ANSI/IIAR 2-2008 (with Addendum B) *Equipment, Design, and Installation of Closed-Circuit Ammonia Mechanical Refrigerating Systems*;

4.1.4.3 ANSI/IIAR 3-2012, *Ammonia Refrigeration Valves*;

4.1.4.4 ANSI/IIAR 5-2013, *Start-up and Commissioning of Closed-Circuit Ammonia Refrigeration Systems;*

4.1.4.5 ANSI/IIAR 7-2013, *Developing Operating Procedures for Closed Circuit Ammonia Mechanical Refrigerating Systems;*

4.2 Reference Regulations

4.2.1 Occupational Safety and Health Administration (OSHA), U.S. Department of Labor, Governing editions:

4.2.1.1 29CFR1910.219, *Mechanical Power Transmission Apparatus*

4.2.1.2 29CFR1910.147, *Control of Hazardous Energy*, (“Lockout/Tagout”);

SECTION 5

General Requirements

5.1 Supervision of Installation

5.1.1 Installation shall be executed by individuals, who through experience and appropriate training, have been verified that they have been taught the skills necessary to safely receive, transport, and install refrigeration equipment, piping and components in a manner so as to assemble a complete refrigeration system and not harm themselves, others, or the structure in which the equipment is to be installed.

5.1.1.1 Individuals who are in training or others who do not have these skills may participate in the installation provided they are closely supervised by those listed in Section 5.1.1.

5.2 Safety Training

5.2.1 All individuals participating in the installation shall be trained in all applicable safety procedures prior to participating in the installation.

5.2.2 All individuals participating in the installation shall be equipped with all necessary personnel protective equipment (PPE) for their protection and safety devices for the protection of others working in their immediate area.

5.3 Materials

5.3.1 General
All materials used in the installation of the equipment designated in Sections 6 –11 shall be suitable for ammonia refrigerant (per Section 4) at the coincident temperature and pressure to which the component shall be subjected. No materials shall be used that will deteriorate because of the presence of ammonia refrigerant or lubricating oil, or a combination of both, or any normal contaminant such as air or water. Where external surfaces of the equipment are exposed to the corrosive effects of air, water or other media, such exposed materials must be suitable for the application.

5.3.2 Metallic Materials
Cast iron, malleable iron, nodular iron, steel, cast steel, and alloy steel shall comply with ASME B31.5-2013 (ref.4.1.1.2) or Section VIII, Division 1, ASME Boiler and Pressure Vessel Code (ref.4.1.1.1), as applicable.

5.3.2.1 Zinc, copper, and copper alloys shall not be used in contact with or for containment of ammonia. Copper-containing anti-seize and/or lubricating compounds shall not be used in contact with ammonia piping.

EXCEPTION: Copper as a component of brass alloys may be used for bearings or other non-refrigerant containment uses.

5.3.2.2 Other metallic materials, such as aluminum, aluminum alloys, lead, tin, and lead-tin alloys are permitted if they conform to Section 5.3.1. Where tin and tin-lead alloys are used, the alloy composition shall be suitable for the temperatures of application.

EXAMPLE: Typical uses would be tubing, valves, gaskets, packing, and joint compounds.

5.3.3 Non-Metallic Materials

5.3.3.1 Non-metallic materials are permitted if they conform to 5.3.1.

5.4 Location and Support of Components

5.4.1 All equipment, pipe, fittings, valves and components shall be positioned to insure that appropriate clearances are provided for specific accessibility and service requirements and allow for safe egress in the event of an emergency.

5.4.2 Roof or ceiling building structures shall be designed to support the weight of all new and existing piping, fittings, equipment, and components.

5.4.2.1 When required by the Building Code, the supporting structure shall be designed to handle all anticipated loads including seismic.

5.4.3 Foundations and supports for equipment shall be of noncombustible construction and capable of supporting loads imposed by such units. Foundations and supports shall be installed according to manufacturer's recommendations.

EXCEPTION: It is permitted to use pressure-treated wood or synthetic bases or "sleepers" under pipe stand bases to protect the roof from damage or between the pipe and stand (e.g. shims).

5.4.4 Insulated or un-insulated refrigeration piping or components, whose surface temperature is expected to be at or below the dew point temperature at any time, shall not be located over electrical equipment and shall avoid locations where condensation would result in a nuisance or hazard.

EXCEPTION: Where the potential for condensation above electrical equipment cannot be avoided, the electrical equipment shall be protected.

5.4.5 All components and piping shall be supported to allow for transport and rigging. Temporary supports and bracing may be used. Stationary and temporary rigging points shall be provided as required for positioning components and piping.

5.4.6 All components and piping shall be spaced to allow for insulation as required, where applicable.

5.4.7 All components and piping shall be installed in such a manner that they are protected from physical and environmental damage.

5.4.8 Refrigerant piping crossing an open space that affords passageway shall not be less than 7.25 ft (2.2 m) above the floor unless the piping is located against the ceiling of such space and is permitted by the authority having jurisdiction (AHJ).

5.4.9 Passages shall not be obstructed by refrigerant piping. Refrigerant piping shall not be placed in any elevator, dumbwaiter, or other shaft containing a moving object, or to in any way hinder means of egress.

5.4.10 Refrigerant piping shall not be installed in an unrestricted (e.g. designated areas for public visitors, guests, or vendors) stairway, stair landing, or means of egress.

5.4.11 Installing refrigerant piping underground is not prohibited. Any such piping installed underground shall be protected against corrosion.

5.4.12 Piping hangers and supports shall carry the weight of the piping, as well as any other anticipated loads.

EXAMPLE: refrigerant weight; insulation; frost/ice; seismic/wind loads; etc.

5.4.13 Sway bracing shall be included when required to accommodate dynamic or seismic loads.

5.4.14 Threaded hot rolled steel hanger rods shall meet or exceed ASTM A575-96 (ref.4.1.2.4)

5.4.15 Anchors, their attachment points and methods of installation shall be sufficient to bear all loads.

5.4.15.1 Mechanically expanded concrete anchor bodies shall not be adjusted (e.g. axially spun) after being set.

5.4.15.2 Mechanically expanded concrete anchors shall have an acceptable shaft length exposed for hardware attachment.

5.4.16 For piping that is insulated, supports and the insulation shall be selected and installed to avoid damage to the insulation from compression.

SECTION 6

Compressor Installation

6.1 Compressors

This section applies to compressors which are utilized in closed-circuit ammonia refrigeration systems.

6.1.1 All exposed rotating components (e.g., shafts, belts, pulleys, flywheels, couplings) shall be protected with screens or guards in accordance with approved safety standards [ref.4.2.1.1].

6.1.2 The compressor(s) shall be installed only where the building structure is designed to provide adequate strength and rigidity to the compressor(s).

6.1.3 Install foundations according to manufacturer's recommendations.

6.1.4 Foundations and supports for compressor units and other equipment shall not impede drainage to floor drains.

6.1.5 All machinery shall be mounted in such a manner as to prevent excessive vibration from being transmitted to the building structure or to the connected equipment. Isolation materials are permitted between the foundation and equipment.

6.1.6 Electrical equipment and wiring shall be installed in accordance with the NFPA Standard 70: National Electrical Code (NEC) (ref.4.1.4).

SECTION 7

Condenser Installation

7.1 Condensers

This section applies to air-cooled, water-cooled, plate-type, plate-and-frame type and evaporative-type refrigerant condensers which are applied to closed-circuit ammonia refrigeration systems.

7.1.1 All exposed rotating components (e.g., shafts, belts, pulleys, flywheels, couplings) shall be protected with screens, guards or access doors in accordance with approved safety standards [ref.4.2.1.1].

7.1.2 The condenser(s) shall be installed only where the building structure is designed to provide adequate strength and rigidity to house and support the condenser(s).

7.1.2.1 When required by the Building Code, the supporting structure shall be designed to handle all anticipated loads including seismic.

7.1.3 All machinery shall be mounted in such a manner as to prevent excessive vibration from being transmitted to the building structure, or to connected equipment. Isolation material is permitted between the foundation and equipment.

7.1.4 Electrical equipment and wiring shall be installed in accordance with the NFPA Standard 70: National Electrical Code (NEC) (ref.4.1.4).

SECTION 8

Evaporator Installation

8.1 Evaporators

This section applies to forced-air evaporator coils, shell-and-tube evaporators, plate-type and plate-and-frame evaporators which are applied to closed-circuit ammonia refrigeration systems.

8.1.1 All exposed rotating components (e.g., shafts, belts, pulleys, flywheels, couplings) shall be protected with screens or guards in accordance with approved safety standards [ref.4.2.1.1].

8.1.2 The evaporator(s) shall be installed only where the building structure is designed to provide adequate strength and rigidity to house and support all evaporator(s).

8.1.2.1 When required by the Building Code, the supporting structure shall be designed to handle all anticipated loads including seismic.

8.1.3 All machinery shall be mounted in such a manner as to prevent excessive vibration from being transmitted to the building structure, or to connected equipment. Isolation materials are permitted between the structural support or foundation and equipment.

8.1.4 Electrical equipment and wiring shall be installed in accordance with the applicable edition of the NFPA Standard 70: National Electrical Code (NEC) (ref.4.1.4).

SECTION 9

Pressure Vessel Installation

9.1 Pressure Vessels

This section applies to high-pressure and low-pressure vessels which are applied for use in closed-circuit ammonia refrigeration systems.

9.1.1 The pressure vessel(s) shall be installed only where the building structure is designed to provide adequate strength and rigidity to house and support the pressure vessels for any operating condition that may occur..

9.1.2 Where the pressure vessel(s) is supported by the roof or ceiling structure, the structure shall be designed to support the weight of all suspended piping and equipment.

9.1.2.1 When required by the Building Code, the supporting structure shall be designed to handle all anticipated loads including seismic.

9.1.3 Electrical equipment and wiring shall be installed in accordance with the applicable edition of the NFPA Standard 70: National Electrical Code (NEC) (ref.4.1.4).

SECTION 10

Pipe and Valve Installation

10.1 General

This section applies to pipe, fittings and valves for use in closed-circuit ammonia refrigeration systems and overpressure protection relief piping systems used in conjunction with closed-circuit ammonia refrigeration systems.

10.1.1 The pipe, fittings and valves shall only be installed where the building structure is designed to provide the needed strength and rigidity to house and support all compressors, accumulators, pumps and other equipment.

10.1.2 The roof or ceiling structure shall be designed to support the weight of all suspended piping, fittings, equipment, and components.

10.1.2.1 When required by the Building Code, the supporting structure shall be designed to handle all anticipated loads including seismic.

10.1.3 Valves shall be installed according to the manufacturer's recommendations. Piping shall not be forced by prying, jacking, or other distortions to facilitate valve installation.

10.1.4 Hot Tap tie-ins are not prohibited when connecting new piping to existing refrigeration piping. Hot Taps shall comply with ASME B31.5 Section 538 and Section 504.3, latest edition. When utilized, Hot Tapping shall follow hot tap equipment manufacturers' procedures and site specific safe work practices.

10.2 The piping materials used for closed-circuit ammonia mechanical refrigeration systems, whether fabricated in a shop or as a field erection, shall comply with ASME B31.5-2013, Refrigeration Piping [ref.4.1.1.2].

10.3 Pipe

10.3.1 Pipe shall be new, clean and free of rust, scale, sand and dirt, both internally and externally.

10.3.2 Pipe that is ½" and smaller is not prohibited when the use is supplemental to instrumentation. Where the use of ½" and smaller pipe is required in the engineering design, it shall be adequately supported and/or protected to prevent damage. See Section 10.5.3 for Threaded Joints.

10.3.3 ASTM A120, A53/A120, or A53 – Type F pipe and cast iron or wrought iron pipe shall not be used for closed-circuit ammonia mechanical refrigeration systems (ref.4.1.2.1 and ref.4.1.2.2)

10.3.3.1 Hydrostatic relief valve piping for overpressure protection discharge which relieve into another part of the closed-circuit ammonia mechanical refrigeration system is part of the closed-circuit ammonia mechanical refrigeration system.

10.3.3.2 Overpressure protection relief vent piping which does not relieve into another part of the closed-circuit ammonia mechanical refrigeration system is not part of the closed-circuit ammonia mechanical refrigeration system.

(a) Overpressure protection relief piping is permitted to be galvanized or un-galvanized ASTM A120, A53/A120, or A53 – Type F (ref.4.1.2.1 and ref.4.1.2.2). It is recommended that when these grades of un-galvanized pipe are used, the pipe be clearly identified with paint striping to prevent their use in the closed-circuit refrigeration system.

(b) Malleable iron ASTM A197 fittings are an acceptable material for overpressure protection relief piping systems (ref.4.1.2.3).

10.4 Refrigerant Valves

This section applies to the valves used in the ammonia-containing and the lubricant-containing parts of closed-circuit ammonia refrigeration systems. Valves shall be compliant with ANSI/IIAR 3-2012, *Ammonia Refrigeration Valves* (ref. 4.1.7.3)

EXCEPTIONS:
Valves within the refrigerant-containing envelope of other equipment such as slide valves in screw compressors; Safety relief valves.

10.4.1 Valves shall be oriented in accordance with the respective manufacturer's instructions or as shown on the drawings.

10.4.2 Valve gasket materials shall match valve manufacturer's specifications, be compatible with ammonia and of the dimensions specified. Flange bolts shall be tightened in accordance with 10.5.2.

10.4.3 Valves with specialized tightening requirements shall be installed according to manufacturer's instructions.

10.4.4 Shut-off (Stop) valves used to isolate equipment, control valves, controls or other components from other parts of the system for the purpose of maintenance or repair shall be capable of being locked out or secured per the facility's "Lock Out / Tag Out" procedure (ref.4.2.1.2).

10.4.5 Shut-off (Stop) valves shall be installed in the refrigerant piping of a refrigeration system to meet minimum safe design requirements (See IIAR 2 – latest edition).

10.4.5.4 Shut-off (Stop) valves connecting refrigerant-containing parts to atmosphere shall be capped, plugged, blanked, or locked closed during shipping, testing, operating, servicing, or standby conditions if they are not used. See Standard ANSI/IIAR 5-2013, *Start-up and Commissioning of Closed Circuit Ammonia Refrigeration Systems* (ref.4.1.7.4).

10.5 Piping Fabrication and Assembly

Valves (or flange sets) shall be installed according to manufacturer's instructions.

10.5.1 Piping joints shall be supported and in alignment such that the joint assembly is not distorted or stressed during assembly and installation.

10.5.2 Flanges

10.5.2.1 The mating surfaces of the gasketed joints shall be parallel, aligned and perpendicular to the pipe axis, in good condition and free of debris and corrosion.

10.5.2.2 Gaskets shall be correctly dimensioned for the flange set.

10.5.2.3 Nuts, bolts, cap screws and washers shall meet manufacturer's requirements for the application. Bolt threads shall extend completely through the mating nut.

10.5.2.4 The fasteners shall be progressively tightened in a diametrically staggered (crisscross or star) pattern.

10.5.2.5 Flange sets with specialized tightening requirements shall be installed according to manufacturer's instructions.

10.5.3 Threaded Joints

10.5.3.1 Thread compound used in threaded joints shall be suitable for service in an ammonia refrigeration system.

10.5.3.2 Threaded joints that require seal welding shall be made up without any thread compound.

10.5.3.3 Threaded joints shall not be used for refrigerant piping larger than 2".

10.5.3.4 All threaded piping shall be a minimum of Schedule 80.

10.5.3.5 Threaded joints shall be supported in the field installation such that the joint withstands all anticipated loading (e.g. vibrations, frost, ice, snow, seismic, etc.).

10.5.4 Welded Joints
Welded joints shall be fabricated as required by ASME B31.5, 2013, *Refrigeration Piping and Heat Transfer Components* (ref.4.1.1.2) and SME Boiler and Pressure Vessel Code Section IX, 2013, *Welding and Brazing Qualifications* (ref.4.1.1.3).

10.5.5 The inside of the piping system shall be kept clean and free of debris during fabrication and assembly.

10.5.5.1 Pipe and system components shall be stored during installation to prevent contaminants from entering the system.

10.5.6 Suction lines, low-temperature liquid lines, accumulators, surge drums and similar cold surfaces shall be insulated to mitigate and control condensation.

EXCEPTION:
See Exceptions Section 12.1.2

SECTION 11

Components and Controls Installation

This section applies to components and controls applied for use in closed-circuit ammonia refrigeration systems.

11.1 Refrigerant Pumps

11.1.1 All exposed rotating components (e.g., shafts, belts, pulleys, flywheels, couplings) shall be protected with screens or guards in accordance with approved safety standards [ref.4.2.3.1].

11.1.2 The refrigerant pump(s) shall be installed only where the building structure is designed to provide adequate strength and rigidity to house and support the pump(s).

11.1.3 Where refrigerant pump(s) are supported by the roof or ceiling structure, the structure shall be designed to support the weight of all suspended piping and equipment.

11.1.4 Foundations and supports for refrigerant pump(s) and other equipment shall be of noncombustible construction and capable of supporting loads imposed by such units. Foundations and supports shall be installed according to manufacturer's instructions.

11.1.5 All machinery shall be mounted in such a manner as to prevent excessive vibration from being transmitted to the building structure, or to connected equipment. Isolation materials are permitted between the foundation and equipment.

11.1.6 Electrical equipment and wiring shall be installed in accordance with NFPA Standard 70: National Electrical Code (NEC) (ref.4.1.4).

11.2 Visual Liquid Level Indicators: Bull's-Eyes, tubular glass and flat "armored glass" linear sight glasses/sight columns

11.2.1 Visual Liquid Level Indicators constructed using Bull's-Eye type indicator(s)

11.2.1.1 All visual liquid level indicators shall be inspected prior to installation. Any indicator found to have a scratch, chip or any defect shall be discarded.

11.2.1.2 Indicators shall be installed according to manufacturer's recommendations.

11.2.1.3 Gaskets shall be new, clean and smooth.

11.2.1.4 Gaskets used shall be those recommended by the manufacturer of the visual liquid level indicator.

11.2.1.5 The retaining ring shall be installed according to specifications provided by the manufacturer.

11.2.2 Visual Liquid Level Indicators constructed of tubular glass and flat "armored glass"

11.2.2.1 Linear liquid level indicators (sight columns) shall be fitted with internal check-type shut-off valves (e.g. ball flow check). This type of site glass shall also have robust protection against accidental breakage 360 degrees around the glass tube, over the full length of the tube.

SECTION 12

Insulation

This section applies to insulation used for closed-circuit ammonia refrigeration systems.

12.1 Refrigeration piping or components, whose surface temperature is expected to be at or below the dew point temperature at any time, shall be insulated and conditioned to prevent or mitigate condensation.

EXCEPTION:
Surfaces where condensation or ice could form on valve groups or on equipment shall be permitted to be left un-insulated to accommodate access for service, provided the vapor stops are installed at all terminations in the adjacent insulation. The vapor retarder shall be complete and continuous throughout the insulation system.

12.1.1 All exterior refrigerant lines which require insulation shall have an insulation thickness selected to minimize condensation and minimize heat gain into the refrigerant within the piping. See Informative Appendix B.

12.2 Newly installed refrigerant piping and joints shall be exposed to allow for visual inspection and acceptance by the authority having jurisdiction prior to being covered and enclosed.

SECTION 13

Testing of Installation

13.1 Field Leak Testing

13.1.1 Upon complete installation of or revision to a closed-circuit ammonia refrigeration system, the system or affected part shall be tested for leaks before charging. This field leak testing program for closed-circuit ammonia refrigeration systems is designed to assure a tight system which will operate without any appreciable loss of refrigerant.

13.1.2 Preparation for Leak Testing

All joints shall remain unpainted and un-insulated until field leak testing has been completed. Prior to testing, the following preparations shall be made:

13.1.2.1 Valve off and isolate from any test pressures all refrigeration compressors, non-hermetic liquid pumps, pressure switches and pressure transducers.

13.1.2.2 Remove all safety pressure relief devices and cap or plug the openings.

13.1.2.3 Open all solenoid, pressure-regulating, check or other control devices by means of their manual lifting stems.

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

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

13.1.3 Pressure Testing

Pressure test shall be in accordance with Section 538 of ASME B31.5, 2013, Refrigeration Piping and Heat Transfer Components (ref.4.1.1.2).

13.1.4 Leak Testing, Evacuation and Dehydration

Upon completion of installation, the ammonia refrigeration system shall have been field tested for tightness, evacuated, and if required dehydrated, in accordance with Appendix C (Normative) of Standard ANSI/IIAR 5-2013, *Start-up and Commissioning of Closed Circuit Ammonia Refrigeration Systems* (ref.4.1.7.4). All parts of the system, including factory tested equipment, shall be exposed to field test pressures equal to those minimum design pressures listed in Appendix A or actual high and low side design pressures, whichever are greater. A pre-test inspection shall be made to verify that all components in the section of piping under examination have a pressure rating which meets or exceeds the specified field test pressure. All leaks shall have been repaired and defective material shall have been replaced.

SECTION 14

(Informative) References and Sources of References

14.1 Informative References

14.1.1 Compressed Gas Association G-2, 1995, Eighth Edition.

14.1.2 International Institute of Ammonia Refrigeration (IIAR):

14.1.2.1 IIAR *Piping Handbook* 2000 [with 2004, 2012 revisions], Chapter 7, *Insulation for Refrigeration Systems*, 2012.

14.1.3 Occupational Safety and Health Administration (OSHA), U.S. Department of Labor, Governing editions:

14.1.3.1 29CFR1910.212, *General Requirements for All Machines*;

14.1.3.2 29CFR1910 subpart D, *Walking-Working Surfaces*;

14.1.3.3 29CFR 1926.1053, subpart X, *Ladders;*

14.1.3.4 29CFR 1926.56, subpart D, *Illumination.*

14.1.4 Manufacturers Standardization Society of the Valve and Fittings Industry (MSS), ANSI/MSS Standard Practice SP 58-2009, *Pipe Hangers and Supports*, *Selection and Application*.

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

14.1.5.1 2010 *ASHRAE Handbook — Refrigeration*, *System Practices for Ammonia Refrigerant*, Chapter 2, page 2.8.

14.1.5.2 Standard 15-2010, *Safety Standard for Mechanical Refrigeration*.

14.1.6 American Society of Testing and Materials (ASTM), Editions as shown below:

14.1.6.1 ASTM A105/A105M-03, *Standard Specification for Carbon Steel Forgings for Piping Applications*;

14.1.6.2 ASTM A106/A106M-04b *Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service*;

14.1.6.3 ASTM A181/A181M-01, *Standard Specification for Carbon Steel Forgings*, *for General-Purpose Piping*;

14.1.6.4 ASTM A193/A193M-04c, *Standard Specification for Alloy-Steel and Stainless*

Steel Bolting Materials for High-Temperature Service;

14.1.6.5 ASTM A234/A234M-04, *Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service*;

14.1.6.6 ASTM A307-04, *Standard Specification for Carbon Steel Bolts and Studs*, *60,000 PSI Tensile Strength*;

14.1.6.7 ASTM A312/A312M-04b, *Standard Specification for Seamless*, *Welded*, *and Heavily Cold Worked Austenitic Stainless Steel Pipes*;

14.1.6.8 ASTM A320/A320M-04, *Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for Low-Temperature Service*;

14.1.6.9 ASTM A333/A333M-04a, *Standard Specification for Seamless and Welded Steel Pipe for Low-Temperature Service*;

14.1.6.10 ASTM A403/A403M-04, *Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings*;

14.1.6.11 ASTM A420/A420M-04, *Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Low-Temperature Service*;

14.1.6.12 ASTM A707/A707M-02, *Standard Specification for Forged Carbon and Alloy Steel Flanges for Low-Temperature Service*.

14.1.7 U.S. Department of Transportation (US DoT), 49 CFR Part 172, *Hazardous Materials Regulations*, 2013.

14.1.8 International Safety Equipment Association (ISEA), ANSI/ISEA Z358.1, *World Safety Standard for Emergency Eyewash and Shower Equipment*, 2009.

14.2 Sources of References

American National Standards Institute (ANSI)
25 West 43rd Street, 4th Floor
New York, NY 10036
www.ansi.org

American Petroleum Institute (API)
1220 L Street NW
Washington, DC 20005-4070
www.api.org

American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE)
1791 Tullie Circle, N.E.
Atlanta, GA 30329
www.ashrae.org

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

American Society of Testing and Materials (ASTM)
ASTM International
100 Barr Harbor Drive
P.O. Box C700
West Conshohocken, PA 19428-2959
www.astm.org

International Institute of Ammonia Refrigeration (IIAR)
1001 N. Fairfax St., Suite 503
Alexandria, VA 22314-1797
www.iiar.org

Manufacturers Standardization Society of the Valve and Fittings Industry (MSS)
127 Park Street, N.E.
Vienna, VA 22180
www.mss-hq.com

National Fire Protection Association (NFPA)
60 Batterymarch Park
Quincy, MA 02169-7471
www.nfpa.org

U. S. Department of Labor/OSHA
Publications Department
200 Constitution Avenue, NW, Room N3101
Washington, DC 20210
www.osha.gov

U. S. Department of Transportation (US DoT)
Research and Special Programs Administration Office
of Hazardous Materials Safety
400 7th Street, S.W.
Washington, DC 20590
www.dot.gov

APPENDIX A (NORMATIVE)

Minimum Values for Leak Test Pressure – NH_3

	Compressors		LP Side Components Including Vessels, Heat Exchangers, Evaporators, Pumps & Piping	Hot Gas Defrost Evaporators & Piping	HP Side Components Including Valves, Sensing Devices, Heat Exchangers, Condensers, Pumps & Piping	
	LP Side & Boosters	HP Side			Water-cooled Systems	Air-cooled Systems
psig	250	300	250	250	250	300
kPa gage	1724	2069	1724	1724	1724	2069

APPENDIX B (INFORMATIVE)

Insulation for Refrigeration Systems

Chapter 7 of the IIAR Piping Handbook [ref.4.2.2.1] covers insulation systems operating on below-ambient temperature piping systems ranging from +50°F to –100°F for piping, fittings, valves, vessels, equipment and heat exchangers typically used in industrial refrigeration systems.

B.1 Purpose

The purpose of the insulation system is to conserve energy by preventing heat infiltration, preventing condensation or ice formation, and minimizing corrosion.

The success of an insulation system for cold piping depends upon four factors: proper pipe preparation, correct refrigeration and insulation system design, adequate insulation thickness, and proper installation of the insulation and related materials such as vapor retarders, sealants, and protective jacketing. It is critical to maintain the integrity of the vapor retarder system. The insulating system must be regularly maintained and inspected after installation.

B.2 Fundamentals of Insulation

Heat is a form of energy, always moving from a higher to a lower temperature.

There are three types of heat transfer as follows:

1) Conduction–through direct thermal contact between a hotter and a colder material,

2) Convection–through natural or forced circulation of air or a fluid,

3) Radiation–through exchange of the infrared energy naturally given off by every object.

Poor heat conductors are good insulation products. Water is a good conductor of heat. Water and water vapor are the prime enemy of an insulation system.

B.3 Design Considerations

When designing thermal insulation for a refrigeration system, consider thermal and mechanical factors, as well as process control issues.

In general, provide sufficient insulation to maintain an 8–10 BTU/hr heat gain per square foot of pipe surface. Recommended thickness tables can be found in Chapter 7 of the IIAR Piping Handbook [ref.4.2.2.1].

B.4 Effect of Water/Ice/Moisture on Insulation Value

Refrigerant systems are insulated to conserve energy and prevent surface condensation or “sweating.”

When high absorption/permeability materials are used on these systems and the vapor retarder system fails, water vapor will move into the insulation condensing and eventually saturating the insulation material. This problem is more severe at lower system temperatures and when the system operates continuously in the cold mode. As more water vapor is absorbed, the thermal conductivity of the insulation material increases, lowering the surface temperature of the pipe.

Lower surface temperatures lead to more condensation which may eventually lead to insulation system freeze-up, frost-ups and total failure of the insulation material due to ice formation and water expansion, as well as corrosion of metal components.

B.5 Insulation Material Selection

Choose insulation material for suitability at both minimum and maximum system operating temperatures.

The manufacturer generally specifies the intended operating temperature ranges for an insulation material, based on thermal properties in that temperature range.

B.6 Corrosion Concerns

Piping systems corrode not because they are insulated, but because they are in contact with aerated water and/ or a water-borne corrosive chemical.

Corrosion can occur under all types of insulation. Corrosion is caused by moisture ingress as a result of improper vapor retarder selection, installation, or maintenance, or mechanical abuse, or of voids in the insulation system that retain water.

Equipment or piping operating either steadily or cyclically at or above freezing (such as hot gas defrost systems) may experience significant corrosion problems. Pipe legs or instruments protruding into ambient-temperature areas may corrode faster than cold, insulated pipe mains.

Some areas of a piping system are more susceptible to corrosion than others. Where the risk of corrosion is elevated, apply a primer-paint coating system. The higher-risk areas include (but are not limited to) all pipe welds, control valve groups, areas around pump bases or control columns, evaporator coil headers, oil pots, valves, unions and flanges or any termination of insulation.

B.7 Insulation System Components

Many low temperature insulation products may perform reliably with proper installation and application of accessory materials.

The insulation itself should be a low thermal conductivity material with low water vapor permeability and it should provide moisture resistance. The types of insulation commonly used in industrial refrigeration are: *extruded polystyrene* insulation, *cellular glass*, *polyisocyanurate* insulation (The terms *polyisocyanurate* (PIR) and *polyurethane* (PU) are frequently used interchangeably. The two products use the same raw materials, in different ratios) and *closed-cell phenolic*.

Use a joint sealant on all insulations operating at below-ambient conditions. The sealant should be resistant to liquid water and to water vapor and be able to bond to the specific insulation surface. Use low-permeance insulation materials and a continuous, effective vapor retarder system. Jacketing on insulated refrigeration piping protects the insulation and vapor retarder from damage.

Use protective jacketing. Seal all lap joints with appropriate weather barrier sealant.

B.8 Recommended Practices for Insulation Applications

Chapter 7 of the IIAR Piping Handbook [ref.4.2.2.2] covers recommended specifications and design features for typical refrigeration insulation applications. Also check State and local building codes for requirements.

Store insulation in a cool, dry location and protect it from the weather before and during application. Install vapor retarders and weather barriers over dry insulation.

Finish all welding and other hot work, as well as all pressure testing, before installing pipe insulation. The surfaces to be insulated should be free from all oil, grease, loose scale, rust and foreign matter and must be dry and free from frost. Complete site touch-up of shop coating (including preparation and painting at field welds) before insulating. For insulation and insulation accessories, use specific manufacturer instructions.

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