SAFE AND SUSTAINABLE USE OF NATURAL REFRIGERANTS

Ammonia Energy Association Workshop

IIAR Standards and Guidelines

SAFE AND SUSTAINABLE USE OF NATURAL REFRIGERANTS

Who we are, what we do

Who we are, what we do

Over 3400
Members Strong

Allied Associations

- ACAIRE - Colombia
- Australian Institute of Refrigeration Air Conditioning and Heating
- Cámara Chilena de Refrigeración y Climatización – Chile
- Chinese Association of Refrigeration - China
- CIEMI – Costa Rica
- Eurammon (i.e., Europe & Ammonia) –Germany
- United States:
  - Global Cold Chain Alliance (GCCA)
  - Refrigerating Engineers & Technicians Association (RETA)
  - Ammonia Safety Training Institute (ASTI)
  - ASHRAE

International Chapter Locations:

- Mexico
- Costa Rica
- Colombia
- Ecuador
- Peru
- Chile
- Argentina
- India
- China

Who we are, what we do

- **Scholarships** for Refrigeration Engineering Students

- **Research projects** used in creating new guidelines and standards for safe design and operation of natural refrigeration systems.

- **Local and International Code recognition** of IIAR standards

- **Government Relations Support** – of DHS, OSHA, EPA, for the creation of sensible and practical regulations & advocate for changes as needed

- **Annual conference** providing education and networking

Who we are, what we do

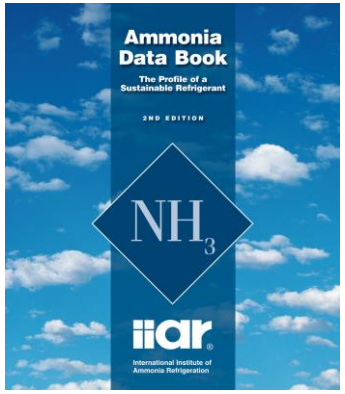
- **Academy of Natural Refrigerants (ANR)** – online classes and testing covering IIAR Standards and Guidelines
- **Online Training Videos Series** – with online testing covering basic ammonia refrigeration, critical safety information, and oil removal
- **Monthly Online Webinars** – covering hundreds of practical topics
- **Tech Papers & Workshops** - Given Face-to-face and virtually with Q&A. Full Library - Years of Technical Papers available online.
- **Regulatory Educational Programs** – OSHA Training, DHS chemical safety, etc

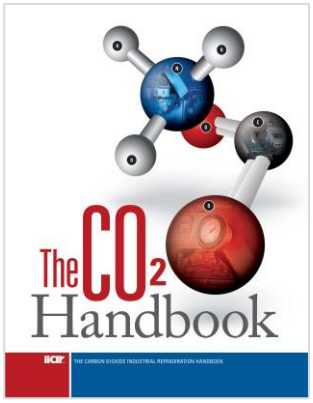
ENGINEERING RCEP
REGISTERED CONTINUING EDUCATION PROGRAM

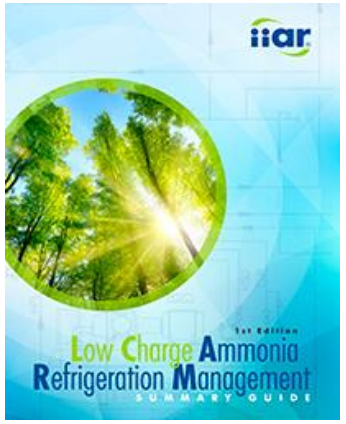
Who we are, what we do

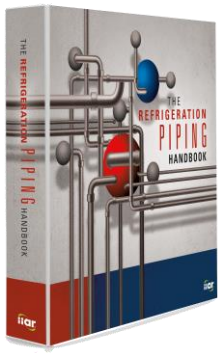
- **Nine (9) ANSI Approved Ammonia Standards -** recognized by international codes and other organizational standards - covering safe design, installation, startup, inspection, testing, maintenance, operating procedures and minimum safety requirements for Existing Closed-Circuit Ammonia Refrigeration Systems

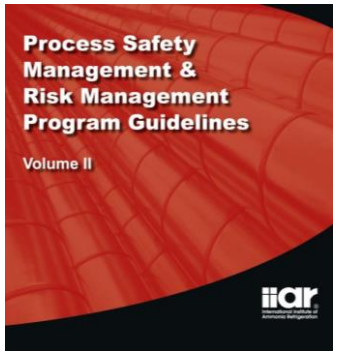
- **Guidelines and Handbooks –** covering practical and technical information relating to the use of ammonia and other natural refrigerants.











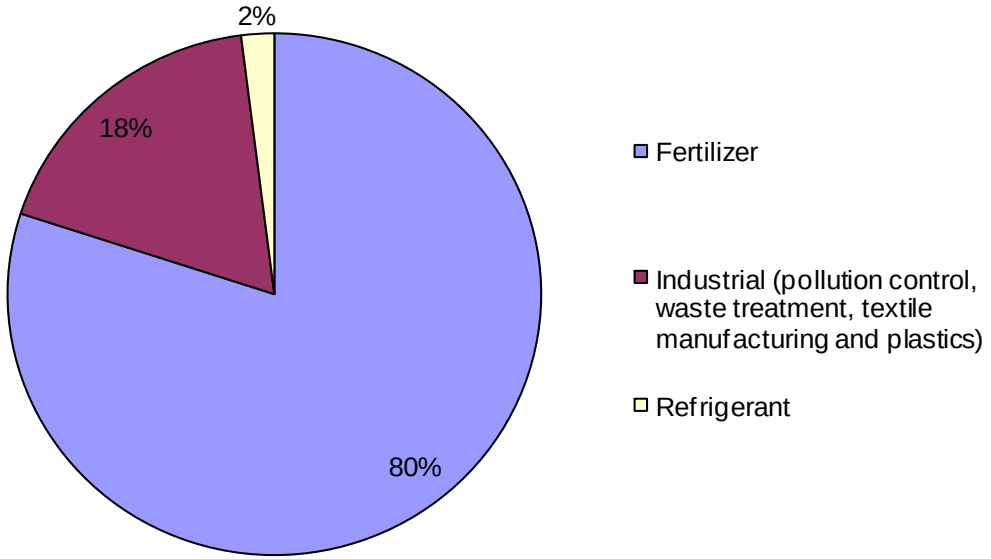
SAFE AND SUSTAINABLE USE OF NATURAL REFRIGERANTS

Use of Ammonia in Refrigeration

- Energy Efficiency
- Ease of Use
- Wide Availability
- Inexpensive for large systems
- GWP=0, ODP=0
- Other Advantages…

About 170 million metric tons produced worldwide, annually

Use of Ammonia in North America



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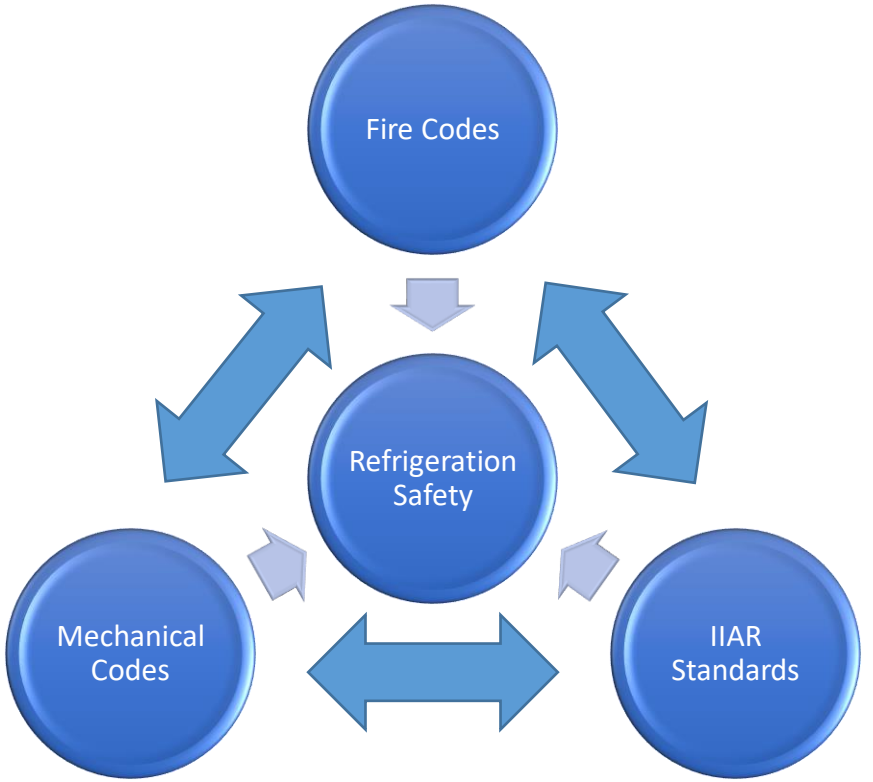
SAFE AND SUSTAINABLE USE OF NATURAL REFRIGERANTS



SAFE AND SUSTAINABLE USE OF
NATURAL REFRIGERANTS

- Risk Management Program – 10,000+ lbs
- General Duty Clause – < 10,000 lbs

- For Systems over 10,000 lbs:
  - PSM – OSHA 1910.119
  - RMP – 40 CFR Part 68
- For Systems under 10,000 lbs:
  - General Duty Clause – ANY QUANTITY
- State Specific Requirements
  - California (CalARP, CalOSHA)
  - New Jersey (NJDEP and the TCPA)

- Process Safety Management – 10,000+ lb
- General Duty Clause - < 10,000 lb

***About 40% of regulated industry are ammonia refrigeration facilities**

PSM & RMP Elements

- Employee Participation
- Process Safety Information
- Process Hazard Analysis
- Operating Procedures
- Training Program
- Contractor Program
- Pre-start-up Safety Review
- Mechanical Integrity
- Hot Work Permit
- Management of Change
- Incident Investigation
- Emergency Action and Response Plans
- Compliance Audit
- Trade Secrets

RMP Specific:

- Hazard Assessment
- Five Year Accident History
- Risk Management (Reporting etc.)

RAGAGEP = Recognized and Generally Accepted Good Engineering Practices

Consideration and Onset

In the early 2000's the IIAR BOD recognized that

- Information should be divided by topic e.g. design, startup, inspection, and maintenance
- Also noted that regulatory agencies referred to Consensus Developed Standard, by law.
- Competing Codes and Standards were hard to follow

By the later 2000's the IIAR BOD Decided:

- A suite of standards covering all aspects to be developed
- Try for model codes to refer to the standards
- Consolidate Design Standards for Ammonia
- Tasked the Standards Committee with Development and Code Committee with model code references

Goal: Control our Destiny or Have it Controlled for Us!

American National Standards Institute

- Created for the development of all kinds of standards
- Establishes the “rules” for standards development
- Ensures process is fair, accessible, and responsive to the needs of affected stakeholders and interested parties

- Maintain ANSI Accreditation:

Standards developers required to consistently adhere to procedures known as

"ANSI Essential Requirements"

- Ensures standards developed in environment to stakeholders:
  - Equitable
  - Accessible
  - Responsive

"ANSI Essential Requirements" include:

Openness
Balance
Lack of dominance
Consensus
Due process

iiar® SAFE AND SUSTAINABLE USE OF NATURAL REFRIGERANTS

IIAR Suite of Standards

IIAR 1 – Definitions and Terminology
*IIAR 2 – Design of Safe Ammonia Systems
IIAR 3 – Ammonia Refrigeration Valves
IIAR 4 – Installation
IIAR 5 – Startup
*IIAR 6 – Inspection Testing and Maintenance
IIAR 7 – Developing Operating Procedures
IIAR 8 – Decommissioning of Systems
IIAR 9 – Minimum System Safety Requirements for Existing Buildings
* = most used/referenced standards

136 page document

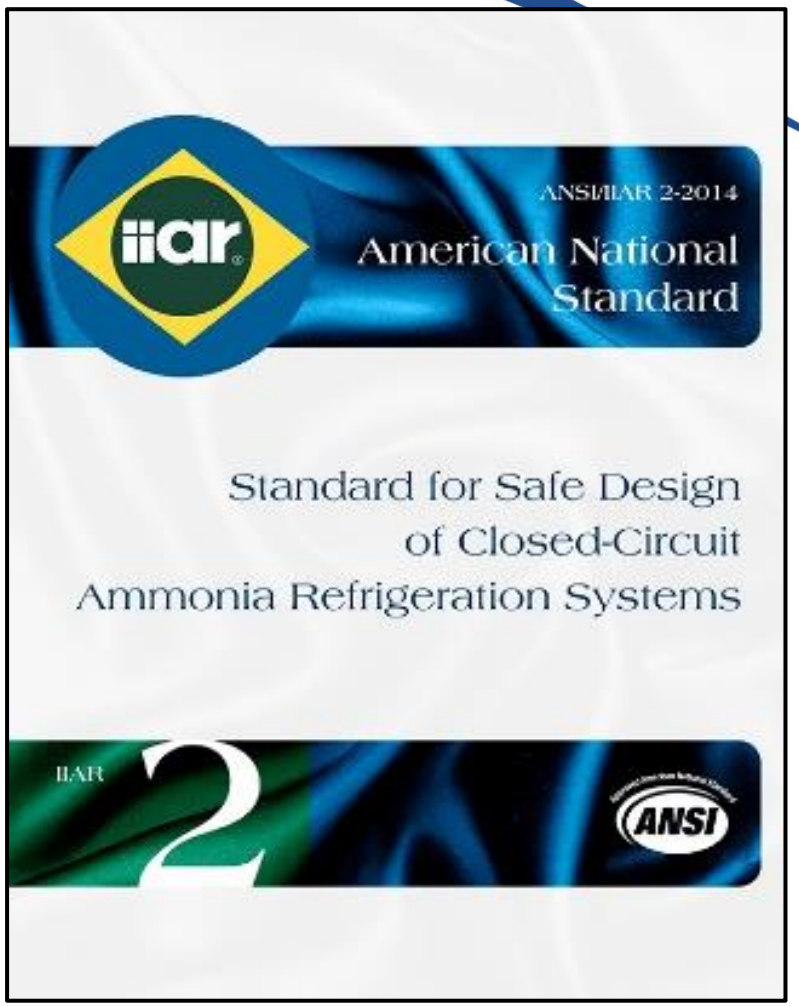
4 parts

Part 1 – General: Purpose Scope, Definitions, References

Part 2 – Design Affecting Construction: location, general design requirements, machinery rooms, areas other than machinery rooms

Part 3 – Equipment

Par 4 – Appendices – non mandatory information to aid designers with compliance



IIAR 2 – Design…

Mandatory References

Several mandatory references are used, sometimes with “over-riding” stipulations.

- ASME VIII, Div. 1 – the Boiler and Pressure Vessel Code
- ASME B31.5 – Refrigeration Piping
- ASME B16.x – flanges, fittings gaskets
- ASTM – piping specifications
- NFPA – 70 (National Electric Code), and 704 (Identification of Fire Hazards for Emergency Response)
- And a few others – hoses and corrugated metals, detectors, eyewash/safety shower performance

IIAR 2 – Design…

Chapter 5. General System Design Requirements

5.1 **General.** The design of closed-circuit ammonia refrigeration systems shall comply with this chapter.

5.2 ***Anhydrous Ammonia Specifications**

5.2.1 ***Purity.** Anhydrous ammonia used for the initial and subsequent charging of ammonia refrigeration systems using mechanical compression shall meet the purity requirements shown in Table 5.2.1.

Table 5.2.1
Purity Requirements

Ammonia Content	99.5% minimum
Water	50 ppm minimum, 5,000 ppm maximum
Oil	50 ppm maximum
Salt (calculated as NaCl)	None
Pyridine, hydrogen sulfide, naphthalene	None

IIAR 2 – Design…

5.7 Materials

5.7.1 General

5.7.1.1 Materials used in the construction of a closed-circuit ammonia refrigeration system shall be suitable for contact with ammonia refrigerant within the closed-circuit system at the coincident temperature and pressure to which the system will be subjected.

5.7.1.2 *Materials that deteriorate in the presence of ammonia, refrigerant lubricating oil, or a combination of both, shall not be used.

5.7.2 Metallic Materials

5.7.2.1 Cast iron, malleable iron, nodular iron, steel, cast steel, and alloy steel shall be permitted in accordance with ASME B31.5 or ASME B&PVC, Section VIII, Division 1. Other metallic materials, including but not limited to aluminum, aluminum alloys, lead, tin, and lead-tin alloys shall be permitted in accordance with Section 5.7.1. Where tin and tin-lead alloys are used, the alloy composition shall be verified as suitable for temperature exposures, as specified in Section 5.6.

5.7.2.2 Zinc, copper, and copper alloys shall not be used to contain or be in contact with ammonia. Copper-containing anti-seize and lubricating compounds shall not be used. Copper, as a component of brass alloys, shall be permitted in rotating shaft bearings and other non-refrigerant-containment uses.

5.7.3 Nonmetallic Materials

5.7.3.1 Nonmetallic materials shall be permitted in accordance with Section 5.7.1.

5.7.3.2 Nonmetallic materials shall be permitted in accordance with ASME B31.5 or ASME B&PVC, Section VIII, Division 1.

Chapter 12. Pressure Vessels

12.1 **General.** Pressure vessels shall comply with this chapter.

12.2 **Design**

12.2.1 Minimum design pressure shall be in accordance with Section 5.5. Where ammonia liquid will be transferred from pressure vessels with pressurized ammonia gas, the pressure vessel design pressure shall accommodate the maximum possible transfer pressure and account for the lowest possible coincident metal temperature.

12.2.2 Pressure vessels exceeding 6 in. (15.24 cm) inside diameter shall comply with ASME B&PVC, Section VIII, Division 1, covering the requirements for design, fabrication, inspection, and testing during construction of unfired pressured vessels. Pressure vessels having inside diameters less than 6 in. (15.24 cm) shall require ultimate strength in accordance with Section 5.13.2.

12.2.3 For vessels with larger than 6 in. (15.24 cm) inside diameter but less than 10 ft^3 (0.28 m^3) in internal volume, the pressure relief device connection shall not be less than ¾ in. (1.91 cm) pipe or a ½ in. (1.27 cm) coupling. For vessels with an internal volume of 10 ft^3 (0.28 m^3) or more, the pressure relief device connection shall not be less than 1 in. (2.54 cm) pipe or a ¾ in. (1.91 cm) coupling.

12.2.4 *The heads of pressure vessels shall be hot formed or stress relieved after cold forming.

EXCEPTION: Vessels primarily containing oil, including but not limited to oil separators, oil filters, oil coolers, and oil pots.

12.2.5 A vessel shall be designed and stamped with a minimum design metal temperature no higher than its lowest expected operating temperature.

12.2.6 * In applications where vessels are subject to external corrosion as determined by the Owner or Owner's designated agent, suitable means shall be used to address vessel protection.

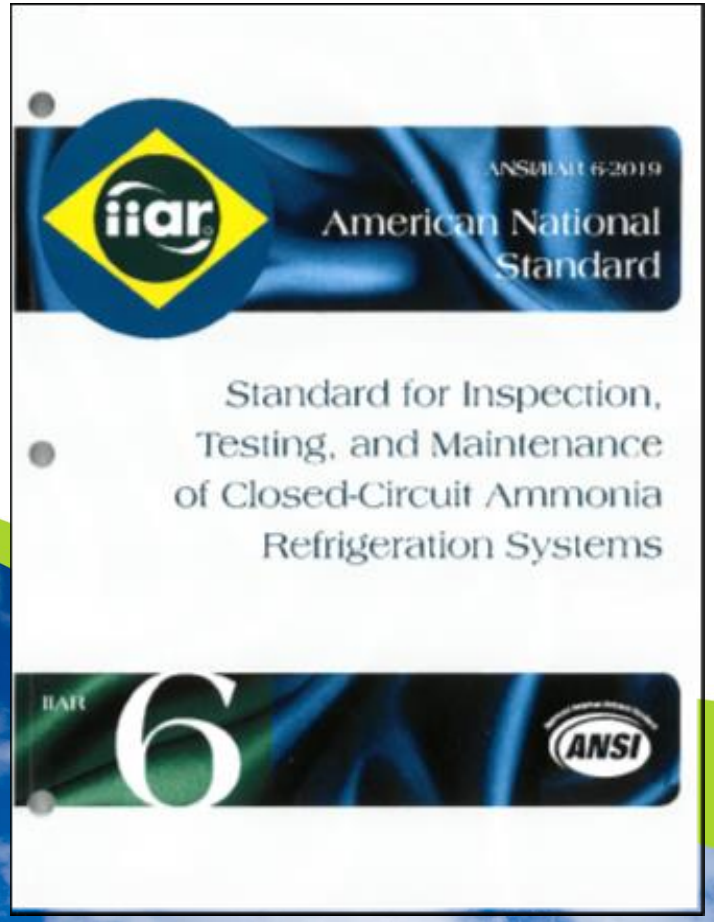
IIAR 2 – Design…

Part 4 Appendices

Appendix A. (Informative) Explanatory Material
Appendix B. (Informative) Ammonia Characteristics and Properties
Appendix C. (Informative) Methods for Calculating Relief Valve Capacity for Heat Exchanger Internal Loads
Appendix D. (Informative) Duplicate Nameplates on Pressure Vessels
Appendix E. (Informative) Method for Calculating Discharge Capacity of a Positive Displacement Compressor Pressure Relief Device
Appendix F. (Informative) Pipe Hanger Spacing, Hanger Rod Sizing, and Loading
Appendix G. (Informative) Hydrostatic and Liquid Overpressure Relief
Appendix H. (Informative) Stress Corrosion Cracking
Appendix I. (Informative) Emergency Pressure Control Systems
Appendix J. (Informative) Machine Room Signs
Appendix K. (Informative) Alternative Ventilation Calculation Methods
Appendix L. (Informative) Pipe, Fittings, Flanges, and Bolting
Appendix M. (Informative) Operational Containment
Appendix N. (Informative) Ammonia Absorption Refrigeration
Appendix O. (Informative) Designing to Avoid Component Failure Caused by Abnormal Pressure or Shock
Appendix P. (Informative) Removal of Water from a Refrigeration System
Appendix Q. (Informative) IIAR Bulletin 114 – Identification of Ammonia Refrigeration Piping and System Components
Appendix R. (Informative) References and Sources of References

ANSI/IIAR 6-2019

Inspection, Testing, and Maintenance of Closed-Circuit Ammonia Refrigeration Systems



Clarification of its Purpose:

- Intended to be part of a Mechanical Integrity (MI) Program as the minimum requirements for Inspection, Testing, and Maintenance (ITM) Tasks
  - Includes Recording Keeping for minimum safe requirements – maintaining records
  - It is NOT an overall encompassing Mechanical Integrity Program

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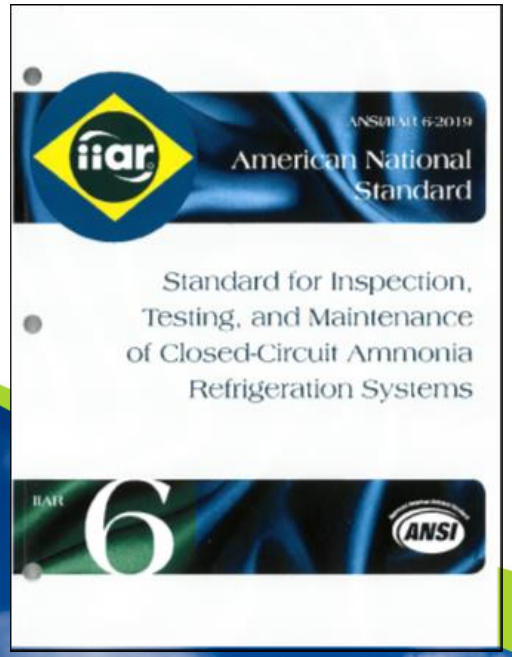
ANSI/IIAR 6-2019

Inspection, Testing, and Maintenance of Closed-Circuit Ammonia Refrigeration Systems



Clarification of its Purpose:

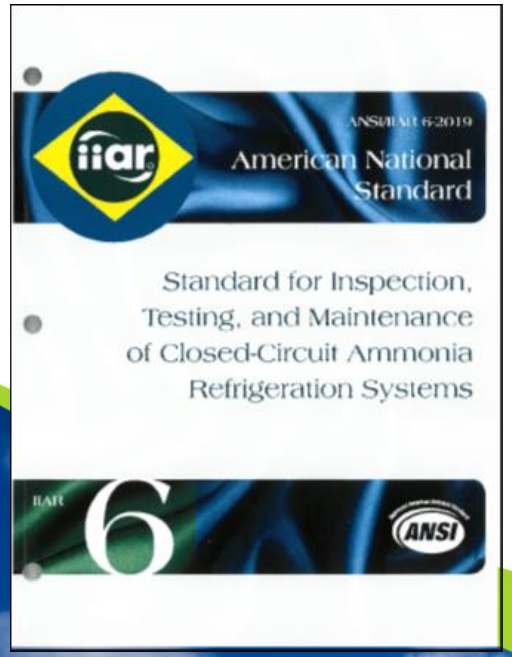
It is NOT intended to be:

- Written Maintenance Procedures
- Overall Preventive Maintenance (PM's) Program
- Inclusive 5-Year MI Compliance Audit
- Maintenance Training Program
- Overall Quality Assurance Program

SAFE AND SUSTAINABLE USE OF NATURAL REFRIGERANTS

ANSI/IIAR 6-2019

Inspection, Testing, and Maintenance of Closed-Circuit Ammonia Refrigeration Systems



Contents:

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  - Scope, Definitions, References, Program Administration
- Part 2: Program Requirements
  - General, Equipment Chapters
- Part 3: Appendices (Informative)
  - “Former” B109 ITM now Safety Checklists

SAFE AND SUSTAINABLE USE OF NATURAL REFRIGERANTS

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IIAR 6 Captures IIAR Bulletins

- Bulletin 108: Water Contamination in Ammonia Refrigeration Systems
- Bulletin 109: Minimum Safety Criteria for a Safe Ammonia Refrigeration System
- Bulletin 110: Guidelines for Start-up, Inspection and Maintenance of Ammonia Mechanical Refrigeration Systems
- Bulletin 116: Avoiding Component Failure in Industrial Refrigeration Systems Caused by Abnormal Pressure or Shock

THANK YOU!

Questions and Answers (Q & A)