Recent Changes to Ammonia Refrigeration RAGAGEP

Eli Macha & Chad Collin

INTRODUCTION

WHAT **CHANGES** WERE MADE TO THESE IMPORTANT STANDARDS?

THIS PRESENTATION WILL PROVIDE THE **HIGHLIGHTS**, RATHER THAN ALL DETAILS.

BECOME PREPARED FOR YOUR NEXT **REGULATORY INSPECTION**.

CALIFORNIA CUPA FORUM

Recent Changes to IIAR Standards

#	Standard Title	Previous	New
2	American National Standard for **Design** of Safe Closed-Circuit Ammonia Refrigeration Systems	2014	2021
4	American National Standard for the **Installation** of Closed-Circuit Ammonia Refrigeration Systems	2015	2020
5	American National Standard for the **Startup** of Closed-Circuit Ammonia Refrigeration Systems	2013	2019
6	American National Standard for the **Inspection, Testing, and Maintenance** of Closed-Circuit Ammonia Refrigeration Systems	N/A	2019
7	American National Standard for Developing **Operating Procedures** for Closed-Circuit Ammonia Refrigeration Systems	2013	2019
8	American National Standard for **Decommissioning** of Closed-Circuit Ammonia Refrigeration Systems	2015	2020
9	American National Standard for **Minimum System Safety** Requirements for **Existing** Closed-Circuit Ammonia Refrigeration **Systems**	N/A	2020

RAGAGEP

Why do IIAR standards matter to the ammonia refrigeration industry?

	Title 29 CFR §1910.119 OSHA's Process Safety Management	Title 40 CFR §68 EPA's Risk Management Program
Equipment (design)	§1910.119(d)(3)(ii) The employer shall document that equipment complies with **recognized and generally accepted good engineering practices**.	§68.65(d)(2) The owner or operator shall document that equipment complies with **recognized and generally accepted good engineering practices**.
Inspection and testing procedures	§1910.119(j)(4)(ii) Inspection and testing procedures shall follow **recognized and generally accepted good engineering practices**.	§68.73(d)(2) Inspection and testing procedures shall follow **recognized and generally accepted good engineering practices**.
Inspection and testing frequency	§1910.119(j)(4)(iii) The frequency of inspections and tests of process equipment shall be consistent with applicable manufacturers' recommendations and **good engineering practices**, and more frequently if determined to be necessary by prior operating experience.	§68.73(d)(3) The frequency of inspections and tests of process equipment shall be consistent with applicable manufacturers' recommendations and **good engineering practices**, and more frequently if determined to be necessary by prior operating experience.

RAGAGEP

References in PSM & RMP Regulations

CalARP

(d) Inspection and testing.

(1) Inspections and tests shall be performed on process equipment.

(2) Inspection and testing procedures shall follow recognized and generally accepted good engineering practices.

(3) The frequency of inspections and tests of process equipment shall be consistent with applicable manufacturers' recommendations and good engineering practices, and more frequently if determined to be necessary by prior operating experience.

Conflicting RAGAGEPS

iiar®

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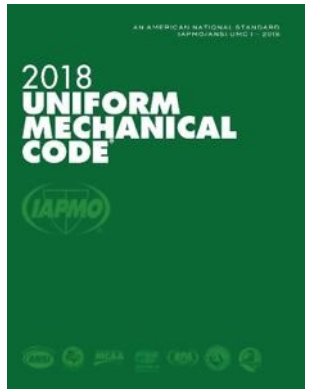

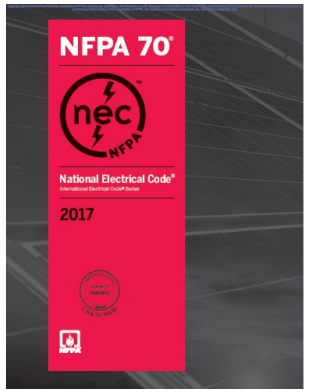

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25th California Unified Program
Annual Training Conference
March 20-23, 2023

Model code	Reference to IIAR
2021 Uniform Mechanical Code	§1102.2 Ammonia Refrigeration Systems. Refrigeration systems using ammonia as the refrigerant shall comply with **IIAR 2, IIAR 3, IIAR 4, and IIAR 5** and shall not be required to comply with this chapter.
2021 International Mechanical Code	§1101.1.2 Ammonia refrigerant. Refrigerant systems using ammonia as the refrigerant shall comply with **IIAR 2, IIAR 3, IIAR 4 and IIAR 5** and shall not be required to comply with this chapter.

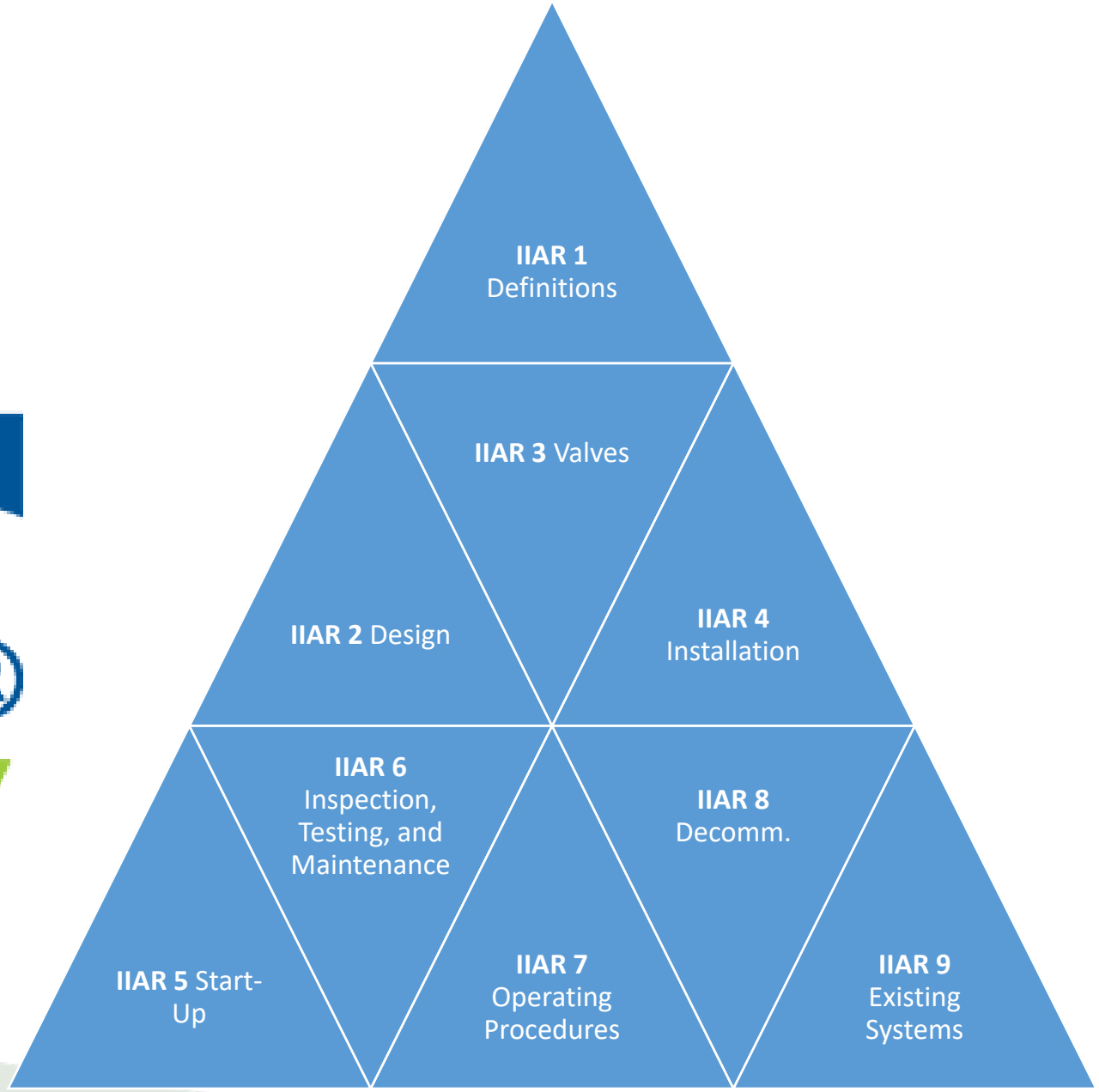
IIAR Standards

Referenced in model codes

Model code	Reference to IIAR
2021 International Fire Code	§608.1.2 Ammonia refrigeration. Refrigeration systems using ammonia refrigerant and the buildings in which such systems are installed shall comply with **IIAR 2** for system design; **IIAR 6** for inspection, testing and maintenance; and **IIAR 7** for operating procedures. Decommissioning of ammonia refrigeration systems shall comply with **IIAR 8**, and engineering practices for existing ammonia refrigeration systems shall be in accordance with **IIAR 9**.
2021 NFPA 1	§53.1.3.2 Refrigeration systems using ammonia as the refrigerant shall comply with ANSI/**IIAR 2**, Standard for Equipment, Design, and Installation of Closed-Circuit Ammonia Mechanical Refrigerating Systems; ANSI/**IIAR 6**, Standard for Inspection, Testing, and Maintenance of Closed-Circuit Ammonia Refrigeration Systems; ANSI/**IIAR 7**, Developing Operating Procedures for Closed-Circuit Ammonia Mechanical Refrigerating Systems; and ANSI/**IIAR 8**, Decommissioning of Closed-Circuit Ammonia Mechanical Refrigerating Systems.

IIAR Standards

Referenced in model codes



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ANSI/IIAR 2-2021

American National Standard for Design of Safe Closed-Circuit Ammonia Refrigeration Systems

IIAR 2

Emergency Eyewash and Shower Stations

Bad News: More Units Are Needed

New Requirement

A permanent or portable means shall be provided for the provision of quick drenching or flushing of the eyes and body within or directly adjacent to the work area for immediate emergency use when maintenance occurs that involves the deliberate opening of an ammonia refrigeration system. Such means shall be indicated in the design documents, and shall comply with the temperature, flow and duration specifications of ANSI/ISEA Z358.1.

Possible Solutions

- Plumbed units throughout?
  - Each valve group?
  - Each oil draining location?
  - Freezing temperature?
- Portable units for each new facility?
  - What kind?

ANSI/IIAR 2-2021, §7.2.10

Options & Features

	Est. cost	Simultaneous use for eyes & body	15 min. for eyes & body	Fully portable (roof access)
15-Gal Portable Eyewash Station with Drench Hose	$1.3k	Partial	No	Yes
30-Gal Mobile Safety Shower & Eyewash with Cart	$8k	Yes	No	Yes
528-Gal Mobile Self-Contained Emergency Unit (Trailer)	$36k	Yes	Yes	No

Good News for Small Machinery Rooms

- An exemption is now provided for machinery rooms with less than 1,000 sqft. (e.g. 30' x 33')
- While an emergency eyewash and shower station is still required immediately outside the machinery room, one may not need to be installed inside given the following:
  1. All areas of the machinery room must still be within 55 feet of the outside unit,
  2. a portable unit must be moved into the machinery room while intentionally opening the system, and
  3. procedures must be posted in the machinery room on how to use the portable unit.

ANSI/IIAR 2-2021, §6.7.1.3

IIAR 2

Emergency Pressure Control Systems (EPCSs)

EPCS Exceptions

- This is the first time the EPCS is listed in the normative (mandatory section) of any IIAR standard.
- Qualifiers:
  1. Where required by the AHJ [authority having jurisdiction]
  2. Relief valves vent to atmosphere
  3. Potentially resulting in a public health consequence
- While installing an EPCS is a great idea, it may not be necessary if:
  1. The AHJ isn't requiring it
  2. The relief valves are piped to a diffusion tank (or other approved means)
  3. The facility is remote enough that relief valves releasing would not result in a public health consequence

ANSI/IIAR 2-2021, §15.6

EPCS Requirement Case Study

Email to AHJ

I would like your input on a matter concerning IIAR requirements. While the new system was built in 2015, the latest edition of IIAR 2 clarifies the intended interplay between diffusion tanks and emergency pressure control systems.

ANSI/IIAR 2-2021 §15.6 says: ….

Since no relief valves discharge directly to atmosphere, but are piped to the ammonia diffusion tank, we believe installing an EPCS may be unnecessary for Company XYZ's system. Please let us know if you agree with our assessment or if you would like us to install an EPCS in addition to the existing diffusion tank.

Response from AHJ

The diffusion tank is very effective. We concur with your conclusion. Company XYZ does not need the EPCS overpressure system. I will place a copy of this correspondence in your permanent file.

IIAR 2

Signage

Signage Changes

NFPA 704 Placards (Diamonds)

Buildings and facilities with refrigeration systems shall be provided with placards that display information in accordance with NFPA 704. Placards shall be located at restricted entrances to rooms or areas identified as likely to be accessed by emergency response personnel.

Machinery Room Signs

2014 Edition	2021 Edition
Instructions with details and steps for shutting down the system in an emergency	Instructions with details and steps for shutting down the system in an emergency
The name and telephone numbers of the refrigeration operating, maintenance, and management staff; emergency responders; and safety personnel The names and telephone numbers of all corporate, local, state, and federal agencies to be contacted as required in the event of a reportable incident	The **contact information** for whom to contact in an emergency
Quantity of ammonia in the system	**Maximum intended inventory** of ammonia in the system
Type and **quantity** of refrigerant oil in the system	Type of refrigerant compressor oil(s)
Field **test pressures** applied	Lowside and highside **design pressures**

ANSI/IIAR 2-2021, §5.14.2, 5.14.1.1

Ammonia Detection

- Previously, it was technically possible to have one sensor with varying setpoints for low-level alarm (25 ppm), activating ventilation (150 ppm), and shutting down equipment (40,000 ppm). Now, IIAR 2 explicitly states, "At least two ammonia detectors that have identical concentration sensing ranges shall be provided in the room…". While two are required, there is an exception to stick with one sensor if the failure of that sensor automatically turns on the emergency ventilation system.
- Visual indicators are required to latch (remain activated) at 150 ppm and must be reset inside the machinery room. Audible alarms, on the other hand, may either be reset by a manual switch inside the room or remotely.

ANSI/IIAR 2-2021, §6.13.1.1, 6.13.2.3

Ventilation Controls

- Instead of fans needing to be "non-sparking," they, "shall be constructed such that radial or axial displacement of the impeller or shaft will not permit two ferrous [consisting of iron] parts of the fan to rub or strike."
- The ventilation failure alert requirement has been clarified: "A means of proving emergency airflow shall be provided. The means of proving emergency airflow shall be capable of sensing a change in air flow of 25% or more, either by direct airflow measurement or indirect sensor readings. Failure to prove airflow when the emergency ventilation fans are energized shall provide notice to a monitored location. Devices that can be used to prove emergency airflow include but are not limited to: 1) pressure differential switches 2) sail switches 3) current monitors."

ANSI/IIAR 2-2021, §6.14.3.5, 6.14.7.6

ANSI/IIAR 2-2021

American National Standard for Design of Safe Closed-Circuit Ammonia Refrigeration Systems

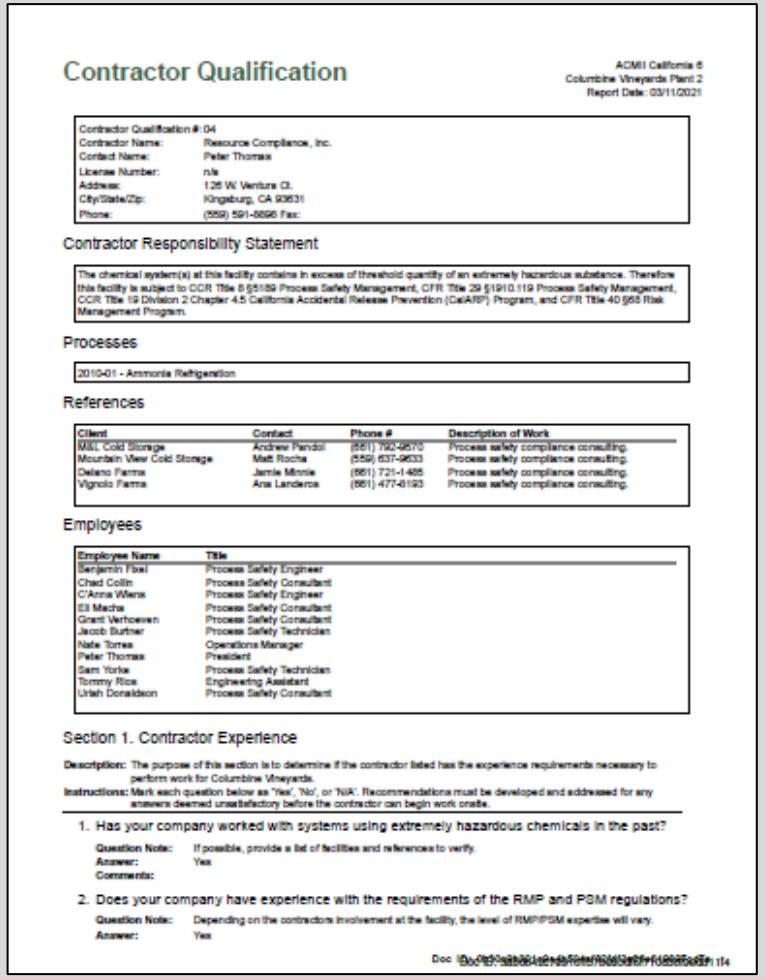
ANSI/IIAR 4-2020

American National Standard for the Installation of Closed-Circuit Ammonia Refrigeration Systems

Contractor Qualifications & Training

1. Contractors must provide the owner with documentation of employee and subcontractor employee qualifications (certifications, training, etc.).
2. Facility-specific safety training is also required prior to installation and must include:
   - Safety rules of the facility
   - Required safe work practices
   - PPE requirements and usage

With a well-formulated contractor packet, trainings and qualifications can be collected offsite. While facility-specific tailgate meetings work well onsite.



Contractor Qualification

ACME California 6
Columbine Vineyards Plant 2
Report Date: 03/11/2021

Contractor Qualification #: 04
Contractor Name: Resource Compliance, Inc.
Contact Name: Peter Thomas
License Number: n/a
Address: 126 W Ventura Ct.
City/State/Zip: Kingsburg, CA 93631
Phone: (559) 591-6696 Fax:

Contractor Responsibility Statement

The chemical system(s) at this facility contains in excess of threshold quantity of an extremely hazardous substance. Therefore this facility is subject to CCR Title 8 §5189 Process Safety Management, CFR Title 29 §1910.119 Process Safety Management, CCR Title 19 Division 2 Chapter 4.5 California Accidental Release Prevention (CalARP) Program, and CFR Title 40 §68 Risk Management Program.

Processes

2010-01 - Ammonia Refrigeration

References

Client	Contact	Phone #	Description of Work
M&L Cold Storage	Andrew Pandol	(661) 792-9870	Process safety compliance consulting.
Mountain View Cold Storage	Matt Rocha	(559) 637-9633	Process safety compliance consulting.
Delano Farms	Jamie Minnis	(661) 721-1405	Process safety compliance consulting.
Vignolo Farms	Ana Landeros	(661) 477-8193	Process safety compliance consulting.

Employees

Employee Name	Title
Benjamin Fbel	Process Safety Engineer
Chad Collin	Process Safety Consultant
C'Anna Wiens	Process Safety Engineer
Eli Macha	Process Safety Consultant
Grant Verhoeven	Process Safety Consultant
Jacob Buttner	Process Safety Technician
Nate Torres	Operations Manager
Peter Thomas	President
Sam Yorke	Process Safety Technician
Tommy Rice	Engineering Assistant
Uriah Donaldson	Process Safety Consultant

Section 1. Contractor Experience

Description: The purpose of this section is to determine if the contractor listed has the experience requirements necessary to perform work for Columbine Vineyards.
Instructions: Mark each question below as 'Yes', 'No', or 'N/A'. Recommendations must be developed and addressed for any answers deemed unsatisfactory before the contractor can begin work onsite.

1. Has your company worked with systems using extremely hazardous chemicals in the past?
   Question Note: If possible, provide a list of facilities and references to verify.
   Answer: Yes
   Comments:
2. Does your company have experience with the requirements of the RMP and PSM regulations?
   Question Note: Depending on the contractors involvement at the facility, the level of RMP/PSM expertise will vary.
   Answer: Yes

ANSI/IIAR 4-2020, §4.3-4

Welding Requirements

- ASME B&PVC, Section IX (2019)
- Welding Process Specification (WPS) – written instructions
- Procedure Qualification Record (PQR) – actual procedure used
- Welding and Welding Operator Performance Qualification Record (WPQR) – test weld records
- **Welder Performance Qualification (WPQ) records – welder test record**

ANSI/IIAR 4-2020, §4.5

QW-484 SUGGESTED FORMAT FOR WELDER/WELDING OPERATOR PERFORMANCE QUALIFICATIONS (WPQ)

(See QW-301, Section IX, ASME Boiler and Pressure Vessel Code)

elder's name _____ Clock number _____ Stamp no. _____
lding process(es) used _____ Type _____
ntification of WPS followed by welder during welding of test coupon _____
se material(s) welded _____ Thickness _____

Manual or Semiautomatic Variables for Each Process (QW-350)	Actual Values	Range Qualified
Backing (metal, weld metal, welded from both sides, flux, etc.) (QW-402)		
ASME P-No. _____ to ASME P-No. (QW-403)		
) Plate ( ) Pipe (enter diameter, if pipe)		
Filler metal specification (SFA): _____ Classification (QW-404)		
Filler metal F-No.		
Filler metal variety for GTAW, PAW (QW-404)		
Consumable insert for GTAW or PAW		
Weld deposit thickness for each welding process		
Welding position (1G, 5G, etc.) (QW-405)		
Progression (uphill/downhill)		
Backing gas for GTAW, PAW, or GMAW; fuel gas for OFW (QW-408)		
GMAW transfer mode (QW-409)		
GTAW welding current type/polarity		

Machine Welding Variables for the Process Used (QW-360)	Actual Values	Range Qualified
rect/remote visual control		
utomatic voltage control (GTAW)		
utomatic joint tracking		
Welding position (1G, 5G, etc.)		
onsumable insert		
acking (metal, weld metal, welded from both sides, flux, etc.)		

Guided Bend Test Results

Guided Bend Tests Type	( ) QW-462.2 (Side) Results	( ) QW-462.3(a) (Trans. R & F) Type	( ) QW-462.3(b) (Long. R & F) Results

examination results (QW-302.4) _____
graphic test results (QW-304 and QW-305) _____
ternative qualification of groove welds by radiography)
Weld — Fracture test _____ Length and percent of defects _____ in.
test fusion _____ Fillet leg size _____ in. × _____ in. Concavity/convexity _____ in.
g test conducted by _____
nical tests conducted by _____ Laboratory test no. _____
tify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements
ion IX of the ASME Code.

Organization _____

By _____

This form (E00008) may be obtained from the Order Dept., ASME, 22 Law Drive, Box 2300, Fairfield, NJ 07007-2300.

E00008

Welding Procedures

TECHNICON
ENGINEERING SERVICES, INC.

GEOTECHNICAL & ENVIRONMENTAL ENGINEERING ▪ CONSTRUCTION TESTING & INSPECTION

WELDER QUALIFICATION TEST RECORD (WQTR)

(Section IX, QW-484, ASME Boiler and Pressure Vessel Code)

Date:	November 14, 2016	**Test #**		**Job #**	
To:	CCA	**WPS #**	CCA-G6-2.375A	**Code:**	ASME Section IX
	39138 Road 56	**Witnessed by:**			
	Dinuba, CA 93618	**Test Date**	November 14, 2016		
Welder:		**Welders ID:**			

Testing Conditions and Range Qualified

Welding Variables	Actual Values	Range Qualified
Welding Processes:	SMAW	SMAW
Type of Welding, (Manual, semi-auto):	Manual	Manual
(QW-403)		
Base Metal, P number to P number:	P-1	P-1
☐ **Plate** ☒ **Pipe (Pipe Diameter):**	2"	1" & above
(QW-404)		
Filler Metal (SFA) Specifications	A5.1/A5.5	A5.1/A5.5
Filler Classification:	E6010	E6010/E6011
Filler Metal / F-Number:	F3	F3
Consumable Insert:	N/A	N/A
Weld Deposit Thickness:	.350"	.350"-.700"
(QW-405)		
Welding Position:	6G	All
Progression:	Downhill	Downhill
Backing:	None	None

Guide Bend Test

Visual Examination of Completed Joint: **Date of Test:**

☐ **Mechanical** ☐ **Peel (QB-462.3)** ☐ **Section (QB-462.4 0** ☐ **Tension (QB-462.1 (e)**

Root Bend	Face Bend	Root Bend	Face Bend		
PASS	PASS	PASS	PASS		

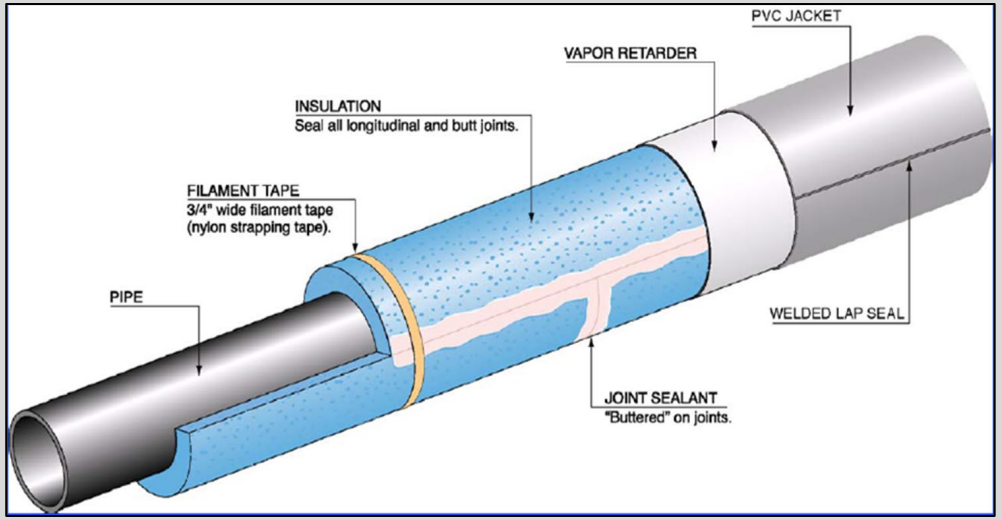
We, the undersigned, certify that the statements in this record are correct and that the tests were prepared, welded, and tested in accordance with the requirements of Section IX, ASME Boiler and Pressure Vessel Code.

Interpreted By:		**CWI STAMP**		**Lab Test Number**	5451
Organization:	TECHNICON Engineering Services, Inc.	AWS	**CWI**	**Date:**	November 14, 2016
Manufacture Or Contractor:	California Controlled Atmosphere		**QC1 EXP. 3/1/2019**	**Certified By:**	
Authorized by:		**Date:**		**CWI Number:**	

CORPORATE OFFICE ▪ 4539 N. Brawley Avenue #108, Fresno, CA 93722 ▪ P 559.276.9311 ▪ F 559.276.9344
VISALIA OFFICE ▪ 151 S. Dunworth Avenue, Visalia, CA 93292 ▪ P 559.732.0200 ▪ F 559.732.0830
MERCED OFFICE ▪ 2345 Jetway Drive, Atwater, CA 95301 ▪ P 209.384.9300 ▪ F 209.384.0891

Insulation

- Material selection
- Corrosion inhibiting gel
- Installation
- Supports
- Insulation must be installed when equipment or piping is clean, free of moisture, and per the insulation manufacturer's recommendations
- *In general*, aluminum jacketing is installed outdoors or in situations where high physical abuse is expected
- PVC jacketing *should* only be used for indoor locations
- The informative appendices provide guidance on ideal installation documentation, safety concerns related to corrosion under insulation (CUI), and more
- **Must keep at least one vessel nameplate visible**



ANSI/IIAR 4-2020, §8.1, App. C-D

ANSI/IIAR 4-2020

American National Standard for the Installation of Closed-Circuit Ammonia Refrigeration Systems

ANSI/IIAR 5-2019

American National Standard for the Startup of Closed-Circuit Ammonia Refrigeration Systems

Congruence Between the 2013 & 2019 Startup Standards

- Track activities related to:
  - Pre-charging
  - System charging
  - Startup
- Pre-Startup Safety Review (PSSR) checklist:
  - Leak testing, pressure testing, evacuation records
  - SOP development
  - Operator training
  - Equipment safety testing
  - For new systems, a formalized Process Hazard Analysis (PHA) was also required prior to ammonia charging

ANSI/IIAR 5-2019, §5-7

Name Change

The 2019 edition dropped the "Commissioning" language that was used in the 2013 title and throughout the standard.

New Requirement – Startup Plan & Team

- Written "Startup Plan" to execute the pre-charging, charging, and startup activities
- Startup Team:
  - Owner or Owner's Designated Representative;
  - Startup team leader;
  - Trained startup technician(s);
  - Qualified contractor(s), where applicable;
  - Operating and maintenance personnel.

ANSI/IIAR 5-2019, §5.1, 5.2

Other Changes

- All electrical system inspections must be completed prior to charging the system with ammonia; as opposed to startup in the 2013 edition.
- The normative requirements for documentation related to startup were reduced considerably: "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."
- Example documents were moved to Appendix A.5.3.1, that should be obtained. This includes typical PSI documents (as-built P&IDs, relief valve information, ventilation system design, etc.), SOPs, and PHAs.

ANSI/IIAR 5-2019, §5.3, 5.7, App. A

ANSI/IIAR 5-2019

Startup of Closed-Circuit Ammonia Refrigeration Systems

ANSI/IIAR 6-2019

American National Standard for the Inspection, Testing, and Maintenance of Closed-Circuit Ammonia Refrigeration Systems

New Standard

IIAR Bulletin Nos. 109 & 110

- These guidance documents are now retired
- Included soft language (e.g., may, should)
- Were not intended to be enforceable

ANSI/IIAR 6-2019

- Covers the minimum requirements for inspection, testing, and maintenance (ITM)
- Removed all soft language with rigid language (e.g., shall, must)
- Intended to be enforceable by authorities having jurisdiction (AHJs)

IIAR 6

Valve Maintenance

Valve Maintenance

- All non-emergency shut-off valves must be exercised and lubricated at least every **five years**.
- All system emergency shut-off valves must be:
  - Exercised and lubricated **annually**
  - Functionally tested every **five years**
- The term, "system emergency shut-off valves" is left undefined, which means it is up to the facility to determine.
  - King Valve(s)
  - LIC Isolation Valves?
  - Zone Isolation Valves?
- 5-year valve maintenance may not be sufficient in drier climates.

ANSI/IIAR 6-2019, Table 11.1.6 Maintenance Items (b) & (c)

IIAR 6

Compressor Inspections & Tests

Running	Yes/No
Run Time	Hours
Oil Level	Sight glass should be 1/2 full
Alarms	Yes/No - check microprocessor
Suction Temperature	19°F - 34°F
Suction Pressure	33 psig - 50 psig
Discharge Temperature (Liquid Injection)	125°F - 145°F
Discharge Temperature (Thermosyphon/Water Cooled)	155°F - 170°F
Discharge Pressure	120 psig - 195 psig
Oil Temperature	120°F - 170°F
Oil Pressure	60 psig - 90 psig
Oil Filter Differential Pressure	1 psig - 10 psig
Free from oil leaks?	Yes/No
Motor Amps	A
Slide Valve	%
Oil Cooling Water	Is water visible in sight glass? (Yes/No)
Free from abnormal sounds and vibration?	Yes/No
Drive guard in place?	Yes/No

ANSI/IIAR 6-2019, Table 6.1

Daily Compressor Inspections

There are quite a few more daily items to inspect on the compressors. Most facilities will need to update their daily log accordingly.

Annual Compressor Activities

Compressor Alignment

- The alignment of the compressor motor drive shaft must be visually inspected.
- This can't be done visually, but with calipers or laser alignment.
- Some in the industry believe vibration analysis satisfies the requirement for determining if misalignment is present.

Oil Analysis

- Oil analysis must be performed annually.
- Instead of analyzing it, the oil can simply be replaced.
- This activity may be completed based on 8,780 runtime hours.

ANSI/IIAR 6-2019, Table 11.1.6 Inspection Item (y) & Maintenance Item (d)

ANSI/IIAR 6-2019, Table 12.3 Testing Item (a)

Ammonia Sensors

The two most common calibration frequencies recommended by manufacturers was six-months and annually. Now, IIAR 6 has prescriptively required calibrating sensors at least every **six months**.

FORM U-1A MANUFACTURER'S DATA REPORT FOR PRESSURE VESSELS

ANSI/IIAR 6-2019 §10.1.4.3 *Where the original pressure vessel nameplate or design information is no longer available, preventing the development and installation of a replacement or duplicate nameplate, the owner shall provide historical ITM data, maintenance reports, or a combination thereof, to verify the pressure vessel has been maintained and has continuously operated safely or the owner shall proceed with the replacement of the subject pressure vessel in a safe and timely manner.

ANSI/IIAR 6-2019 §**A**.10.1.4.3 Where no documentation exists for the material of construction, welding procedures, or radiographic testing, an engineering analysis can be conducted as a means of determining that the in-service condition of the pressure vessel is appropriate for its intended safe use. This can also be done for regulated (e.g., PSM/RMP) pressure vessels where no documentation exists. The engineering analysis should be in conformance with the latest editions of codes and standards. The owner should document the engineering analysis results pertaining to its design and also determine and document that the pressure vessel is inspected, tested, maintained, and operating in a safe manner.

Manufacturer Data Reports

While other codes have consistently required manufacturer data reports to be maintained for all pressure vessels (and ASME-certified heat exchangers), this requirement was not explicitly found within IIAR standards until now.

ANSI/IIAR 6-2019, §5.3.3.7

Year	Regular annual due date	IIAR 6 window (9-15 months)
1	August 15, 2016	August 15, 2016
2	August 2, 2017	September 3, 2017
3	July 5, 2018	August 24, 2018
4	June 21, 2019	August 8, 2019
5	June 8, 2020	July 13, 2020
6	May 28, 2021	August 3, 2021
7	May 12, 2022	August 25, 2022

Date Creep

IIAR 6 now offers substantial lenience on due dates. For example, annual activities must be completed within 9-15 months.

Because of this flexibility, date creep is prevented.

ANSI/IIAR 6-2019, Table 5.2

B109

International Institute of Ammonia Refrigeration

Ammonia Refrigeration Safety Inspection Checklist

ID Number: _____

COMPRESSORS

Plant Owner: _____

Address: _____

Contact: _____ Telephone: _____

Inspector: _____ Date: _____

Compressor

Compressor Location: _____

Compressor Identification Mark/No.: _____

Application

☐ High Stage ☐ Single Stage

☐ Booster ☐ Swing

Type

☐ Rotary Screw ☐ Rotary Vane

☐ Reciprocating ☐ Vertical Reciprocating

Application Data

Type of Drive: ☐ Belt ☐ Direct

Operating Speed (*rpm*): _____

Design Capacity (TR): _____ Suction (*psig*): _____ Discharge (*psig*): _____

Min. Suction Pressure (*psig*): _____ Max. Discharge Pressure (*psig*): _____

Type of Relief Valve: ☐ Internal ☐ External

Size (*lb/min air*): _____ Set Pressure (*psig*): _____

Compressor Nameplate Data

Manufacturer, Name, Model, Serial No.: _____

Year Manufactured: _____

Refrigerant: ☐ Ammonia ☐ Other: _____

Max. Design Working Pressure (*psig*): _____

Max. Rotation Speed (*rpm*): _____

Direction of Rotation: ☐ clockwise ☐ counterclockwise

Flow Direction Shown? ☐ Yes ☐ No

Compressor Operating Limits

Speed Max. (*rpm*): _____ Min. (*rpm*): _____

Max. Compression Ratio: _____

Design Discharge Pressure (*psig*): _____

Design Crankcase/Housing Pressure (*psig*): _____

Max. Discharge Temperature (*°F*): _____

Max. Oil Temperature (*°F*): _____

Motor Nameplate Data

Manufacturer, Name, Model, Serial No., Year Manufactured: _____

Frame Size: _____ Type: _____ Speed (*rpm*): _____ Power (*hp*): _____

Voltage (*V*): _____ FLA (*amps*): _____ Phase: ☐ 1 ☐ 3

Frequency (*Hz*): _____ Belt size and number: _____

Safety Cutouts

High Pressure Setting (*psig*): _____ Type: _____ Functions Properly? _____

Low Pressure Setting (*psig*): _____ Type: _____ Functions Properly? _____

Oil Pressure Setting (*psid*): _____ Type: _____ Functions Properly? _____

IIAR 6B

Ammonia Refrigeration Safety Inspection Checklist

COMPRESSORS

Location: _____ ID/Tag No.: _____

Facility Owner: _____

Address: _____

Contact: _____ Phone: _____

Inspector: _____ Date: _____

Application:

High Stage ☐ Booster ☐ Single Stage ☐ Swing ☐

Type:

Rotary Screw ☐ Rotary Vane ☐ Reciprocating ☐ Vertical Recip. ☐

Oil Cooling:

Shell & Tube ☐ Plate & Shell ☐ Plate & Frame ☐ Welded Plate ☐ Liquid Injection ☐ Other ☐

Cooling Medium: Ammonia ☐, Water ☐, Glycol ☐, Other ☐

Equipment Data and Limits:

Manufacturer: _____ Model: _____ Serial Number: _____

Year Mfg.: _____ Refrigerant: ☐ Ammonia, ☐ Other: _____

Max Speed (rpm): _____ Min Speed (rpm): _____

Max Discharge Temp (°F): _____ Max Working Pressure (psig): _____

Max Oil Temp (°F): _____ Design Discharge Temperature (°F): _____

Operating Data:

Type of Drive: ☐ Belt, ☐ Direct, ☐ VFD Operating Speed: (rpm) _____

Direction of Rotation: ☐ Clockwise, ☐ Counter Clockwise Direction Arrow Installed? ☐ Yes, ☐ No

Saturated Suction (psig[Hg] / °F): _____ / _____ Discharge (psig/°F): _____ / _____

Relief Valve Data:

Manufacturer: _____ Model: _____ Year Installed: _____

Assembly: Type of Relief Valve: ☐ Internal, ☐ External

Pressure Setting (psig): _____ Capacity (lbs. air per min/SCFM): _____ / _____

Motor Data:

Manufacturer: _____ hp: _____ rpm: _____ FLA: _____

Frequency (Hz): _____ Voltage: _____ Phase: _____ Service Factor: _____

Frame Size: _____ Belt Qty: _____ Belt Size: _____

Safety Cutouts: Type: Pressure Switch = PS, Transducer = TD *Typically Fixed Factory Setpoints

Type:			Type:	
_____ Low Suction Pressure Alarm	_____ psig/ Hg		_____ Low Oil Temperature Alarm*	_____ °F
_____ Low Suction Pressure Cutout	_____ psig/ Hg		_____ Low Oil Temperature Cutout*	_____ °F
_____ Low Suction Temperature Alarm	_____ °F		_____ High Oil Temperature Alarm*	_____ °F
_____ Low Suction Temperature Cutout	_____ °F		_____ High Oil Temperature Cutout*	_____ °F
_____ High Discharge Pressure Alarm*	_____ psig		_____ Low Oil Pressure Alarm*	_____ psig
_____ High Discharge Pressure Cutout*	_____ psig		_____ Low Oil Pressure Cutout*	_____ psig
_____ High Discharge Temp Alarm*	_____ °F		_____ High Discharge Temp Cutout*	_____ °F

B109

ID Number: _____

COMPRESSORS

Requirement/Recommendation	Conforms	Recommended Action/Comments	Safety Status	Target Date
a) Nameplate legible and complete?	☐ Yes ☐ No			
b) Designed for ammonia?	☐ Yes ☐ No			
c) Operating within limitations:				
1) Compressor RPM?	☐ Yes ☐ No			
2) Compressor ratio?	☐ Yes ☐ No			
3) Discharge pressure?	☐ Yes ☐ No			
4) Max. crankcase pressure?	☐ Yes ☐ No			
d) Drive (belts, sheaves, coupling) properly cleaned?	☐ Yes ☐ No			
e) Has compressor been modified, altered, damaged or repaired such that casing integrity is affected? If yes, has casing been recertified and documented?	☐ Yes ☐ No			
f) Free from excessive vibration?	☐ Yes ☐ No			
g) Anchored and grouted securely in place?	☐ Yes ☐ No			
h) Suction, discharge and oil pressure discharge temperature gauges present and functioning properly?	☐ Yes ☐ No			
i) High pressure, low pressure, and low diff. oil pressure switches functioning properly?	☐ Yes ☐ No			
j) Does compressor have internal or external relief valve? If external, does it meet applicable requirements?	☐ Yes ☐ No ☐ Yes ☐ No			
k) Does compressor have suction and discharge stop valves and discharge check valve?	☐ Yes ☐ No			

Are there any other conditions that might negatively affect safe compressor operation? ☐ Yes ☐ No

If yes, describe. _____

_____

_____

_____

_____

IIAR 6B

Ammonia Refrigeration Safety Inspection Checklist

COMPRESSORS

Location: ID/Tag No.:

Inspection Items	Conforms	Safety Status	Recommended Action, or Comments	Target Date
a) Equipment labeled and nameplate legible per ANSI/IIAR 2?	Yes ☐ No ☐ N/A ☐			
b) Suitable for ammonia?	Yes ☐ No ☐ N/A ☐			
c) Operating within limits?	Yes ☐ No ☐ N/A ☐			
d) Fasteners tight, adequately anchored, and supported?	Yes ☐ No ☐ N/A ☐			
e) Safe access for Inspection, Testing, and Maintenance (ITM)?	Yes ☐ No ☐ N/A ☐			
f) Free of excessive ice buildup?	Yes ☐ No ☐ N/A ☐			
g) Free of abnormal sounds/vibration?	Yes ☐ No ☐ N/A ☐			
h) Free of ammonia leaks?	Yes ☐ No ☐ N/A ☐			
i) All piping has markers per ANSI/IIAR 2?	Yes ☐ No ☐ N/A ☐			
j) Are valves in good condition?	Yes ☐ No ☐ N/A ☐			
k) Are critical manual and control valves tagged, exercised, and stems lubricated?	Yes ☐ No ☐ N/A ☐			
l) Sufficient pressure/temperature gauges and/or transducers are present and functioning adequately?	Yes ☐ No ☐ N/A ☐			
m) Drive train (belts, sheaves, coupling, etc.) in good working order and adequately guarded?	Yes ☐ No ☐ N/A ☐			
n) Free of modifications, alterations, damage or repairs such that casing integrity is or has been affected?	Yes ☐ No ☐ N/A ☐			
o) If No, has it been pressure tested and documentation filed?	Yes ☐ No ☐ N/A ☐			
p) At a minimum, compressor has suction and discharge stop valves, and a discharge check valve?	Yes ☐ No ☐ N/A ☐			
q) Safety Cutouts functioning adequately?	Yes ☐ No ☐ N/A ☐			
r) At a minimum, high pressure, low pressure, and differential oil pressure control devices are present and functioning adequately?	Yes ☐ No ☐ N/A ☐			
s) Free of pitting and surface damage? a. If No, note damage level:	Yes ☐ No ☐ N/A ☐ Slight ☐ Extensive ☐			
t) Free of any other conditions that negatively affect safe operation?	Yes ☐ No ☐ N/A ☐			

If No, describe: _____

_____

_____

ANSI/IIAR 6-2019

American National Standard for the Inspection, Testing, and Maintenance of Closed-Circuit Ammonia Refrigeration Systems

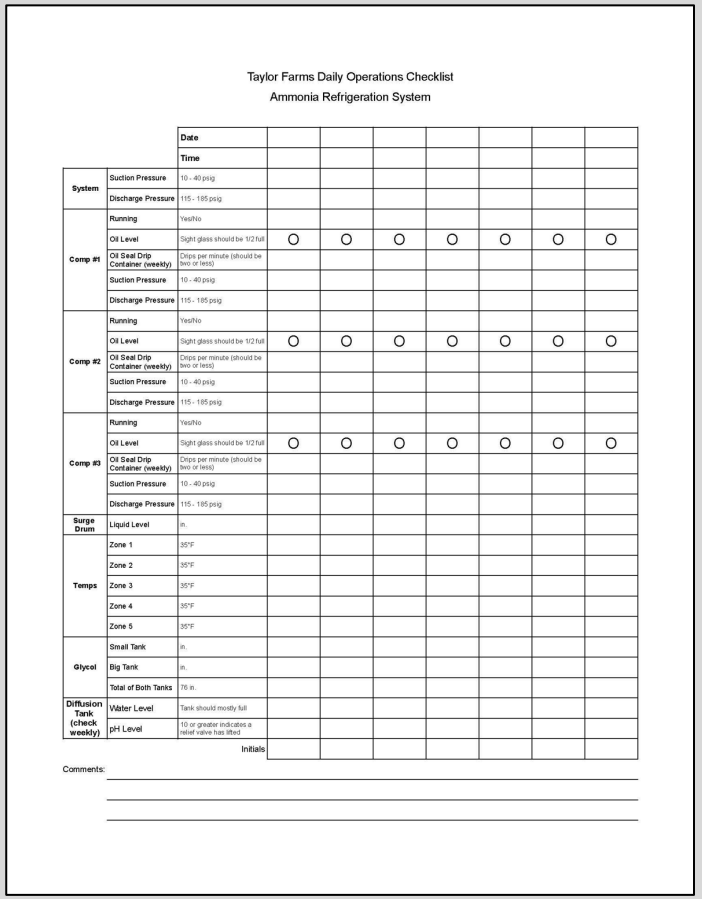
BREAK TIME!

ANSI/IIAR 7-2019

American National Standard for Developing Operating Procedures for Closed-Circuit Ammonia Refrigeration Systems

Operating Procedures & ITM Procedures

- This newer edition is careful to delineate which procedures should be covered in the operating procedures and which procedures should be covered in the mechanical integrity program (ITM procedures).
- In the 2019 edition, these details have been scrubbed in lieu of this statement: "Verification that the [equipment type] parameters are within expected operating limits and troubleshooting as necessary."



Taylor Farms Daily Operations Checklist
Ammonia Refrigeration System

		Date							
		Time							
System	Suction Pressure	10 - 40 psig							
	Discharge Pressure	115 - 185 psig							
Comp #1	Running	Yes/No							
	Oil Level	Sight glass should be 1/2 full	O	O	O	O	O	O	O
	Oil Seal Drip Container (weekly)	Drips per minute (should be two or less)							
	Suction Pressure	10 - 40 psig							
	Discharge Pressure	115 - 185 psig							
Comp #2	Running	Yes/No							
	Oil Level	Sight glass should be 1/2 full	O	O	O	O	O	O	O
	Oil Seal Drip Container (weekly)	Drips per minute (should be two or less)							
	Suction Pressure	10 - 40 psig							
	Discharge Pressure	115 - 185 psig							
Comp #3	Running	Yes/No							
	Oil Level	Sight glass should be 1/2 full	O	O	O	O	O	O	O
	Oil Seal Drip Container (weekly)	Drips per minute (should be two or less)							
	Suction Pressure	10 - 40 psig							
	Discharge Pressure	115 - 185 psig							
Surge Drum	Liquid Level	in.							
Temps	Zone 1	35°F							
	Zone 2	35°F							
	Zone 3	35°F							
	Zone 4	35°F							
	Zone 5	35°F							
Glycol	Small Tank	in.							
	Big Tank	in.							
	Total of Both Tanks	76 in.							
Diffusion Tank (check weekly)	Water Level	Tank should mostly full							
	pH Level	10 or greater indicates a relief valve has lifted							
		Initials							

Comments:

ANSI/IIAR 7-2019, §6.3.1

Abnormal Shutdown Conditions

Changes in IIAR 7

- Previously, the wording was, "Start-up following a turnaround, or after an emergency shutdown."
- IIAR 7 has updated verbiage regarding this operating phase: "Startup Procedures Following **Abnormal** Shutdown Conditions or a Turnaround."

Case Study

A two-stage system in California had a release after a power outage. The controls of the compressors allowed the booster compressor to turn on before the high stage compressor which resulted in a pressure build up in the intercooler. The intercooler's relief valve functioned properly, but this scenario highlighted the need for better controls and the steps to take for properly restarting the system with technician oversight after a power outage.

ANSI/IIAR 7-2019, §4.1.7

Miscellaneous SOP Updates

- When manually purging noncondensables from the system, the operating procedure should address properly disposing of the "water and ammonia fluid mixture."
- The ammonia charging procedure should address, "steps to achieve the proper pressure differential."
- The "Sample Line Opening Procedures" that were included in Appendix C of ANSI/IIAR 7-2013 were removed from the 2019 edition.
- And finally, a whole new chapter was added entitled, "Safety Systems." While this term is not defined, ostensibly this means operating procedures should be developed for ammonia detection systems, ammonia diffusion tanks, emergency ventilation systems, and equivalent apparatuses.

ANSI/IIAR 7-2019, §14.2.7, 14.1.1.6, 13

ANSI/IIAR 7-2019

American National Standard for Developing Operating Procedures for Closed-Circuit Ammonia Refrigeration Systems

ANSI/IIAR 8-2020

American National Standard for Decommissioning of Closed-Circuit Ammonia Refrigeration Systems

Stringent Documentation

2015 Edition

- "The following items shall be ***considered*** when developing an initial plan…"
- "Specify in writing the precautions and ***general*** steps that shall be followed during decommissioning activities…"

2020 Edition

- "The requirements in Chapter 4 shall be ***addressed prior*** to the start of the decommissioning activities."
- "Develop ***operating procedures*** that document the steps that will be taken during decommissioning activities." (Aligns with RMP/PSM language)

ANSI/IIAR 8-2020, §4.1, 4.10

Decommissioning Team

- Certain positions must be filled and identified prior to decommissioning:
  - Coordinator
  - Decommissioning Team Members
  - Response Personnel
  - Affected Personnel
- Was this an intent to mirror the HAZWOPER regulations for emergency response?
- Note: the "Response Personnel" may be offsite personnel, but it can also be facility personnel or contractors.

ANSI/IIAR 8-2020, §4.7

Verifying Safety Systems

Requirement

- Before decommissioning, the team needs to, "Conduct a review of the latest inspections, testing, and maintenance tasks previously performed on the safety systems and transfer equipment associated with the decommissioning activities."

Example

- 150 psig relief valves were recently bench tested and failed. This would be crucial information to know during decommissioning where stagnant ammonia is liable to reach this pressure based on ambient temperatures.

ANSI/IIAR 8-2020, §4.11

Final Review

Before decommissioning can begin, a “final review” must be conducted to ensure all preparatory steps have been completed.

ANSI/IIAR 8-2020, §5.1.1

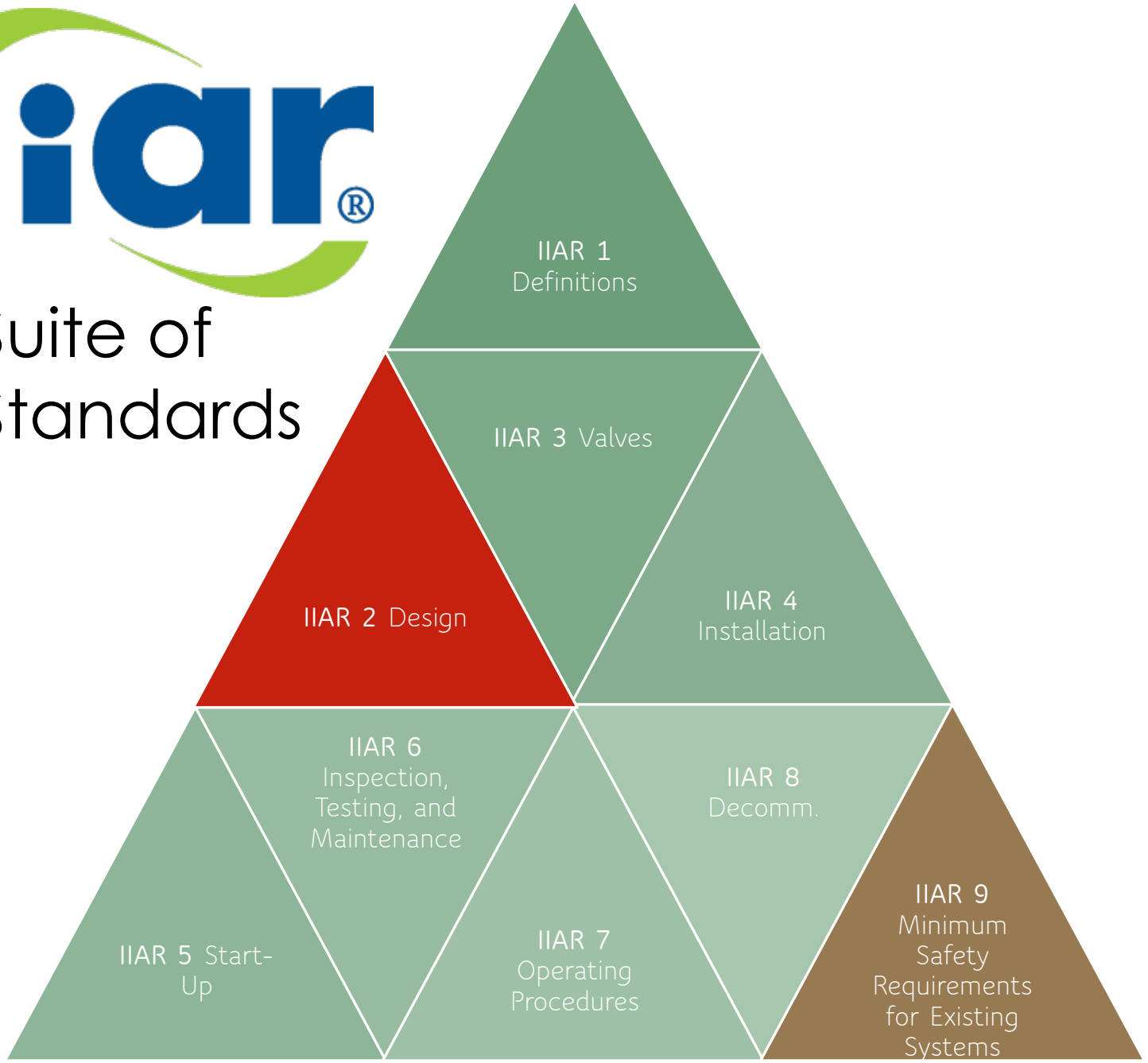
ANSI/IIAR 8-2020

American National Standard for Decommissioning of Closed-Circuit Ammonia Refrigeration Systems

ANSI/IIAR 9-2020

American National Standard for Minimum System Safety Requirements for Existing Closed-Circuit Ammonia Refrigeration Systems

Suite of Standards



IIAR 9 -2020:

1. Completed **IIAR's suite of standards** from standard 1 (Definitions) to this first installment of standard 9, addressing all phases of ammonia refrigeration in between.
2. IIAR 9 aims to address the age-old question of **"grandfathering" equipment** when compared to new design requirements.

Existing systems have risks that could impact employees and the community at large

IIAR 2 was not written to force existing systems into extensive upgrades

New Requirement – Minimum System Safety Evaluation (MSSE)

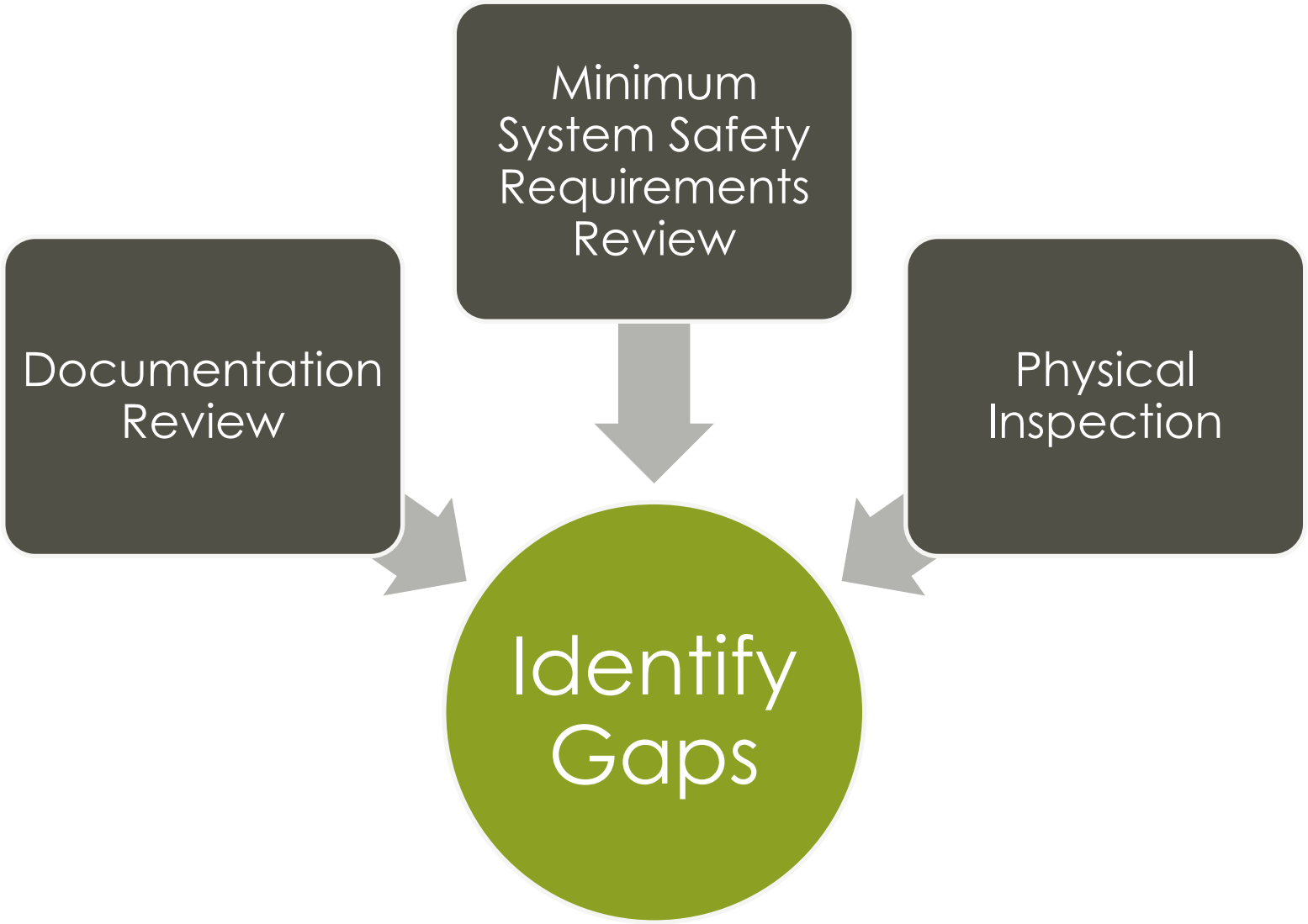
Basic Requirements:

- An MSSE must evaluate and identify gaps that were discovered compared to chapter 7 of the standard.
- Initial MSSE must be completed by **March 2025**, so there is still time.
- MSSEs must be re-validated every five years.

Options for Completion:

- Beneficial but not required, to perform MSSEs in conjunction with PHAs.
- End users may check with their PSM coordinator or consultant, as they likely have already developed a procedure which can be used.
- Research and develop in house

ANSI/IIAR 9-2020, §8.2, §8.3



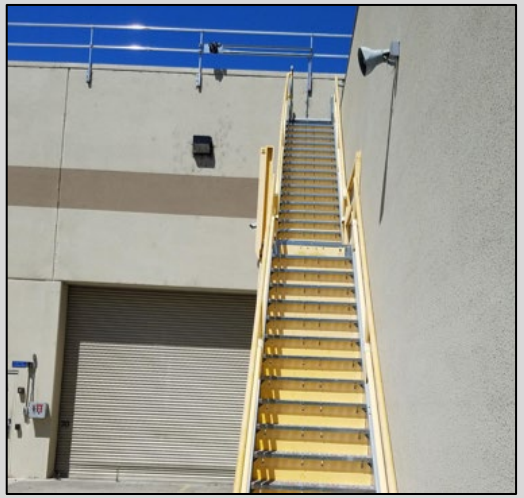
MSSEs

Must Include:

- Documentation review
- Minimum system safety requirements review compared to chapter 7
- Physical system inspection
- A written report with the identified gaps
- The gaps must be closed out or declined with justification, in a timely manner.

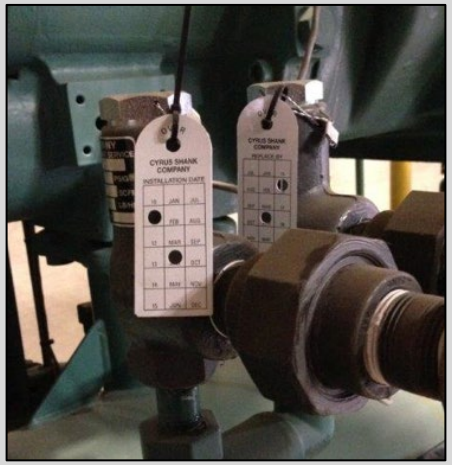
Shared between IIAR 9 & IIAR 2-2021

– See Table 6 in paper



Shared between IIAR 9 & IIAR 2-2021

– See Table 6 in paper



Subject	IIAR 2 Summary	IIAR 9 Summary	IIAR 9 Ref.
Low-side minimum design pressure	250 psig	150 psig	§7.2.2
Ammonia detection locations	Detection required everywhere ammonia refrigeration equipment is installed indoors; some exceptions apply	Prior to 2014, detection is not required outside of the machinery room.	§A.7.3.12
Ammonia detection minimum alarm levels	25 ppm	50 ppm	§7.3.12.2
Machinery room emergency ventilation activation	150 ppm	1,000 ppm	§7.3.12.2
Eyewash and safety showers	…required wherever deliberate opening of an ammonia system occurs (line break).	At least one inside one and outside the machinery room; no requirement in other areas.	§7.3.7.1

Allowed differences comparing IIAR 9 and IIAR 2-2021

Other Notable Requirements

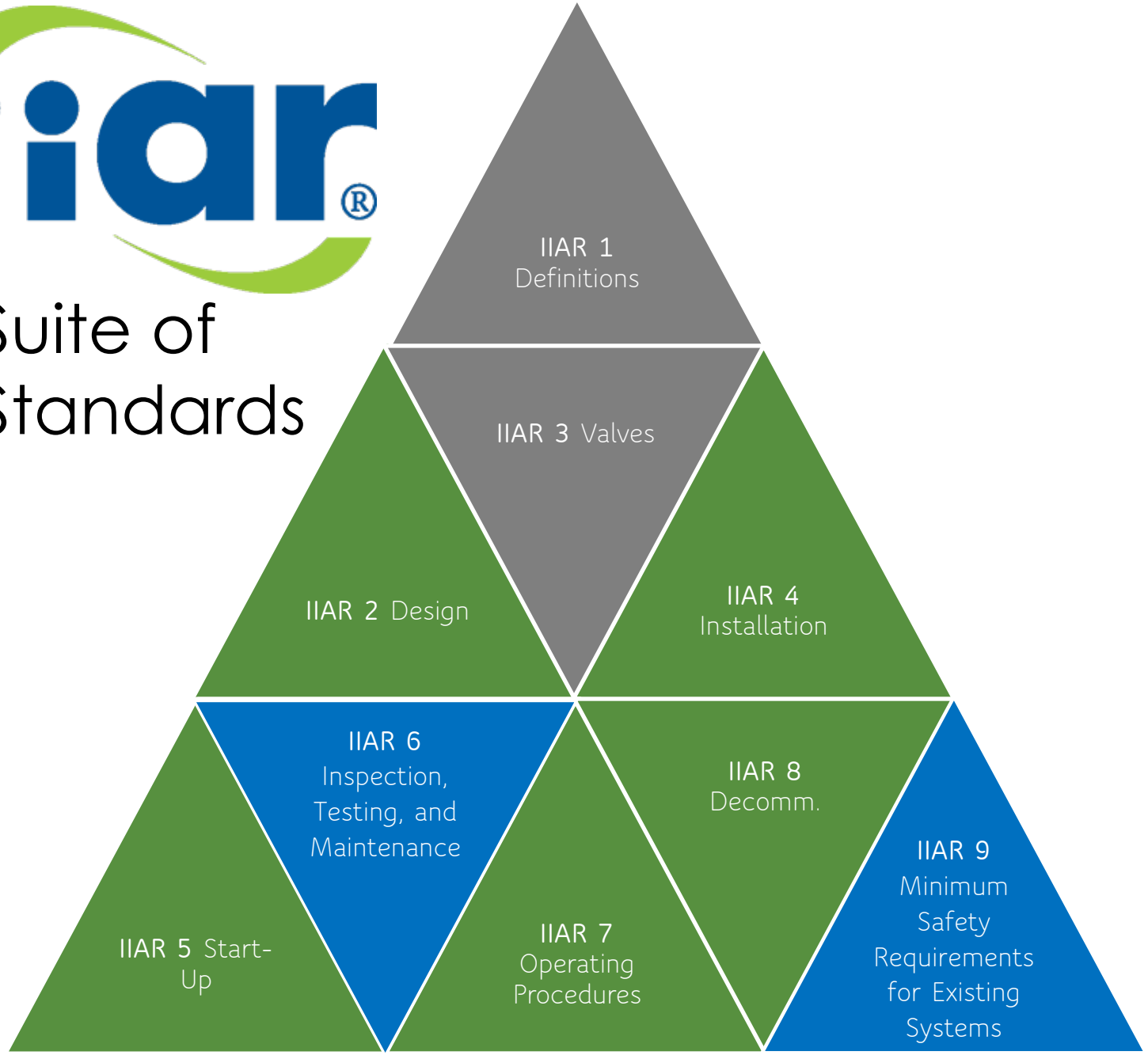
- The normative sections in IIAR 9, which do not pertain to the MSSE, are brief but include critical information for any facility. These notable requirements include:
  - All equipment and system components shall be inspected, tested, and maintained in accordance with ANSI/IIAR 6 (2019).
  - Operating procedures shall be developed in accordance with the requirements of ANSI/IIAR 7 (2019).

ANSI/IIAR 9-2020, §5.1, §6.1

ANSI/IIAR 9-2020

American National Standard for Minimum System Safety Requirements for Existing Closed-Circuit Ammonia Refrigeration Systems

Suite of Standards



Conclusion

- Updated Standards since 2019 – 7
- Initial publication of Standards since 2019 – 2

References

- IIAR. (1997). Bulletin No. 109: IIAR Minimum Safety Criteria for a Safe Ammonia Refrigeration System.
- IIAR. (2007). Bulletin No. 110: Guidelines for Start-up, Inspection and Maintenance of Ammonia Mechanical Refrigerating Systems.
- IIAR. (2013). ANSI/IIAR 7-2013: Developing Operating Procedures for Closed-Circuit Ammonia Mechanical Refrigerating Systems.
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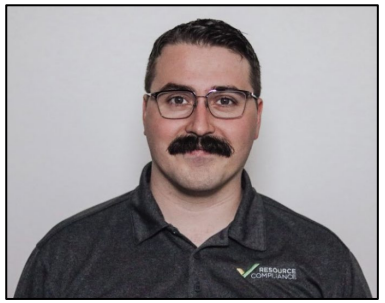
CALIFORNIA CUPA FORUM

THANK YOU



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