IIAR Standards & Safe Ammonia Refrigeration Management Practices

Presented by:
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Senior Director of Standards and Safety

SAFE AND SUSTAINABLE USE OF NATURAL REFRIGERANTS

IIAR Suite of Standards

Closed-Circuit Ammonia Refrigeration Systems

IIAR 1 – Definitions and Terminology Used in IIAR Standards
IIAR 2 – Safe Design (of…)
IIAR 3 – Ammonia Refrigeration Valves
IIAR 4 – Installation (of…)
IIAR 5 – Start-up (of…)
IIAR 6 – Inspection, Testing, and Maintenance (of…)
IIAR 7 – Developing Operating Procedures (for…)
IIAR 8 – Decommissioning (of…)
IIAR 9 – Minimum System Safety Requirements (for Existing…)

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IIAR 8 – Decommissioning (of…)

IIAR 9 – Minimum System Safety Requirements (for Existing…)

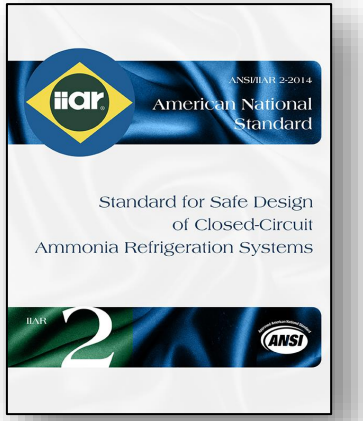
Ammonia Refrigeration Systems

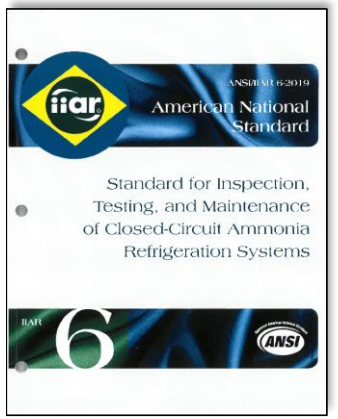
RAGAGEP

✓ Refrigeration System of EXCELLENCE

✓ IF, it follows **RAGAGEP** for**:**

- Design
- Manufacturing
- Construction/Fabrication
- Operation
- Inspection, Testing, & Maintenance





By following RAGAGEP, the Ammonia Refrigeration System CAN exist and function under ALL necessary conditions without representing risks or dangers!

RAGAGEP:

Recognized and Generally Accepted Good Engineering Practices

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IIAR Standards & RAGAGEP

- **ANSI/IIAR 2:** ***Standard for Safe Design of Closed-Circuit Ammonia Refrigeration Systems***
- **ANSI/IIAR 6:** ***Standard for Inspection, Testing, and Maintenance of Closed-Circuit Ammonia Refrigeration Systems***

Approved American National Standards ANSI

ANSI Accredited Standards Developer

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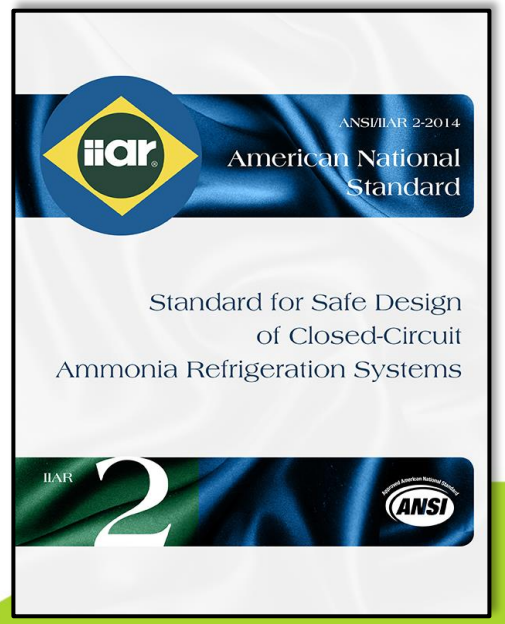
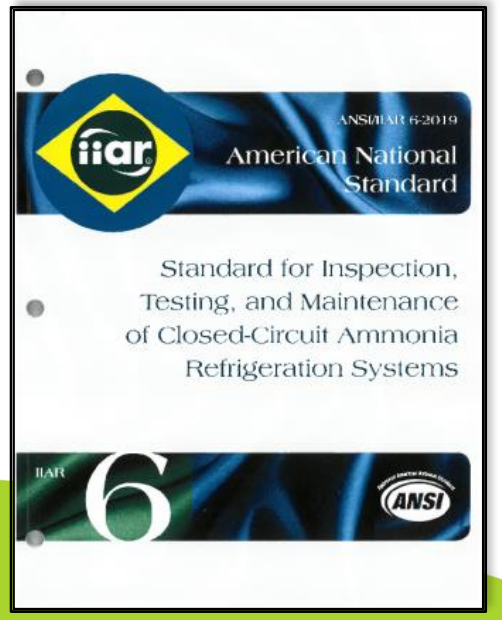
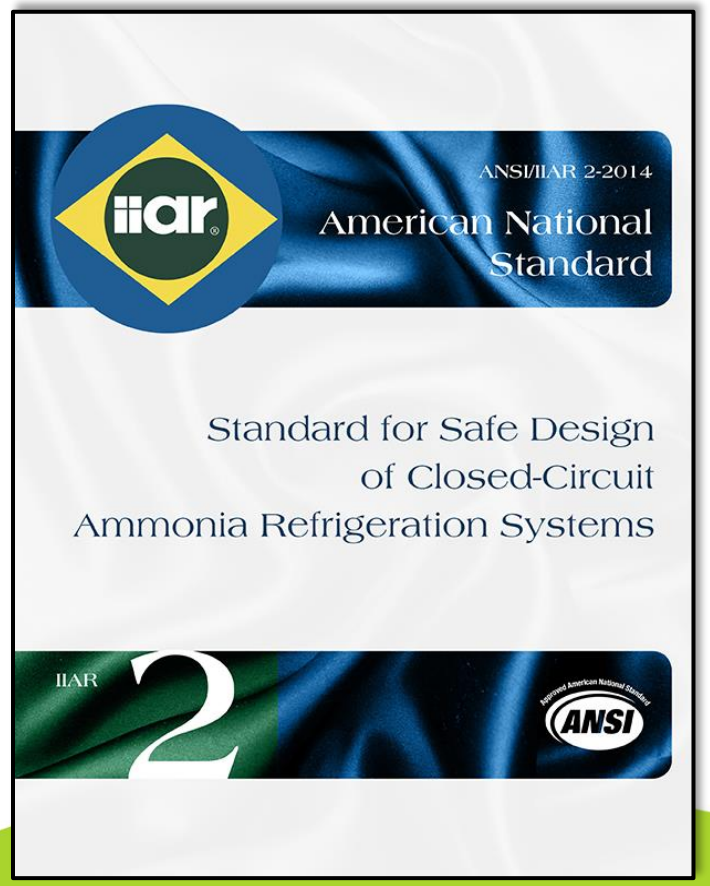




IIAR Standards & RAGAGEP

➢ ANSI/IIAR 2: *Standard for Safe Design of Closed-Circuit Ammonia Refrigeration Systems*

Specifies minimum requirements for designing safe Ammonia Refrigeration Systems



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ANSI/IIAR 2: *Standard for Safe Design of Closed-Circuit Ammonia Refrigeration Systems*

Part 1: General

- Purpose, Scope, and Applicability

Part 2: Design and Installation Considerations Affecting Construction

- General Requirements
- Machinery Rooms
- Refrigeration Equipment Located in Areas Other than Machinery Rooms

Part 3: Equipment

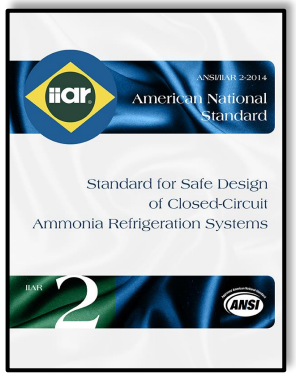
- Compressors, Condensers, Evaporators, Pressure Vessels, Piping, Refrigerant Pumps, Packaged Systems, Overpressure Protection Devices, Instrumentation & Controls, Ammonia Detection & Alarms, & Absorption Systems

Part 4: (Informative) Appendices

- Explanatory Material

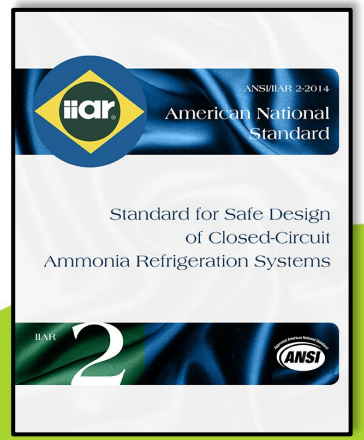
ANSI/IIAR 2: *Standard for Safe Design of Closed-Circuit Ammonia Refrigeration Systems*

Machinery Rooms



ANSI/IIAR 2: *Standard for Safe Design of Closed-Circuit Ammonia Refrigeration Systems*

Machinery Rooms



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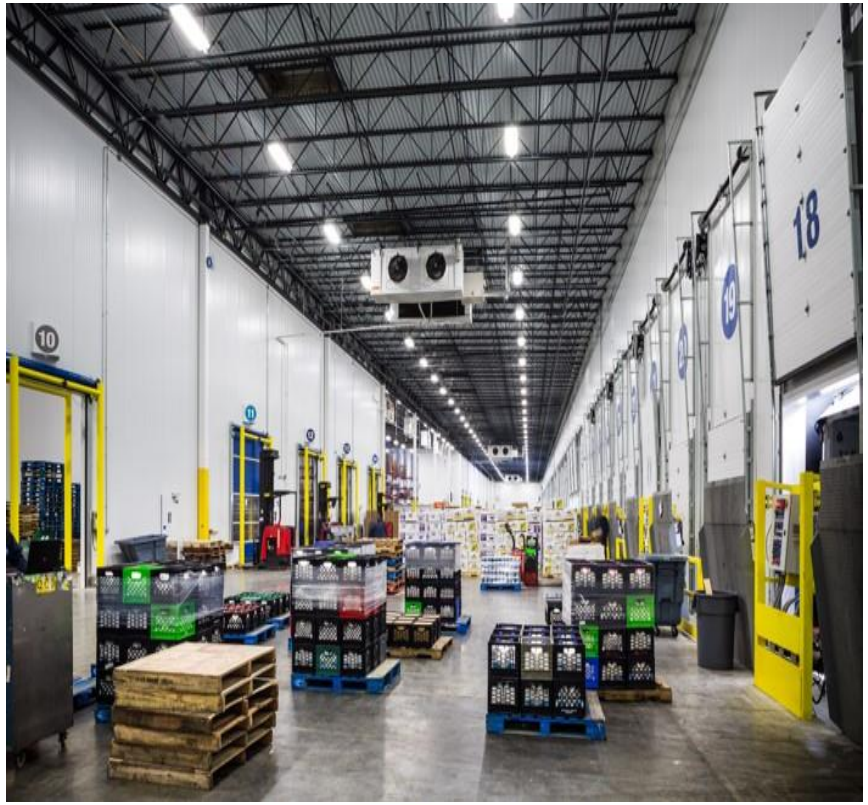
ANSI/IIAR 2: *Standard for Safe Design of Closed-Circuit Ammonia Refrigeration Systems*

Refrigeration Equipment Installed in Other Areas



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Ammonia Detection and Alarms

Visual &
Audible
Alarms

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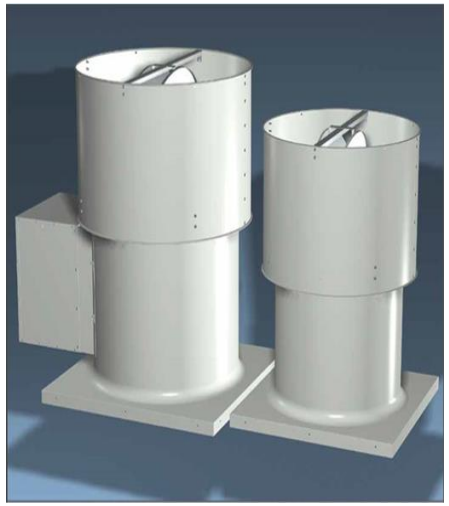
Ventilation



SAFE AND SUSTAINABLE USE OF NATURAL REFRIGERANTS

ANSI/IIAR 2: *Standard for Safe Design of Closed-Circuit Ammonia Refrigeration Systems*

Overpressure Protection Devices

No valve installed between a Pressure Vessel and a PRV!

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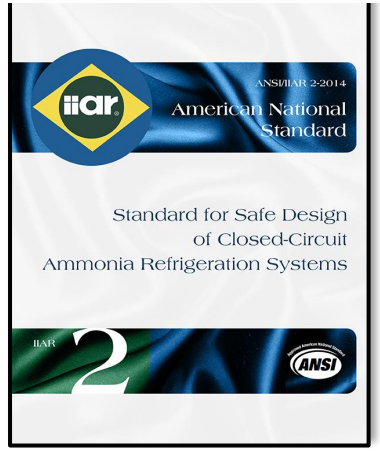
ANSI/IIAR 2: *Standard for Safe Design of Closed-Circuit Ammonia Refrigeration Systems*

Oil Draining



Shut-off Valve in series with a Self-closing Valve!

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ANSI/IIAR 2: *Standard for Safe Design of Closed-Circuit Ammonia Refrigeration Systems*

Emergency Eyewash and Showers

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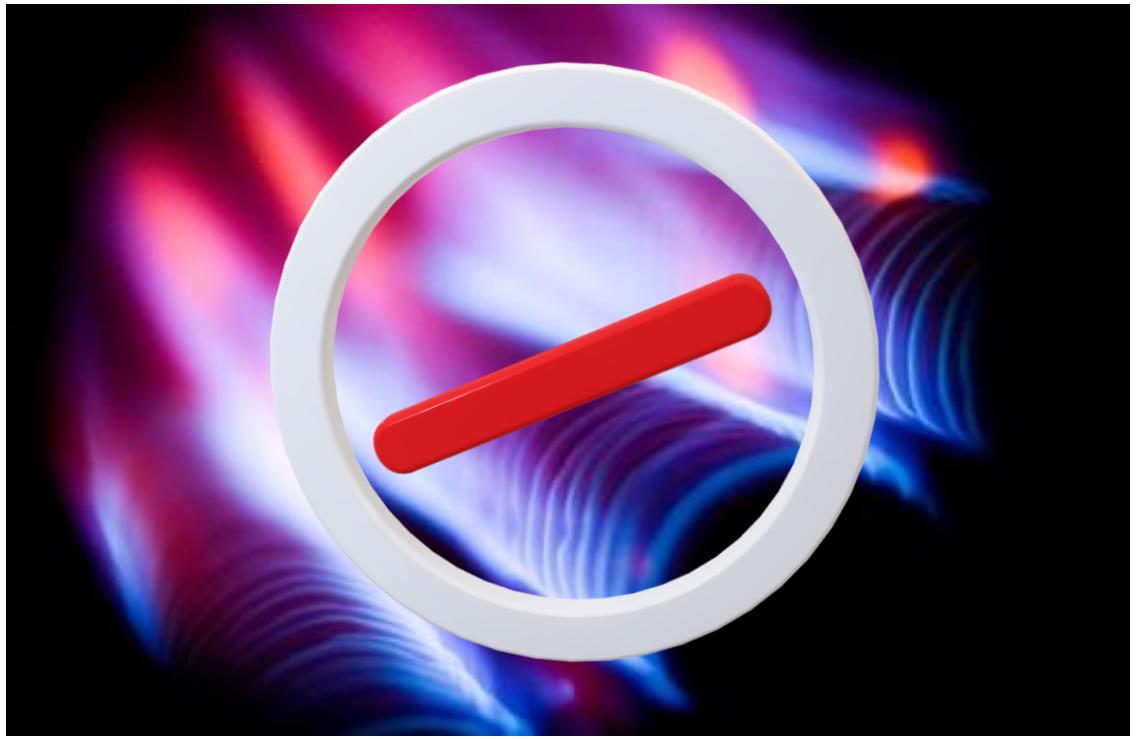
ANSI/IIAR 2: *Standard for Safe Design of Closed-Circuit Ammonia Refrigeration Systems*

Open Flame Prohibition

No Open Flame Fuel Burning Appliances in a Machinery Room!



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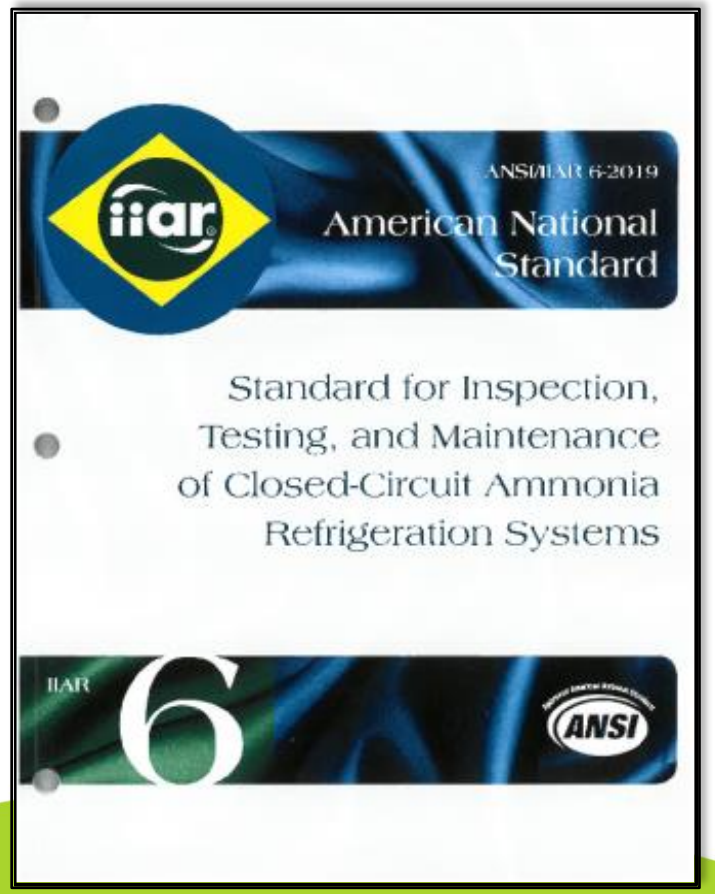
IIAR Standards & RAGAGEP

➢ ANSI/IIAR 6: *Standard for Inspection, Testing, and Maintenance of Closed-Circuit Ammonia Refrigeration Systems*

Specifies minimum requirements for inspection, testing, and maintenance of Ammonia Refrigeration Systems



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ANSI/IIAR 6: *Standard for Inspection, Testing, and Maintenance of Closed-Circuit Ammonia Refrigeration Systems*

Part 1: General

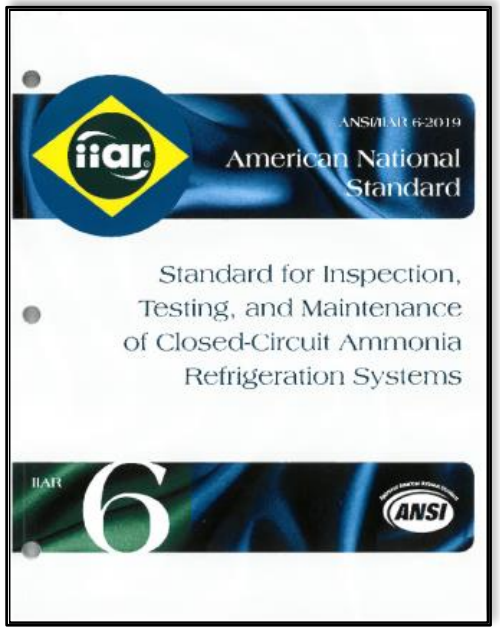
- Purpose, Scope, and Applicability

Part 2: Program Administration

- ITM Program Requirements
- Frequency
- Record Keeping
- Inspection, Testing, & Maintenance Requirements - General
- ITM of Equipment:
  - Compressors, Refrigerant Pumps, Condensers, Evaporators, Pressure Vessels, Piping, Safety Systems, Overpressure Protection Devices, Purgers, Ammonia Refrigerant and Secondary Coolants

Part 3: (Informative) Appendices

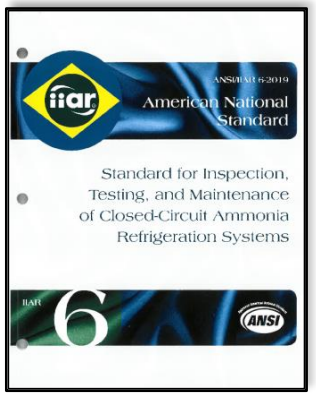
- Explanatory Material
- Ammonia Refrigeration Safety Inspection Checklists



➢ANSI/IIAR 6: *Standard for Inspection, Testing, and Maintenance of Closed-Circuit Ammonia Refrigeration Systems*

TABLE 10.1
Pressure Vessels Inspection, Testing, and Maintenance Tasks

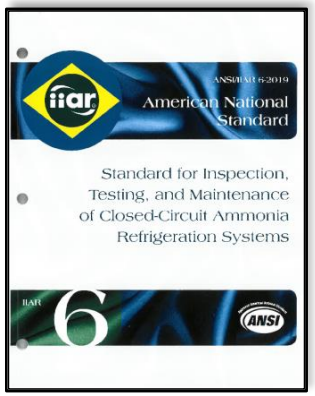
ITM Task Description	Frequency	
Inspection	Insulated	Noninsulated
a) Visually inspect metal surfaces for pitting or surface damage	NA	A
b) Visually inspect nozzle connections for pitting or surface damage	NA	A
c) Visually inspect sight glass metal surfaces for pitting or surface damage	WA-A	WA-A
d) Visually inspect for damage and/or moisture in insulation (i.e., dampness, condensation, frost, ice buildup)	A	NA
e) Visually inspect for indications of degradation of the protective coating (i.e., paint)	NA	A
f) Visually inspect foundation for cracking and oversettling	A	A
g) Visually inspect anchors for cracking or damage (i.e., bolts, nuts, welds)	A	A
h) Visually inspect structural supports and mounting bolts are in place	A	A
i) Visually inspect for excessive vibration or movement when liquid is being supplied	S	S
j) Visually inspect insulation protective jacketing for cracks and holes	A	NA
k) Visually inspect nameplate legibility and attachment	A	A
l) Verify base frame anchors are in place	WA-A	WA-A



➢ANSI/IIAR 6: *Standard for Inspection, Testing, and Maintenance of Closed-Circuit Ammonia Refrigeration Systems*

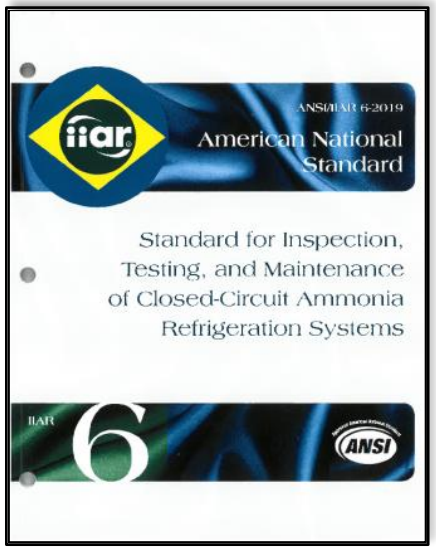
TABLE 11.1
Piping Inspection, Testing, and Maintenance Tasks

ITM Task Description	Frequency			
	Insulated		Noninsulated	
Inspection	Carbon steel	Stainless steel	Carbon steel	Stainless steel
a) Visually inspect metal surfaces for pitting or surface damage	NA	NA	A	A
b) Visually inspect for damage or moisture incursion in insulation (i.e., dampness, condensation, frost, ice buildup)	A	A	NA	NA
c) Visually inspect for indications of degradation of the protective coating (i.e., paint)	NA	NA	A	WA-A
d) Visually inspect supports for cracks and degradation	A	A	A	A
e) Visually inspect mounting bolts are in place	A	A	A	A
f) Visually inspect piping for indications of movement	A	A	A	A
g) Visually inspect seismic joints and restraints	WA-A	WA-A	WA-A	WA-A
h) Visually inspect materials used under roof pipe stands for indications of degradation (e.g., bases or sleepers)	WA-A	WA-A	WA-A	WA-A
i) Visually inspect piping supports are in place and for indications of degradation that could impede their ability to provide continued support of the piping as designed	A	A	A	A
j) Visually inspect insulation protective jacketing	A	A	NA	NA
k) Visually inspect condition of connections (i.e., interchanging parts—valves, fittings, flanges, bolting, gaskets) and threaded joints	NA	NA	A	A
l) Visually inspect to verify all piping system openings, except relief discharge termination points, are plugged, capped, or locked closed with appropriate administrative controls	A	A	A	A
m) Visually inspect to verify self-closing/quick-closing valves are installed on oil pots	A	A	A	A
n) Visually inspect ammonia refrigeration pipe labeling for correct placement, accuracy, and degradation	A	A	A	A



➢ANSI/IIAR 6: *Standard for Inspection, Testing, and Maintenance of Closed-Circuit Ammonia Refrigeration Systems*

Chapter 12. Safety Systems ITM Tasks

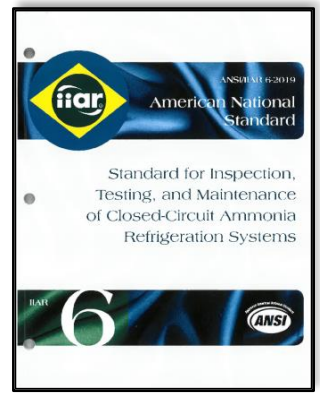


- Emergency Ventilation Systems
- Emergency Shutdown Switches
- Ammonia Detection and Alarms Systems
- Computer Controlled Safety Systems
- Emergency Eyewash and Showers

➢ANSI/IIAR 6: *Standard for Inspection, Testing, and Maintenance of Closed-Circuit Ammonia Refrigeration Systems*

TABLE 13.1
Overpressure Protection Devices Inspection, Testing, and Maintenance Tasks

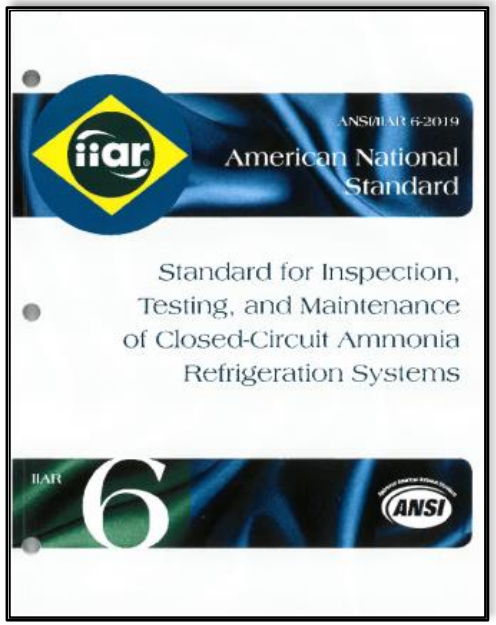
ITM Task Description	Frequency	
	PRV	Hydrostatic/Internal
Inspection		
PRV:		
a) Visually inspect for unbroken ASME seal	A	A
b) Verify legible nameplate/tag	A	A
c) Confirm "installation date" is less than 5 years old	A	NA
d) Verify relief valves are free of stop valves installed in ASME pressure-relief inlets	A	WA-A
e) Verify stop valves in relief discharge piping are locked open or car-sealed open with appropriate administrative controls	WA-A	WA-A
f) Verify discharge outlet piping supports are not missing or broken	A	A
g) Verify discharge outlet piping has no obstructions (e.g., nests, insects, or debris)	A	NA
h) Verify atmosphere diffuser would not discharge within 20 ft of a building opening	A	NA
i) Verify inlet size, outlet size, set pressure, and capacity are compliant with PRV design records	5	5
j) Inspect rupture disc or discharge relief indicators	WA-W	NA



ANSI/IIAR 6: *Standard for Inspection, Testing, and Maintenance of Closed-Circuit Ammonia Refrigeration Systems*

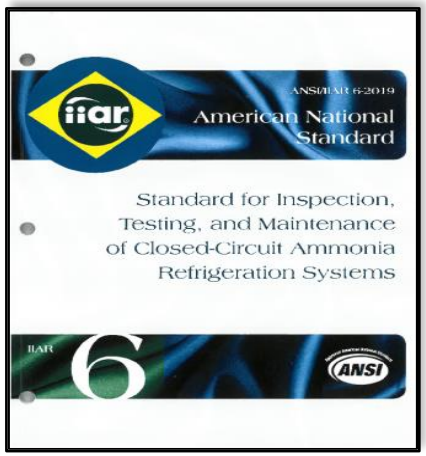
TABLE 14.1
Purgers Inspection, Testing, and Maintenance Tasks

ITM Task Description	Frequency
	Refrigerated or Nonrefrigerated
Inspection	
a) Visually inspect water level in water column is adequate	WA-D
b) Visually inspect unit is mounted in place	M
c) Visually inspect insulation for cracks and holes	A
d) Inspect piping for pitting or surface damage	A
Testing	
a) Manually cycle through active purge points	S
b) Confirm purger effectiveness with refrigeration system pressure/temperature relationship	WA-A
Maintenance	
a) Verify operation of all indicator lights	WA-A
b) Clean water bubbler	WA-A
c) Drain oil	A
d) Clean line strainers	A
e) Service solenoid valves with plunger kits	As Needed



ANSI/IIAR 6: *Standard for Inspection, Testing, and Maintenance of Closed-Circuit Ammonia Refrigeration Systems*

APPENDIX B.
Ammonia Refrigeration System Safety Checklist
PRESSURE VESSELs – General Information



SAFE AND SUSTAINABLE USE OF NATURAL REFRIGERANTS

Ammonia Refrigeration Safety Inspection Checklist

PRESSURE VESSELS

Location: _____ ID/Tag No.: _____
Facility Owner: _____
Address: _____
Contact: _____ Phone: _____
Inspector: _____ Date: _____

Application:

High Pressure Receiver ..... ☐
Accumulator ..... ☐
Recirculator ..... ☐
Intercooler ..... ☐
Transfer Drum ..... ☐
Oil Separator ..... ☐
Oil Pot ..... ☐
Other (Describe) ..... ☐
_____

Orientation:

Horizontal ..... ☐
Vertical ..... ☐

Equipment Data and Limits:

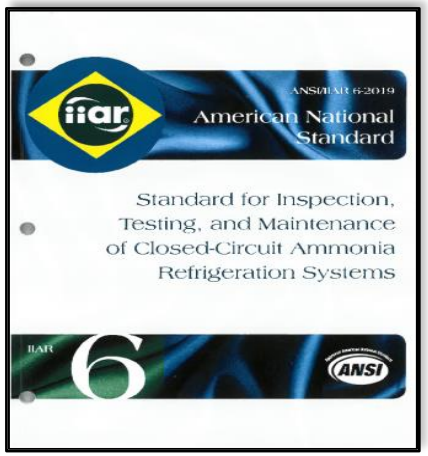
Manufacturer: _____ Model #: _____ Serial #: _____
ASME Cert. Stamp? ☐ Yes, ☐ No Year Mfg.: _____ National Board #: _____
MAWP (psig): _____ @ °F _____ MDMT (°F): _____ @ psig
Operating (psig /°F): _____ / _____ Normal Liquid Level: _____
Total Internal Vol: _____ Cu. Ft. Normal Ammonia Inventory (lbs.): _____
Material: ☐ Carbon Steel, ☐ Stainless Steel, ☐ Aluminum, ☐ Other: _____
Level Indicator Type: ☐ None, ☐ Armored Bullseye, ☐ Level Column w/Bullseye, ☐ Flat Armored, ☐ Level Column Only, ☐ Level Column w/ Veri/Techni Level

Relief Valve Data:

Manufacturer: _____ Model: _____ Year Installed: _____
Assembly: ☐ Dual w/change over valve, ☐ Single Type of Relief Valve: ☐ Internal, ☐ External
Pressure Setting (psig): _____ Capacity (lbs. air per min/SCFM): _____ / _____

ANSI/IIAR 6: *Standard for Inspection, Testing, and Maintenance of Closed-Circuit Ammonia Refrigeration Systems*

APPENDIX B.
Ammonia Refrigeration System Safety Checklist
PRESSURE VESSELs – Inspection Items



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Ammonia Refrigeration Safety Inspection Checklist PRESSURE VESSELS Location:				ID/Tag No.:
Inspection Items	**Conforms**	**Safety Status**	**Recommended Action, or Comments**	**Target Date**
a) Equipment is labeled and the nameplate and ASME # are legible and secure 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) Certification drawings on file?	Yes ☐ No ☐ N/A ☐			
n) Manufacturer data report on file?	Yes ☐ No ☐ N/A ☐			
o) Free of modifications, alterations, damage, or repairs such that casing integrity is or has been affected?	Yes ☐ No ☐ N/A ☐			
p) If No, has it been recertified and documentation filed?	Yes ☐ No ☐ N/A ☐			
q) Are tubular linear liquid level sight glasses protected from traffic with 360° guards and internal check shutoff valves?	Yes ☐ No ☐ N/A ☐			
r) Insulation free of damage, moisture, frost, vapor retarder leaks, etc.? a. If No, note damage level:	Yes ☐ No ☐ N/A ☐ Slight ☐ Extensive ☐ ☐ Not insulated			
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:				

RAGAGEP & ARM

- **RAGAGEP** practices are focused on:
  - ✓ **Control or mitigation** of risks associated with ammonia use.
  - ✓ Ensuring refrigeration systems efficiency.

- **The ARM Manual:**
  - ✓ Is an important part of **RAGAGEP** & consists of a series of practices that help us maintain **SAFE and EFFICIENT systems.**

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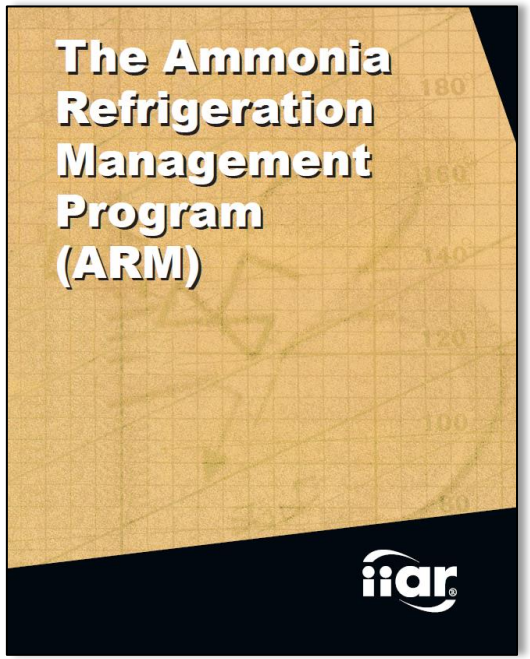
Introduction to IIAR ARM

Purpose: *The ARM program is a voluntary program designed to* ***help end users supervise their refrigeration systems in a safe and responsible manner.***

Scope: *Installations that use ammonia as a refrigerant.*



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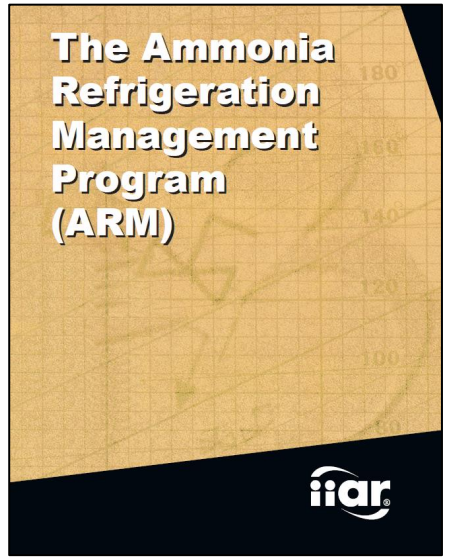
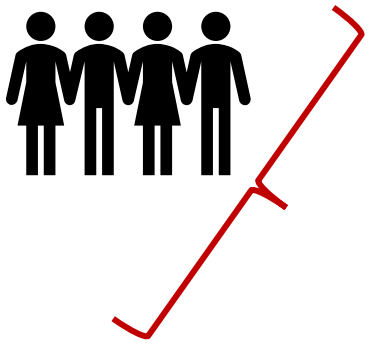
Ammonia Refrigeration Management (ARM) Elements

- Management System
- Participation and Supervision
- Documentation
- Risk Analysis and Developing Procedures
- Hazard Review
- Training and Emergency Preparedness
- Emergency Readiness (Response Plan)
- Incident Investigations
- Audits
- Manage Changes



Participation and Supervision



Participation is CENTRAL. Management's commitment is KEY.

Steps:

- ❑ Establish responsibilities
- ❑ Employee participation and access to information
- ❑ Collect necessary documentation
- ❑ Establish an agenda of activities, (Ex*: audits*)
- ❑ Establish actions to take for:
  - ✓Changes to the system
  - ✓Accidents
  - ✓Maintenance

ARM- Template Plan

MANAGEMENT SYSTEM

The ARM Manual provides us with a guidance plan that you can adopt and adapt as your own.

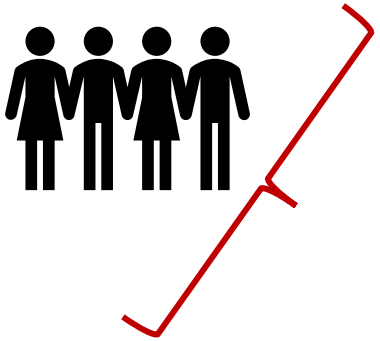
Revision Table

Rev. #	Description of Change	Date	Revised By
0	Initial issue	(*Insert Date*)	

Tips: *You may wish to use this revision table to track changes made to your document. Alternatively you may wish to provide a revision date and revision number for this document, for example in the footer.*

Remove this "Tip" and all other tips from the sample plan after the tips have been read and addressed. These tips are provided to describe suggestions when developing the plan and thus should not be included in the final plan.

Documentation based on RAGAGEP



RAGAGEP & Documents needed

- ❑ Ammonia inventory
- ❑ Safety data Sheets (SDS)
- ❑ Process description
- ❑ Operating limits
- ❑ Equipment lists
- ❑ Safety systems installed
- ❑ System diagrams
- ❑ Materials of construction
- ❑ Safety relief system information
- ❑ Ventilation system and ammonia detection information
- ❑ Codes and standards used
- ❑ Manufacturer's documentation / operating and maintenance processes

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Ammonia Inventory- Vessels

Ammonia Inventory Worksheet — Pressure Vessels

Component/Unit/Duty	Volume		Temp (°F)	Refrigerant Density		Mass (lb)
	Liquid (ft^3)	Vapor (ft^3)		Liquid (lb/ft^3)	Vapor (lb/ft^3)	
Thermosyphon Receiver	2.64	2.64	96	36.66	0.66	99
High Pressure Receiver	56.50	341.00	96	36.66	0.66	2,296
+20°F Intercooler	62.80	94.20	20	40.46	0.17	2,557
–25°F Accumulator	94.20	141.40	–2	42.46	0.06	4,008
					Total Mass	8,960

Ammonia Inventory- Summary Sheet

Inventory Summary

Pressure Vessel Inventory (lb) *(Form IC2)*	8,960 lbs
Piping Inventory (lb) *(Form IC3)*	1,815 lbs
Air Unit Inventory (lb) *(Form IC4)*	211 lbs
Special Purpose Equipment Inventory (lb) *(Form IC5)*	1,704 lbs
Evaporative Condenser (lb)	150 lbs
Total Inventory (lb)	**12,840 lbs**

Equipment List Example

Sample Equipment Data Table

Tips: *The sample equipment data table is only provided for guidance purposes. If used, this table should be filled out with information that reflects the specific ammonia refrigeration equipment contained in your system. If the table is not used it should be deleted from the document.*

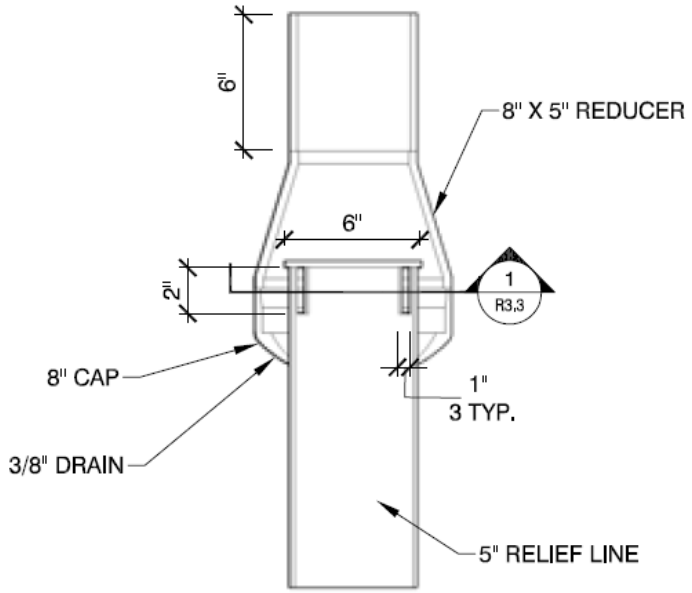
Equipment ID	Manufacturer	Year	Model No.	Serial No.	Capacity*	Maximum Allowable Pressure**	Minimum Design Temperature***
Compressor #_____							
Evaporative Condenser #____							
Vessel #_____							

Technical Operating Specifications – Safety Systems

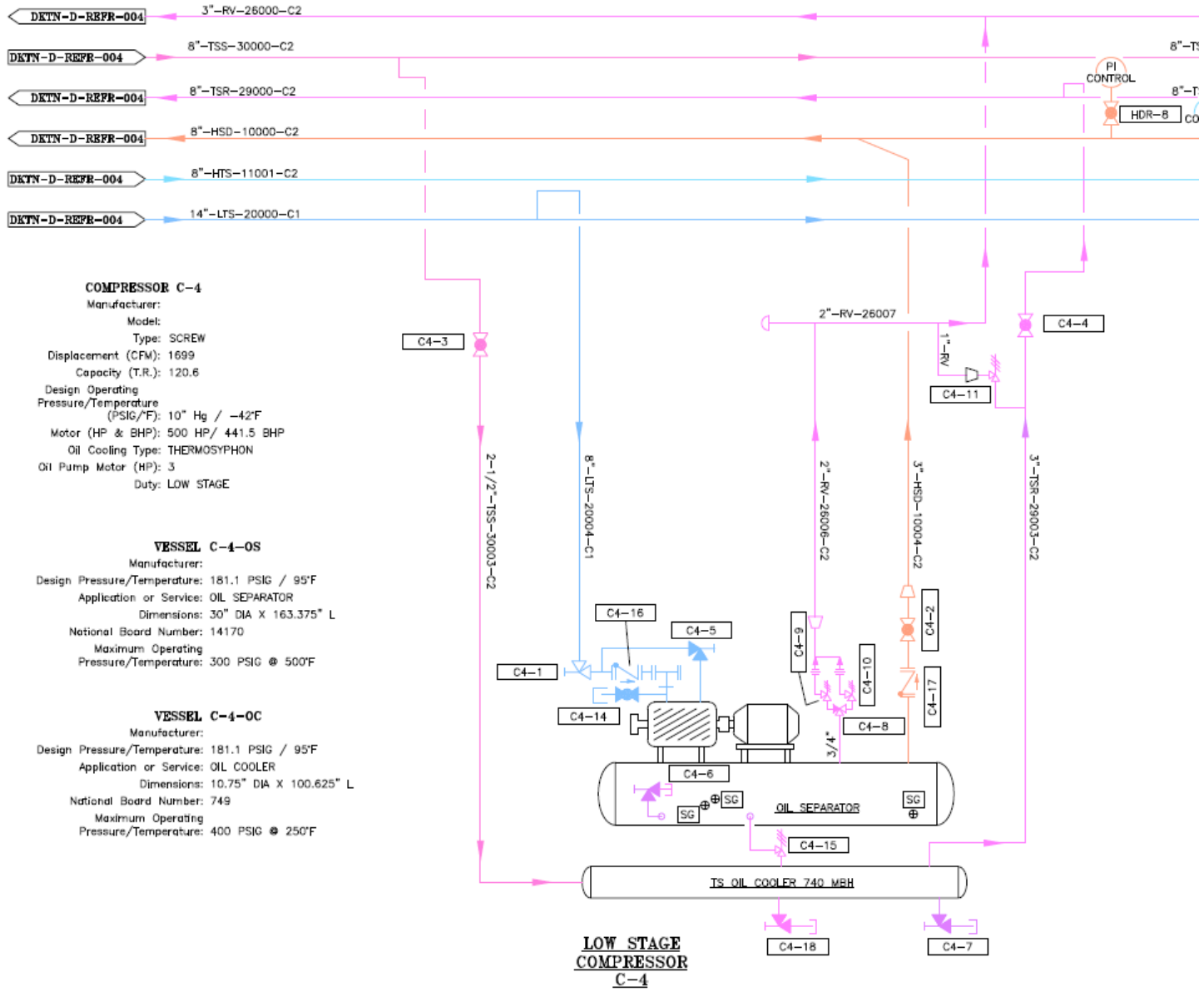
Safety Systems

Equipment	Safety Systems
Ammonia Compressors	Each compressor is equipped with the following safety cutouts: High discharge pressure cutout: _____ psig Low suction pressure cutout: _____ psig Low oil differential pressure cutout: _____ psig Low oil temperature cutout: _____ºF High discharge temperature cutout: _____ºF
Evaporative Condensers	The evaporative condenser fans and cooling water pumps are controlled by _____
Intermediate Pressure Vessel	Low level alarm/pump cutout: _____ in (or %) High level alarm: _____ in (or %) High level compressor cutout: _____ in (or %)
Low Pressure Vessel	Low level alarm/pump cutout: _____ in (or %) High level alarm: _____ in (or %) High level compressor cutout: _____ in (or %)

System Diagrams



DIFFUSER DETAIL



COMPRESSOR C-4
Manufacturer:
Model:
Type: SCREW
Displacement (CFM): 1699
Capacity (T.R.): 120.6
Design Operating Pressure/Temperature (PSIG/°F): 10" Hg / -42°F
Motor (HP & BHP): 500 HP/ 441.5 BHP
Oil Cooling Type: THERMOSYPHON
Oil Pump Motor (HP): 3
Duty: LOW STAGE

VESSEL C-4-OS
Manufacturer:
Design Pressure/Temperature: 181.1 PSIG / 95°F
Application or Service: OIL SEPARATOR
Dimensions: 30" DIA X 163.375" L
National Board Number: 14170
Maximum Operating Pressure/Temperature: 300 PSIG @ 500°F

VESSEL C-4-OC
Manufacturer:
Design Pressure/Temperature: 181.1 PSIG / 95°F
Application or Service: OIL COOLER
Dimensions: 10.75" DIA X 100.625" L
National Board Number: 749
Maximum Operating Pressure/Temperature: 400 PSIG @ 250°F

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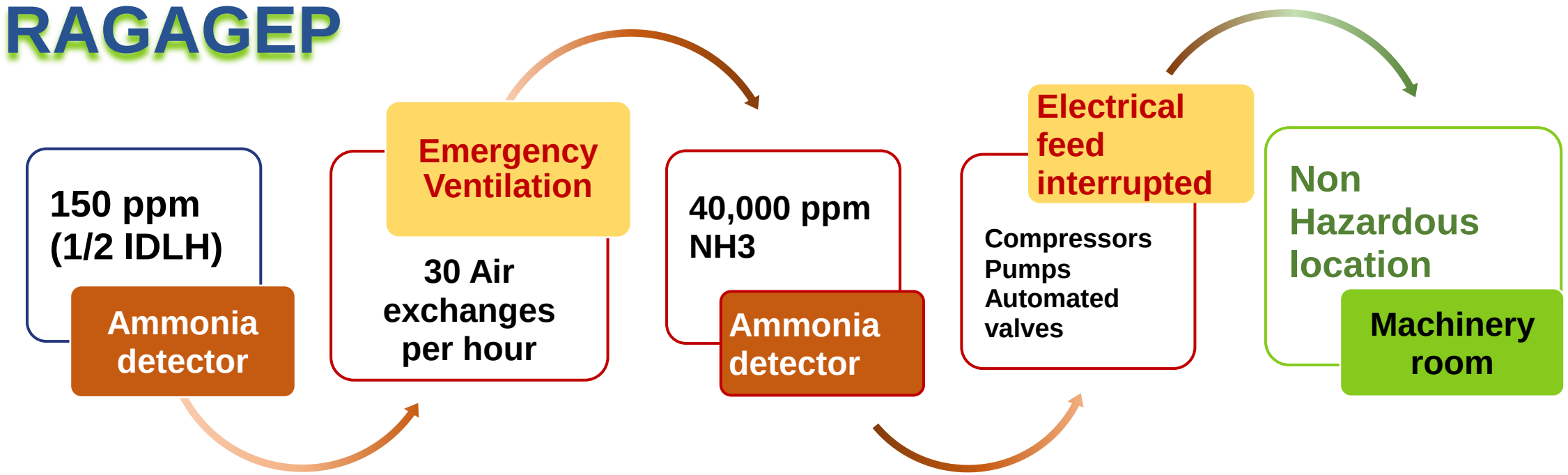
Materials of Construction RAGAGEP ANSI IIAR 2

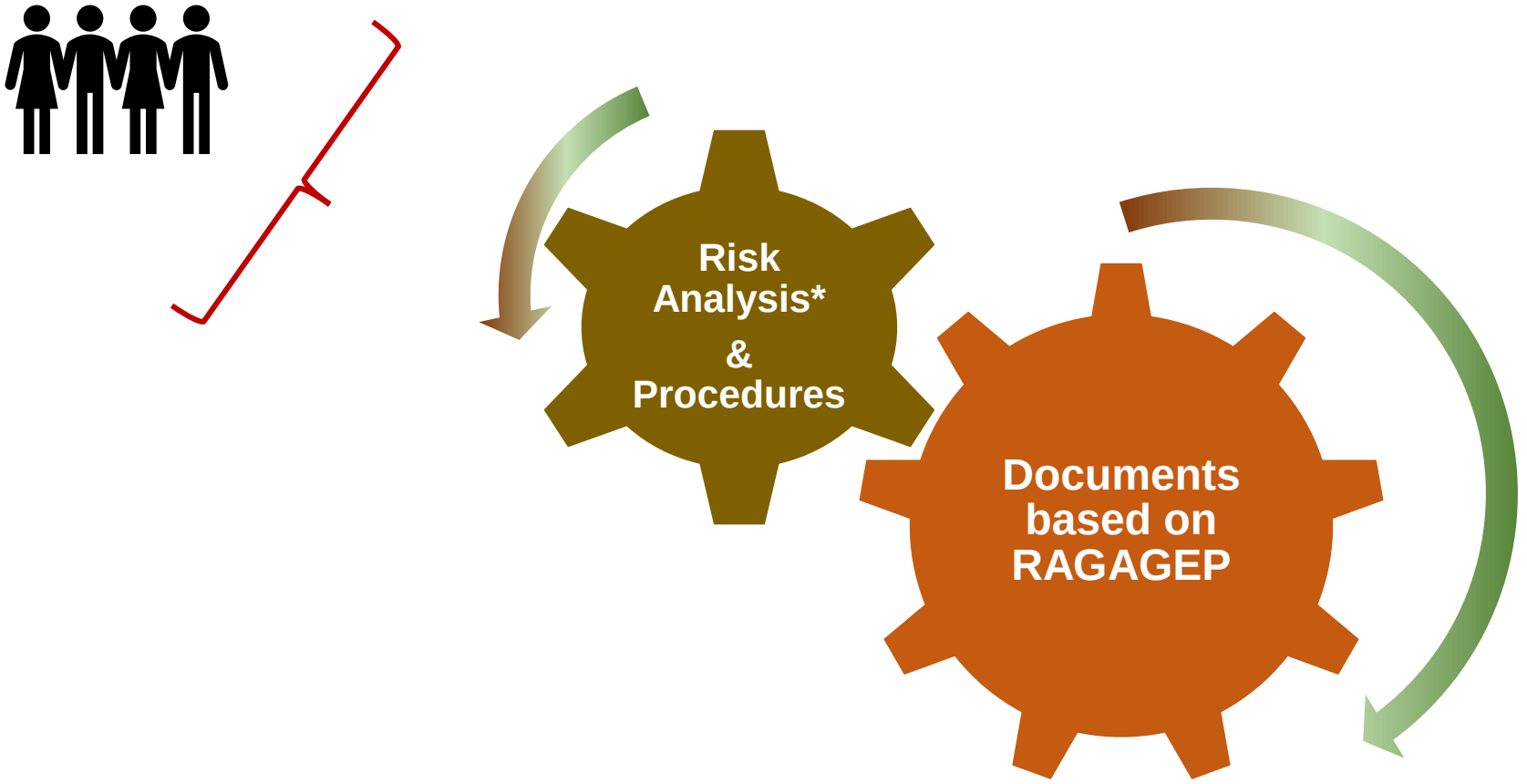
- **Permissible**:
  - ✓ Cast iron, malleable iron, nodular iron, steel, cast steel, and alloy steel as long as these comply with ASME B31.5 or ASME B&PVC, Section VIII, Division I
- **Not permissible:**
  - Ø Zinc, copper, copper alloys
  - Ø ASTM A53-Type F pipe and cast iron or wrought iron pipe for the pressure containing side of the system.

Malleable cast iron fittings NOT allowed per ASME B31.5

Simplified Diagram of Ventilation and NH3 Detection Requirements



Risk Analysis and Developing Procedures



ARM Provides a System for Hazard Review:

HAZARD REVIEW:

A complete, organized & systematic process for **identifying, evaluating** and **controlling** potential hazards associated with the process.

Steps:

- ❑ Determine responsible personnel to conduct the review
- ❑ Determine the methodology to use
- ❑ Conduct the review
- ❑ Determine a system to correct identified deficiencies
- ❑ Define revalidation cycle

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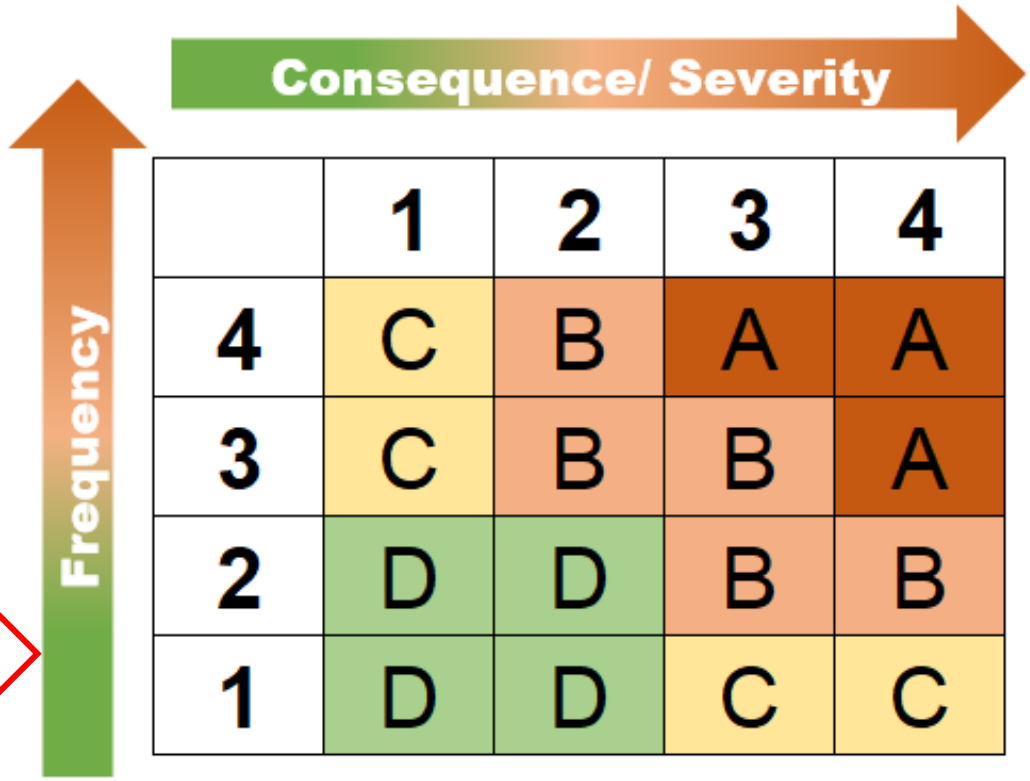
ARM Provides a System for Hazard Review:

The **'What-if/Checklist'** method is commonly used in this industry

Should include:

- ❑ Process risks
- ❑ Previous accidents
- ❑ System and equipment siting
- ❑ Human factors
- ❑ Evaluation of risks based on existing engineering and administrative CONTROLS



	1	2	3	4
4	C	B	A	A
3	C	B	B	A
2	D	D	B	B
1	D	D	C	C

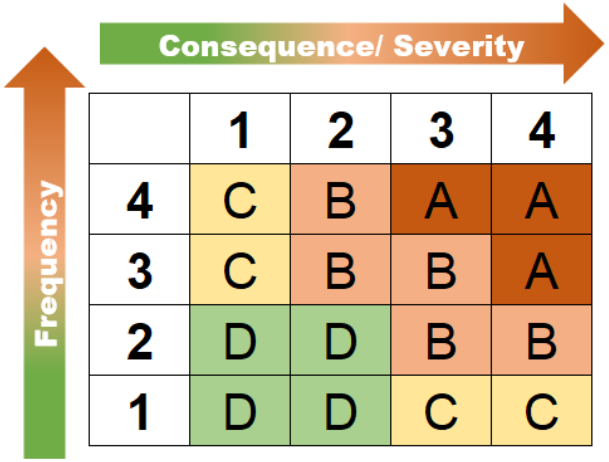
ARM: Hazard Review Example

Subsystem: 1. Compressors

Item	Equipment/Activity	What-If Questions	Scenario	Consequences/Hazards	E/A Controls	C	F	R	Recommendations
1.1	Compressors	What if there is no pressure safety relief valve (SRV) on this equipment?	An overpressure condition exists and there is no SRV. This causes a leak or rupture, resulting in an NH3 release						
1.2	Compressors	What if the equipment's preventative maintenance program for SRVs is insufficient or non-existent?	A SRV preventive maintenance program is insufficient or non-existent. The SRV fails to perform as designed (e.g., SRV fails to lift at set pressure during an						

ARM: Hazard Review Example

	Scenario	Consequences/Hazards	E/A Controls	C	F	R	Recommendations
n this	An overpressure condition exists and there is no SRV. This causes a leak or rupture, resulting in an NH3 release						
icient	A SRV preventive maintenance program is insufficient or non-existent. The SRV fails to perform as designed (e.g., SRV fails to lift at set pressure during an						



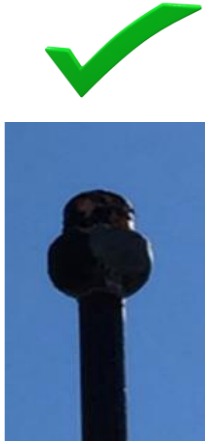
C = Consequence/Severity
F = Frequency
R = Risk (Ranking)

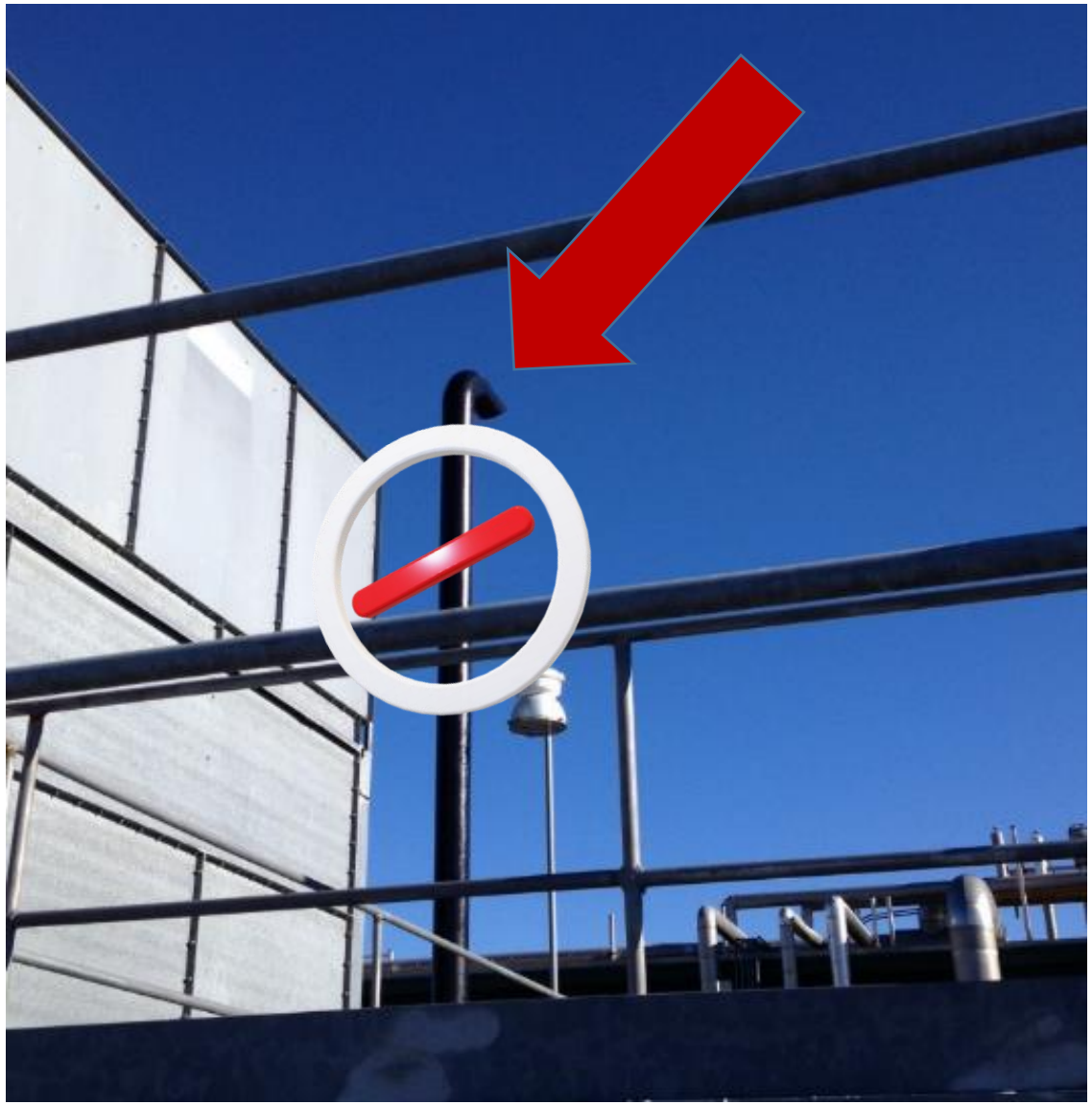
Hazard Review

Consequence/ Severity

Frequency

	1	2	3	4
4	C	B	A	A
3	C	B	B	A
2	D	D	B	B
1	D	D	C	C





Hazard Review

Consequence/ Severity

Frequency

	1	2	3	4
4	C	B	A	A
3	C	B	B	A
2	D	D	B	B
1	D	D	C	C

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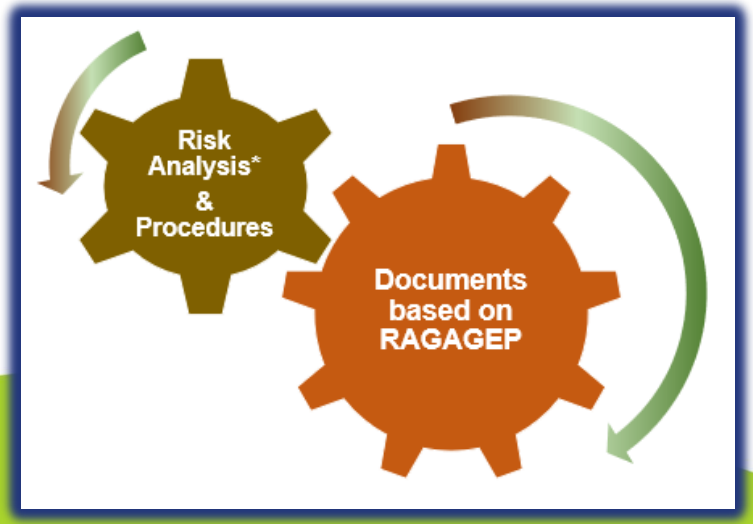
Developing Procedures for Operation

- **Gather**:
  - System Documentation *(described earlier)*
  - **RAGAGEP** – ANSI/IIAR Standards & Guides
  - Completed Hazard Reviews *(described earlier)*

- **All procedures MUST:**
  - Be written in a way that operators can understand.
  - Include ALL equipment operating phases.
  - Describe operating limits, system safeties, health risks and ways to reduce associated risks.



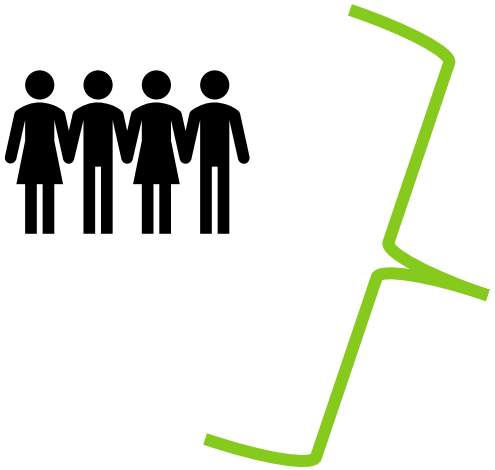
Safe Work Practices

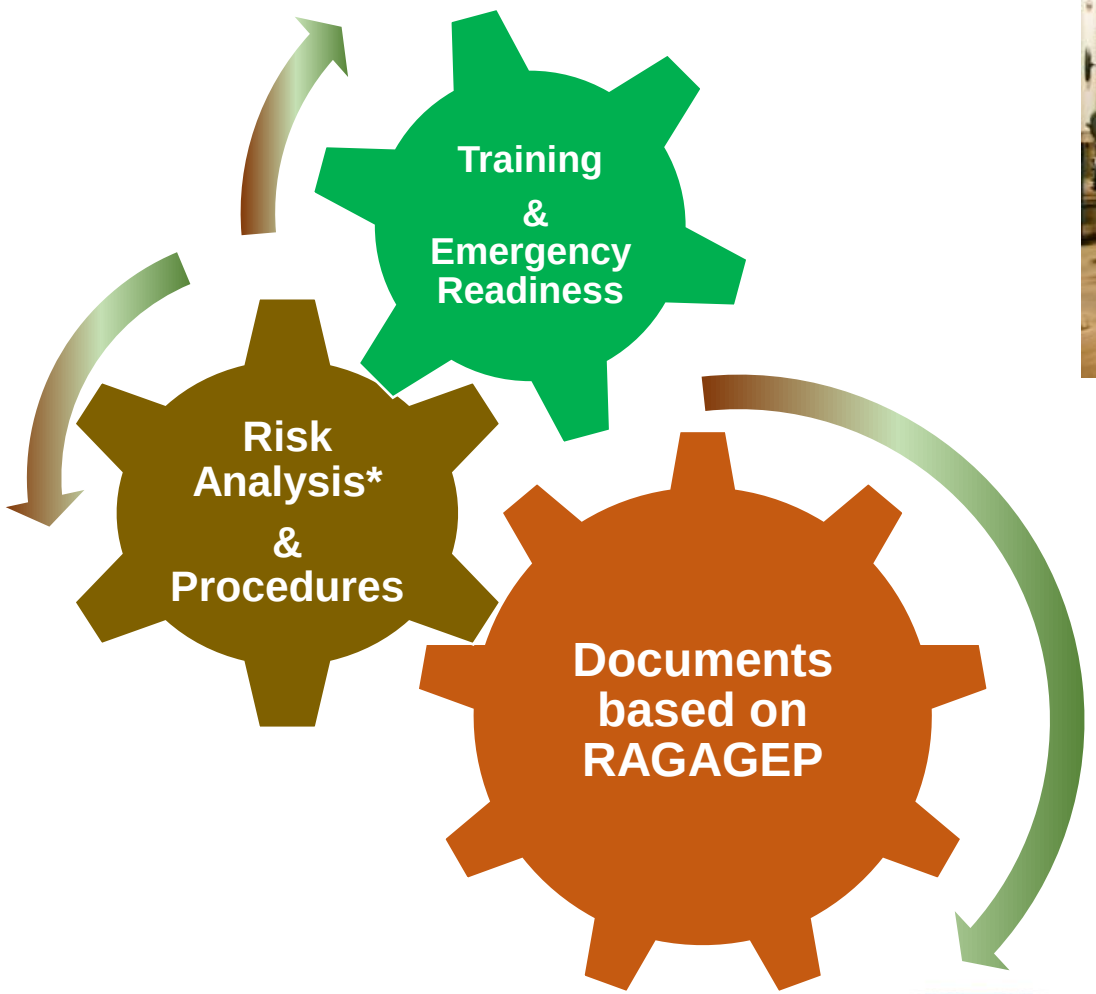
- ✓ It is important to **develop & follow**

SAFE WORK PRACTICES:

- ✓ Lockout /Tagout
- ✓ Confined Spaces Entry
- ✓ Line Opening
- ✓ Oil Draining from the system
- ✓ Working at Height (Fall Protection)
- ✓ Adding Oil to the system
- ✓ Contractor Safety
- ✓ Control Access
- ✓ Electrical Safety
- ✓ Ground Disturbance

Training and Emergency Readiness





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Training and Emergency Readiness

- **Operating and Maintenance Procedures will serve as:**
  - **Training** Material
  - Material used for **Emergency Preparedness**

- **All personnel should be trained on:**
  - Overview of the process
  - Safety risks and how to reduce such risks
  - Ammonia properties
  - Operating limits and consequences of deviation
  - Procedures for operating, inspecting, testing, and maintaining the system; and procedures for emergency response

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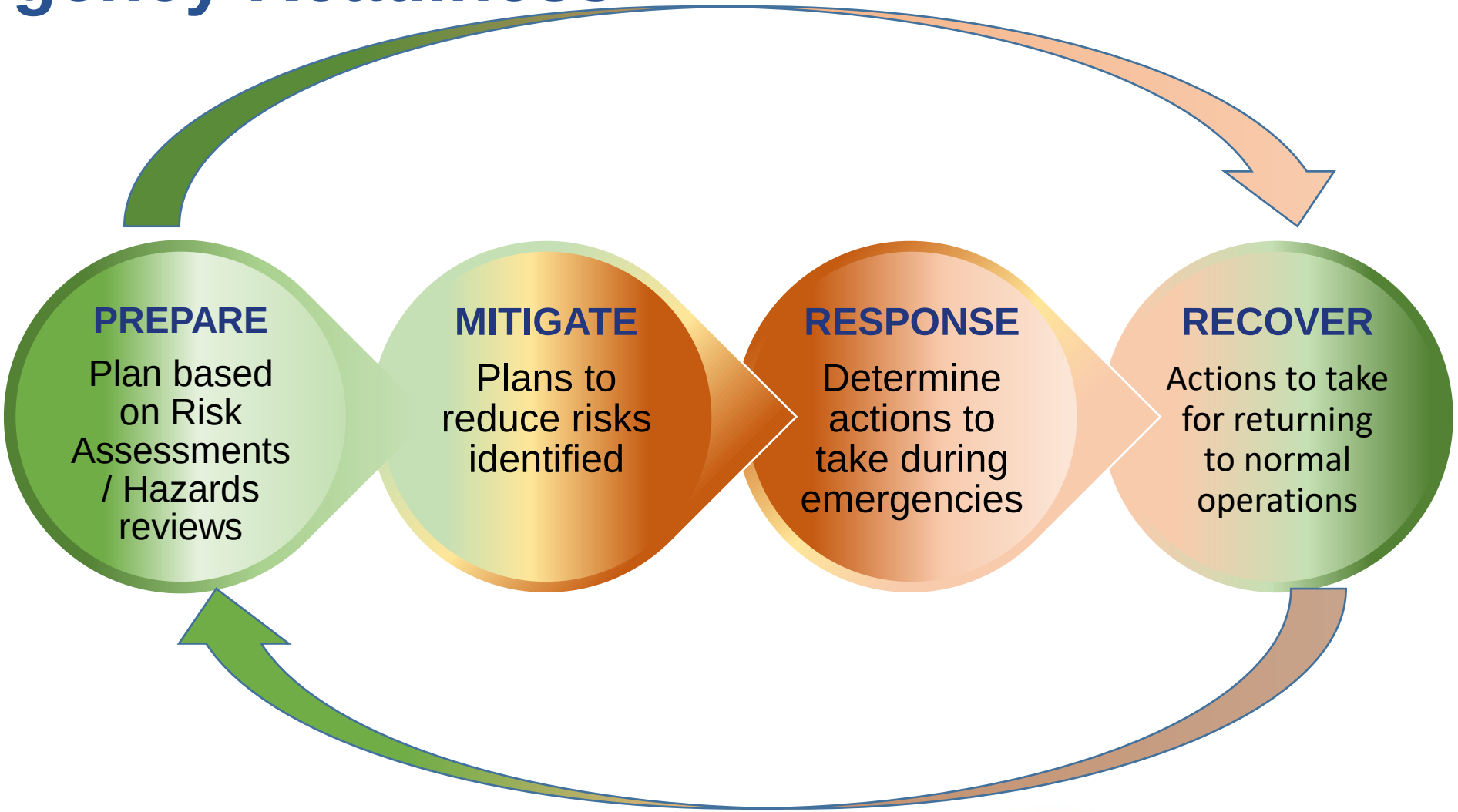
Emergency Readiness



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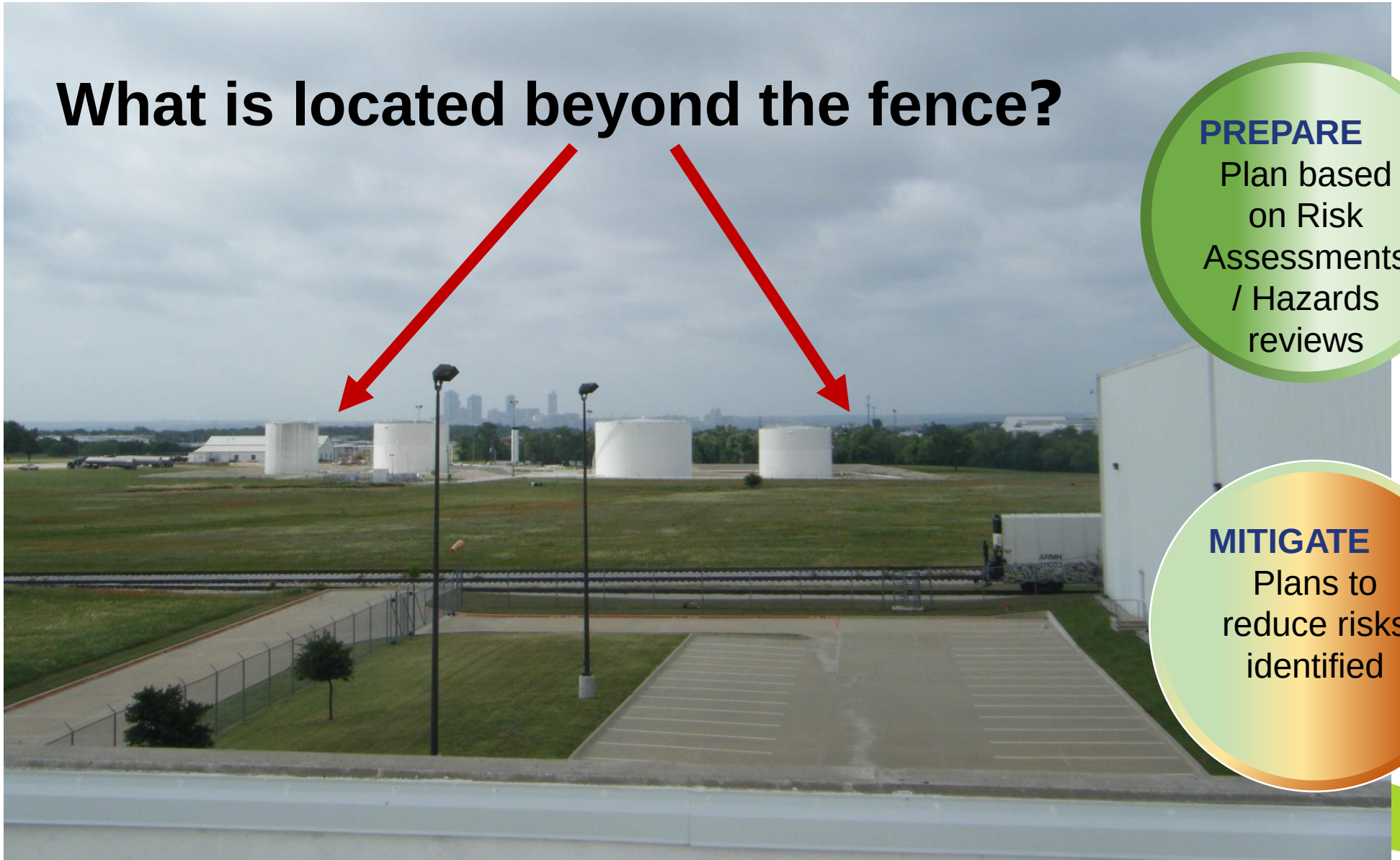
Continuous Improvement Process

Preparation



PREPARE
Plan based on Risk Assessments / Hazards reviews

MITIGATE
Plans to reduce risks identified

RESPONSE

RESPONSE
Determine actions to take during emergencies

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ARM- Emergency Plan

EMERGENCY RESPONSE PLAN

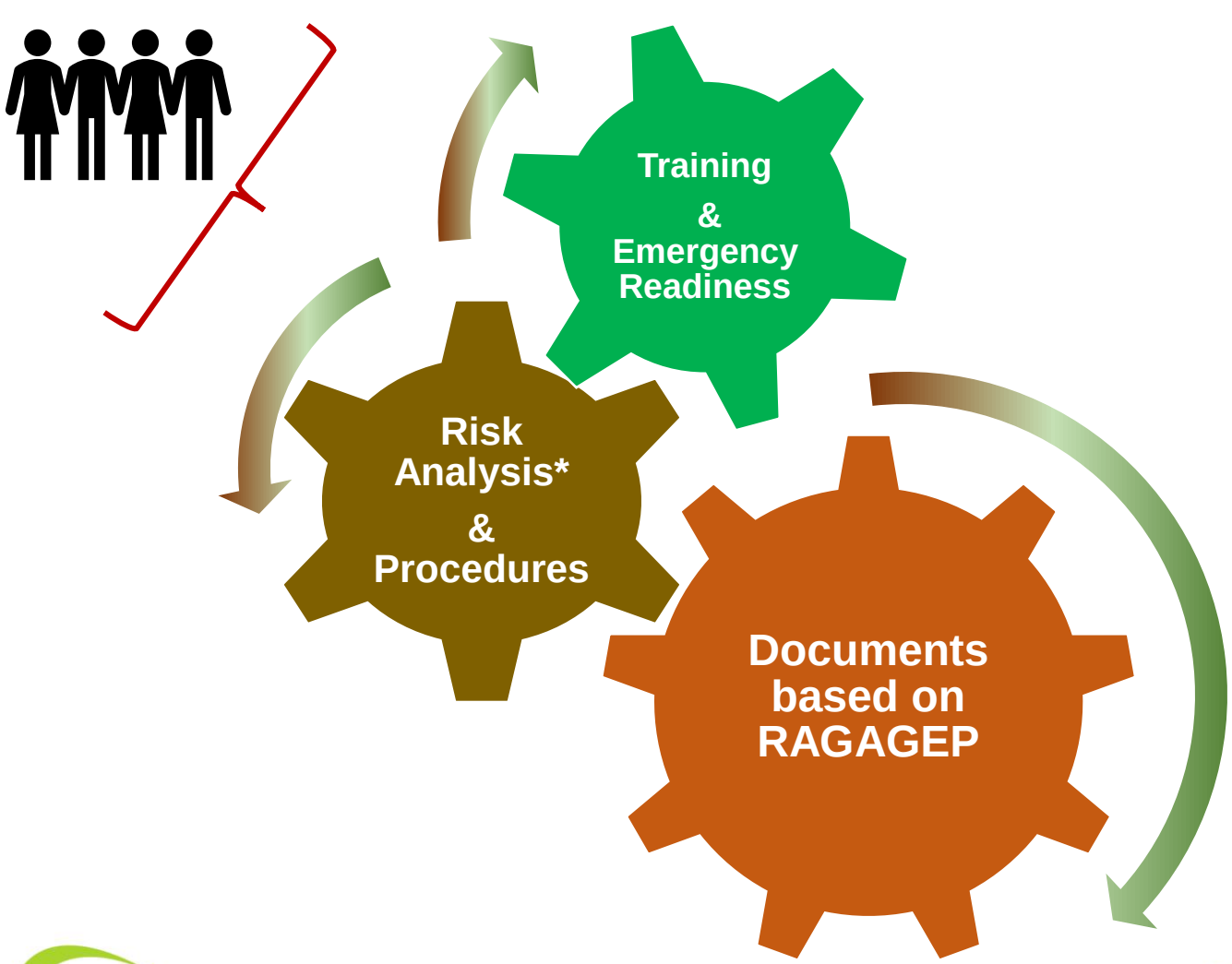
The ARM Manual provides us with a guidance plan that you can adopt and adapt as your own.

Revision Table

Rev. #	Description of Change	Date	Revised By
0	Initial issue	(*Insert Date*)	

Tips: You may wish to use this revision table to track any changes made to your document. Alternatively you may wish to provide a revision date and revision number for this document, for example in the footer.

Application of ARM Components



Incident Investigations

Audits
&
ONGOING
Risk Analysis*

Manage Changes

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Incident Investigations

- ✓ **Investigate any incident that** resulted or could have resulted in a catastrophic NH_3 release.
- ✓ **The investigation shall include:**
  - ✓ Events that occurred,
  - ✓ Root causes
  - ✓ Recommendations or actions to take to avoid or reduce the risk of similar events.

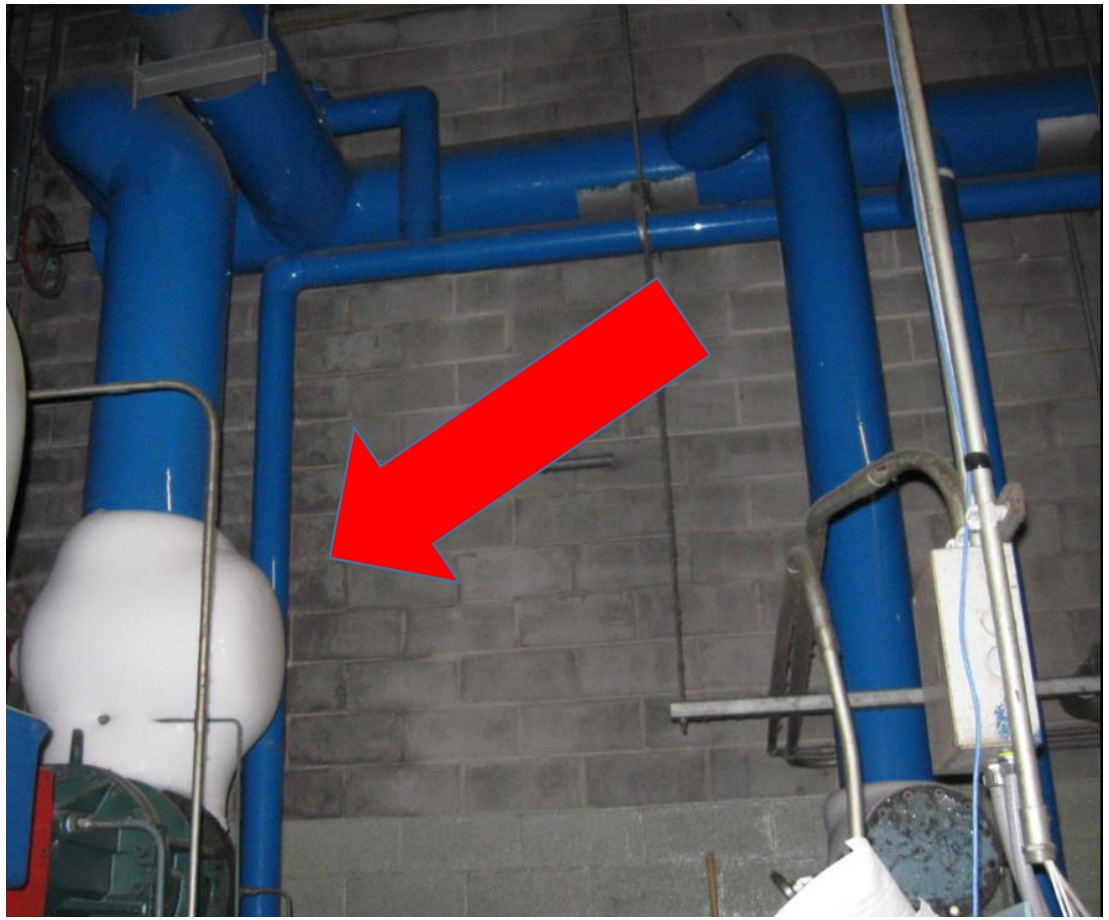
Audits

- ✓ **Periodic process** that investigates whether or not the established procedures have been used consistently and effectively.
- ✓ **Audits shall include:**
  - ✓ A documentation of found deficiencies
  - ✓ Actions taken to correct found deficiencies
  - ✓ A defined Audit format.

Managing Changes

- ✓ **A 'change' includes** modifications to the process, equipment, procedures, &/or addition of new equipment
- ✓ **Changes** can be:
  - ✓ Replacement in kind;
  - ✓ Temporary
  - ✓ Permanent
- ✓ It is important to establish a system to **preserve the Integrity of the Process.**

Audits

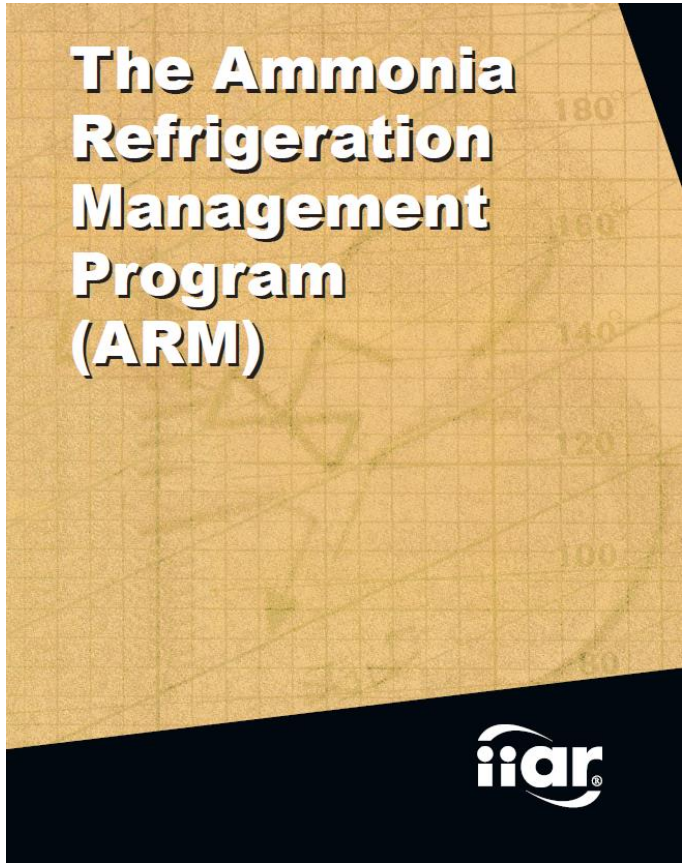


Audits

Pipe Coating for
Corrosion Prevention
Pipe Coloring?
Pipe Labels?
Training?

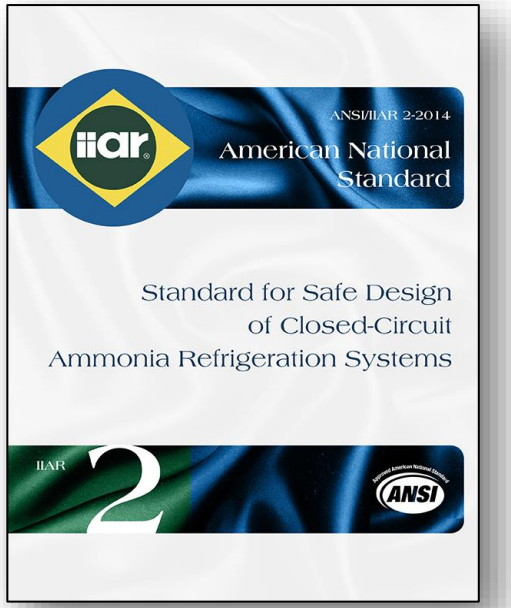
Conclusions

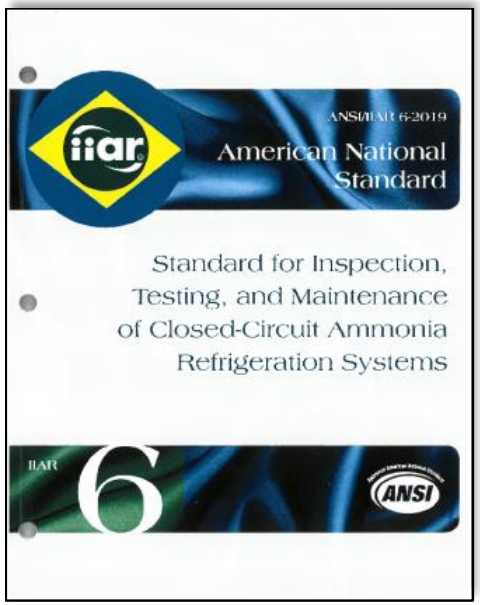
- **The IIAR-ARM Manual:**
  - ✓ Is an important part of **RAGAGEP;**
  - ✓ Provides template procedures to use as **TOOLS** in implementing an effective program;
  - ✓ Consists of a series of practices that help us maintain **SAFE and EFFICIENT Ammonia Refrigeration Systems.**

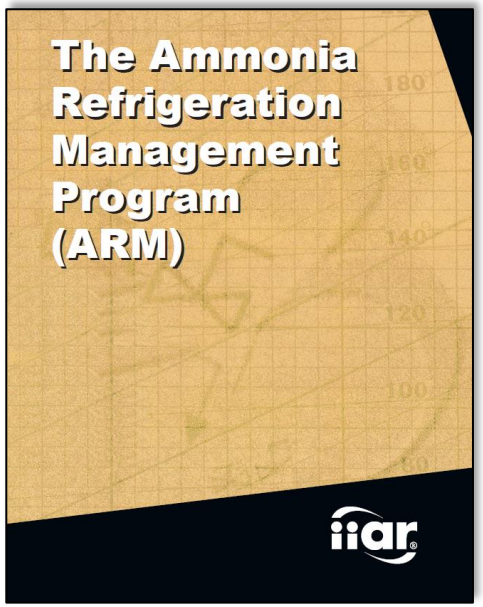


IIAR Academy of Natural Refrigerants

ACADEMY OF NATURAL REFRIGERANTS







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Questions?

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