

## IIAR 9 Minimum System Safety Evaluation Checklist

Facility Name:		Gap Assessor:	
Address:		Company:	
Facility Contact:		E-mail:	
E-mail:		Phone:	
Phone:		Date(s) of Assessment:	

**Purpose:** This standard provides the minimum safety requirements for existing closed-circuit ammonia refrigeration systems (1.1.1).

**Frequency:** An initial safety evaluation shall be conducted for each ammonia refrigeration system to ensure that it complies with the minimum system safety requirements specified in IIAR 9 no later than January 1st, 2026. (1.3.1 and 8.3.1). The safety evaluations shall be revalidated at least every five (5) years (1.3.2 and 8.3.2).

**Applicability:** This checklist applies to existing stationary closed-circuit vapor compression refrigeration systems using ammonia as a refrigerant in industrial occupancies. (1.2.1).

**Scope of Evaluation:** The scope of the minimum system safety evaluation is to include a review and verification of equipment and system component documentation (4.1 - 4.2), a review of the inspection, test, and maintenance program (5.1), a review of operating procedures (6.1), and a physical inspections of the ammonia refrigeration system to verify applicable minimum system safety requirements (7.1 - 7.4).

**Documentation:** The results of the minimum system safety evaluation and the procedures used to identify gaps will be documented using this checklist or an equivalent form (8.2.3 - 8.2.4).

**Findings:** The owner or the owner's designated representative shall close the gap(s) identified during the evaluation to meet the minimum system safety requirement(s) in a timely manner by documenting the resolutions using the 'method used to address gaps' column on this checklist (8.2.5.1).

**Declining to close an identified gaps** must be determined by the following options and documented in the 'Method used to Address Gaps' column of this checklist; 1) A semi-quantitative technique for risk-based ranking, 2) An analytical tool, 3) A quantitative risk analysis, or 4) variance from the Authority Having Jurisdiction (8.2.5.2).

**References:** Any number sequence between open and closed parenthesis (i.e. (X.X.X)) is a reference back to to the IIAR 9 Standard.

Item #	IIAR 9 Section	Requirement	Guideline	Existing Documentation/ Condition	Gaps Identified and recommended corrective action(s)	Date Resolved	Resolution
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### Documentation Review

#### Equipment and System Components Documentation

1	§4.1.1.1	Manufacturer Data Report(s) for Compressor oil separators	This documentation commonly resides in the Process Safety Information of the RMP/PSM or ARM Program.				
2	§4.1.1.2	Manufacturer Data Report(s) for Compressor oil cooler (if applicable)	Manufacturer Data Reports (U-1A, U-2, U-3, etc.) can be either be obtained from the manufacturer or through the National Board as long as the pressure vessel or heat exchanger has a legible National Board Number, Manufacturer Name, and Date of Manufacturer on the nameplate.  Manufacturer's data reports may not be available or required where these pieces of equipment are not registered with the National Board under ASME code rules (A.4.1.1).				
3	§4.1.1.3	Manufacturer Data Report(s) for Condensers (if applicable)					
4	§4.1.1.4	Manufacturer Data Report(s) for Pressure Vessels					
5	§4.1.1.5	Manufacturer Data Report(s) for Heat Exchanger (if applicable)					

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6	§4.1.2.1	Materials of Construction for Compressors	<p>This documentation commonly resides in the Process Safety Information of the RMP/PSM or ARM Program.</p> <p>The materials of construction for equipment in the ammonia refrigeration system could be documented utilizing the following items: equipment specifications; design specifications; equipment, valve and instrument tables; equipment drawings; manufacturer manuals; etc (A.4.1.2).</p>				
7	§4.1.2.2	Materials of Construction for Condensers					
8	§4.1.2.3	Materials of Construction for Evaporators					
9	§4.1.2.4	Materials of Construction for Auto Purgers					
10	§4.1.2.5	Materials of Construction for Ammonia Refrigerant Pumps					
11	§4.1.2.6	Materials of Construction for Heat Exchangers					
12	§4.1.3.1	Manufacturer Documentation for Valves					
13	§4.1.3.2	Manufacturer Documentation for Instrumentation					
14	§4.1.3.3	Manufacturer Documentation for Controls					
<b>Inspection, Testing, and Maintenance</b>							
15	§5.1	All equipment and system components shall be inspected, tested, and maintained in accordance with ANSI/IIAR 6 (2019)	<p>Evaluate a random sample of inspection, test, and maintenance records for the ammonia refrigeration system components to evaluate the facility's Mechanical Integrity Program is consistent with the requirements IIAR 6 and manufacturer recommendations.</p> <p>A review of the most recent 3-yr Compliance Audit, 5-yr Mechanical Integrity Inspection, and 5-yr Process Hazard Analysis can sufficiently verify compliance with this item.</p>				
<b>Location of Ammonia Refrigeration Equipment</b>							
16	§6.1	Operating procedures shall be developed in accordance with the requirements of ANSI/IIAR 7 (2019)	<p>Evaluate a random sample of operating procedures for the ammonia refrigeration system components to ensure the Operating Procedures are consistent with the requirements of IIAR 7.</p> <p>A review of the most recent 3-yr Compliance Audit, 5-yr Mechanical Integrity Inspection, and 5-yr Process Hazard Analysis can sufficiently verify compliance with this item.</p>				

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<b>Field Inspection</b>							
<b>Location of Ammonia Refrigeration Equipment</b>							
1	§7.1.2	<p>The following ammonia refrigeration equipment shall be permitted to be installed in areas other than a machinery room.</p> <ul style="list-style-type: none"> <li>• Evaporators used for refrigeration or dehumidification.</li> <li>• Condensers used for heating the space in which they are located.</li> <li>• Low-probability pumps.</li> <li>• Valves, including but not limited to control and pressure-relief valves, and connecting piping, any of which are associated with 7.1.2.1, 7.1.2.2 and 7.1.2.3.</li> <li>• An ammonia refrigeration system or portions thereof with a total connected compressor drive power not exceeding 100 HP (74.6 kW).</li> </ul>	Compressors and open drive pumps must be installed in a machinery room or outdoor machinery area, unless the total connected compressor drive power does not exceed 100 HP (74.6 kW).				
<b>Ammonia Purity</b>							
2	§7.2.1.1	<p>Anhydrous ammonia used for the initial and subsequent charging of ammonia refrigeration systems using mechanical compression shall meet the purity requirements shown in Table 7.2.1.1</p> <p>ANSI/IIAR 9-2020 Table 7.2.1.1</p> <ul style="list-style-type: none"> <li>• Ammonia Content: 99.5% minimum</li> <li>• Water: 50 ppm minimum, 5000 ppm maximum</li> <li>• Oil (as soluble petroleum ether): 50 ppm maximum</li> <li>• Salt (calculated as NaCl): None</li> <li>• Pyridine, Hydrogen Sulfide, Naphthalene: None</li> </ul>	An ammonia purity record provided by the ammonia supplier can validate the ammonia purity charged into the system. Performing an ammonia purity test is another way to verify the purity of ammonia in a refrigeration system.				

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<b>System Pressure and Temperature Ratings</b>							
3	§7.2.2.1(2)	Equipment connected to pressure vessels, and their interconnecting piping, that are subject to the same pressure as the pressure vessel shall have a design pressure that is equal to or greater than the set pressure of the pressure relief protection for the pressure vessel.					
4	§7.2.2.1(4)-(7)	<p>The minimum system pressure ratings shall be:</p> <ul style="list-style-type: none"> <li>• Low-pressure side: 150 psig [1035 kPa].</li> </ul> <p>EXCEPTION: When ammonia liquid is to be transferred from pressure vessels by pressurized ammonia gas, the pressure vessel design pressure shall accommodate the maximum possible transfer pressure and take into account the lowest possible coincident metal temperature</p> <ul style="list-style-type: none"> <li>• High-pressure side of water-cooled systems: 250 psig [1724 kPa].</li> <li>• High-pressure side of evaporatively-cooled systems: 250 psig [1724 kPa].</li> <li>• High-pressure side of air-cooled systems: 300 psig [2069 kPa].</li> </ul>	Component pressure ratings can be confirmed by reviewing equipment nameplates, manufacturer data reports, or equipment specification sheets.				
5	§7.2.3	Equipment shall be rated to operate within the full range of temperatures associated with the system rating and for the full range of ambient temperatures to which equipment will be exposed at the installation location.	The temperature design parameters are often identified on the equipment nameplate and/or manufacturer data reports.				

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<b>Purging and Oil Management</b>							
6	§7.2.4	Means shall be provided to remove air and other non-condensable gases from the refrigeration system.	The purging non-condensable gases from the refrigeration system is commonly accomplished through the use of an auto-purger or manual valves installed on the condenser drain pipes.				
7	§7.2.5.1	Provisions shall be made for removing oil from locations in piping and equipment where oil accumulation is expected.	Oil is accumulated on the low pressure side of the sytem and purging locations are commonly available on oil pots and low pressure vessels with a drop leg configuration.				
8	§7.2.5.2	Compressor packages shall have a means to sample oil for periodic oil analysis when required by the manufacturer's recommendations.	Oil sample valves are typically installed on the the oil separator.				
9	§7.2.5.3	Oil removal shall be accomplished by one or more of the following: 1) A rigid-piped oil return or transfer system. 2) A vessel equipped with a shut-off valve in series with a self-closing shut-off valve. 3) A valve and piping assembly at the drain point where oil is removed from the system. At a minimum, a shut-off valve in series with a self-closing shut-off valve is required.	Field verify all oil drain locations are configured to drain oil according to one of the three allowed options.  The valve and piping connections can be either permanently attached to the system or they can be temporary, such as through the use of ammonia rated hoses (A.7.2.5.3).				
10	§7.2.5.4	Where draining of oil requires the use of temporarily attached rigid piping, such piping shall be supported and shall have tight connections.	If applicable, oil draining procedures can address temporary piping for support during the oil draining process.				

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<b>Insulation</b>							
11	§7.2.6.1, 7.3.6.1	<p>Piping and equipment surfaces not intended for heat exchange shall be insulated, treated, or otherwise protected to mitigate condensation and excessive frost buildup where the surface temperature is below the dew point of the surrounding air during normal operation and in an area where condensation and frost could develop and become a hazard to occupants or cause damage to the structure, electrical equipment, or refrigeration system.</p> <p>EXCEPTIONS:</p> <p>1) Valves and other equipment shall be permitted to be uninsulated where necessary for service access provided that the vapor retarder is sealed to the piping or equipment where insulation of adjoining piping terminates.</p> <p>2) Piping and fittings constructed of corrosion-resistant materials or protected with a corrosion-resistant treatment shall be permitted to be uninsulated if they are routinely defrosted or are otherwise managed to limit ice accumulation. Where defrost will be the method of ice control, a means to control and drain condensate shall be provided where condensate will present a nuisance or a hazard.</p>	Observe the system for large or unusual ice formations or condensation that could cause a safety issue. Ice accumulation must not render a valve inaccessible or inoperable.				
<b>Foundations, Piping, Tubing, and Equipment Supports</b>							
12	§7.2.7.1, 7.3.2.2, 7.3.2.3, 7.3.2.4	Piping, tubing, and equipment shall be supported to prevent excessive vibration and movement.	Observe the components and piping for excessive vibration, sagging, and movement. Additionally, equipment should be properly anchored and piping should be properly fastened to supports.				

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<b>Service Provisions</b>							
13	§7.2.8	Equipment shall be accessible for inspection, testing, maintenance, and emergency shutdown.	Observe components to ensure they are accessible from the ground, platform, or other means that provides safe access.				
14	§7.2.8.1	Refrigeration system charging connections shall be plugged or capped when the charging connection is not in use. When located outdoors, they shall be locked or otherwise restricted to access by authorized personnel.	Verify all charging connections are plugged and capped. When the charging location is located outdoors, the connections be locked or have some method of restricted access.				
15	§7.2.8.2	Where a pressure gauge is installed on the high side of the refrigeration system, the gauge shall be capable of measuring and displaying not less than 120% of the system rated pressure.	Verify gauges are appropriate for the system pressure. For example, system high side pressure rating of 250 PSI should be equipped with a gauge measuring and displaying at least 300 PSI. (250 PSI x 120% = 300 PSI)				
16	§7.2.8.3	Serviceable equipment shall have manual isolation valves. EXCEPTION: Packaged systems and portions of built-up systems shall be permitted to have pump-down arrangements that provide for the removal or isolation of ammonia for servicing one or more devices in lieu of isolation valves.	Verify equipment can be isolated with manual isolation valves at the inlet and outlet of the component. Reference the Standard Operating Procedure for Pump-down instructions.  Hand isolation valves should not be placed where they could hinder the function of control valves. The designer should use judgement regarding location and number of valves needed to perform service (A.7.2.8.3).				
17	§7.2.8.4	Provisions for pumpout of equipment and control valves shall be provided for maintenance and service.	Verify the equipment can be pumped down. Reference Standard Operating Procedure.  Provisions for pumpout of equipment and control valves may include a manual vent valve near a high point or a manual drain valve near a low point or both. Dedicated pumpout systems may also be employed. Connections for pumpout points should be capped or plugged when not in use, if they are not permanently piped to dedicated pumpout gas or liquid transfer equipment (A.7.2.8.4).				

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<b>Signage, Labels, Pipe Marking, and Wind Indicators</b>							
18	§7.2.9.1	<p>Signage shall be provided in accordance with this section.</p> <p>1) NFPA 704 Placards. Buildings and facilities with refrigeration systems shall be provided with placards in accordance with NFPA 704.</p> <p>2) Alarm Signage. The meaning of each alarm shall be clearly marked by signage near the visual and audible alarms.</p> <p>3) Restricted Access Signage. Each machinery room entrance door shall be marked with a permanent sign to indicate that only Authorized personnel are permitted to enter the room.</p>	<p>1) The appropriate NFPA 704 Placard for ammonia refrigeration equipment installed indoor is 3 Health/Blue, 3 Flammability/Red, 0 Reactivity/Yellow, while ammonia refrigeration equipment outdoors is: 3 Health/Blue, 1 Flammability/Red, 0 Reactivity/Yellow.</p> <p>2) Verify alarm signage is installed at the alarm and is legible as to the meaning of the alarm.</p> <p>3) Verify every engine room door is marked restricted access signage (i.e. Authorized Personnel Only signage).</p>				
19	§7.2.9.2	Refrigeration equipment shall be provided with labels indicating the equipment's name or identifier.	Visually verify component markers exist and are consistent with the guidance provided in IIAR 2 Appendix Q.				
20	§7.2.9.3	Valves required for emergency shutdown of the system shall be clearly and uniquely identified at the valve itself and in the system schematic drawings.	Visually verify the emergency shutdown valves such as the 'King Valve' are clearly identified and consistent with the P&IDs.				
21	§7.2.9.4, 7.3.6.3	<p>Ammonia piping mains, headers, and branches shall be identified with the following information</p> <p>1) "AMMONIA"</p> <p>2) Physical state of the ammonia</p> <p>3) Relative pressure level of ammonia, being low or high as applicable</p> <p>4) Pipe service, which shall be permitted to be abbreviated</p> <p>5) Direction of flow</p>	Visually verify component markers exist and are consistent with the guidance provided in IIAR 2 Appendix Q.				
22	§7.2.9.5	Emergency Contact Information. The contact information for whom to contact in an emergency.	This contact information is commonly listed on posted evacuation maps or signage around the machinery room.				

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<b>Equipment Enclosures</b>							
23	§7.2.10.1	Enclosures for ammonia equipment shall be suitable for the installation location and shall be provided with protection from physical and environmental damage as required for the installed location.	An equipment enclosure is an enclosure designed to house refrigeration equipment or devices associated with a closed-circuit refrigeration system, or both, that is not intended for occupancy.				
24	§7.2.10.2	Operational and maintenance service egress shall be provided by access panels or doors, or shall provide for remote service by removal of the enclosure or the contents from the installed location.					
<b>General Safety Requirements</b>							
25	§7.2.11.1	Where ammonia-containing equipment is installed in a location subject to physical damage, guarding or barricading shall be provided.	Field observation that ammonia equipment is guarded and protected from physical damage. Examples include bollards protecting equipment installed on the ground and cages protecting ceiling suspended evaporators.				
26	§7.2.11.2	Exposed moving parts shall be protected with screens or guards in accordance with OSHA 29 CFR 1910.212 and 29 CFR 1910.219.	Field observation of screens and guards protecting equipment such as compressor and pump drives and evaporator and condenser fans.				
27	§7.2.11.3	Ammonia shall be stored in cylinders or vessels designed for ammonia containment.	Field observation of nameplates or documentation of cylinders or vessels used to store ammonia are suitable for anhydrous ammonia.				
28	§7.2.11.4	Refrigerant piping with an external surface temperature of 140°F (60°C) or higher and located outside the machinery room at a height less than 7.25 ft (2.2 m) above the floor, or located adjacent to passageways, aisles, walkover stairs, or landings, shall be provided with one of the following: 1) caution signs; 2) insulation; or 3) guards to prevent contact.	Field observation that caution signs, insulation, or guards have been installed, as needed. Piping that may have external surface temperature of 140°F (60°C) or higher is likely the compressor discharge piping to the condenser.				

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<b>Machinery Room Construction</b>							
29	§7.3.2.1	The machinery room shall be separated from the remainder of the building by tight-fitting construction. Doors shall comply with Section 7.3.9.2.	Field verify the machinery room penetrations are tight-fitting construction not allowing air flow to and from the room.				
30	§7.3.2.2	Piping supports shall carry the weight of the piping system including contents and insulation; if necessary, provide sway bracing to minimize vibration.	Observe piping for areas of sagging, excessive vibration or swaying.				
31	§7.3.2.3	Supports and foundations shall be adequate to prevent movement of the equipment.	Equipment should be adequately anchored to the foundation and the foundation should be free from deterioration that allows excessive vibration and movement of equipment.				
32	§7.3.2.4	Supports and foundations shall be adequate to prevent excessive vibration of the equipment.					
33	§7.3.2.5	Air shall not flow to or from any portion of a premises that is routinely accessible to or occupied by people on a part-time or full time basis through a machinery room unless the air is ducted and sealed to prevent ammonia leakage from entering the airstream. Access doors and panels in ductwork and air-handling units located in a machinery room shall be gasketed and tight fitting.	Evaluate the airflow in and out of the machinery room to ensure the airflow to/from the machinery room is not being shared with other occupied rooms at the facility.				
34	§7.3.6.2	Pipes penetrating the machinery room envelope shall be sealed to walls, ceilings, or floors through which they pass to prevent leakage of ammonia vapor to adjoining spaces and to maintain the fire rating of the machinery room envelope.	Verify that all pipe penetration through wall, ceilings and floor are sealed in a way to prevent ammonia vapor from spreading to other locations.				
<b>Machinery Room Access and Egress</b>							
35	§7.3.3.1	Equipment installed in machinery rooms shall be located in such a manner as to allow egress from any part of the room in the event of an emergency and to provide clearances required for operation, inspection, testing, and maintenance according to manufacturers' instructions.	First, ensure equipment in the machinery room is installed in a manner that does not prevent safe egress from the machinery room. Additionally, ensure equipment is installed in a manner that allows safe access to operate and maintain the equipment in the machinery room.				

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36	§7.3.3.3	Manually operated system emergency valves identified as being part of the system emergency shutdown procedure that are inaccessible from floor level shall be operable from a fixed permanent work surface, or by use of a chain or a remote-actuated manual operator that shall be readily accessible from the floor or a permanent work surface. Ready access and clearance to operate the valves while wearing emergency response personal protective equipment shall be provided.	Field observation is limited to the machinery room as this question is contained within the 'Machinery Room Access and Egress' section of the checklist.				
37	§7.3.3.4	Access to a machinery room shall be restricted to authorized personnel. Signage on machinery room doors shall comply with Section 7.2.9.	Ensure Authorized Personnel Only signage is installed on doors which have access to the machinery room.				
<b>Combustible Materials, Open Flames, and Hot Surfaces Inside Machinery Rooms</b>							
38	§7.3.4	Combustible materials shall not be stored in machinery rooms outside of approved fire-rated storage containers.	Field observation of the machinery room to be free from combustible materials being stored outside of a fire-rated storage containers. The storage of oil products (i.e. compressor oil drums) is common in machinery rooms, but must be store in a fire-rated storage container or moved to a separate storage location outside the machinery room.				

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39	§7.3.5	<p>Fuel-burning appliances and equipment and surfaces with temperatures exceeding 800°F (427°C) shall not be installed in a machinery room</p> <p>EXCEPTIONS:</p> <ol style="list-style-type: none"> <li>1. Fuel-burning appliances and equipment shall be permitted in a machinery room where combustion air to the fuel-burning appliance is ducted from outside of the machinery room and sealed to prevent ammonia leakage from reaching the combustion chamber</li> <li>2. Fuel-burning appliances and equipment shall be permitted in a machinery room where an ammonia detector is in accordance with Section 7.3.12 and automatically shuts off the combustion process upon detection of ammonia</li> <li>3. The use of matches, lighters, sulfur sticks, welding equipment, and similar portable devices shall be permitted except when charging is being performed and when oil or ammonia is being removed from the system</li> <li>4. Internal combustion engines powering compressors shall be permitted in a machinery room.</li> </ol>	<p>Evaluate the machinery room for the installation of fuel-burning appliances such as boilers. Installation of fuel-burning equipment is only allowed when meeting one of the four noted exceptions.</p>				
<b>Ammonia Cylinders</b>							
40	§7.3.6.4	<p>Ammonia cylinders shall not be connected to a refrigeration system unless ammonia is in the process of being transferred by authorized personnel.</p>	<p>Ammonia cylinders in storage should be secured to a fixed object such as a wall or mounted rack with a restraint such as a chain or strap.</p>				

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<b>Eyewash and Safety Showers</b>							
41	§7.3.7.1	Each machinery room shall have access to a minimum of two eyewash/safety shower units, one located inside the machinery room and one located outside of the machinery room, each meeting the requirements in Section 7.3.7.3. Additional eyewash/safety shower units shall be installed such that the path of travel in the machinery room is no more than 55 ft to an eyewash/safety shower unit.	The size and shape of the machinery room may be large and/or long enough to require additional eyewash/safety shower unit(s). Measuring the machinery room may be necessary to identify the necessary amount and locations of the eyewash/safety shower units.				
42	§7.3.7.2	The path of travel within the machinery room to at least one eyewash/safety shower unit shall be unobstructed and shall not include intervening doors.	Obstructions may include stairs to or from the eyewash/safety shower units, materials stored around the eyewash/safety shower units or other configurations.				
43	§7.3.7.3	Emergency eyewash/safety shower unit installations shall comply with ANSI/ISEA Z358.1.	It is recommended to reference the ANSI/ISEA Z358.1 for specific requirements of eyewash/safety shower units including; water flow, water temperature, unit access, unit identification, etc.				
<b>Machinery Room Drains</b>							
44	§7.3.8.1	Floor drains or other means shall be provided to dispose of liquids.	Methods for limiting the spread of a liquid ammonia spill into a machinery room drainage system may be the use of drain plugs, drain mats, absorption pads, an in ground drainage pit, or other equivalent means (A.7.3.8.3).				
45	§7.3.8.2	Where a drainage system is not designed for handling oil, secondary coolants, or other liquids that might be spilled, a means shall be provided to limit such substances from entering the drainage system.					
46	§7.3.8.3	A means shall be provided to limit the spread of a liquid ammonia spill into the machinery room drainage system.					

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<b>Machinery Room Entrances and Exits</b>							
47	§7.3.9.1	Machinery rooms exceeding 1,000 ft <sup>2</sup> (93 m <sup>2</sup> ) in area shall not have fewer than two exit doors or exit-access doors. Where two doors are required, one door shall be permitted to be served by a fixed ladder or an alternating tread device. Doors shall be separated by a horizontal distance equal to or greater than one-half of the maximum horizontal dimension of the room. All portions of a machinery room shall be within 150 ft (45.7 m) of an exit door or exit-access door, unless the Building Code permits an increased travel distance.	<p>First measure the square footage of the machinery room. If the machinery rooms area exceeds 1,000 ft<sup>2</sup> (93 m<sup>2</sup>) and two exit doors are required, ensure any point of the machinery room is within 150' of an exit door.</p> <p>If it is impractical to install a second emergency exit in an existing machinery room which exceeds 1,000 ft (93 m ), the owner or operator should provide an alternative escape method from the machinery room such as the use of escape equipment (A.7.3.9.1).</p>				
48	§7.3.9.2	Machinery room doors shall be self-closing and tight fitting. Doors that are part of the means of egress shall be equipped with panic hardware and shall be side hinged to swing in the direction of egress for occupants leaving the machinery room. Where the machinery room is not provided with fire sprinklers, doors communicating with the building interior shall be one-hour fire rated. Doors to the outdoors shall be fire rated based on the fire rating required for exterior wall openings.	A typical machinery room door will be equipped with panic hardware (crash bar) which should swing in the direction of egress. The door should be configured to be self-closing and be tight fitting as to not allow airflow around the door and door frame. To verify the door's fire rating, a fire label is often located on the hinge side of a fire-rated door, but it can also be located on the top or bottom of a door as well.				
<b>Machinery Room Lighting</b>							
49	§7.3.10.1	Machinery rooms shall be equipped with light fixtures delivering a minimum of 30 foot-candles (320 lumens/m <sup>2</sup> ) at the working level, 36 in (0.91 m) above a floor or platform.	A light test can be performed with a light meter. It is recommended to take several samples within the machinery room to verify consistency of the mimimum lighting requirements.				

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<b>Emergency Control Switches</b>							
50	§7.3.11.1	A clearly identified emergency shut-off switch with a tamper-resistant cover shall be located outside and adjacent to the designated principal machinery room door. The switch shall provide off-only control of refrigerant compressors, refrigerant pumps, and normally closed automatic refrigerant valves located in the machinery room. The function of the switch shall be clearly marked by signage near the controls.	<p>An emergency shut-off switch is commonly identified with a label titled 'E-Stop' or Emergency Shut-Off Switch'.</p> <p>Common tamper-resistant covers include but are not limited to tamper-proof clear switch cover or break glass configurations. The function of the switch can be communicated on the identification signage.</p> <p>The purpose of installing a tamper-resistant style cover is to prevent the inadvertent operation of the Emergency Stop Switch and the Emergency Ventilation Control Switch (A.7.3.11).</p>				
51	§7.3.11.2	A clearly identified control switch for emergency ventilation with a tamper-resistant cover shall be located outside the machinery room and adjacent to the designated principal machinery room door unless the continuous ventilation operates at a rate at or above that required for emergency ventilation. The switch shall provide "ON/AUTO" override capability for emergency ventilation. The function of the switch shall be clearly marked by signage near the controls.	If continuous ventilation operates at a rate at or above that required for emergency ventilation, ensure administrative controls or engineering controls are in place to ensure the continuous ventilation is not shut down during normal operations.				

Item #	IIAR 9 Section	Requirement	Guideline	Existing Documentation/ Condition	Gaps Identified and recommended corrective action(s)	Date Resolved	Resolution
<b>Machinery Room Ammonia Detection and Alarms</b>							
52	§7.3.12.1	Machinery rooms shall be provided with ammonia detection and alarms with the following features: 1) At least one ammonia detector shall be provided in the room or area.	Ammonia detection in areas other than machinery rooms is not required by IIAR 9. However, ammonia detection may be required in areas other than machinery rooms by the Building Code, Fire Code, or Mechanical Code in effect at the time of installation. In addition, the current version of IIAR 2 (ANSI/IIAR 2-2021) specifies that ammonia detection be provided in areas other than machinery rooms for all new construction unless the exceptions listed in IIAR 2 are met (A.7.3.12).				
		2) The detector shall activate an alarm that reports to a monitored location so that corrective action can be taken.	Monitored means 'A means of continuous oversight, such as notification to on-site staff, a third-party alarm service, or a responsible party.'				
		3) Audible and visual alarms shall be provided inside the room. Additional audible and visual alarms shall be located outside of each entrance to the machinery room.	Verify at least one visual and audible alarm is located inside the machinery room, while a visual and audible alarm is located outside each entrance to the machinery room.				
53	§7.3.12.2	At a minimum, the machinery room alarm response shall be at an appropriate arrangement for the following to occur: 1) Activates an alarm to a monitored location so an immediate response can be set in place at a detected concentration of no higher than 50 ppm.	Verify the sensor set point through the controls system. Additionally, review service records and Process Safety Information records for additional details related to the function of the ammonia detection system.				
		2) Activate emergency ventilation at a detected concentration of no higher than 1000 ppm.	While the minimum safety requirement in this standard to activate emergency ventilation is 1000 ppm, it is important to note that NFPA 70, the National Electrical Code (NEC), requires that the emergency ventilation be activated no higher than 150 ppm in order to maintain an unclassified hazardous location designation. AHJs may choose to enforce this provision over the requirement of IIAR 9 (A.7.3.12.2(2)).				
		3) Automatically de-energize determined equipment at a detected concentration no higher than 40,000 ppm (25% LFL). At a minimum, the determined equipment shall include the following: the refrigerant compressors; refrigerant pumps; and normally closed automatic refrigerant valves that are not part of an emergency control system.					

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54	§7.3.12.3	The power supply for the ammonia detectors and alarms shall be a dedicated branch circuit. In the event of a loss of power on other circuits or an emergency shutdown of refrigeration equipment, the ammonia detection and alarm system shall remain on. In the event of a loss of power to the ammonia detection and alarm system, a power failure trouble signal shall be sent to a monitored location.	Monitored means 'A means of continuous oversight, such as notification to on-site staff, a third-party alarm service, or a responsible party.'				
55	§7.3.12.4	Are all leak detection sensors, or the inlet of sampling tubes that draw air to a leak detection sensor mounted in a position where ammonia from a leak is expected to accumulate and positioned where they can be accessed for maintenance and testing? In rooms equipped with continuous exhaust ventilation, the leak detection sensors and sampling tubes shall take into account the air movement toward the inlet of the ventilation system.	Evaluate the location of the installed ammonia sensors to ensure the sensors are positioned in an area where ammonia is likely to accumulate but not located in a manner that the sensor are not accessible for maintenance.				
56	§7.3.12.5	The audible alarms providing notification shall provide a sound pressure level of 15 decibels (dBA) above the average ambient sound level and 5 dBA above the maximum sound level of the area in which it is installed.	Use a decibal meter to test the sound levels. Decibal meter cell phone applications are readily available.				
57	§7.3.12.6	Ammonia leak detection alarms shall be identified by signage adjacent to visual and audible alarm devices.	Verify signage is installed and accurately identifies the alarm warning and associated instructions for what to do in the event the alarm is activated.				

Item #	IIAR 9 Section	Requirement	Guideline	Existing Documentation/ Condition	Gaps Identified and recommended corrective action(s)	Date Resolved	Resolution
<b>Machinery Room Ventilation</b>							
58	§7.3.13.1	In occupied conditions, outdoor air shall be provided at a rate that complies with the codes and standards adopted at the time of installation or at the time that there was an addition or modification that would affect the occupancy ventilation rate.	The Ventilation System Design basis information is commonly available in the facility's Process Safety Information of the RMP/PSM or ARM Program. The ventilation fan rates identified in the Ventilation System Design basis documentation should be consistent with the actual fan specifications.				
59	§7.3.13.2	Machinery rooms shall be vented to the outdoors by means of a mechanical exhaust ventilation system at a rate that complies with the codes and standards adopted at the time of installation or at the time that there was an addition or modification that would affect the emergency ventilation rate.					
		Mechanical exhaust ventilation system shall be automatically activated by ammonia leak detection in accordance with Section 7.3.12.2 and shall be manually operable.	7.3.12.2 states "Activate emergency ventilation at a detected concentration of no higher than 1000 ppm".				
		Machinery room exhaust fans shall be equipped with non-sparking blades. Other non-emergency exhaust fans shall be equipped with non-sparking blades or automatically be de-energized when an ammonia detector is activated at 150 ppm.	The machinery room exhaust fan manufacturer specification sheet should be reviewed to verify the machinery room exhaust fans have non-sparking blades.				
		Emergency exhaust fan motors located in the air stream or inside the machinery room shall be of the totally enclosed type.	A totally enclosed electric motor is a type of industrial electric motor with an enclosure that does not permit outside air to freely circulate through the interior of the motor.				

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60	§7.3.13.3	1) Make-up air shall be provided to replace air being exhausted. 2) Make-up air supply locations in the machinery room shall prevent short-circuiting of the make-up air directly to the exhaust. 3) Intakes for make-up air shall draw uncontaminated outdoor air. 4) Intakes for make-up air to the machinery room shall serve only the machinery room. 5) Motorized louvers or dampers, where utilized, shall fail to the open position upon loss of power. 6) Where direct openings or openings with ducts are not provided to supply makeup air, make-up air shall be provided by fans or fans with ducts.	Individually field verify each item satisfies the listed requirements. Emergency ventilation system tests and emergency ventilation system design documentation can assist in determining the emergency ventilation system meets the requirements.				
<b>Pressure Relief Protection</b>							
61	§7.4.1	Pressure vessels and other types of equipment built and stamped in accordance with ASME B&PVC, Section VIII, Division 1, shall be provided with relief devices built, tested, and marked in accordance with that code.	This includes all pressure vessels and heat exchangers that have an ASME clover stamp on the equipment nameplate. The inspector should verify that all vessel and heat exchangers with an ASME clover stamp on the nameplate are protected with pressure relief valve(s).				

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62	§7.4.2	<p>If the pressure relief devices discharge vapor directly to the atmosphere outdoors, they shall comply with the following:</p> <p>The termination of pressure relief device discharge piping relieving to the atmosphere shall not be less than 15 ft (4.6 m) above grade and not less than 20 ft (6.1 m) from windows, ventilation intakes, or exits.</p>	<p>Each discharge termination location, must be evaluated and verified to meet all identified distances from grade level, roof level, adjacent roof level, and platform surfaces as specified in this requirement.</p>				
		<p>The discharge termination from pressure relief devices relieving to atmosphere shall not be less than 7.25 ft (2.2 m) above a roof that is occupied solely during service and inspection. Where a higher adjacent roof level is within 20 ft (6.1 m) horizontal distance from the relief discharge, the discharge termination shall not be less than 7.25 ft (2.2 m) above the height of the higher adjacent roof.</p>					
		<p>Discharge piping shall be permitted to terminate not less than 7.25 ft (2.2 m) above platform surfaces, such as upper condenser catwalks, that are occupied solely during service and inspection.</p>					
		<p>Discharge piping from pressure relief devices discharging to atmosphere shall have a provision for draining moisture from the piping.</p>	<p>This requirement is most commonly satisfied by a drain valve located at the low point of the discharge piping.</p>				

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63	§7.4.3	<p>Protection against overpressure due to thermal hydrostatic expansion of trapped liquid ammonia shall be provided for equipment and piping sections that can be isolated and can trap liquid ammonia in an isolated section in any of the following situations:</p> <ul style="list-style-type: none"> <li>Automatically during normal operation.</li> <li>Automatically during shutdown by any means, including alarm or power failure.</li> <li>During planned isolation for standby or seasonal conditions.</li> <li>During planned isolation for standby or seasonal conditions.</li> <li>Refrigerant pumps and connected piping shall be provided with a means of protection from hydrostatic overpressure.</li> </ul> <p>EXCEPTION: If trapping of liquid with subsequent thermal hydrostatic expansion is only possible during maintenance or service operations, engineering or administrative controls, or both, shall be permitted as a means of relieving or preventing overpressure.</p>	Evaluate each scenario independently and verify each item is addressed with an engineering or administrative control.				
<b>High Liquid Level Shutdown and Pressure Limiting Devices</b>							
64	§7.4.4	Where a compressor suction line is directly connected to a vessel, the vessel shall incorporate a control to cause the associated compressors to shut down if a high ammonia liquid level is detected in the vessel.	A high level float switch is the most common safety control installed on a vessel. A high level float switch is wired to shut down the compressors in the event of a high liquid level in the vessel or a level controller equipped with high level set point.				
65	§7.4.5	Compressors shall be provided with high-discharge-pressure limiting device to shut down the compressors when the safe ranges are exceeded.	High-discharge-pressure limiting device or commonly referred to as high-discharge-pressure cut outs must be provided on any type of compressor screw, reciprocating, or rotary vane compressors.				

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<b>Location of Piping</b>							
66	§7.4.6	<ul style="list-style-type: none"> <li>Refrigerant piping shall not obstruct a means of egress.</li> <li>Refrigerant piping shall not be placed in an elevator shaft, dumbwaiter shaft, or other shaft containing a moving object.</li> <li>Refrigerant piping shall not be installed in a stair, landing, or means of egress that is enclosed and is accessible to the public.</li> <li>Refrigerant piping shall be permitted to be installed underground provided that the piping is protected from corrosion.</li> <li>Refrigerant piping installed in concrete floors shall be encased in pipe duct.</li> </ul>	Visually verify that each statement is true.				
<b>Instrumentation</b>							
67	§7.4.7.1	Instrumentation and controls shall be provided to indicate operating parameters of the refrigeration system and equipment and provide the ability to manually or automatically control the starting, stopping, and operating of the system or the equipment.	Field observation of control system/ instrumentation.				
68	§7.4.7.2	A means shall be provided for monitoring the concentration of an ammonia release in the event of a power failure.	One possible means of monitoring ammonia concentration resulting from a leak during a power failure is a portable ammonia monitoring device (A.7.4.7.2).				
69	§7.4.7.3	Changing of safety settings shall be limited to authorized personnel only. Changing of system operational settings shall not permit or affect changes to safety settings.	Authorized only signage to control room, password protected computer control system, or permission settings that limit user access				
70	§7.4.7.4	The pressure-containing envelope maximum allowable working pressure of instruments and visual level indicators shall be equal to or greater than the maximum allowable working pressure of the system or subsystem in which they are installed.	Evaluate the specification sheets of the instruments and visual level indicators to ensure they meet or exceed the maximum allowable working pressure of the part of the system the component is installed.				

Item #	IIAR 9 Section	Requirement	Guideline	Existing Documentation/ Condition	Gaps Identified and recommended corrective action(s)	Date Resolved	Resolution
<b>Liquid Level Indicators</b>							
71	§7.4.7.5	<p>Visual liquid level indicators, including but not limited to glass bull's eyes, flat "armored glass" linear sight glasses, or sight columns and pressure gauges, shall comply with this section.</p> <p>1) Sight glasses and linear liquid level indicators shall not be installed where a risk of hydraulic shock exists</p>	<p>Linear liquid level indicators are sometimes referred to as sight columns. Use of "checktype shut-off valve" refers to a valve that will close in the event that the linear liquid level indicator was to break. It is recommended that linear liquid level indicators be of the flat "armored glass" type in preference to the tubular glass type (A.7.4.7.5).</p>				
		<p>2) Visual liquid level indicators used to observe ammonia level, such as in a vessel or heat exchanger, shall be specified for installation in a manner that provides protection from physical damage.</p>	<p>Verify visual liquid level indicators are protected from accident impact by objects such as ladders, pallet jacks, or forklifts.</p>				
		<p>3) Linear liquid level indicators shall be fitted with internal check-type shutoff valves. Protection against accidental breakage of the glass tube from any direction shall be provided for the entire length of the tube.</p> <p>EXCEPTION: Liquid level indicators using bull's eye type sight glasses.</p>	<p>Review the manufacturer's sheets to determine if the linear liquid level indicators are fitted with internal shutoff valves.</p>				
		<p>4) Bull's eye sight glass types shall be compatible for use with ammonia, and the thickness and diameter shall be sized for the intended application.</p>	<p>Review the manufacturer's sheets to determine if the bull's eye sight glass is compatible for ammonia application.</p>				