

Ammonia Machinery Rooms

Codes and Standards

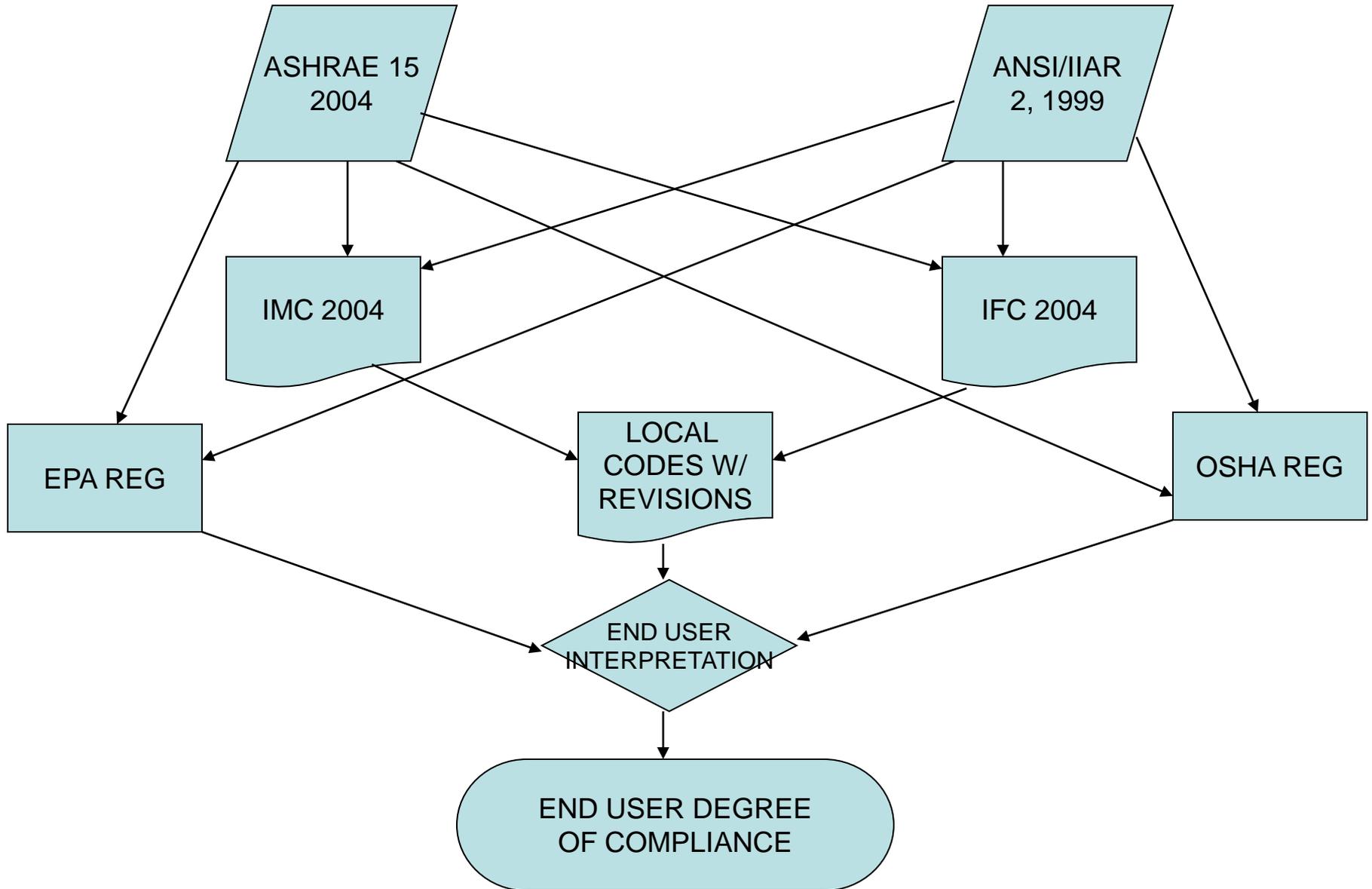




Machinery Room Requirements

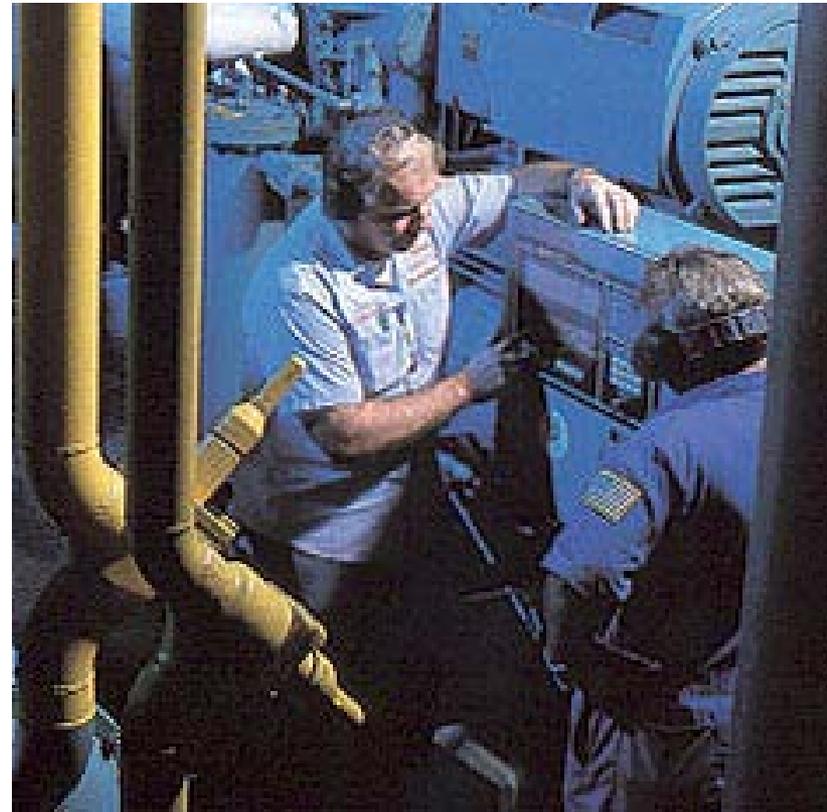
- 1. What codes/standards apply?**
- 2. Who is involved with compliance?**
- 3. Key design elements.**
- 4. Code analysis worksheet.**
- 5. Additional Considerations**
- 6. Discussion.**

Machinery Room Web



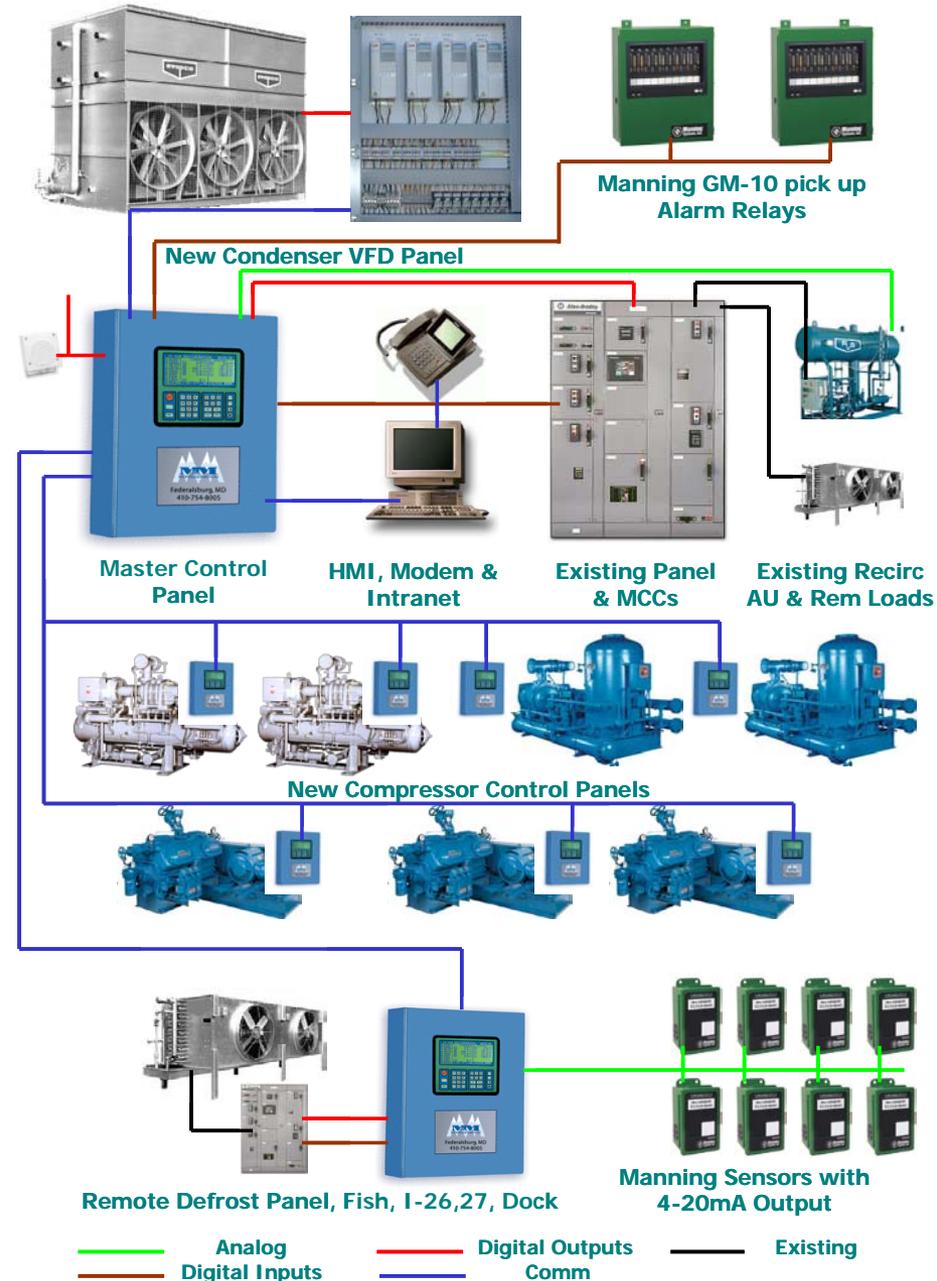
Machinery Room Compliance Interested Parties

- **Architect/Engineer of Record**
- **Construction Team-Contractors**
- **Plan Check and Code Officials**
- **Inspectors**
- **Fire Marshall**
- **Corporate Safety Officer**
- **Insurance Company**
- **Employees**
- **OSHA**
- **EPA**



Key Design Elements

- Egress / Exits
- Access
- Separation / Fire Walls
- Electrical
- No Open Flames
- Signage and Markings
- Ventilation
- Detection and Alarming
- Pressure Relief System
- Emergency Controls



Code Analysis Worksheet

AMMONIA REFRIGERATION MACHINERY ROOM DESIGN AND OPERATION CODES and STANDARDS (note 1, 2)

DESCRIPTION, FUNCTION	MANDATORY CODES / STANDARDS	
	REFERENCE	REQUIREMENT
DESIGN / INSTALL		
GENERAL	IMC	1101.6 - "Ammonia-refrigerating systems shall comply with this code and, except as modified by this code, ASHRAE 15 and IAR 2."
	IMC	1105.1 - "Machinery rooms shall be designed and constructed in accordance with the International Building Code and this section."
MACHINERY ROOM DEFINITION	IAR-2	"A space designed to safely house compressors, pressure vessels, or associated refrigeration equipment."
	ASHRAE 15	"a space, meeting the requirements of 8.11 or 8.12 that is designed to house compressors and pressure vessels."
	ASHRAE 15	8.11, 7.4 - "All components containing refrigerant shall be located either in a machinery room or outdoors..."
	ASHRAE 15	7.2.2.7 - "All refrigerant-containing parts in systems exceeding 100 HP (74.6 kW) compressor drive power, except evaporators used for refrigeration or dehumidification, condensers used for heating, control and pressure-relief valves for either, and connecting piping, are located either in a machinery room or outdoors."
	IMC	"A room meeting prescribed safety requirements and in which refrigeration systems or components thereof are located (see Sections 1105 and 1106)."
	IMC	1104.2 - "...all components containing the refrigerant shall be located either outdoors or in a machinery room where the quantity of refrigerant in an independent circuit of a system exceeds the amounts shown in Table 1103.1."
		No more than 4.4 lbs for 10,000 SF x 20 Ft space.
		Exceptions: 1. "listed equipment not containing more than 6.6 pounds (3 KG) of refrigerant" 2. "Piping...to connect components installed in a machinery room with those installed outdoors."
SITE / LOCATION	IAR-2	6.3.3.1 - "A remote location separated from production or office facilities is preferred."
	IAR-2	6.3.3.2 - "The machinery room shall be readily accessible for emergency response."
EGRESS / EXITS	IBC	1015.4 - "Machinery rooms larger than 1,000 square feet (93 m ²) shall have not less than two exits or exit access doors...."
		"Exit access doorways shall be separated by a horizontal distance equal to one-half the maximum horizontal dimension of the room."
		"All portions of machinery rooms shall be within 150 feet (45 m) of an exit or exit access doorway." (Unobstructed path) (Increased distance with fire sprinklers)
	ASHRAE 15	8.11.2 - "tight fitting door(s) opening outward, self-closing if they open into the building, adequate in number to ensure freedom for persons to escape in an emergency"
	ASHRAE 15	8.12(d) - "shall have a door that opens directly to the outside air or through a vestibule..."
	IAR-2	6.3.1.5 - (Same as ASHRAE 15 8.11 and 8.12 except) "Machinery rooms shall have tight fitting doors that open outward and are provided with panic-type hardware."

Code Analysis Worksheet

ACCESS	IMC	306.1 - "Clearances around appliances to elements of permanent construction, including other installed equipment and appliances, shall be sufficient to allow inspection, service, repair or replacement without removing such elements of permanent construction or disabling the function of a required fire-resistance-rated assembly."
	IMC	306.2 - "...Provided with a door and an unobstructed passageway measuring not less than 36 inches wide and 80 inches high."
	ASHRAE 15	8.3 - "A clear and unobstructed approach and space shall be provided for inspection, service, and emergency shutdown of condensing units, compressor units, condensers, stop valves, and other serviceable components..."
	ASHRAE 15	8.11.1 - "parts are accessible with space for service, maintenance, and operations. There shall be clear head room of not less than 7.25 ft (2.2 m)..."
	IFC	606.5 - "Refrigeration systems having a refrigerant circuit containing more than... 30 pounds (14 kg)... shall be accessible to the fire department at all times as required by the fire code official."
	ASHRAE 15	8.11.8 - "Access to the refrigerating machinery room shall be restricted to authorized personnel. Doors shall be clearly marked or permanent signs shall be posted at each entrance to indicate this restriction."
	IAR-2	6.1.1.3 - "All valves inaccessible from floor level shall be operable only from approved portable platforms, fixed platforms, ladders, or shall be chain operated."
	IAR-2	6.3.2.2 - "A means shall be provided for removal and replacement of motors or equipment."
SEPARATION / FIRE PROTECTION	ASHRAE 15	8.11.2 - "...there shall be no openings that will permit passage of escaping refrigerant to other parts of the building."
	ASHRAE 15	8.11.7 - "There shall be no airflow to or from an occupied space through a machinery room unless the air is ducted and sealed to prevent any refrigerant leakage from entering the airstream."
	ASHRAE 15	8.12(b),(c) - "Walls, floor, and ceiling shall be tight and of non-combustible construction...separating...from other occupied spaces shall be of at least one-hour fire-resistive construction." Fire doors required.
	ASHRAE 15	8.12(f) - "All pipes piercing the interior walls, ceiling, or floor of such rooms shall be tightly sealed to the walls, ceiling, or floor through which they pass."
ELECTRICAL	IFC	606.16 Electrical Equipment - ammonia "machinery rooms shall conform to the Class I, Division 2 hazardous location classification requirements..."
		Exception: Ammonia machinery rooms that are provided with ventilation in accordance with Section 1106.3 of the IMC. ("automatically start the ventilation system at...a detection level not to exceed 1000 ppm...")
	ASHRAE 15	8.12(h) - (Same as IFC)
	IAR-2	6.2.1 - (Same as ASHRAE 15)
	IAR-2	6.1.1.4 - "Machinery or piping which may cause condensation or drips shall not be located over electrical equipment."

Code Analysis Worksheet

STRUCTURE	IIAR-2	6.3.1.1 - "All structural components of the machinery room shall be constructed of non-combustible materials."
	IIAR-2	6.3.1.2, 6.3.1.3 - "The building structure shall be designed to provide adequate strength and rigidity to safely...support all...piping and equipment."
	IIAR-2	6.3.1.6 - "Exterior openings, if present, shall not be under any fire escape or any open stairway."
	IIAR-2	6.1.1.2 - "All machinery shall be mounted in such a manner as to prevent excessive vibration from being transmitted to the building structure, or to connected equipment."
	IIAR-2	6.3.2.1 - "The compressor and other heavy equipment foundations shall be designed in accordance with manufacturer's recommendations and other parameters dictated by subsoil or structural conditions and vibrations."
NO OPEN FLAMES	IMC	1105.5 - "Open flames that use combustion air from the machinery room shall not be installed..."
		"Exceptions:...3. Fuel -burning appliances shall not be prohibited in the same machinery room with refrigerant-containing equipment or appliances where combustion air is ducted from outside the machinery room... or where a refrigerant vapor detector is employed to automatically shut off the combustion process..."
	IMC	1106.2 - "There shall not be an open flame-producing device or continuously operating hot surface over 800°F (427°C) permanently installed in the room."
	ASHRAE 15	8.11.6, 8.12(a) - (Same as IMC except) Exception: "where ammonia (R-717) is the refrigerant and internal combustion engines are used as the prime mover for the compressors."
SIGNAGE / MARKING	IMC	1107.7.3 - "Stop valves shall be identified where their intended purpose is not obvious. Numbers shall not be used to label the valves unless a key to the numbers is located near the valves."
	ASHRAE 15	9.12.6 - (Similar to IMC 1107.7.3)
	IFC	606.7 - "Refrigeration units or systems...containing more than...30 pounds (14 kg)...shall be provided with approved emergency signs, charts, and labels in accordance with NFPA 704 ."
	ASHRAE 15	11.2.1 - "Each refrigerating system erected on the premises shall be provided with a legible permanent sign...indicating (a) the name and address of the installer, (b) the refrigerant number and amount of refrigerant, (c) the lubricant identity and amount, and (d) the field test pressure applied."
	ASHRAE 15	11.2.2 - "Systems containing more than 110 lb (50 kg) of refrigerant shall be provided with durable signs...designating: (a) valves or switches for controlling the refrigerant flow, the ventilation, and the refrigeration compressor(s), and (b) the kind of refrigerant or secondary coolant contained in exposed piping outside the machinery room."
	ASHRAE 15	11.2.4 - "Each entrance ...shall be provided with a legible permanent sign ...reading 'Machinery Room - Authorized Personnel Only'. The sign shall further communicate that that entry is forbidden except by those personnel trained in the emergency procedures ... when the refrigerant alarm...has been activated."

Code Analysis Worksheet

VENTILATION	IMC	1105.6 - "Machinery rooms shall be mechanically ventilated to the outdoors....exhausting the minimum quantity of air both at normal and emergency conditions."
	IMC	1105.6.1 - "Exhaust from mechanical ventilation systems shall be discharged not less than 20 feet (6096 mm) from a property line or openings into buildings."
	IMC	1105.6.2 - "Provisions shall be made for make-up air to replace that being exhausted. Openings for make-up air shall be located to avoid intake of exhaust air. Supply and exhaust ducts to the machinery room shall serve no other area"
	ASHRAE 15	8.11.4 - (Same as IMC 1105.6, 1105.6.2 except) "...The discharge of the air shall be to the outdoors in such a manner as not to cause a nuisance or danger."
	IMC	1105.6.3 - Quantity - normal ventilation. "1. Not less than 0.5 cfm per square foot...2. A volume required to limit the room temperature rise to 18 Deg. F..."
	IMC	1105.6.4- Quantity - emergency conditions. "Upon actuation of the refrigerant detector...exhaust air from the machinery room in the following quantity: $Q = 100? \cdot G$ (Q = airflow in cubic feet per minute, G = mass of refrigerant in pounds in the system)
	IIAR-2	6.2.3.3 - (Same as IMC 1105.6.4 except) The emergency ventilation rate shall also be calculated by $Q = V \times 0.2$ (ft ³ /min) (V = room volume). The larger ventilation rate of the two calculations shall govern.
	ASHRAE 15	8.11.5 - (Same as IMC 1105.6.3, 1105.6.4)
	IMC	1106.3 - "Ventilation systems...shall be operated continuously."
		"Exceptions: 1. Machinery rooms equipped with a vapor detector that will automatically start the ventilationsystem and actuate an alarm at a detection level not to exceed 1000 PPM; or 2. Machinery rooms conforming to the Class 1, Division 2..."
	ASHRAE 15	8.12(h) - (Same as IMC 1106.3 except) "failure of the mechanical ventilation system actuates an alarm or...the machinery room is equipped with a detector...alarm at 1000 ppm."
	IIAR-2	6.2.3.3 - "In basements, the ventilation system shall be operated continuously at the emergency ventilation rate..."
	IIAR-2	6.2.3.8 - "The ventilation air inlets shall be near the machinery..."
	IFC	606.13 - "Exhaust from mechanical ventilation systems serving refrigeration machinery rooms capable of exceeding ...50 percent of the IDLH shall be equipped with approved treatment systems to reduce the discharge concentrations ... to those values or lower."
	IIAR-2	6.2.3.12 - "Air discharge shall be directed to provide good dispersion, taking into account the natural air flow around the building, prevailing wind and surrounding structures."
	IIAR-2	6.2.3.13 - "If direct dispersion is impractical, a water wash of the air exhausted to the atmosphere shall be used...."
	PFC	606.5 - "...systems designed to ANSI/IIAR 2 1999 and IIAR Piping Handbook are exempt from (sic) treatment systems and flaring systems on exhaust or relief systems"

Code Analysis Worksheet

DETECTION / ALARM	IMC	1105.3 - "Refrigerant detectors in machinery rooms shall be provided as required by the IFC"
	IFC	606.8 - "Machinery rooms shall contain a refrigerant detector with an audible and visual alarm...located in an area where refrigerant from a leak will concentrate. The alarm shall be actuated at a value not greater than the corresponding TLV-TWA values..." (Threshold Limit Value - Time Weighted Average; ammonia 25 PPM) "Detectors and alarms shall be placed in approved locations."
	ASHRAE 15	8.11.2.1 and 8.12(h) - (Same as IFC 606.8 except) the detector shall alarm at 1,000 PPM. The alarm shall annunciate visual and audible alarms inside the refrigerating machinery room and outside each entrance... The alarms...shall be of the manual reset type with the reset located inside the ...machinery room."
	PFC	606.8 - an approved, distinctive alarm and must comply with NFPA 72 and placed in an area where ammonia is expected to concentrate...
PRESSURE RELIEF	IMC	1105.7 - "Pressure relief devices...located within the machinery room shall terminate outside the structure at a location not less than 15 feet (4572 mm) above the adjoining grade level and not less than 20 feet (6096 mm) from any window, ventilation opening or exit."
	IMC	1105.8 - "Pressure relief valves for ammonia systems shall discharge in accordance with ASHRAE 15."
	ASHRAE 15	9.7.8 - (Same as IMC 1105.7 except) "The discharge shall be terminated in a manner that will prevent the discharged refrigerant from being sprayed directly on personnel in the vicinity and foreign material or debris from entering the discharge piping."
	IFC	606.12 - "Pressure relief devices...for refrigeration systems... shall be provided with an approved discharge system..."
	IFC	606.12.3 - "Systems containing ammonia refrigerant shall discharge vapor to the atmosphere through an approved treatment system...flaring system...or through an approved ammonia diffusion system..." (Water Tank)
		Exception: "2. When the fire code official determines, on review of an engineering analysis...that a fire, health or environmental hazard would not result from discharging ammonia directly to the atmosphere."
	ASHRAE 15	9.7.8.2 - "Ammonia from pressure-relief valves shall be discharged into one or more of the following: (a) The atmosphere... (b) A tank containing...water....(c) Other treatment systems that meet the requirements of the authority having jurisdiction."
EMERGENCY CONTROLS	IMC / IFC	1106.5 / 606.9 - "Remote control of the mechanical equipment and appliances located in the machinery room shall be provided at an approved location immediately outside the machinery room and adjacent to its principal entrance."
	IMC / IFC	1106.5.1 / 606.9.1 - "A clearly identified switch of the break-glass type shall provide off-only control of electrically energized equipment and appliances in the machinery room, other than refrigerant leak detectors and machinery room ventilation."
	IMC / IFC	1106.5.2 / 606.9.2 - "A clearly identified switch of the break-glass type shall provide on-only control of the machinery room ventilation fans."
	ASHRAE 15	8.12(i) - "Remote control of the mechanical equipment in the refrigerating machinery room shall be provided immediately outside the machinery room door solely for the purpose of shutting down the equipment in an emergency. Ventilation fans shall be on a separate electrical control and have a control switch located immediately outside the machinery room door."
	IFC	606.10 - "Refrigeration systems containing more than 6.6 pounds (3 kg)... shall be provided with an emergency pressure control system in accordance with Sections 606.10.1 and 606.10.2."
	ASHRAE 15	8.13 - "When required by the authority having jurisdiction, manual emergency discharge of diffusion arrangements for ammonia refrigerants shall be provided...."
	PFC	606.10 - Emergency over pressure relief system for each high to low pressure system---automatically stop all compressors and equalize the high side pressure to a low side pressure group if the pressure rises to within 15 PSI of the pressure relief device setpoint.
	PFC	606.12.6 - Ammonia Water Diffusion System deleted

Code Analysis Worksheet

SAFETY EQUIPMENT	IIAR-2	6.3.1.4 - "An eye-wash and body shower unit shall be located just outside the machinery room exit door and it is recommended that one be located centrally inside the machinery room."
DRAINAGE	IIAR-2	6.3.1.8 - "Adequate hub drains shall be provided to properly dispose of all wastewater. The accumulation of or the running of wastewater across the floor shall not be permitted."
	IIAR-2	6.3.1.9 - "When floor drains are utilized, a means shall be provided to prevent contamination of the drainage system by oil or ammonia."
LIGHTING	IIAR-2	6.3.2.3 - "machinery rooms shall be equipped with light fixtures to provide a minimum of 30 ft-candle (320 lumen/m ²) at the working level..."
OPERATIONS		
AUTHORIZED ENTRY	ASHRAE 15	11.7 - "The emergency procedures shall forbid entry into the refrigerating machinery room when the refrigerant alarm...has been activated except by persons provided with the appropriate...equipment and trained..."
NO STORAGE	IFC	606.11 - "Flammable and combustible materials shall not be stored in machinery rooms for refrigeration systems having...more than...30 pounds (14 kg) of...refrigerant..."
		"Exception: This provision shall not apply to spare parts, tools, and incidental materials necessary for the safe and proper operation and maintenance of the system."
MAINTENANCE / MECH. INTEGRITY	IMC	1101.7 - "Mechanical refrigeration systems shall be maintained in proper operating condition, free from accumulations of oil, dirt, waste, excessive corrosion, other debris and leaks."
	ASHRAE 15	11.6 - "Refrigerating systems shall be maintained by the user in a clean condition, free from accumulations of oily dirt, waste, and other debris, and shall be kept accessible at all times."
	PFC	606.17 - similar to IMC, but adds: ...system to be maintained and inspected per recommendations of IIAR Bulletin 109, 1997.
TESTING	IMC	1105.4 - "Periodic tests of the mechanical ventilating system shall be performed..."
	IMC / IFC	1109.1 / 606.6.1 - "The following emergency devices and systems shall be periodically tested in accordance with the manufacturer's instructions and as required by the code official:"
		"1. Treatment and flaring systems. 2. Valves and appurtenances necessary to the operation of emergency refrigeration control boxes. 3. Fans and associated equipment intended to operate emergency ventilation systems. 4. Detection and alarm systems." (606.6 - "A written record of required testing shall be maintained...")
	ASHRAE 15	11.6.3 - (Similar to IMC/IFC 1109.1 /606.6.1)
	IIAR 2	6.2.2 - "The machinery room design shall establish a time schedule for testing of the mechanical ventilation system, the ammonia detectors, and the alarm system....Where no recommendations are provided, these devices shall be scheduled for exercising on an annual basis."

Code Analysis Worksheet

EMERGENCY PROCEDURES	ASHRAE 15	11.7 - "Emergency shutdown procedures...shall be displayed on a conspicuous card...posted outside the room, immediately adjacent to each door."
SYSTEM DIAGRAMS	ASHRAE 15	11.7 - "provide a schematic drawing or panel giving directions for the operation of the system at a location convenient to the operators..."
NOTIFICATIONS	IFC	606.14 - "The fire code official shall be notified immediately when a discharge becomes reportable under state, federal or local regulations..."
RECORDS	IFC	606.15 - "A written record shall be kept of refrigerant quantities brought into and removed from the premises...."

REFERENCES:
 IBC - International Building Code - 2006
 IFC - International Fire Code - 2006
 IMC - International Mechanical Code - 2006
 ANSI / ASHRAE 15 - 2004, Safety Standard for Refrigeration Systems
 ANSI / IIAR 2 - 1999, Equipment Design, and Installation of Ammonia Mechanical Refrigerating Systems
 OSHA PSM - 29 C.F.R. 1910.119, Process Safety Management Regulation (Note 2)
 PFC- Phoenix Fire Code Amendments to IMC

Notes:

1. The referenced documents noted here represent the current versions of commonly used sources. A few states (most notably California) and localities have adopted the Uniform Codes. This summary highlights typical requirements and is not intended to be all inclusive or to represent requirements for individual localities, which vary significantly. Each facility must review the laws, regulations and policies of their locality to confirm the complete and specific requirements that apply.

2. Many federal, state and local regulations apply to the installation and operation of facilities utilizing ammonia refrigeration. This summary only includes requirements directly associated with the building codes and does not include other regulations. Most notably, the OSHA (Occupational Safety and Health Administration) PSM regulation includes comprehensive and specific requirements for safe operation of ammonia refrigeration facilities. Facility owners should expect to meet all or some of the PSM requirements whenever installing or operating such a system. Every facility using ammonia must review the PSM regulation to determine applicable requirements and how to meet them.

Additional Considerations

- **Lighting**
- **Safety Equipment (Respirators, Eyewash, etc)**
- **Layout of Equipment**
- **Drainage**
- **Trip Hazards**
- **Passage to Exits**
- **Mechanical Integrity Inspections**
- **Record Keeping**
- **P&IDs**
- **Valve Tagging**
- **OSHA/EPA 10,000# rule**

Additional Considerations

- **Separate Control Room, egress**
- **Managing Expansions, New Codes**
- **Grandfather Clauses**
- **Permitting and Inspection**
- **New 2007 IMC/IFC issued**
- **New ASHRAE 15 issued**
- **New ANSI/IIAR 2 forthcoming**
- **New DHS risk assessment rules**