Introduction
The use of Ammonia Refrigeration Systems in cold storage warehouses is commonplace and presents both a product contamination exposure as well as fire/explosion potential if not properly controlled. This exposure can be found in both Ocean Cargo as well as Inland Marine-Warehouse Legal Liability lines of business.

Of 22 ammonia releases that were reported as involving product contamination only (no fire/explosion) and resulting in losses over $100,000, all occurred in the refrigerated area (i.e., outside of the main engine room). Seventeen (17) involved mechanical damage to piping or pipe/valve failures due to poor maintenance, fatigue, or material defects. Five (5) were caused by impact with the pipe.

Loss Control Engineering Guidelines
The following provides basic loss control engineering guidelines to utilize in risk assessments:

Fire and explosion hazard
- Do not locate boilers or flame-producing equipment in the room for any ammonia refrigerant system.
- Proper ventilation of the engine rooms is essential. Natural ventilation at roof level is acceptable with electrical equipment rated for Class I, Division 2 location. Locate intake louvers and exhaust devices to promote air mixing and avoid short circuiting of airflow. Power fans from a source separate from the machinery room so a shutdown of power to the room does not affect the fans. Provide remote actuation for any emergency vent fans.
- New construction machine rooms should be classified as Class 1, Division 2 electrical area in accordance with National Electrical Code, Article 500. This is uncommon to see, except in modern/new installations.

Background
Ammonia is classified as a Group 2 refrigerant, whose primary hazard is toxicity as well as being moderately flammable. Ammonia refrigerant is most often used in food processing and storage, due to its efficiency and economy of large scale systems. It has an explosive range from 16% (LEL) to 25% (UEL) when mixed with air. It is highly toxic above 500 parts per million (ppm).

Losses
Loss Data from FM Global accounts alone, over a 14 year period, shows there were 22 fires/explosion losses reported. Of those, at least five were initiated outside of the main machinery/compressor rooms (“engine rooms”). Most often a part mechanically failed or was improperly installed/maintained, which resulted in the accidental release of product and resulting explosion/fire. Electrical equipment was the primary source of ignition.
For existing ammonia machine rooms, the following can be substituted for Class 1, Division 2 electrical equipment, reducing the fire/explosion potential of a small vapor release:

- Provide continuous mechanical exhaust ventilation at the roof capable of supplying 1 cfm/ft² of room area. Arrange for the failure of this ventilation to sound an alarm at a continuously manned location.
- Install a UL listed or FM approved ammonia detection system set to alarm to a constantly manned location and initiate emergency ventilation at 25% of the LEL and shut down of all electrical equipment at 50% LEL.
- The detectors should be located in accordance with the manufacturers guidelines.
- The detectors should be calibrated monthly by trained personnel. Documentation should be reviewed to verify this has been done.
- All threaded pipe joints should be seal welded or brazed.
- Protect piping from mechanical damage from forklift and material handling equipment. Provide suitable barriers/cages, etc around piping. Piping should be clearly marked identifying "Ammonia" within pipe. Forklift driver training and orientation about the hazard is essential.
- Facility should have on call or on staff a qualified refrigeration engineer. A formal written emergency plan should be in effect.
- Preventative maintenance in accordance with the equipment manufacturers guidelines should be performed by qualified refrigeration contractors and documented.

Product contamination

The amount of contamination to a product from an exposure to ammonia is determined by the concentration of ammonia, duration of exposure, temperature, type of product, and packaging. Long-term exposure to low levels could be just as damaging to exposure of high levels for short period of time. Shrimp and other seafood products are very susceptible to ammonia absorption, along with acidy products such as fruit and vegetables, as well as high fat products like ice cream, milk, and nuts. Frozen products are somewhat less susceptible to contamination.

Packaging of products plays an important role. Any packaging capable of protection against changes in moisture content due to changing humidity levels lends itself to good protection from ammonia. Well sealed, plastic wrapped foods tend to offer good protection also. Unpackaged foods may be contaminated after only 15 minutes of exposure. Cardboard will tend to trap ammonia and relay the contamination to the product unless promptly re-packaged. Ammonia will also tend to rapidly de-thaw product which may lead to spoilage concerns.

- A formal facility plan to deal with accidental ammonia release is desirable, but often not found in many facilities. The plan should include procedures to finding and isolating the leak, controlling ventilation to limit the spread of vapors, sealing off areas not already exposed, and relocation of goods to a proper area.
- To minimize the effects of ammonia release upon food products, leak detection systems should be set at a much lower rate than for purposes to prevent an explosion (well below Lower Explosive Limit (LEL) levels).
- For prevention of contamination, the detectors should be set and capable of detecting vapors in the 50-100 ppm range. Documentation re: the calibration of detectors should be available and reviewed.
- Location of detectors should be within the refrigerated areas, not just in the engine/compressor rooms, and follow manufacturers guidelines.
- These detectors should be tested/calibrated monthly or in accordance with manufacturers guidelines. If the insured tests/calibrates detectors themselves (not advisable), then employees should be formally trained and have the qualifications to do so.

Sources

Factory Mutual Data Sheet, 7-13 “Mechanical Refrigeration”