*Ammonia leak from a cold storage in Chhindwara, Madhya Pradesh*

# Safety Equipment for Ammonia Installations and Emergency Procedures

***By Ramesh Paranjpey***

*I had written an article in Cold Chain – Part I was published in the January-March 2011 issue and Part II in the April-June 2011 issue – on 'Designing for Safety in Ammonia Plants'. Many readers have since then approached me to write an exclusive article on the essential safety equipment for operators to be kept in the plant room and emergency procedures to be followed in case of ammonia leakage. This article carries such information for the use of plant owners and managers, and for operators – Author.*

## Why Ammonia Refrigeration Safety?

While ammonia has an excellent thermodynamic performance as a refrigerant, it is toxic and flammable. It is unsafe for long duration exposure above 50-100 ppm, and for short duration exposure above 400 ppm. It is flammable above 16% concentration by volume, with an ignition point of 650°C.

Ammonia leaks can, therefore, be major issues. Such issues can be avoided by following the prescribed safety precautions.

- Ammonia is toxic when inhaled.
- It has a pungent odour causing eye irritation and tears, and is clearly detectable even at 25 ppm.
- As a gas, it causes strong irritation or damage to eyes.
- In liquid form as concentrated aqueous solution and in gaseous form, it has strong caustic effect on the skin, mucous membranes and eyes in high concentrations.
- Liquid ammonia can cause frostbite if it comes in contact with the skin.
- Ammonia and air produce an explosive mixture between 15-28% by volume.

## Personal Protection

- Do not wear rings or other jewelry, long ties, gloves or loose garments when working around moving machinery.


## About the Author

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- Do not wear rings or watches when working around electrical equipment and arc welding machines.
- One bottle of boric acid and an eye cup as well as one bottle of vinegar should be kept in the machine room.
- Provide 100 ft length of ½" diameter sturdy rope to tie a person before entering a suspected high ammonia concentration area.
- Sulphur dioxide and hydrochloric acid to detect ammonia leaks should be available in the plant room.
- First aid kit should be available in the plant room.

*First aid kit*

## Safety Accessories

It is important to wear safety accessories when working in the machine room.

- Safety glasses with side shields before entering a construction site or manufacturing areas, suitable for ammonia plants.
- Goggles and gloves when handling chemicals, when welding, cutting, brazing, or grinding or when near such an area.
- Gloves before touching any part of equipment that is operating, or one that has recently been shut down. Always assume that the item is hot.
- Gloves when handling machinery components after a major failure, e.g. after motor burn out, not only the refrigerant but the oil would also be acidic.
- Gloves and coveralls when working with or around machines.
- Hearing protection in areas where sound levels exceed 90 dBA.
- Safety torch-light: While entering a cold storage, always carry a torch-light. If the electricity fails, it is difficult to locate the door, and many deaths have been reported of persons getting trapped in cold rooms and unable to locate or open the door. Also, keep one person standing outside to ensure that in case of abnormal delay, the person outside is able to get the trapped person out safely.
- Provide 100 ft length of ½" diameter sturdy rope to tie a person before entering a suspected high ammonia concentration area.
- Safety shoes, or special shoes wherever necessary.
- A hard hat when there is a possible danger of falling or flying objects.
- Wear an ammonia suit before entering ammonia leak area.

*Safety glasses*

*Gloves*


*Hearing protection*

*Safety torch-light*

*Safety shoes*

*Hard hat*

*Ammonia suit*

## Leak Detctor Sensor, Alarm and Ventilation

It is recommended to use two leak detector sensors.

- One detector should alarm and activate normal ventilation at 35 to 50 ppm.
- The second detector should alarm and activate emergency ventilation below 1000 ppm. The fan should discharge up vertically with minimum discharge velocity of 12.7 m/s (250 fpm).

*Leak detector sensors*


*Typical ammonia leak detector*

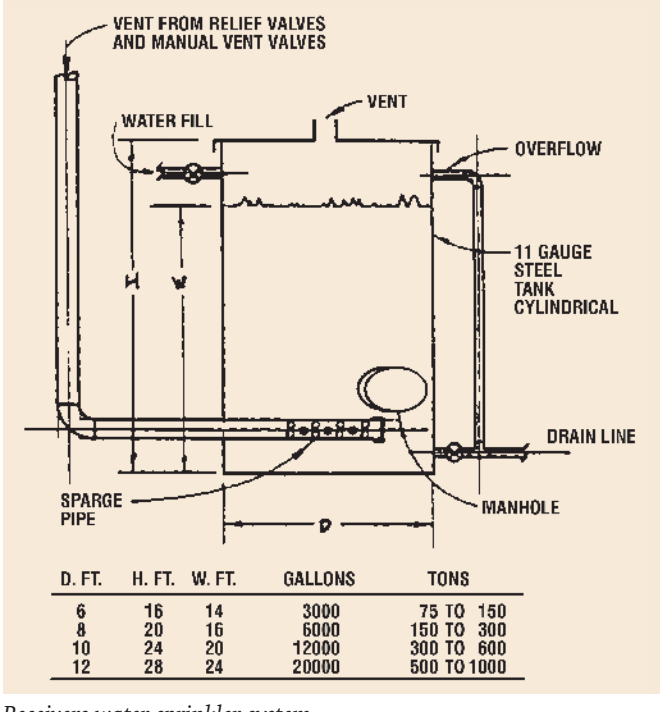
Eye wash station is an essential emergency equipment. Ammonia receivers may be provided with water sprinklers.

*Eye wash station and water sprinkler*

## Ammonia Dump Tanks

Ammonia systems should be provided with an emergency discharge into a tank of water provided exclusively for ammonia absorption. At least 1 gallon (379 ml) of fresh water should be provided for each pound (454 g) of ammonia in the system. The water used should be prevented from freezing without the use of salt or chemicals. The tank should be substantially constructed of not less than 1/8 inch or No. 10 M.S.G. (2.51 mm) steel. The horizontal dimensions of the tank should be equal to or less than one half of the height. The tank should have a hinged cover or, if of the enclosed type, a vent hole at the top. Pipe connections should be through the top of the tank. The discharge pipe from the pressure-relief valves should discharge ammonia in the center of the tank near the bottom but not more than 30 feet (9104 mm) below the surface of the water.

## Ammonia Absorption Tanks




| D. FT. | H. FT. | W. FT. | GALLONS | TONS |
|---|---|---|---|---|
| 6 | 16 | 14 | 3000 | 75 TO 150 |
| 8 | 20 | 16 | 6000 | 150 TO 300 |
| 10 | 24 | 20 | 12000 | 300 TO 600 |
| 12 | 28 | 24 | 20000 | 500 TO 1000 |

*Receivers water sprinkler system*

Ammonia is easily absorbed in water; therefore in case of ammonia leaks, water curtains are also used to precipitate vapours of ammonia and prevent them from going in other areas.

## Safety Relief Valve

The location of safety relief piping should be 15 ft above the occupied area.

All safety relief valve outlets should be taken outside the plant room, 15 ft (5m) above the highest occupied area. Ammonia, being lighter than air, escapes to atmosphere without causing any harm to people.

*Safety relief valve*

## Emergency Procedure in Case of Ammonia Leaks

In case of an ammonia leak:

- Leave the working area immediately and actuate the alarm if ammonia escapes from the refrigerating plant.
- If need be, put on a respiratory protection apparatus with ammonia filter (colour code: green).
- Rubber gloves, protection apron and protection boots must be used.
- Start up the ammonia absorption device.
- Do not drain ammonia containing water into the sewerage system or public waters.
- The entire plant's electrical supply should be stopped with one emergency switch fitted in the panel


*Emergency electrical trip switch*

### *First Aid Measures*

- The affected person(s) should be taken away from the contaminated atmosphere into the open air.
- Ammonia contaminated clothes should be taken off.
- Irritated parts of the body – including the mouth and eyes – should be sufficiently rinsed with water for about 20 minutes.
- Do not cover the affected parts of the body with bandage, oil, etc., but protect them against frost.
- The affected person(s) should be taken to a hospital or a doctor as soon as possible after rinsing off the parts of the body concerned.

- Medical treatment is immediately necessary if ammonia is inhaled in large quantities and causes irritation – especially of the eyes.

***Treatment***

Liquid ammonia spill is more dangerous than gas leakage and, when in contact with skin, can cause third degree burns and may lead to blindness.

- In case of an ammonia leak, do not spray water on ammonia liquid but wipe it with cloth, as ammonia has a large latent heat and can cause cloud formation if water is spread on it.
- Shower a person with ammonia injuries for 5 to 15 minutes with water. At this time the person should wear a mask to ensure that ammonia vapours are not inhaled. During showering, remove the clothes cautiously.
- Decontaminate the victim as quickly as possible. Start with the eyes. The whole body, or the exposed area, must be flushed with generous amounts of water; this includes the hair, ears, under the chin, and armpits. Water sources such as showers, hoses, eye wash stations or stock tanks are acceptable.
- Even if only a small amount of ammonia enters the eyes, irrigate the eyes with an abundance of water for a minimum of 15 minutes. Continually and thoroughly flush the entire eye surface and the inner lining of the eyelids. Eyes affected by ammonia close involuntarily; the eyelids must be held open so that water can flush the entire eye surface as well as the inner lining of the eyelid. If there is no physician available, continue irrigation for an additional 15 minutes.
- Do not wear contact lenses when handling anhydrous ammonia. If ammonia gets in the eyes, it will get trapped under the lenses causing even more damage. They may also prevent immediate flushing of the eye surface.
- Serious eye injury should be treated by an ophthalmologist, but in an emergency, wash with large quantities of water for 15 minutes or more as quickly as possible. In fact, the only real hope for preventing permanent eye injury lies in quick and generous washing.
- One suggestion for those likely to be exposed is to carry a small, eight-ounce squeezable squirt bottle filled with water, which can be used to get excess ammonia out of the eyes until a larger water supply can be reached. This small amount of water is not sufficient to remove all the ammonia. It is essential that the eyes be irrigated for a minimum of 15 minutes as soon as possible.

*Squirt bottle*

- Another emergency method is to duck the head in water and rapidly blink and move or rotate the eyes about.
- It is essential that any ammonia spilled on the worker be removed immediately and that the worker be moved to an uncontaminated area quickly.
- Clothes that have been saturated by liquid ammonia may freeze to the skin. In any case, the victim, still clothed, should get immediately under a shower, if available, or jump into a stock tank, pond, or into any other source of water. Time is important! Remove clothes only after they are thawed and they can be freely removed from frozen areas. If the clothing is removed incorrectly, whole sections of skin can be torn off.
- No salves, creams, ointments, or jellies should be applied to the skin during the 24-hour period following the injury, since they will prevent natural elimination of ammonia from the skin. After the 24-hour period, medical treatment is the same as for thermal burns. A physician should view any second- or third-degree freeze burns of the skin.
- If ammonia is ingested, call a physician. If conscious, have the victim drink large amounts of water. Do not induce vomiting if the victim is in shock, in extreme pain, or is unconscious. If vomiting begins, place the victim face down with head lower than hips. This prevents vomit from entering the lungs, and prevents severe injury.
- In all inhalation exposures, severe or minimal, take the exposed workers at once to a clean, uncontaminated area. Watch workers exposed to low concentrations for a short period of time. They will usually require no treatment and can be released.
- For severe exposure to higher concentrations, call a physician. Oxygen should be administered by an individual who is trained and authorized to do so by a physician. This will help relieve pain and symptoms of lack of oxygen. Begin artificial respiration immediately if the patient is not breathing. Keep victim warm (but not hot) and rested until transported to the hospital.
- To sum up, in any accident involving contact with ammonia with the eyes or skin, immediately flush the affected area with large quantities of clean water. Place the injured person into a container of clean water or under an emergency shower. Provide the injured worker with first aid treatment and call a physician at once in case of extreme exposure. Give the physician a complete account of the incident.

- Seconds count; wash the ammonia away with water immediately.

## Safety Tips for Reciprocating Compressors

- Do not take resistance measurements or make continuity checks on a compressor until you are sure that all power to the unit or system is off, including crankcase heaters. In addition, be sure the compressors have been valved off from the unit or system. Release all refrigerant from the compressor.
- Never pump a compressor into vacuum to test for weak or broken valves. This can cause the compressor terminals to arc internally and fail, or cause severe injury.
- Lock open and tag electrical circuits during servicing. If work is interrupted, confirm that all circuits are de-energized before resuming work.
- Never use a torch to remove a compressor or a component from the refrigerant circuit. The oil could ignite and cause a fire. Instead, use a hacksaw or tubing cutter to cut refrigerant lines.
- Never energize the compressor until the discharge and suction service valves are open to the system.
- Never purge refrigerant from compressor through a loosened pipe plug or flare connection. Always purge through a gauge manifold that is set to control the rate of purging.
- Never loosen any head or cover bolts when compressor is open to the system or is under pressure. Make sure the internal pressure is at zero to two psig before any bolts are removed.
- Never pump a compressor down below two to zero psig. Electrical or mechanical failure could occur and result in personal injury.
- Do not apply voltage or operate compressor with compressor motor terminal box cover removed.
- Valve off all compressors in a multiple refrigeration circuit before working on that circuit. Because of the oil equalizer connection, pressure cannot be purged from only one compressor of a multiple circuit.

## Safety Tips for Air Handling Equipment

- Never enter an enclosed fan cabinet nor reach into a unit while the fan is running.
- Lock open and tag the fan motor power disconnect switch before working on a fan. In addition, remove the fuses and take them with you after noting this on the tag.
- Lock open and tag the power disconnect switch of the electric heat coil before working on or near the heaters.
- Do not operate fans unless belt guards are in place.
- Never pressurize the coil with a non-liquid to test leaks. A dangerous burst may occur.
- Do not steam clean coils until you are sure all personnel are clear of the area.
- Check to ensure adequate ventilation when welding or flame cutting inside an air handling unit so that fumes will not migrate through the duct work to occupied spaces.
- Do not handle access covers and removable panels where winds are strong or gusting, unless you have sufficient help to control them. Make sure all panels are properly secured while repairs are being made to a unit.
- Do not work on dampers until you have disconnected their operators.
- Check to be sure that fans and rooftop units are properly grounded before working on them.
- Secure drive sheaves with rope or strap before working on a fan to be sure that the fan does not freewheel.
- Protect adjacent flammable material when welding or flame cutting. Use sheet metal or asbestos cloth to contain sparks. Have a fire extinguisher ready at hand for immediate use.
- Never pressurize equipment in excess of specified test pressures.
- Never wear loose clothing around air handling equipment.
- Do not climb over a machine or fan cabinet; use platforms, catwalks or staging.
- Some air handling equipment have gas heaters; when servicing, be sure main gas valve and pilot gas valve have been off at least five minutes before attempting to restart the unit after shutdown.

## Safety Tips for Cooling Towers

- Lock open and tag electrical circuits before working on them. If work is interrupted, confirm that the circuits are de-energized before resuming work.
- Never work on a cooling tower when the fan is operating.
- Use the side access door to service the interior chamber; never work through the fan cylinder.
- Be careful during winter operations; tower drift could cause ice on the walkways and ladder.
- Clear all personnel before putting a tower back in service.