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भारतीय मानक मसौदा

आमोनिया — सुरक्षा संहिता

(*IS 4544 का दूसरा पुनरीक्षण*)

Draft Indian Standard

Ammonia — Code of Safety

(*Second Revision of IS 4544*)

ICS 13.300; 71.060

Chemical Hazards Sectional Committee, CHD 7

Last date for Comments: 20.03.2025

FOREWORD

(*Formal clause to be added later*)

Ammonia is mainly used in the manufacture of fertilizer and as refrigerant. It is also used as detergent for removing stains, in bleaching and calico printing and for extracting plant colours (cochineal, archil, etc) and alkaloids. Its other uses are in the manufacture of nitric acid, rubber vulcanization, water treatment, nitriding of steel, oil refining, extracting certain metals from ores, solvent and reaction medium in organic synthesis, yeast nutrient, sulphite paper pulp process, and explosives.

The elimination of accidents is vital to public interest. Accidents produce economic and social loss, and impair individual or group productivity. Realization of this loss has led the authorities to devote a good deal of attention to safety education. In any programme of safety education, preparation of code of safety is an essential part. The manufacture of ammonia involves handling of flammable and corrosive gases under high pressures. Apart from general precautions, some typical precautions are required to be taken and this code of safety lays special emphasis on these points.

The properties of ammonia listed in Clause **4** have been taken from literature and have been included for information only. Moreover, these properties pertain to pure ammonia. BIS has published a separate standard IS 662 : 2020 on the requirements and the methods of sampling and test for ammonia intended for industrial purposes.

The standard was originally published in 1968 and revised in 2000. In the first revision more information was incorporated under general properties and threshold limit was changed according to the latest available data. Some important practices were also incorporated in this revision under the clauses, like handling of cylinders, unloading of tank, storage, personal protective equipment and repair of tanks.

With a view to update the standard based on the experience of last two decades and on the currently available data, the Committee felt a need to revise the standard. In this revision general properties have been incorporated and modifications have been made to update safety measures for controlling hazards and essential information on symptoms of asphyxiation, first-aid, medical treatment, storage, handling, labelling and employee safety based on the currently available data and last two decades experience.

There is no ISO standard on the subject.

The filling, transport and importation of liquid ammonia or compressed ammonia gas in cylinders is governed by the Gas Cylinder Rules, 2016.

The various clauses of the standard have been aligned with the format being applied for all Indian Standards on code of safety of chemicals.

1 SCOPE

This standard describes code of safety concerning the hazards related to ammonia and properties of ammonia, the nature of hazards associated with it and essential information with respect to personal protection, handling & storage, labelling, transport, spillage/leakage (emergency preparedness), fire prevention and firefighting, communication, training, health monitoring, first aid and waste disposal.

2 REFERENCES

The standards listed in **Annex A** contain provisions which through reference in this text, constitute provisions of this standard. At the time of publications, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of these standards.

3 TERMINOLOGY

For the purpose of this standard the definitions given in IS 4155 shall apply.

4 PROPERTIES

4.1 General Information

4.1.1 *Chemical Name* — Ammonia.

4.1.2 *Common Name & Synonyms* —Anhydrous ammonia, Ammonia gas, liquid ammonia.

4.1.3 *Uses*

Ammonia is used as a refrigerant gas, for purification of water supplies, and in the manufacture of plastics, explosives, textiles, pesticides, dyes and other chemicals. It is found in many household and industrial cleaning solutions.

4.2 Identification

4.2.1 *Formula* — NH_3.

4.2.2 *CAS Number* — 7664-41-7.

4.2.3 *UN Number* — 1005 anhydrous ammonia.

4.3 Physical Properties

4.3.1 *Molecular Mass* — 17 g/mol.

4.3.2 *Physical State* — Liquefied compressed gas.

4.3.3 *Colour* — Colourless.

4.3.4 *Odour* — Pungent, strong, sharp, and irritating odor

4.3.5 *Melting Point* — (-) 77.7 °C.

4.3.6 *Critical Temperature* — 132.85 °C.

4.3.7 *Vapour Density (Air=1)* — 0.597 at 0 ℃, 1 atm.

4.3.8 Vapour Pressure — 114.2 psig.

4.3.9 *Specific Gravity* — 0.682 at (-) 33.3 ℃.

4.3.10 *Viscosity, dynamic* — 0.254 mPa.s at (-) 33 ℃.

4.3.11*Vapour Pressure* — 8.600 hPa at 20 ℃.

4.3.12 *Auto Ignition Temperature* — 651 ℃.

4.3.13 *Minimum Ignition Energy* — 100 mJ.

4.3.14 *Heat of combustion* — (-) 185 893 92 J/kg.

4.3.15 *Solubility in Water* — 531 g/l at 20 ℃

4.3.16 *Solubility in Other Solvents* — Ammonia is soluble in alcohol and ether.

4.3.17 *Light Sensitivity* — No data available.

4.4 Chemical Properties

4.4.1 *Reactivity*

Anhydrous ammonia is basic in nature and hence reacts exothermally with all acids. It also readily combines with silver oxide or mercury to form compounds that explode on contact with halogens. When ammonia comes in contact with chlorates it forms explosive ammonium chlorate. It react violently to produces explosive products with fluorine, chlorine, bromine and iodine and some of the interhalogen compounds (bromine pentafluoride, chlorine trifluoride). Mixing of bleaching powder (hypochlorite solution) with ammonia solutions produces toxic/explosive ammonia trichloride vapors. Ammonia react violently with 1,2-dichloroethane (with liquid ammonia), boron halides, ethylene oxide (polymerization), perchlorates or strong oxidants (chromyl chloride, chromium trioxide, chromic acid, nitric acid, hydrogen peroxide, chlorates, fluorine, nitrogen oxide, liquid oxygen). It react with silver chloride, silver nitrate or silver azide to form the explosive silver nitride. It may also react with some heavy metal compounds (mercury, gold (III) chloride) to produce materials that may explode when dry. Incompatible materials are oxidizers and yellow metals (brass & copper).

4.4.2 *Stability*

It is chemically stable under standard ambient conditions (room temperature).

4.4.2.1 At 450 ℃ to 500 ℃ it begins to decompose to form nitrogen and hydrogen.

4.4.3 *Possibility of Hazardous Reactions*

Ammonia may react exothermically with chemicals such as acetaldehyde, bromine, hydrogen bromide, HCl gas, CO_2, phosgene, sulphur dioxide, barium, calcium, chlorine etc.

4.5 Fire and Explosion Hazard Properties

4.5.1 *Auto Ignition Temperature* — 651 ℃.

4.5.2 *Flash Point* — No data available.

4.5.3 *Upper Explosive Limit* — 25 percent (*v/v*).

4.5.4 *Lower Explosive Limit* — 16 percent (*v/v*).

4.5.5 *Fire Risk*

Ammonia is capable of forming flammable mixtures with air within the range of lower and upper explosive limits (*see* **4.5.3** & **4.5.4**). The presence of oil, or a mixture of ammonia with other combustible materials, will increase the fire hazard. The explosive range of ammonia is broadened by admixture of oxygen replacing air, and by temperature and pressure higher than atmospheric pressure. The contact of ammonia with certain other chemicals, including mercury, chlorine, iodine, bromine, calcium, silver oxide, and hypochlorite, may form explosive compounds. Mercury instruments employed in anhydrous ammonia service should never be connected in such a manner as to permit contact of the mercury with liquid or gaseous anhydrous ammonia.

5 HEALTH HAZARDS & TOXICITY INFORMATION

5.1 Routes of entry

5.1.1 *Skin*

Exposure to lower concentrations of ammonia in air or solution may cause skin irritation, redness, and pain. Higher concentrations may result in skin burns and blister formation. Contact with liquefied ammonia can cause frostbite.

5.1.2 *Eyes*

Exposure to lower concentrations of ammonia in air or solution may cause eye irritation, redness, and pain. Contact with concentrated ammonia solutions may cause corrosive injury including permanent eye damage or blindness. The full extent of eye injury may not be apparent for up to a week after the exposure. Contact with liquefied ammonia can also cause frostbite injury.

5.1.3 *Ingestion*

In an unlikely event, if ammonia is ingested, it may induce severe stomach pain. Exposure to high concentrations of ammonia from swallowing ammonia solution results in corrosive damage to the mouth, throat and stomach. Ingestion of ammonia does not normally result in systemic poisoning.

5.1.4 *Inhalation*

Ammonia is irritating and corrosive. Exposure to high concentrations of ammonia in air causes immediate burning of the nose, throat and respiratory tract. Inhalation of lower concentrations can cause coughing, and nose and throat irritation. Ammonia's odor provides adequate early warning of its presence, but ammonia also causes olfactory fatigue or adaptation, reducing awareness of one's prolonged exposure at low concentrations.

5.1.5 *Long term effects*

Repeated exposure to ammonia may cause chronic irritation of the respiratory tract. Chronic cough, asthma and lung fibrosis have been reported. Chronic irritation of the eye membranes and dermatitis have also been reported.

5.2 Toxicity information

Following Exposure Limits are recommended for ammonia:

a) Threshold Limit Value-Time Weighted Average Value (TLV-TWA) — 25 ppm (17 mg/m^3) at 8 h (TWA).

b) Short Term Exposure Limit (STEL) — 35 ppm (24 mg/m^3) at 15 min (TWA).

c) Lethal concentration (LC_{50}) Rat — 7 338 ppm at 1 h.

5.3 Antidote — Thers is no antidote.

5.4 Health Effects

5.4.1 *General*

Anhydrous ammonia is a strongly irritant chemical for the skin, eyes and respiratory tract. The liquid produces severe burns. The gas has a characteristic sharp penetrating odour. In sufficient concentrations, it produces painful irritation. Due to its unpleasant odour and prompt irritation, it is unlikely to voluntarily remain in an atmosphere seriously contaminated with ammonia. However, serious injury may result if escape is not possible.

5.4.2 *Acute Toxicity*

5.4.2.1 *Systemic effects*

Ammonia is not a systemic poison.

5.4.2.2 *Local effects*

Inhalation of high concentrations produces violent coughing due to its local action on the respiratory tract. If rapid escape is not possible, severe lung irritation, pulmonary oedema and death can result. Lower concentrations cause eye irritation, pulmonary oedema and bronchitis. The effects of various concentrations of ammonia gas in air are as specified in Table 1. Swallowing of the liquid results in severe corrosive action on the mouth, throat and stomach. Exposure to high gas concentrations may cause temporary blindness and severe eye damage. Direct contact of the eyes with liquid anhydrous ammonia will produce serious eye burns. Liquid anhydrous ammonia produces skin burn on contact.

Table 1 Effects of Various Concentrations of Ammonia in Air

(*Clause* 5.4.2.2)

Sl. No.	Vapour Concentration, ppm	General Effect	Exposure Period
(1)	(2)	(3)	(4)
i)	1 to 5	Odour detectable by most person	Prolonged repeated exposure produces no injury
ii)	25	No adverse effect for average worker	Maximum allowable concentration for 8 h working exposure
iii)	35	No adverse effect for average worker	Exposure should not be longer than 15 min and should not occur more than four times per day
iv)	400 to 700	Nose and throat irritation Eye irritation with tearing	Infrequent short (1/2 h) exposure ordinarily produces no serious effect
v)	2 000 to 3 000	Conclusive coughing Severe eye irritation	No permissible exposure. May be fatal after short exposure
vi)	5 000 to 10 000	Respirator spasm. Rapid asphyxia	No permissible exposure. Rapidly fatal

5.4.3 *Chronic Toxicity*

Chronic irritation to the eyes, nose, and upper respiratory tract may result from repeated exposure to the vapours.

6 PERSONAL PROTECTIVE EQUIPMENT

6.1 Availability and Use

6.1.1 While personal protective equipment is not an adequate substitute for good, safe working conditions, adequate ventilation, and intelligent conduct on the part of employees working with ammonia, it is, in many instances, the only practical means of protecting the worker, particularly in emergency situations. The personal protective equipment protects only the worker wearing it, and other unprotected workers in the area may be exposed to danger.

6.1.2 Proper training of personnel is essential for the correct usage of personal protective equipment (PPE) in undesired condition. In hazardous condition, it should be supervised that appropriate PPEs are used to handle it.

6.2 Non-Respiratory Equipment

6.2.1 *Eye and Face Protection*

Eye and face protection (*see* IS 8520) should be worn when handling ammonia, where leaks or spills may occur. Eye and face fountains (*see* IS 10592) or water wash or water sprays should be available in areas where ammonia leaks, spills or splashes may be encountered.

6.2.2 *Head Protection*

Where there is no danger from falling objects, safety helmets (*see* IS 2925) or ‘hard’ hats are considered unnecessary, soft brimmed hat or caps should be worn to give protection against liquid leaks and splashes.

6.2.3 *Foot and Leg Protection*

Rubber boots or safety-toed rubber booties should be used as required. Rubber boots should he thoroughly cleaned and ventilated after contamination [*see* IS15298 (Part 2) and IS 10667].

6.2.4 *Body, Skin and Hand Protection*

6.2.4.1 Neoprene, butyl, nitrile latex and natural rubber or other protective gloves should be worn where any danger of contact with ammonia may occur. Impermeable wears may also be used.

6.2.4.2 For the protection of the skin, cotton shirt, trousers should be worn (cotton resists alkalis better than wool).

6.2.4.3 In case of emergency, a rubber apron or rubber coat may provide sufficient protection, but in areas of high ammonia concentration a complete gas suit should be worn.

6.2.4.4 For optimum protection of the body, the collar should be kept buttoned, glove (gauntlets) should be tucked inside of sleeves, and trouser legs should be left outside of boots.

6.2.4.4.1 It is also suggested to have a valcro type tight fitting strap to have the legs and arm areas tight enough to avoid ammonia gas entry into the protective suit.

6.2.4.5 In area of high ammonia concentration, ammonia may be absorbed by perspiration on the body even though appropriate protective clothing is worn. Severe discomfort may be minimized or prevented by the application of protective oil to such body areas in addition to the wearing of protective clothing (*see* IS 8519).

6.3 Respiratory Equipment

Severe exposure to ammonia may occur in tanks during equipment cleaning and repairs, when decontaminating areas following spills, or in case of failure of piping or equipment. Employees who may be subject to such exposures should be provide with proper respiratory protection and trained in its use and care. Available types are described below.

NOTE

Respiratory protective equipment shall be carefully maintained, inspected, cleaned and sterilised at regular intervals, and always before and after use by another person.

6.3.1 *Self-contained breathing apparatus*

6.3.1.1 It permits the wearer to carry a supply of oxygen or air compressed in the cylinder [*see* IS 10245 (Part 1)] and the self-generating type produces oxygen chemically (*see* IS 15803). These allows considerable mobility. The length of time a self-contained breathing apparatus provides protection varies according to the amount of air, oxygen or regenerating material carried.

6.3.1.2 Compressed oxygen should not be used where there is danger of contact with flammable liquids or vapours, especially in confined spaces such as tanks or pits. A special type of self-contained breathing apparatus may be used which is provided with a small cylinder of compressed air for escape but is supplied with air through an air-line for normal work purposes.

6.3.2 *Positive pressure hose masks*

These are supplied by blowers and require no internal lubrication. The wearer shall be able to use the same route for exit as for entrance and shall take precautions to keep the hose line free of entanglement. The air blower shall be placed in an area free of contaminants.

6.3.3 *Air-line masks*

These are supplied with clean compressed air, are suitable for use only where conditions will permit safe escape in case of failure of the compressed air supply. These masks are usually supplied with air piped to the area from a compressor. It is extremely important that the air supply is taken from a safe source, and that is not contaminated by oil decomposition from inadequate cooling at the compressor. The safer method is to use a separate compressor of the type not requiring internal lubrication. Pressure reducing and relief valves as well as suitable traps and filters, shall be installed at all mask stations.

6.3.4 *Chemical cartridge respirators*

These may be used to avoid inhaling disagreeable but relatively harmless concentrations of ammonia vapour. These respirators, however, are not recommended for protection where toxic quantities of ammonia may be encountered. While using cartridge care must be taken to check the oxygen content in the area. It should be more than 16.5 percent (*v/v*) and chemical cartridges whose life is over, must not be available for use.

CAUTION — Filter type respirators do not offer protection against gases and are unsuitable for use when working with ammonia.

7 STORAGE, HANDLING, LABELLING, AND TRANSPORT

7.1 Storage

7.1.1 *Indoor Storage*

7.1.1.1 If anhydrous ammonia is stored inside, it shall be stored in a fire resistant structure, away from steam pipes and heating devices. Storage areas should be dry and cool. The mechanical damage or overheating of storage tanks and cylinders shall be avoided.

7.1.1.2 Suitable safety device like pressure control relieving system must be there to avoid excess pressurization. The safety valve on ammonia storage tanks are to be designed for fire conditions.

7.1.1.3 Ventilation should be provided through the structure in such a manner that full advantage of natural ventilation may be obtained. If natural ventilation is not sufficient, then storage area should be equipped with suitable type of mechanical ventilation.

CAUTION — Avoid pocketing of ammonia gas under floors, roots, and similar structures.

7.1.1.4 The vents from the storage tanks, relief valve must lead to a safe location to avoid any unwanted ammonia contamination in the working area. The ammonia vapours should be scrubbed in water or other suitable scrubber solution before releasing them into the environment.

7.1.1.5 Locations used for inside storage of anhydrous ammonia shall be cut off from other occupancies and the building and are to be protected with automatic sprinklers, vapour tight electrical equipment, good natural ventilation, good floor drainage and adequate exposition venting.

7.1.1.6 There should be provision of diagonally opposite emergency exits of each corner of the building and emergency push button at each exit which should sound alarm as part of warning system. The source of water should be available in vicinity for dealing with small spill and leaks. Fire hydrants should be located within 25 m of storage.

7.1.2 *Outdoor Storage*

Outside storage tanks may be located at least 15 m away from buildings or adjacent to blank masonry building walls. The location should be away from any flammable liquid storage. Dyke of adequate size should be constructed around the storage tank.

7.1.3 *Bulk Storage (Non-Refrigerated)*

7.1.3.1 Anhydrous ammonia vaporizes at atmospheric temperature and pressure and for that reason shall be stored in gas-tight containers under pressure. Storage tank if kept outside should have arrangement for protection from sun.

7.1.3.2 In case of multiple storage facilities, a plan should be prepared for readily and definitely approaching all shut-off valves and valves used for isolating various parts of the storage facilities. This is imperative, otherwise a serious leak under certain weather conditions may blanket out completely the storage area and make approach impossible. Approach routes to these valves should be demarcated prominently.

7.1.3.3 Each storage area should be protected by at least one standard fire hydrant so located that a suitable hose stream may be brought to bear upon the storage for extinguishing a fire, or for the cooling effect in case of adjacent fires. This problem should be discussed beforehand with the fire department that would respond, so that a minimum delay will ensure in case fire exposes the storage. Isolated storage areas are recommended, in so far as may be practical, with respect to adjacent buildings and consistent with adequate safety. Adequate supply of fire extinguishers of the CO_2 or water type should be made at strategic points.

7.1.3.4 In laying out new storage facilities or studying existing storage, consult suppliers of ammonia and of equipment and comply with all local, state or other regulations which apply.

7.1.3.5 Storage tank should be designed for a minimum of 15.5 bar absolute pressure and maximum temperature of (-) 10 °C {preferably (-) 33 °C}. Each storage tank shall be equipped with relief valve(s). Two relief valves may be mounted on a 3 way hand valve to provide means for repair of faulty valve while protecting the tank. Inlet to relief valve should be designed or protected so that internal fittings such as level floats do not block it, which may get accidentally detached. Vent pipes from the valves should terminate upward. Suitable provision should be made to prevent water, ice, or snow from entering the vents. A drain should also be provided at the bottom of vent pipe. They should be so arranged that in case of a release through the safety devices, the escaping ammonia will not enter working areas, collect under roofs, contact sources of ignition, or endanger workmen.

7.1.3.6 If gauge glasses are used, they should be provided with excess flow check valves. The gauge glasses should not be longer than 120 cm and not more than 60 cm between supports. If gauge glasses are less than 25 mm, excess flow check valves may not be necessary. The gauge glasses should be protected by suitable guards to prevent breaking on external impact.

7.1.3.7 Industrial emergency showers (*see* IS 10592) should be placed appropriately to provide immediate access to affected personnel.

7.2 Handling

7.2.1 *Handling of Cylinder*

7.2.1.1 Before filling the cylinder with ammonia check and confirm for its validity. It shall have valid test certificate from the competent authorities.

7.2.1.2 Cylinders should never be subjected to rough handling or to abnormal mechanical shock, such as dropping and bumping.

7.2.1.3 Do not use rope slings for unloading. When handling by crane or derrick, suitable platform, cradle or boat should be used. Use of hooks, tongs or similar fastening devices shall be avoided.

7.2.1.4 The use of electric magnets for unloading or handling shall be avoided.

7.2.1.5 Avoid dragging or sliding cylinders. It is safer to move the bottle type cylinders even short distances by using a suitable truck rather than by tilting or rolling them on their bottom edges.

7.2.1.6 Use a rack or chain to hold cylinders in place when hooked up for discharging.

7.2.1.7 Do not place or handle cylinders where they might form part of an electrical circuit. Contact with third rails or trolley wires shall be avoided.

7.2.1.8 Do not remove valve protection until ready to withdraw ammonia from the cylinder.

7.2.1.9 Do not temper with numbers, markings, or test dates stamped on cylinders.

7.2.1.10 Cylinders for ammonia or any other compressed gas, whether full or empty, should never be used as rollers for moving heavy or bulky articles.

7.2.2 *Emptying of Cylinders*

7.2.2.1 The tube type cylinder is normally used in the horizontal position. Two general types of valves are supplied. Depending on which type is involved, either the valve outlet or the valve stem is at an angle with the longitudinal axis of the cylinder. It is the position of this valve outlet or stem which determines whether liquid or gaseous ammonia will be discharged from the cylinder.

7.2.2.1.1 When the valve outlet or stem is on top, the dip-pipe on -the inside of the cylinder is under the liquid, and therefore, liquid anhydrous ammonia will be discharged. To discharge gaseous ammonia, the cylinder is turned so that the valve outlet or stem points downward. Follow instructions of ammonia manufacturer concerned.

7.2.2.2 The bottle type or vertical cylinder will discharge ammonia as a gas when placed in an upright or vertical position. Due to liquid ammonia expansion, a bottle type cylinder may, under certain elevated temperature conditions, discharge a small amount of liquid when the valve is opened, and it is recommended that bottle type cylinders be allowed to reach room temperature before the valve is opened. To discharge liquid anhydrous ammonia, this type of cylinder shall be placed in horizontal position with the valve outlet pointed up.

7.2.2.3 The rate at which gaseous ammonia may be discharged from either type cylinder depends upon the temperature of the surrounding atmosphere and the surface area of the liquid ammonia.

7.2.2.4 When the cylinder is empty, disconnect it, insert the valve plug and replace the cylinder protective cap.

7.2.2.5 If a bottle type cylinder has frozen during discharge, never use a pry under the valve end to loosen the cylinder. Use water to loosen the cylinder or wait for it to thaw out.

7.2.2.6 The empty cylinders shall be stored separately from filled cylinders and shall be fastened with an EMPTY tag on cylinders immediately upon emptying. Close valve, replace plug or nut on valve outlet, and secure valve protecting cap snugly.

7.2.3 *Unloading of Tank*

7.2.3.1 Unloading operations should be conducted by carefully instructed, reliable employees under adequate super vision. They should be provided with proper personal protective equipment.

7.2.3.2 It shall be monitored that the train or engine crew accurately spots the car at the unloading line. The unloading track should be level.

7.2.3.3 Only licensed tanks/ tankers shall be used for transporting ammonia.

7.2.3.4 All tanks/ tankers should have excess flow check value as per the current rule in force.

7.2.3.5 Brakes shall be set and wheels blocked on all cars being unloaded. It is considered good practice that derails be placed at one or both ends of the unloading track approximately one car length from the car being unloaded, unless the car is protected by a closed and locked switch or gate.

7.2.3.6 Metal caution signs shall be so placed on the track or car as to give necessary warning to persons approaching car from open end or ends of siding. These signs shall not be removed until the car has been unloaded and all fittings disconnected. The signs should prominently display the words: '**STOP — TANK CAR CONNECTED**'.

7.2.3.7 Anhydrous ammonia is unloaded by creating a pressure differential between the tank car and the storage tank. This may be accomplished by means of a compressor, with the suction side connected to the top of the storage tank and the discharge side to the gas line on the tank car. Unloading compressor should provide discharge pressure high alarm trip and safety valve in its discharge line.

7.2.3.8 The connection between the liquid line on the tank car and the unloading line to the storage tank should have a remote operated isolation valve, an excess how check valve and can be made by an anhydrous ammonia hose equipped with high pressure screw couplings. This will take care of any accidental leak as well as provide flexibility in spotting the car.

7.2.3.9 Bleed off pressure on flexible lines or connections at car through vent valve before disconnecting hose or transfer lines.

7.2.3.10 There should be provisions for high level alarm in storage tank set to operate at a level which gives time for effective action and also for two independent level indicating devices one of which can be a float- and-tape type or a float guided on a stainless steel tube containing a magnetic follower.

7.2.4 *Return of Tank Cars*

As soon as the tank cars are completely unloaded all valves shall be made tight, the unloading connections removed, and all other closures made tight. Before releasing empty tank cars, the dome cover should be closed tightly.

NOTE — The filling, transport and importation of liquid ammonia or compressed ammonia gas in cylinders shall be governed by the Gas Cylinder Rules, 2016.

7.3 Labelling

7.3.1 Tankers or large consignments or smaller containers shall carry an identifying label or stencil depicting the symbol given in Label model No. **2.3** of Annex B of IS 18149 and the following information shall also be given in the lower half of the label.

AMMONIA, ANHYDROUS

WARNING ! Hazardous liquid and gas under pressure

Liquid Causes Burns

Gas Extremely Irritating

Do not breathe gas.

Do not get in eyes, on skin, on clothing.

In case of contact, immediately flush skin or eyes with plenty of water for at least 15 minutes. Call a physician at once in case of burns, especially to the eyes, nose and throat, or if the patient is unconscious.

Keep cylinders away from heat and sun. Do not store with flammable or explosive materials.

Never drop cylinders.

Be sure connections are tight. Use no oil or lubricants on valves.

Never refill cylinders.

Keep the cylinders up-right (vertical) with its valve at the top and secure it properly.

7.4 Transport

Only driver trained in ammonia handling should be employed for transportation of ammonia. Driver should carry Trem card when vehicle is on road.

NOTE — If transport of the hazardous chemical is involved it shall be carried out in accordance with the *Central Motor Vehicles Rules*, 1989. While referring to the statutes, the stipulations given in the subsequent amendments of those statutes shall be taken into account.

8 SPILLAGE, LEAKAGE AND WASTE DISPOSAL

8.1 Spills and Leaks

8.1.1 The leaks of ammonia should be searched for, preferably with hydrochloric acid solution or with either chlorine gas or sulphur dioxide gas using a small cylinder of the compressed gas. A white cloud is produced in the presence of ammonia. The use of sulphur candles should be avoided, because of the fire risk.

8.1.2 If leaks or spills occur, only properly protected personnel should remain in the area. In cases where leaks cannot be isolated, use large volumes of water sprayed directly on the leak and maintain contact until the contents have been discharged and the tank is empty. The leaking cylinders should be removed to the outdoors or to an isolated, well-ventilated area and the contents transferred to other suitable containers. All spills should be flushed away promptly with water.

8.1.3 In handling or operating any type of ammonia system, always be sure that all valve connections and pipe lines are in proper order and condition before starting the operation. Keep compressors and motors clean and in good condition.

8.1.4 During cold weather keep all steam traps warm, whether or not tanks are in service.

8.1.5 Never, under any circumstances, close all valves on a full line of liquid ammonia unless protected by pressure relief or liquid expansion device.

8.2 Waste Disposal

8.2.1 Waste disposal of ammonia and materials containing ammonia depends to a great extent upon local conditions. Be sure that all central, state, and local regulations regarding health and pollution are followed.

8.2.2 If not prohibited, waste may be disposed of by diluting with large quantities of water and washing into sewers.

8.3 Tank Cleaning and Repairs

8.3.1 *Preparation of Tanks and Equipment*

8.3.1.1 Tank and equipment cleaning and repairing should be done under the direction of thoroughly trained personnel who are fully familiar with all of the hazards and the safeguards necessary for the safe performance of the work.

8.3.1.2 In addition to the precautions generally recommended in tank work, such as procurement of written approval of supervision, testing for oxygen content, use of rescue harness or life belt and life line, provision of grounded equipment in good condition for portable lights and power tools and stationing of thoroughly trained ‘watchers’ outside and tank entrance, additional precautions are recommended as follows:

a) It shall be ensured that all pressure has been relieved from tank. Use of compressor is frequently made to remove bulk of gas remaining after the liquid has been removed.

b) Pressurize and depressurize the tank with air till ammonia content inside the tank becomes nil. After stopping the compressor, slowly vent the tank. Make sure that any gas escaping does not enter working area or expose other person.

c) Fill tank completely with water and drain out. Repeat if any ammonia gas remains.

d) Keep adequate vents in open condition to avoid vacuum formation during filling the tank with water.

e) If oil is found in the tank and requires to be removed, it should be done by steaming and draining and not by the use of solvents.

f) Provide adequate fresh air supply.

g) Use proper personal protective equipment.

h) Flush all lines completely with water until no ammonia remains.

j) Blank off lines; do not depend on shut-off valves.

8.3.2 *Entering Tank*

8.3.2.1 No one should enter a tank or confined space until a work permit has been signed by an authorized person, indicating that the area has been tested and found to be safe. Furthermore, no workman should enter a tank or vessel that does not have a manhole opening large enough to admit a person wearing his safety harness, life line and emergency respiratory equipment. It should be ascertained that the tank or vessel can be left through the original entrance.

8.3.2.2 One personnel should be placed outside of the tank to keep the personnel in the tank under observation and another personnel should be available nearby to aid in rescue if any of the personnels in the tank are overcome.

8.3.2.3 A supplied-air respirator or self-contained breathing apparatus, together with rescue harness and life line should always be located outside the tank entrance for rescue purposes, regardless of the type of respiratory equipment or air supply which is provided for employees inside the tank.

8.3.2.4 If a tank cleaner or repairperson is overcome, they should be removed to fresh air immediately, artificial respiration should be applied if breathing has stopped, and a physician summoned at once.

8.3.3 *Repair Work*

8.3.3.1 No welding and cutting of any type should be conducted on tanks or lines until they are completely free of ammonia and certified by competent person as well as safety work permit issued.

8.3.3.2 Before refilling the tank with anhydrous ammonia, the tank should be thoroughly dry and vented to safe location.

9 TRAINING

9.1 Employee Education and Training

9.1.1 Safety in handling ammonia depends, to a great extent, upon the effectiveness of employee education, proper safety instructions, intelligent supervision and the use of safe equipment.

9.1.2 The education and training of employees to work safely and to use the personal protective equipment or other safeguards provided for them is the responsibility of supervision. Workers should be thoroughly informed of the hazards that may result from improper handling of ammonia. Each employees should be fully informed as what to do in an emergency.

9.1.3 Employee education and training should include the following:

a) Instruction and periodic drill or quiz regarding the locations, purpose and use of respiratory protective devices and other personal protective equipment and action to be taken during emergency.

b) Instruction and periodic drill or quiz regarding the locations of safety showers, eye baths, bubbler drenching fountains, or the closest source of water for use in emergencies.

c) Instructions to avoid all unnecessary inhalation of vapours of ammonia and all direct contact with the liquid.

d) Instruction and periodic drill or quiz regarding the location, purpose and the use of emergency fire-fighting equipment. Instruction to strictly prohibit smoking in storage area.

e) Instructions to report to the proper authority all equipment failures and any unusual odour of ammonia.

10 HEALTH MANAGEMENT AND FIRST-AID

10.1 Health Monitoring

10.1.1 *Personal Hygiene*

10.1.1.1 Emergency showers and eye baths (*see* IS 10592) should be placed at convenient locations wherever anhydrous ammonia is used in quantity. Every employee should be trained that direct contact with the chemical requires the instant application of large amounts of water to the affected area. These safety showers should he tested periodically for their proper functioning.

10.1.1.2 Skin, eye, and respiratory protective equipment should often be necessary.

10.1.2 *Physical Examinations*

10.1.2.1 *Preplacement examinations*

Most employees may be assigned to processes in which the use of anhydrous ammonia is carefully controlled. Under some circumstances the physician carrying out preplacement examinations may wish to exclude from exposure people with the following disabilities:

a) Those with only one functioning eye;

b) Those with severe faulty vision; and

c) Those with chronic diseases of the nose, throat or lung.

10.1.2.2 *Periodic health examination*

Periodic examination should be conducted. Additionally, it should also be conducted when personnel get exposed to above (TLV) levels of ammonia.

10.2 First-Aid

10.2.1 *General Principles*

After severe exposure to ammonia gas, it is important to move the patient from the contaminated area promptly. In case of contact of the liquid with the eyes or skin, immediate flushing with large quantities of running water is imperative. In all cases of serious injury, call a physician at once giving him a complete account of the accident.

10.2.2 *Contact with Skin and Mucous Membranes*

10.2.2.1 On exposure to ammonia, the patient should be instantaneously moved to uncontaminated atmosphere.

10.2.2.2 If skin contact is extensive and emergency showers available, the employee should get under the shower immediately. Contaminated clothing and shoes should be removed under the shower. In other instances, flushing with large amounts of running water should be continued for at least 15 min.

10.2.2.2.1 Under no condition should salves or ointments be applied to the skin or mucous membrane burns during the 24 h period following the injury. Subsequent medical treatment is otherwise the same as tor thermal burns.

10.2.3 *Contact with the Eyes*

If even small quantities of ammonia enter the eyes, they should be rinsed immediately and copiously with water for a minimum of 15 min. The eyelids should be held apart during the rinsing to ensure the contact of water with the tissues of the eye surface and lids. A physician should be called at the earlier possible moment. After the first 15 min period of rinsing, if a physician is not available, the rinsing should continue for a second period of 15 min. No oils or oily ointment should be instilled unless ordered by a physician. The affected person should be sent to a physician, preferably an eye specialist, as soon as possible.

10.2.4 *Ingestion*

If liquid anhydrous ammonia has been swallowed, call a physician immediately. If the patient is conscious and able, he should drink large amounts of water to dilute the chemical. Do not induce vomiting if the patient is in shock or in extreme pain or is unconscious. If vomiting begins, place the patient face down with head lower than hips, this prevents vomitus from entering the lungs and causing further injury.

10.2.5 *Inhalation*

Exposed persons should be removed at once to an uncontaminated area. If the exposure has been to minor concentrations for a limited time, usually no treatment will be required.

10.2.5.1 When there is severe exposure to higher concentrations, and if oxygen apparatus is available, oxygen may be administered but only by a person authorized for such duty by a physician. If the patient is not breathing, an effective means of artificial respiration should he initiated immediately. Call a physician.

10.2.5.2 The patient should be kept comfortably warm but not too hot and should be kept at rest.

10.2.5.3 Never attempt to give anything by mouth to an unconscious patient.

ANNEX A

(*Clause* 2)

LIST OF REFERRED STANDARDS

IS No.	*Title*
IS 2925 : 1984	Specification for industrial safety helmets (*second revision*)
IS 4155 : 2023	Glossary of terms relating to chemical and radiation hazards and hazardous chemicals (*first revision*)
IS 8519 : 2024	Guide for selection of occupational protective clothing — Body protection (selection, care and maintenance) (*first revision*)
IS 8520 : 2023/ ISO 19734 : 2021	Eye and face protection — Guidance on selection, use, and maintenance (*first revision*)
IS 10245 (Part 1) : 1996	Breathing apparatus Part 1 Closed circuit breathing apparatus (compressed oxygen cylinder) — Specification (*first revision*)
IS 10592 : 2018	Industrial emergency showers, eye and face fountains and combination units — Specification (*first revision*)
IS 10667 : 1983	Guide for selection of industrial safety equipment for protection of foot and leg
IS 15298 (Part 2) : 2024	Personal protective equipment Part 2 Safety footwear (*third revision*)
IS 15803 : 2008	Respiratory protective devices — Self-contained closed circuit breathing apparatus chemical oxygen (KO_2) type, self-generating, self-rescuers — Specification
IS 18149: 2023	Transportation of dangerous goods – Guidelines