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A Basic Understanding of Anhydrous Ammonia

Ammonia (frequently called anhydrous ammonia) is one of the most valuable and versatile chemical compounds in today's modern world. For example, it finds wide application in food production and processing, textile and chemical manufacturing, refrigeration, metal treating and pollution abatement.

An ever-increasing use of ammonia has been accompanied by a corresponding growth in the need for the dissemination of knowledge regarding ammonia safety among persons working with ammonia under either normal or emergency conditions. Recognizing this need, LaRoche Industries Inc. prepared this booklet which contains a selected collection of helpful information and suggestions for the ammonia user and for the safety personnel. The suggestions are offered as an aid in the preparation of the ammonia user's own comprehensive safety program and should be altered or augmented in accordance with individual requirements. Anyone using this publication should also research original and current sources of authority.

Anyone working with ammonia, either directly or indirectly, whether at a supervisory or non-supervisory level, has a responsibility not only to be thoroughly familiar with basic ammonia safety principles, but also to observe faithfully all necessary precautions and to react promptly and appropriately should an emergency arise. Readers of this booklet will find answers to questions most often asked regarding general properties, potential hazards, exposure effects, personal protective and safety equipment, first aid procedures and methods of dealing with emergencies involving ammonia. Information as to the manufacture, transportation, and or application of ammonia is not detailed.

Persons requiring any information regarding ammonia not covered in this booklet are urged to consult with LaRoche Industries Inc. or with the Compressed Gas Association, Inc., Arlington, Va., or The Fertilizer Institute, Washington, D.C., for assistance.

Anhydrous Ammonia Safety

General

The term "anhydrous ammonia" appearing in the title of this booklet refers to the compound having the formula NH_3, formed by the chemical combination of nitrogen and hydrogen. Whenever the term "ammonia" appears in this booklet, it should be understood as meaning anhydrous ammonia and not aqua ammonia, aqueous ammonia or ammonium hydroxide which are solutions of ammonia in water. Ammonium hydroxide solutions generally range in concentrations of ammonia from about 30% down to the 2 to 4% found in the well known household ammonia. These solutions are commonly known as ammonia, but should never be confused with liquid anhydrous ammonia which has a much greater hazard potential. "Anhydrous" means "free from water".

At room temperature and atmospheric pressure, ammonia is a pungent, colorless gas approximately 40% lighter than air. Compressed and cooled, ammonia gas condenses to a colorless liquid about 68% as heavy as water. At atmospheric pressure, the liquid boils at -28°F.

In a container, ammonia in the liquid form normally coexists with vapor. Temperature affects both the vapor pressure and volume of liquid ammonia.

As the temperature of the liquid rises, the vapor above the liquid phase exerts increased pressure. It should be noted that the pressure observed within a container is NOT a measure of the quantity of the liquid present.

With increasing temperature, ammonia in the liquid phase expands. For example, in an ammonia cylinder at 65°F loaded to its maximum allowable limit in accordance with federal regulations, the vapor phase occupies about 12% of the total cylinder volume. This vapor space would be completely filled with liquid ammonia if its temperature were permitted to reach 145°F. Upon further temperature rise, the cylinder will bulge and could rupture due to the internal hydrostatic pressure caused by the expanding liquid.

Because of these characteristics, ammonia containers should not be exposed to excessive heat. (See THERMAL EXPANSION and FIRE EXPOSURE.)

Under equilibrium conditions, the vapor pressure and volume of liquid ammonia vary with temperature as shown in Table 1 (see below).

Ammonia is most frequently shipped by highway and rail and stored in pressure containers as a liquefied compressed gas at ambient temperatures.

TABLE 1. VAPOR PRESSURE AND VOLUMES OF LIQUID AMMONIA AT VARIOUS TEMPERATURES

Temperature ° F	Vapor Pressure psig	Volume Gal./CWT
-28	0.0	17.57
0	15.7	18.10
30	45.0	18.72
60	92.9	19.43
90	165.9	20.25
115	251.5	21.04
130	315.6	21.58

(Data derived from U.S. Bureau of Standards Circular No.142.)

Ammonia in very large quantities is transported in high pressure pipelines at ambient temperatures and is shipped by barge or tanker as refrigerated liquid at -28°F and atmospheric pressure. When stored in large quantities, such as at a terminal, ammonia is generally refrigerated and kept in insulated tanks at -28°F.

Primary Hazards

Ammonia acts as an irritant to human tissue in varying degrees depending upon concentration and exposure.

The pungent and distinctive odor of the vapor, even at low concentrations, generally provides adequate warning so that no reasonably prudent person would voluntarily remain in concentrations which are hazardous. **(See HUMAN PHYSIOLOGICAL EFFECTS.)**

At the time of this printing, ammonia is classified by the U.S. Department of Transportation as a NONFLAMMABLE GAS. Conditions favorable for ignition are seldom encountered in normal handling due to its narrow range of susceptibility to ignition. In the presence of a flame or spark at about 1200°F, ammonia vapor will ignite, but only within the limited range of 16-25% of ammonia in air by volume. The heat generated by combustion is insufficient to maintain a flame which therefore will extinguish upon ignition source removal.

Other Hazards

CHEMICAL- As a chemical compound, ammonia is highly associated and stable at ordinary temperatures. At about 840°F ammonia begins to dissociate with the formation of nitrogen and highly flammable hydrogen.

Ammonia will not corrode most of the common metals, but in the presence of water, ammonia will attack copper, zinc and alloys containing these elements. For this reason, materials of construction used for ammonia containers, fittings, piping and equipment are limited to steel and iron or certain non-ferrous alloys resistant to attack by ammonia.

Ammonia is a highly reactive chemical, forming salts with many inorganic and organic acids, usually with the release of heat. Under certain conditions, ammonia is known to react with bromine, chlorine, fluorine or iodine, to form compounds which explode spontaneously. Ammonia has been reported as reacting with gold, silver or mercury to form fulminate-like compounds which are explosive.

THERMAL EXPANSION- Liquid ammonia exhibits a high coefficient of cubic expansion. A given quantity of liquid ammonia therefore expands considerably in volume with a rise in temperature (See Table 1). For this reason, appropriate measures must be taken to avoid hydrostatic rupture of containers, piping or other equipment which could be caused by such expansion.

Human Physiological Effects

Ammonia is NOT a cumulative metabolic poison; ammonium ions are actually important constituents of living systems. Depending upon concentration and time, the effects of exposure to ammonia vapor vary from none or mild irritation, to obstruction of breathing from laryngeal and bronchial spasm, to edema and severe damage of the mucous membranes of the respiratory tract with possible fatal results.

Ammonia in the presence of water is highly alkaline. Contact of the skin or mucosa with liquid ammonia or a high concentration of vapor can result in a caustic burn. Due to the great attraction of water to ammonia, water may be absorbed simultaneously from the tissue resulting in dehydration of the affected area.

Liquid ammonia boils at -28°F under atmospheric conditions, acting as a refrigerant to remove heat from any warmer object it may be contacting. Accordingly, liquid ammonia in contact with the skin can cause frostbite.

Exposure levels of ammonia vapor which are tolerated by some persons may produce adverse reactions in others. Persons having chronic respiratory disease or persons who have shown evidence of undue sensitivity to ammonia should not be exposed to ammonia. Table 2 indicates human physiological response to various concentrations of ammonia in air upon inhalation.

TABLE 2. PHYSIOLOGICAL EFFECTS OF AMMONIA VAPOR

Effect	PPM Ammonia in Air by Volume
Least perceptible odor	5 ppm
Readily detectable odor	20-50 ppm
No discomfort or impairment of health for prolonged exposure	50-100 ppm
General discomfort and eye tearing; no lasting effect on short exposure	150-200 ppm
Severe irritation of eyes, ears, nose and throat; no lasting effect on short exposure	400-700 ppm
Coughing, bronchial spasms	1,700 ppm
Dangerous, less than 1/2 hour exposure may be fatal	2,000-3,000 ppm
Serious edema, strangulation, asphyxia, rapidly fatal	5,000-10,000 ppm
Immediately fatal	over 10,000 ppm

(From "Anhydrous Ammonia" Pamphlet G-2 Seventh Edition, Compressed Gas Association, Inc.)

Exposure Limits

Occupational Safety and Health Administration (OSHA) regulations require that an employee's permissible exposure limit (PEL) for ammonia is not to exceed a time-weighted average of 50 ppm in an eight-hour workday.

The American Conference of Government and Industrial Hygienists (ACGIH) has established an exposure limit of 25 ppm ammonia in air by volume as an 8-hour time-weighted average (TWA).

Personal Protective Equipment

Persons working with ammonia under routine circumstances of operation and maintenance should wear chemical splash-proof goggles and rubber or plastic gauntlet gloves impervious to ammonia to protect critical body areas which are most vulnerable to contact with ammonia should a minor leak occur. A full face shield may be worn over the goggles for additional protection, but not as a substitute for the goggles.

Emergency Protective and Safety Equipment

Each location having an ammonia installation should have readily available and freely accessible, emergency protective and safety equipment as required by federal, state and local governmental regulations. The location of such protective and safety equipment should be well identified by appropriate signs.

Depending upon the size and nature of the installation, emergency protective and safety equipment may include one or more of the following:

SAFETY SHOWER- Parts of the body injured by contact with ammonia must be flooded immediately with large quantities of water. An emergency safety shower, eye wash fountain or other source of clean water can be used for this purpose. Such a source should be protected from freezing in cold weather.

RESPIRATORY DEVICES-

1. A full-face GAS MASK with an ammonia (green) or a universal (red) industrial size canister approved by MSHA/NIOSH (formerly U.S. Bureau of Mines). OSHA regulations require at least two gas masks to be maintained at a stationary ammonia storage installation.

It should be noted these canisters are limited to brief periods of use not exceeding 15 minutes and for use in concentrations of ammonia in air by volume not exceeding 2% (20,000 ppm) for escape purposes or 300 ppm for entry purposes.

A person wearing a mask must leave a contaminated area immediately on detecting an odor of ammonia or experiencing difficulty in breathing. These are indications that the mask or

canister is not functioning properly, that the ammonia concentration is excessive, or that adequate oxygen is not available.

2. For protection when entering an area where ammonia concentrations are unknown or exceed the IDLH level of 300 ppm or in oxygen deficient atmospheres, SELF-CONTAINED AIR BREATHING APPARATUS of an approved pressure demand type should be used. This apparatus, which consists of a sealable full-face shield, a pressure and flow control and a high pressure cylinder of air, provides protection for a period of time which varies with the amount of air carried and the extent of exertion by the user. The user must have a clean-shaven face and be OSHA-trained in the use of respirators.

Any respiratory device must be used and maintained in accordance with the manufacturer's instructions. Because the device is normally used in an emergency where there is tension and excitement, a person who uses it should have received thorough training and practice.

PROTECTIVE CLOTHING- Emergency or rescue personnel required to work in high ammonia concentrations should wear protective gloves, boots, pants and jacket (or slicker) impervious to ammonia. A hard hat should be worn as required by plant practice or dictated by special hazards.

RESCUE HARNESS- A safety belt and lifeline should be worn by an individual using respiratory equipment and entering contaminated air in a confined location. Another person also wearing respiratory equipment and protective clothing should be located outside the contaminated area to act in case of emergency.

WATER SYSTEM- At a large installation, a high capacity water system should be available not only for fire fighting, but also for controlling ammonia leaks.

STRETCHER AND BLANKETS- Inadequate facilities for transporting a seriously injured person from the scene of an accident to a first aid station can add to the seriousness of the injury. A stretcher provides the most acceptable method of hand transportation and it may be used as a temporary cot at the first aid station or during transit in a vehicle.

First Aid Procedures

Ammonia is one of the most water soluble of all gases. Accordingly, the best means of providing first aid for an injury caused by ammonia contact with the eyes or skin is to flush immediately the injury area with large quantities of clean water. Promptness in initiating treatment, using adequate quantities of water and continuous application for at least fifteen minutes, or longer if necessary, are all essential in successful first aid management of an eye or skin injury resulting from contact with ammonia. Cool coffee, tea and even a fruit flavored beverage are all reported as having been used with good effect in starting first aid treatment when water was not immediately available. A physician must be called promptly for any person who has been burned severely or overcome by ammonia. The physician should be given a complete account of the cause of injury. Speedy removal of the patient from the contaminated location is important to avoid aggravation of the injury.

PRIOR TO MEDICAL AID BY THE PHYSICIAN, FIRST AID PROCEDURES SHOULD BE EMPLOYED. THOSE PRESENTED HEREIN ARE BASED UPON WHAT IS BELIEVED TO BE COMMON PRACTICE IN INDUSTRY. THEIR ADOPTION IN ANY SPECIFIC CASE SHOULD, OF COURSE, BE SUBJECT TO PRIOR ENDORSEMENT BY A COMPETENT MEDICAL ADVISOR.

As a guide in case of injury caused by ammonia, the following first aid procedures are suggested:

INHALATION- Any conscious person who has incurred irritation due to inhalation of ammonia and vapor should proceed at once to a location free of ammonia and breathe fresh air. If exposure has been minimal, usually no other treatment will be necessary.

A person overcome by ammonia must be carried to a location free of ammonia and the services of a physician obtained promptly. Successful resuscitation requires SPEED and EFFICIENCY. DELAY AND INEXPERIENCE MAY RESULT IN A FATALITY.

If there is an obstruction to the patient's breathing, the airway must be cleared by appropriate methods which may include proper positioning of the patient's head, pulling the tongue forward and clearing any blockage from the mouth such as dentures or vomitus. If spontaneous breathing does not resume after the airway has been cleared, artificial respiration should be started immediately by mouth-to-mouth resuscitation (expired-air ventilation, rescue breathing), preferably by an individual trained in the procedure.

Oxygen therapy may be indicated once the patient's breathing has been restored or if it continues to be labored. Such therapy should not replace immediate mouth-to-mouth resuscitation and should only be applied during a sustained resuscitation period or if the patient is to be moved. CAUTION: It may not be advisable to administer oxygen under positive pressure if the patient is in shock or there is impending or existing cardio-vascular failure. Oxygen therapy equipment should be used only by qualified and experienced personnel.

Treatment with oxygen may be discontinued if breathing becomes easy, the color is good and there are no signs of lung congestion. During treatment, the patient should be placed in a reclining position. He should be kept quiet, at rest and comfortably warm, but not hot. The patient should be examined by a physician and not allowed to return to work until found free of injury.

EYES- If contacted by ammonia, the eyes must be flooded immediately with copious quantities of clean water. Speed is essential. If contact lenses are worn, they must be removed, otherwise ammonia may be trapped underneath causing a severe burn. In isolated areas, water in a squeeze bottle which can be carried in the pocket is helpful for emergency irrigation purposes. An eye fountain should be used, but if not available, clean water from any source may be poured over the eyes. In any case, the eyelids MUST BE HELD OPEN and irrigation continued for at least 15 minutes. Repeat this procedure every 10 minutes for an hour, each time irrigating for a period of 5 minutes until medical attention can be obtained. Such attention must be received promptly from a physician, preferably an opthamologist. No oils or any medication should be placed in the eyes unless ordered BY A PHYSICIAN. If prescribed BY A PHYSICIAN, 2 to 3 drops of topical anesthetic such as 1/2% tetracaine hydrochloride (Pontacaine) may be instilled to relieve pain and to permit more thorough flushing of the eyes with water.

SKIN AND MUCOSA- If contacted by liquid ammonia, the body area affected should be immediately flooded with water. If no safety shower is available, utilize any available water source. Water will have the effect of thawing out clothing which may be frozen to the skin. Such clothing should be removed and flooding of the skin with water continued for at least 15 minutes.

Do not apply salves or ointments to skin or mucous membrane burns during the 24-hour period following injury. Subsequent medical treatment is otherwise the same as for thermal burns.

INTERNAL- Swallowing of liquid ammonia is very unlikely. However, if ammonia has been taken internally and if the patient is CONSCIOUS and able, have him drink large quantities of water immediately. NEVER GIVE ANYTHING BY MOUTH TO AN UNCONSCIOUS PERSON. Should the patient vomit, place his face down with head lower than hips to prevent vomitus from entering lungs. Transport patient to a physician promptly and apply other first aid treatment as he or she may prescribe.

Emergency Measures

Every plant, warehouse, office or other facility is susceptible to emergency situations which can result in property damage and/or bodily harm to employees, visitors or even neighbors. An entity using ammonia bears responsibility for the development and implementation of comprehensive and effective plans designed to meet these situations in a manner as will protect the safety of human life, physical assets and the environment to the greatest degree practicable within the constraints of governmental regulations and prudent business practice.

No one plan will serve the needs of all companies and each organization must assess the

various potential emergency conditions that might occur and develop a program to suit its own requirements. Where ammonia is stored and used, the following procedures and actions are suggested for incorporation into an emergency response plan upon the understanding that the publisher is not offering professional advice.

When an ammonia leak occurs, personnel trained for and authorized to handle such situations should take immediate steps to locate and control the condition. Respiratory equipment and protective clothing as may be necessary and suitable for ammonia must be worn. All other persons must be kept away from the affected area until the leak has been stopped. Keep on the windward side of the leak when possible.

If ammonia vapor is released, the irritating effect of the vapor will generally force personnel to leave the area before they are overcome by harmful concentrations. Sufficient, well-marked and readily accessible exits must be provided to facilitate rapid evacuation from a building. Should an individual become trapped in an ammonia-contaminated atmosphere, breathing should be held to a minimum and eyes opened only as necessary.

Because ammonia vapor is lighter than air, a trapped person should remain close to the floor to take advantage of lower vapor concentrations while seeking an escape route, unless liquid ammonia has been spilled. If respiratory equipment is not available, some temporary protection may be afforded by holding a wet cloth over the nose and mouth.

Should a leak occur which is extensive, such as might be involved with a spill of liquid ammonia, all persons in the path of the vapor should be warned. If necessary, local emergency authorities should be contacted to control evacuation. The evacuation area should be adjusted according to wind changes and observed effects on population. Suggested evacuation distances are given in Table 3, starting with the circle as shown in the accompanying diagram.

With good ventilation or rapidly moving air currents, ammonia vapor, being lighter than air, can be expected to dissipate readily to the upper atmosphere. Further action may not be required other than to stop the leak. If necessary, the concentration of ammonia vapor in the air can be reduced effectively by the use of an adequate volume of water applied through a spray or fog nozzle.

Under some conditions, ammonia in a container may be colder than available water supply. At such times, water must not be applied to the container walls since heat would be transferred to the ammonia thus causing increased pressure within the container resulting in aggravation of any leakage or relief valve discharge.

Water should not be applied to a liquid spill unless at least 100 parts of water to 1 part of ammonia are available. Runoff of a liquid spill should be diverted if the direction of flow will create an additional problem. UNDER NO CIRCUMSTANCES SHOULD AN ATTEMPT BE MADE TO NEUTRALIZE AN AMMONIA SPILL WITH AN ACID.

It is recommended that an up-to-date telephone listing of various emergency, rescue, medical and regulatory agencies be maintained for use by designated personnel should it become necessary to call for sources of outside help to cope with a situation which is beyond the self-sufficiency of local plant employees. Included in the listing should be numbers for fire and police departments, ambulance, rescue or paramedical services, doctors, hospitals, governmental authorities, material and equipment suppliers. Also listed should be the names and numbers for selected company supervisory and management personnel (such as foreman, superintendent, safety and public relations directors, etc.) who are to be notified of an emergency situation. Where appropriate, both day and night or alternate numbers should be shown.

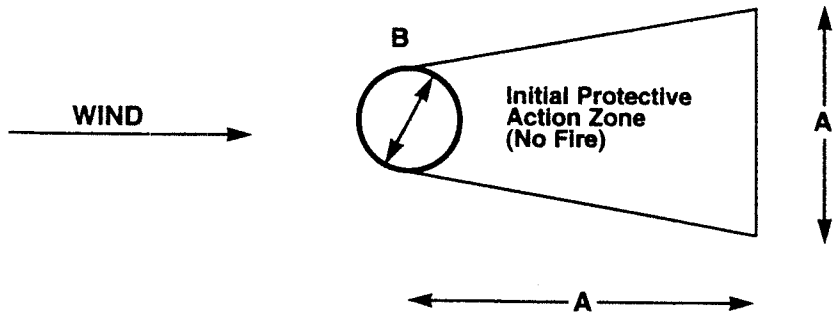
If company or security personnel are not present at a facility during off-hours, the name(s) and telephone number(s) of a responsible individual(s) should be posted at a gate or entrance for purposes of notification by local authorities should an emergency arise.

Leak Detection

An ammonia leak is readily detectable by its characteristically pungent odor. The location of a small leak may often be determined by holding a

TABLE 3. TABLE OF INITIAL ISOLATION AND PROTECTIVE ACTION DISTANCES

Small Spill	Large Spill
A) Downwind and Crosswind Distances: 0.1mi. Day Downwind and Crosswind Distances: 0.2mi. Night B) Isolation Zone Diameter: 100 ft.	A) Downwind and Crosswind Distances: 0.2mi. Day Downwind and Crosswind Distances: 0.5mi. Night B) Isolation Zone Diameter: 300 ft.



(Derived from "1996 North American Emergency Response Guidebook", U.S. Department of Transportation NAERG 96)

moist strip of phenolphthalein or red litmus paper near the suspected leak source. The rapidity and intensity of the color change in the paper will give some indication of leak proximity or size. In the presence of ammonia, phenolphthalein paper will turn from white to pink or deep red, whereas the red litmus will become blue.

Sulfur dioxide vapor reacts with ammonia to form a dense white cloud and may be used for leak detection. Care must be exercised to avoid breathing sulfur dioxide vapor as it is also highly irritating. It should be noted that a gas mask canister which is specific for ammonia will not offer protection against sulfur dioxide. If there is an appreciable quantity of ammonia in the air, it may be difficult to pinpoint the leak source.

Various types of devices are available to detect and measure the concentration of ammonia vapor in air. One such device employs a colorimetric detector tube through which air to be tested is drawn by a special hand or battery operated pump. A comparison of the length of the color stain produced in the tube is made with a calibrated chart which gives an indication of the concentration.

Leak Control

EQUIPMENT OR PIPING- If a leak occurs in equipment or piping, shut off the ammonia supply and carefully vent all ammonia from the system before attempting to dismantle any part or make repairs. The appearance of frost on an external surface indicates the presence of liquid ammonia vaporizing in the system. Accordingly, the frost should be allowed to dissipate before breaking any connection. If welding is required, the system should be thoroughly purged until all ammonia and any oil residue has been removed. Welding must conform with applicable codes.

VALVE- A leak at a valve stem can usually be stopped by tightening the packing gland nut. A leak at a valve bonnet may be stopped by tightening the bonnet threads or the bolts holding the bonnet to the valve body. All tightening should be performed slowly and without application of excessive force. Packing gland nut and bonnet threads on some ammonia valves are left-handed. If tightening procedures fail to stop the leak, the valve should be closed. If the valve should fail to close completely, it should be plugged.

PRESSURE RELIEF DEVICE- A leak or discharge through a pressure relief device, such as a pressure relief valve, may occur if the pressure within the equipment, piping, tank or container exceeds the rated pressure setting of the device or if the device is faulty. Reducing the pressure within the system by removing ammonia as vapor to process or cooling the container with a water spray may permit the device to reseat. If reseating does not take place, it most often will be necessary to replace the device with one approved for ammonia service and of the proper pressure rating and capacity.

No attempt should be made to plug, cap or otherwise tamper with a pressure relief device under any circumstances. However, a pressure relief valve may sometimes be provided with a shut-off valve in an arrangement whereby the leaking device can be isolated for removal purposes while another pressure relief valve(s) provides not less than the full rate of discharge capacity required for safety. Unless returned to the manufacturer, a pressure relief device should not be repaired or adjusted in any manner. Pressure relief valves should be replaced at regular intervals as suggested by the manufacturer. Failure to observe these precautions could result in a serious weakening or catastrophic rupture of the equipment, piping, tank or container which was being protected by the device.

STORAGE TANK- A leak at a threaded or flanged storage tank opening may often be stopped by a careful tightening of threads or bolts. Should such efforts fail, it will be necessary to empty the tank of all ammonia before attempting further repair. If the leak is small, the tank can frequently be emptied by removing the ammonia as a vapor or liquid to process. If necessary to remove the ammonia promptly, or if the tank is equipped with a vaporizer, your supplier should be contacted for advice and assistance.

Occasionally, a storage tank will develop a leak in a plate, weld or coupling. No attempt to peen such a leak should be made. Instead, call your tank or ammonia supplier promptly. Welding on an ammonia storage tanks must be performed in accordance with ASME code procedures and only after complete purging.

SHIPPING CONTAINER- Ammonia is shipped in special containers which are fabricated, transported and maintained in accordance with the U.S. Department of Transportation regulations. Shipping containers include cylinders, portable tanks, tank trucks, rail tank cars, barges and tankers. If an ammonia leak occurs in a shipping container while at the user's facility, these actions should be taken to limit and control the escape of ammonia:

(1) If liquid is leaking from a cylinder, position it if possible so that the vapor instead of liquid escapes. The quantity of ammonia released from a vapor leak is considerably less than from a liquid leak through an opening of the same size.

(2) If possible, move the container to an area of reduced hazard.

(3) If no risk is entailed, attempt to reduce the pressure in the container by removing the ammonia to process as a vapor.

(4) Reduce the quantity of vapor in the atmosphere with a water spray applied to the leak area.

(5) Aside from trying to stop a leak from a shipping container by tightening a valve packing nut, closing a valve or possibly tightening a flange bolt, no other repairs should be attempted or authorized by the user.

(6) It is a violation of federal regulations to transport an ammonia shipping container which is leaking or damaged. If a shipping container is damaged or is leaking in a manner which cannot be handled by personnel at the site, the nearest office of the producer or supplier should be called for assistance. If the producer or supplier cannot be reached, contact the Chemical Transportation Emergency Center (CHEMTREC) by telephoning the toll free number (800) 424-9300 for advice or help day or night.

When calling for assistance, be prepared to provide the following information:

(a) Nature of emergency: when, where and extent.

(b) Type and condition of container.

(c) Name of shipper or supplier.

(d) Extent of injuries or property damage, if any.

(e) Description of surrounding area and prevailing weather conditions.

(f) Corrective measures being applied.

(g) Name of caller and location now and where telephone contact may be re-established with caller or other responsible party at the emergency site.

Environmental protection and/or other regulatory authorities should be notified of an ammonia spill as may be appropriate and required by applicable law or regulation.

Fire Exposure

If possible, an ammonia container should be disconnected and removed immediately from the fire zone. If, for any reason, a container cannot be moved, it should be kept cool with water until well after the fire is extinguished. Firefighting personnel should be equipped properly with protective clothing and respiratory equipment.

Employee Safety Training

Safety in working with ammonia depends on more than just the availability of personal or emergency protective equipment and clothing. Employee training in safe operation procedures, in first-aid measures and in the use of suitable operating and protective equipment, properly maintained, must also be included as an essential element in any comprehensive safety program.

Such safety training is the responsibility of management and should be given to new and old employees at periodic intervals as needed to maintain high proficiency levels. Included should be written and oral instructions followed by drills regarding the location, purpose and use of personal and emergency protective clothing, equipment, safety showers or other water sources, first aid supplies and shut-down equipment such as valves and switches.

Training should also stress the avoidance of body contact with liquid ammonia or inhalation of gas and the reporting of equipment failures to appropriate supervisory authority.

Additional copies of this booklet are available by forwarding a request to LaRoche Industries Inc.

Material Safety Data Sheets are also available by similar request.

Selected Ammonia Safety References and Training Aids

1. *Safety Requirements for the Storage and Handling of Anhydrous Ammonia,* ANSI-K61.1
   American National Standards Institute, Inc. (ANSI)
   1430 Broadway
   New York, NY 10018
   (212) 354-3300

2. *Anhydrous Ammonia*, Pamphlet G-2
   Compressed Gas Association, Inc. (CGA)
   1235 Jefferson Davis Highway
   Arlington, VA 22202
   (703) 979-0900

3. *Anhydrous Ammonia Safety Video*
   LaRoche Industries Inc.
   1100 Johnson Ferry Road, N.E.
   Atlanta, GA 30342
   (404) 851-0300

4. *For The Rest of Your Life*, 16mm color sound film
   National Society for the Preservation of Blindness, Inc.
   79 Madison Avenue
   New York, NY 10016
   (212) 684-3222