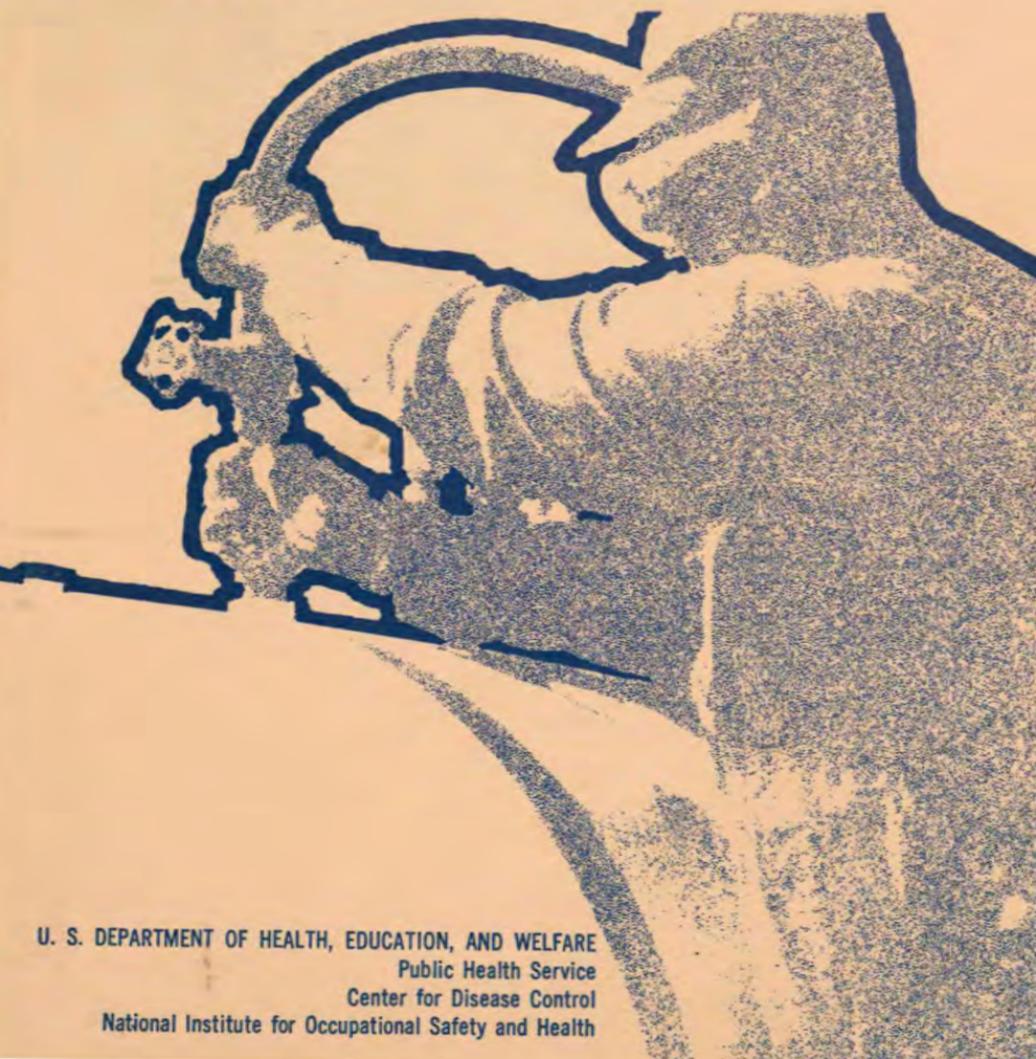


NIOSH

**A Guide for Developing a
Training Program for**

ANHYDROUS AMMONIA WORKERS



U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health

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CONTENTS

INTRODUCTION,	1
EMPLOYEE TRAINING,	4
ANHYDROUS AMMONIA PHYSICAL PROPERTIES,	7
HOW AMMONIA AFFECTS THE BODY,	10
FIRST AID,	13
CONTACT WITH THE SKIN,	14
CONTACT WITH THE EYES,	14
TAKEN INTERNALLY,	15
INHALATION,	16
SUMMARY,	17
PERSONAL PROTECTIVE AND SAFETY EQUIPMENT,	18
BULK PLANTS AND PERMANENT INSTALLATIONS,	23
STORAGE TANKS,	25
TRANSPORTATION OF ANHYDROUS AMMONIA,	28
PIPING, FITTINGS, AND VALVES,	31
HOSES,	33
TRANSFER OPERATIONS,	36
POTENTIAL ACCIDENTS,	38
FURTHER INFORMATION,	40
APPENDIX A - TRANSFER OPERATIONS,	42
APPENDIX B - VALVES AND FITTINGS,	73
APPENDIX C - CYLINDERS,	77
APPENDIX D - AMMONIA PLANT SAFETY CHECK LIST,	81

INTRODUCTION

NIOSH estimates that 500,000 workers in the United States--ranging from aluminum workers to wool scourers--are potentially exposed to ammonia. Ammonia is the third largest volume chemical produced, and current annual consumption is about 18 million tons. Nearly 50% is used to make other chemicals used as fertilizers; but the biggest single use, nearly 30% of the total consumption, is for direct application to the soil.

The agricultural use of anhydrous ammonia has increased a hundredfold in the last twenty years. Thousand-gallon nurse tanks, which were once used only to fill 60- to 250-gallon applicator tanks, are now being used as applicator tanks. Larger and more efficient equipment is being used, yet every year a number of injuries are caused by exposure to anhydrous ammonia. Some of these injuries result in skin burns, pulmonary problems, partial or total blindness, or death from overexposure.

This publication primarily emphasizes safety in the operation of facilities that handle anhydrous ammonia for agricultural purposes; however, the information included should interest all who handle anhydrous ammonia at other permanent installations. A section on the use and handling of cylinders is included as Appendix C.

To achieve maximum safety ammonia should not be allowed to escape except under controlled conditions. It is important that all equipment involved in its storage, handling, and transportation be of suitable material, design, and construction for the use intended.

In addition, it is incumbent upon management to:

- *Be familiar with the properties, characteristics, and behavior of ammonia.
- *Establish a sound maintenance program for plants and equipment, including regular inspection and prompt repair of damaged or malfunctioning units.
- *Provide proper training for all persons who work with anhydrous ammonia and related equipment.
- *Provide and maintain standard protective equipment necessary for the safe handling of anhydrous ammonia and train all concerned in its proper use.
- *Investigate and obtain all facts relative to any injury or property damage resulting from exposure to anhydrous ammonia.
- *Inform local police, fire, and medical authorities of the properties of anhydrous ammonia and emergency practices to be used.

Employers must comply with the standards promulgated by the Secretary of Labor under the Occupational Safety and Health Act of 1970. However, many employers may not be familiar with the standards that require them to provide training for their employees.

General industry standards for operations where anhydrous ammonia is handled are stated in the Code of Federal Regulations, Title 29, Section 1910.111. Key regulations regarding employee training require "employers to train employees in safe operating practices and actions to take in emergencies" and "to ensure that unloading operations are performed by properly instructed, reliable persons."

Although neither the Occupational Safety and Health Administration (OSHA) nor NIOSH approves or certifies training programs, the employer should develop a training program and maintain records indicating that employees have received training.

EMPLOYEE TRAINING

Safe handling of anhydrous ammonia depends greatly upon the effective education of employees, proper safety instruction and procedures, careful supervision, and the use of safe equipment. This booklet provides information useful to employers in establishing a training program for their employees who handle anhydrous ammonia. The type of training an employee receives will be determined by the facilities available. It may include formal lectures in a classroom setting with audio-visual aids available from suppliers, trade associations, or the employer himself. However, training is ultimately received from on-the-job experience in the assigned work area.

Training should provide employees with a useful knowledge of the characteristics of ammonia, the effects of overexposure, first aid to counteract such exposure, and proper use of personal protective equipment. Safe procedures for the operation, maintenance, and repair of the equipment are other fundamentals to be stressed in training programs.

All new employees who have no experience with anhydrous ammonia or are not familiar with the equipment being used must participate in a formal training program. New employees begin to learn and to form attitudes about their company, their job, their boss, and their fellow workers as soon as they arrive on the job. Training in a correct and safe

job performance in the first few hours and days is critical. It should be considered as an investment of time which will reduce the amount of supervision required in the long term. Other benefits are: fewer accidents, less pain and suffering, reduced absenteeism, and lower insurance and compensation costs. The employee's responsibility to follow safe procedures and health practices should be stressed -- unsafe or unhealthful activities should be corrected immediately.

Training programs must be tailored to the individual worker, taking into consideration the employee's abilities, background, and experience, as well as the job requirements and the specific equipment involved. A useful tool in such a program is a written, step-by-step description of each task necessary for the employee to accomplish in carrying out his job responsibilities. By analysis of these written procedures, one may determine when the employee will risk exposure to anhydrous ammonia (and other hazardous substances) or where unsafe conditions may prevail. These should be highlighted, and effective precautionary warnings and instruction in the use of engineering controls or use of personal protective equipment should be provided for the trainee.

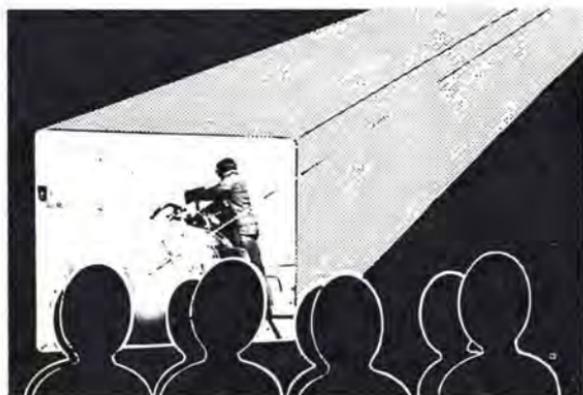
Appendix A is an example of this approach, relating to transfer operations. It is a slightly modified procedure taken from the "Agricultural Anhydrous Ammonia Operator's Manual" published by The Fertilizer Institute.

Some organizations post their procedures at process points in the form of a check list. These check lists often outline both the operating procedures and the personal protective equipment and tools to be used while performing tasks involving anhydrous ammonia. They also might list stand-by equipment and facilities for use in emergency and escape situations.

All emergency and escape procedures should be rehearsed with a sufficient number of drills so that employees will know how to respond in an emergency. Employees should also rehearse first aid procedures, such as using an emergency shower, jumping into a stock tank, flushing the eyes, etc., so that they will have the experience before the emergency arises. (This will also assure both management and employees that the emergency equipment functions properly!)

This booklet is not a comprehensive training manual, but contains information useful in developing a training program. It also contains some incidental discussion relating to general safety and health principles for working with anhydrous ammonia. Several excellent publications from which further information may be obtained are listed at the end of this publication.

It is recommended that the training program provide for "refresher" sessions at least annually. However, where anhydrous ammonia is used seasonally, as in agriculture, a refresher session should be given at the start of each season during which the chemical will be used. It should not be assumed that because employees have done the job before, they are ready to work without reviewing the procedures or without refamiliarizing themselves with the equipment.



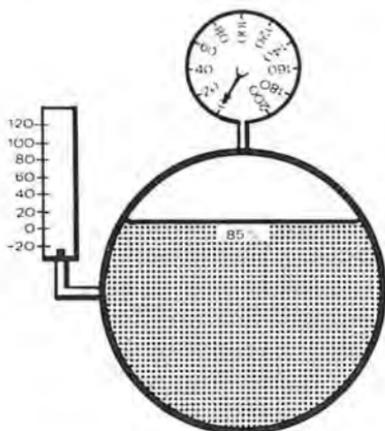
ANHYDROUS AMMONIA PHYSICAL PROPERTIES

Anhydrous ammonia is, simply, ammonia without water. The chemical formula is NH_3 (one atom of nitrogen chemically combined with three atoms of hydrogen, 82% by weight nitrogen and 18% hydrogen). Some of the more important physical properties of anhydrous ammonia are:

Boiling point	-28 F
Weight per gallon of liquid	
at -28 F	5.69 pounds
Weight per gallon of liquid	
at 60 F	5.15 pounds
Specific gravity of the	
water (water = 1)	0.617
Specific gravity of the gas	
(air = 1)	0.588
Flammable limits in air	16-25%
Ignition temperature	1204 F
Vapor pressure at 0 F	16 psig
Vapor pressure at 68 F	110 psig
Vapor pressure at 100 F	198 psig
One gallon of liquid	
at 60 F expands to	113 cu.ft. of gas
One cubic foot of liquid	
at 60 F expands to	850 cu.ft. of gas

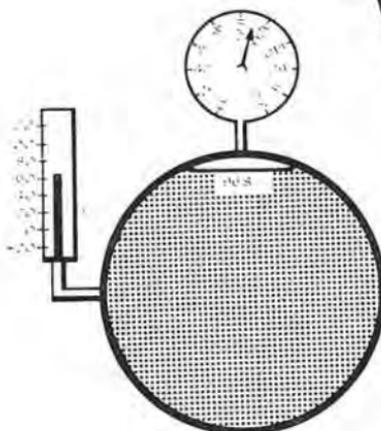
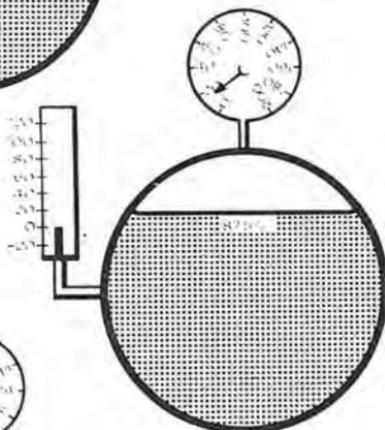
Anhydrous ammonia, a clear liquid, boils at -28 F and becomes an invisible gas when released to the atmosphere. Although the term "gas" is technically

correct, the gaseous form of ammonia is more commonly called ammonia "vapor" and the latter term will be used in this booklet. The liquid expands rapidly with rising temperature; for instance, it expands about 10% when the liquid is heated from 0 F to 68 F. The vapor pressure increases from 16 psig at 0 F to 110 psig at 68 F.



$T = -28^{\circ} F$
 $P = 0 \text{ psig}$
 $V = 85\%$

$T = 0^{\circ} F$
 $P = 16 \text{ psig}$
 $V = 87.5\%$



$T = 68^{\circ} F$
 $P = 110 \text{ psig}$
 $V = 96.8\%$

In the presence of moisture ammonia reacts readily with copper, zinc, and many alloys. Only iron, steel, certain rubbers and plastics, and specific nonferrous alloys resistant to ammonia should be used for fabrication of anhydrous ammonia containers, fittings, and piping. Ammonia will combine with mercury to form a fulminate which is an unstable explosive compound.

Because the specific gravity of the vapor is less than that of air, anhydrous ammonia will normally rise. However, particularly in bulk plant areas, it has been observed occasionally to hover as a cloud near the ground. The reason for this is its tremendous affinity for water. At 68 F, about 700 volumes of vapor can be dissolved in one volume of water to make a solution containing 34% ammonia by weight. Ammonia in water solution is called aqua ammonia or ammonium hydroxide. Household ammonia is aqua ammonia having 5% to 10% ammonia and sometimes a small amount of detergent in water solution.

Anhydrous ammonia is classified by the Department of Transportation as nonflammable. However, ammonia vapor in high concentrations (16% to 25% by weight in air) will burn. It is very unlikely that such concentrations will occur except in confined spaces or in the proximity of large spills. The fire hazard from ammonia is increased by the presence of oil or other combustible materials.

HOW AMMONIA AFFECTS THE BODY

Ammonia is not, strictly speaking, a poison; and repeated exposure to it produces no additive (chronic) effects on the human body. However, even in small concentrations in the air it can be extremely irritating to the eyes, throat, and breathing passages.

In greater concentration ammonia vapor produces convulsive coughing, difficult or painful breathing, pulmonary congestion, and, in extreme cases, death. In some instances, several hours may elapse before the more serious symptoms develop. High concentrations in the air can also dissolve in the moisture of the skin or perspiration and result in a corrosive action on the skin and mucuous membranes. Because the intensive odor of ammonia is extremely pungent, few people will remain voluntarily in areas where concentrations are great enough to be a serious health hazard.

The most serious hazard of ammonia, in terms of permanent disability, is injury to the eyes since ammonia penetrates the eye more rapidly than other alkalis. Prompt irrigation of the eyes with clean water has prevented many serious eye injuries. Accident reports substantiate this fact. Where several employees have had eye exposure to anhydrous or aqua ammonia, those fortunate enough to receive immediate eye irrigation contracted only temporary or no eye damage, whereas others, unable to wash their

eyes promptly, sustained permanent eye injury, frequently resulting in blindness.

Anhydrous and aqua ammonia are both caustic to the skin. Contact with the skin produces first and second degree burns similar to alkali burns. Skin burns and blisters may develop from exposures to 1 1/2 - 2% ammonia for more than 15 minutes. Complete skin protection should be worn, if possible, where direct skin contact to 1% or higher anhydrous (in air) or aqua ammonia may occur, or where entry into areas of unknown concentrations of ammonia is necessary.

Liquid anhydrous ammonia causes severe burns not only because it reacts with skin moisture, but also because it produces freezing by its rapid evaporation. For example, if ammonia liquid at -28 F falls on flesh which is 77% water and is at a temperature of 98.6 F, the water in the body cells cools to below 32 F and freezes, producing ice crystals which injure the cells. The wounds can be deep and slow in healing.

The effect of exposure to ammonia at low concentrations may differ from person to person and may be dependent upon acclimatization (recent exposures). In controlled tests, almost all subjects could easily identify the odor of ammonia at 50 ppm, although some sensitive individuals detected concentrations of less than 1 ppm.

Controlled exposure for 5 minutes of up to 50 ppm of ammonia produced some complaints of dryness of the nose, but no eye irritation or discomfort. However, in industrial operations, complaints of eye and respiratory irritation were correlated with exposures of 20 to 45 ppm. Volunteers exposed to 134 ppm for 5 minutes experienced eye irritation with tearing and discomfort of the nose and throat. In another test,

exposure by means of an oral-nasal mask to 500 ppm for 30 minutes resulted in upper respiratory irritation lasting up to 24 hours and some cases of tearing even though there was no direct exposure of the eye to ammonia.

Exposures to higher concentrations of ammonia that resulted in serious injury or death occurred generally in emergency situations, and the concentrations and durations of the exposures have not been recorded. In one instance, where death occurred six hours after the accident, calculations indicated that the victim had been exposed to 10,000 ppm (1%) ammonia for an unknown length of time.

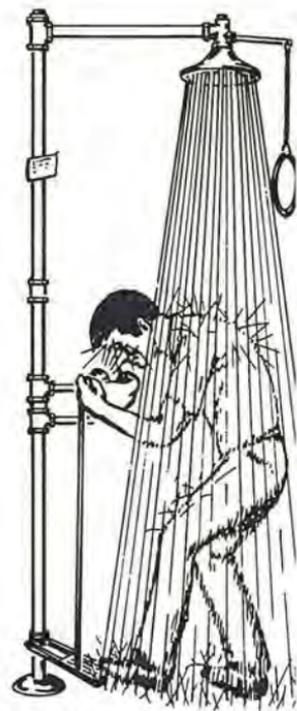
FIRST AID

First aid is immediate and temporary care given to victims of an accident or sudden illness until the services of a physician can be obtained.

Anhydrous Ammonia First Aid = FLUSH WITH LARGE AMOUNTS OF WATER FOLLOWED BY FLUSHING WITH MORE WATER IMMEDIATELY!!!!

Contact with the Skin

1. It is essential that any ammonia spilled on the worker be removed immediately and that the worker be moved to an uncontaminated area quickly.
2. 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! The clothes should be removed only after they are thawed and can be freely removed from frozen areas.
3. No salves or ointments should be applied to the skin during the 24-hour period



following injury since this will prevent natural elimination of the ammonia from the skin. After the 24-hour period, the medical treatment is the same as for thermal burns.

Contact with the Eyes

1. Even if only a small amount of ammonia enters the eyes, they should be irrigated with an abundance of water for a minimum of 15 minutes. The entire eye surface and the inner lining of the eyelids must be flushed continually and thoroughly. Eyes affected by ammonia close involuntarily, so the eyelids must be held open so that the water can flush the entire eye surface, as well as the inner lining of the eyelid.
2. If there is no physician available, irrigation should be continued for an additional 15 minutes.

3. Contact lenses must not be worn when handling anhydrous ammonia. If they are worn and ammonia gets in the eyes, the ammonia will be trapped under the lenses causing even more damage. They may also prevent immediate flushing of the eye surface.
4. Serious eye injury should be treated by an ophthalmologist, but in an emergency, washing with copious quantities of water for 15 minutes or more must be implemented as quickly as possible. In fact, the only real hope for preventing permanent injury lies in quick and generous washing. One suggestion is for those likely to be exposed to carry a small, eight-ounce squeezable squirt bottle such as a plastic catsup or mustard dispenser, filled with water, which can be used to get the 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. Another emergency method is to duck the head in water and rapidly blink and move or rotate the eyes about.

Taken Internally

1. Call the doctor.
2. If conscious, have the victim drink large amounts of water.
3. Do not induce vomiting if the victim is in shock, extreme pain, or unconscious.

4. If vomiting begins, place the victim face down with head lower than hips. This prevents vomitus from entering the lungs and prevents severe injury.

Inhalation

In all exposures severe or minimal:

1. Exposed workers should be removed at once to a clean, uncontaminated area.
2. Low exposures for a short period of time will usually require no treatment.
3. For severe exposure to higher concentrations:
 - a. Call a physician.
 - b. If oxygen apparatus is available, oxygen can 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.
 - c. If patient is not breathing, begin artificial respiration immediately.
 - d. Keep victim warm (but not hot) and rested until transported to the hospital.

Summary

In any accident involving contact of ammonia with eyes or skin, IMMEDIATE flushing of the affected area with large quantities of clean water is essential. Placement of the injured person into a container of clean water or under an emergency shower may be the most practical way of accomplishing this. In the case of severe exposure, provide the injured worker with first aid treatment and call a physician at once. Give the physician a complete account of the accident. SECONDS COUNT--WASH AMMONIA AWAY WITH WATER IMMEDIATELY.

PERSONAL PROTECTIVE AND SAFETY EQUIPMENT

Employees who work regularly with anhydrous ammonia and are subject to overexposure either to the liquid or the vapor should be provided with the proper safety equipment.

Safety Goggles and Impervious Gloves

It is preferable that the goggles be gas tight; however, unventilated goggles tend to steam up, especially in hot and cold weather. Ventilated, splashproof goggles are more comfortable and will provide adequate protection in most instances. In addition, where splashing may occur, a fullface shield should be worn to protect the face. Gloves impervious to ammonia should also be worn. Where there is a likelihood of a spill or in clean-up operations, both boots or shoe covers and slickers or jackets and pants made of ammonia-impervious materials should also be worn. If glove gauntlets are worn, they should be tucked inside the sleeves; and trouser legs should be kept over the boots. Cotton is the preferred fabric for work clothing since it is more alkali resistant than wool and more comfortable than all-synthetic fabrics.

Gas Masks

The term "gas mask" normally applies to respiratory equipment consisting of a fullface piece with a chest or back mounted cannister. (This is the respiratory equipment most familiar to ammonia workers.) Although the term "respirator" may bring to mind only the half or fullface mask equipped with cartridges, it is a general term for all forms of breathing apparatus for protecting the respiratory tract, and is used in the following discussion in this broad sense. Where respiratory equipment is used, a minimal respiratory protection program should be instituted in accordance with 29 CFR 1910.134 (b). Such a program requires:

1. Written standard operating procedures governing the selection and use of respirators.
2. Selection of respirators on the basis of the hazards to which the worker is exposed.
3. Instruction and training of workers in the proper use of respirators and their limitations.
4. Assignment of respirators to the individual workers for their exclusive use, where practical. The efficiency of a respirator depends upon a proper fit. Employees should try models from various manufacturers to find which respirator face piece provides the best seal. They should be refitted periodically since a change in body weight, dental work, etc., can affect the fit.

5. Regular cleaning and disinfection of respirators. Those respirators issued for the exclusive use of one worker should be cleaned after each day's use or more often if necessary. Those used by more than one worker must be thoroughly cleaned and disinfected after each use.
6. Storage of respirators in a convenient and sanitary location.
7. Routine inspection of respirators during cleaning. Worn or deteriorated parts must be replaced. Respirators for emergency use, such as self-contained devices, should be inspected at least once a month and after each use.
8. Appropriate surveillance of work area conditions and monitoring of the degree of employee exposure or stress.
9. Regular inspections and evaluations to determine the continued effectiveness of the program.
10. The assignment to tasks requiring the use of respirators of only those workers physically able to perform the work and use the equipment. A physician should determine what health and physical conditions are pertinent. The respirator user's medical status should be reviewed periodically (for instance, annually).
11. The use of only those respirators approved for ammonia by the National Institute for Occupational Safety and Health (NIOSH). Look for the approval marking on the box.

A non-technical booklet, "Respiratory Protection - An Employer's Manual" (GPO No. 017-033-0032, price \$2.30), explaining how to set up a respirator program and select respirators, is now in preparation by NIOSH and will soon be available. A companion booklet "Respiratory Protection - A Guide to the Employee" (GPO No. 017-033-00327-1; price \$1.50), explaining the respiratory program to the employees who are required to use respirators, is also being prepared. These booklets may be purchased from:

The Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402

RESPIRATOR SELECTION GUIDE FOR PROTECTION AGAINST AMMONIA

The present OSHA permissible exposure level for ammonia is 50 parts per million (ppm) on a time-weighted-average basis. NIOSH recommends that this be a "ceiling" limit; that workers should never be exposed to an ammonia concentration of more than 50 ppm as determined by a 5-minute sampling period. When exposure exceeds 50 ppm the following respiratory protection devices should be used.

<u>EXPOSURE</u>	<u>RESPIRATOR TYPE</u>
100 ppm or less	<ol style="list-style-type: none">1) Chemical cartridge respirator with replaceable ammonia cartridge and half mask facepiece; or2) Type C supplied air respirator, demand type (negative pressure), with half mask facepiece.
1000 ppm or less	Fullface gas mask, chin type, with ammonia canister (maximum service life of 1 hour only).
2500 ppm or less	<ol style="list-style-type: none">1) Fullface gas mask, chest or back mounted type with industrial size ammonia canister (maximum service life of two hours only); or2) Type C supplied air respirator, demand or pressure demand type (negative or positive pressure), with fullface piece, hood, or helmet with shroud.
Greater than 2500 ppm	<ol style="list-style-type: none">1) Self-contained breathing apparatus with positive pressure in fullface piece; or2) Combination supplied air respirator, pressure demand type, with auxiliary self-contained air supply.
Emergency (no concentration limit)	<ol style="list-style-type: none">1) Self-contained breathing apparatus with positive pressure in fullface piece;2) Combination supplied air respirator, pressure demand type, with auxiliary self-contained air supply; or3) Fullface gas mask, back or front mounted type, with industrial size ammonia canister. Not for use in limited exit emergencies.
Evacuation or Escape (no concentration limit)	<ol style="list-style-type: none">1) Self-contained breathing apparatus in demand or pressure demand mode (negative or positive pressure);2) Fullface gas mask, front or back mounted type, with industrial size ammonia canister; or3) Mouth-piece respirator with escape type ammonia canister (escape type gas mask).

BULK PLANTS AND PERMANENT INSTALLATIONS

Bulk plants and permanent installations include storage facilities for large quantities of ammonia and have the potential for catastrophic exposures. However, modern plants are designed and located with safe operating conditions in mind, and very few accidents of large proportion have been reported. Nonetheless, all bulk plants and permanent installations should have well-planned emergency procedures. Employees must be instructed in the specific roles they must assume in emergencies. Emergency procedures should be rehearsed by frequent drills with simulated emergencies occurring at various locations and times. This will ensure that employees know what to do and will also point out deficiencies in the emergency plans.

In most bulk plants, anhydrous ammonia facilities are constructed with open, rudimentary structures and are isolated so that few workers need be in the vicinity. Under such conditions, ammonia released from small leaks and spills, bleeding of lines, venting, etc., will dissipate into the atmosphere rapidly.

If ammonia is used in closed buildings and/or where many persons are working, it may be necessary to provide mechanical ventilation to control the ammonia vapors. Employees should be instructed to be certain that the ventilation systems are working properly before performing any operations where ammonia may be released. A method of controlling ammonia exposure

during the bleeding of couplings or fittings is to direct the bleed with a tube or pipe into water in special containers. FIRST AID WATER MUST NEVER BE USED FOR THIS PURPOSE. There is, however, a danger in this method. As the ammonia vapor dissolves in the water, a vacuum is formed, and the water may be sucked into the process or transfer lines. At inside areas where ammonia hazards may exist notices should be posted. These areas should also have sufficient, well-marked exits for quick evacuation of personnel in case of emergencies.

The equipment for handling ammonia may be divided into several categories: Personal protective and safety equipment; containers (tanks or vessels); valves, piping and fittings; and hoses.

Emergency protective and safety equipment required by OSHA, state and local regulations, or company or trade association standards should be always readily available and easily accessible in any emergency. In determining the quantity and locations for such equipment, consideration should be given to such factors as: proximity to transfer operations; prevailing winds; obstructions, such as fences, parked vehicles, stored equipment, locked doors, etc.; and the number of persons who may be involved.

Ammonia bulk plants should be equipped with the following safety equipment:

1. At least two fullface gas masks with an ammonia type canister, as well as additional canisters within the date limitations printed on the container label.
2. Tight-fitting safety goggles and fullface shields.

3. Protective gloves made of rubber or other material impervious to anhydrous ammonia.
4. Protective boots made of rubber or other material impervious to anhydrous ammonia.
5. Protective slicker and/or protective pants and jacket made of rubber or other material impervious to anhydrous ammonia.
6. Easily accessible shower or 100 gallons or more of clean water in an open-top container. The container should be big enough so that the largest employee can jump into the tank easily and be completely submerged.
7. Special eyewash fountains for eye irrigation.
8. Rescue harnesses and life lines where confined spaces must be entered, e.g., entering a tank for cleaning or repair.

When a person must work in an area of high ammonia vapor concentration, another person should be present with suitable personal protective equipment at hand to help in an emergency. Appendix D is a check list of safety equipment for a bulk plant.

Storage Tanks

In some permanent installations ammonia is refrigerated and stored in low-pressure tanks. The operation and maintenance of the refrigeration equipment and auxiliaries are dependent upon the specific installation. Safety guidelines for this area are beyond the scope of this booklet. Federal

standards relating to this equipment may be found in 29 CFR 1910.111(b). Employees must be trained in the proper operation, inspection, and maintenance of their particular facilities.

If ammonia is stored inside, it should be in a fire-resistant structure, separated from work areas. Storage areas should be dry and cool, away from steam pipes, heating devices, and tanks containing flammable liquids. Natural and/or mechanical ventilation should be designed to ensure that ammonia vapors do not accumulate under floors, roofs, or in confined spaces. Where mechanical ventilation is required, employees should be instructed not to enter such areas if the ventilation system is not working. They should also report any malfunction. For instance, if a system does not seem to be working as well as the last time they were in an area, they should notify a foreman or supervisor.

Agricultural ammonia is usually stored at bulk plants under pressure in outside, above-ground, non-refrigerated tanks. These tanks must meet the requirements of the American Society of Mechanical Engineers (ASME) Unfired Pressure Vessel Code. They are normally designed for a minimum working pressure of 250 psig.

Improper alteration of anhydrous ammonia tanks can be serious. All welding on tanks must be done in strict accordance with the ASME code and by a certified code welder. When welding is anticipated, the tank must be properly purged. This includes filling the tank with water after all liquid ammonia and as much of the vapor as possible have been withdrawn and then flushing with air until ammonia vapors are no longer detectable. Repaired tanks must be pressure tested before they are returned to service.

If a tank is to be entered for cleaning or repair, the piping connections should be disconnected from the rest of the system by the removal of a section of

pipng. Even after purging and flushing, workers entering the tank should use an air line respirator or self-contained breathing apparatus and a safety harness and lifeline. An assistant should remain outside at all times and have suitable personal protective equipment immediately available if rescue is necessary. A third person should be made aware before rescue operations are started.

Tanks should be painted with a reflective paint, such as aluminum or white. This not only reduces the possibility of rust or corrosion, but helps to keep the temperature and internal pressure lower during hot and sunny weather. When tanks are painted, care must be taken not to obliterate any required labels or markings.

Although specific requirements for tank markings vary from state to state, the following general requirements must be met in all states:

- *The notation "Anhydrous Ammonia."

- *A nameplate that includes the name of the manufacturer, tank capacity, working pressure, design code, date of manufacture, and other such data provided by the tank manufacturer.

In addition, warnings and reminders to employees may be required or desired. These are usually available from safety equipment suppliers or trade associations as decals or signs and include such items as:

- *Guaranteed Analysis or Grade of Ammonia.

- *Emergency First Aid Procedures.

- *Caution or Warning Signs.

- *Instructions Dealing with Procedures, Equipment, Need for Personal Protective Equipment, etc.

Transportation of Anhydrous Ammonia

All tanks or containers used in the transportation of anhydrous ammonia should be constructed to comply with specifications and regulations of the United States Department of Transportation and the Interstate Commerce Commission. Tanks and containers should be stamped or have a permanently attached nameplate which contains the tank specifications or ICC designation. Employees should check for these markings on any container they are requested to fill. All fittings, valves, instruments, etc., should be designated for ammonia use.

Where ammonia is transported by motor vehicles, the following safety equipment should be carried:

- *At least five gallons of readily accessible clean water. The water container should be checked before each trip to be certain it is full. Water should be changed at regular intervals, such as weekly, to ensure that it is clean.
- *Tight-fitting safety goggles. In addition, a fullface shield may be desired.
- *Gloves impervious to anhydrous ammonia.
- *A fullface gas mask or self-contained breathing apparatus.
- *Unexpired replacement canisters.
- *Chock blocks.

The markings on tanks used to transport ammonia, as with stationary tanks, must conform to Federal, state, and local governmental regulations. In addition to those described for stationary tanks, "Maximum Pulling Speed" and "Slow-Moving Vehicle" signs may be needed and are available as decals. The valves on non-farm vehicles must be labelled to designate whether they are liquid or vapor valves.

Full trailers must connect to the pulling vehicle with a suitable tongue (drawbar) and also by a safety chain (or chains) or safety cables. Alternately, ruggedly designed and securely attached "fifth wheels" may be used. Skid tanks must be securely fastened to prevent slippage. The trucks must not only have sufficient power to pull the load, but must also have adequate braking power to stop it. Self-actuating brakes are required on full trailers pulled by non-farm vehicles.

Where ammonia is transported from the bulk plant or distribution center, employees should ascertain that the equipment is in suitable condition. Following is a typical checklist of items bulk plant employees should inspect before loaded nurse tanks are released from the plant. Similar checklists should be designed for other means of shipment.

ANHYDROUS AMMONIA NURSE TANK SAFETY CHECK LIST

	YES	NO
1. Safety water container on and full.	—	—
2. Glove and goggle pouch.	—	—
3. Gloves and goggles.	—	—
4. Condition of hose and hose end valve.	—	—
5. Has hose been retested according to the hose manufacturer's recommendation or replaced within time set by the company policy?	—	—
6. Current dated pressure relief valve.	—	—
7. Cap on pressure relief valve.	—	—
8. Acme caps on all vapor and liquid valves.	—	—
9. Are valves marked "liquid" and "vapor"?	—	—
10. Is the back check on combination valves working?	—	—
11. Gauges	—	—
Pressure	—	—
Float	—	—
85 percent bleeder.	—	—
12. Condition of paint.	—	—
13. Proper decals (in accordance with state requirements)	—	—
Caution Ammonia	—	—
Wear Your Goggles	—	—
First Aid Water	—	—
Guaranteed Analysis	—	—
Vapor and liquid valve markings	—	—
Maximum pulling speed	—	—
Ownership identification	—	—
Tank identification numerals.	—	—
14. Condition of wagon tongue.	—	—
15. Tongue pins (tongue to axle).	—	—
16. Safety chain and hitch pin.	—	—
17. Tire and wheel condition.	—	—
18. A pair of chock blocks on each nurse tank.	—	—

Piping, Fittings, and Valves

The use of piping and valves should receive particular attention in any safety program. Vapor and liquid lines should be identified with a decal on or near the valve and pipe. The direction of flow may also be indicated by arrow decals.

Alternatively, lines and valves can be color coded. The code should be readily discernable, e.g., yellow for vapor and orange for liquids. It should be fully described in a written procedure and posted at appropriate locations within the operating area. Normally, liquid lines are larger than vapor lines.

The more common valves and fittings are briefly described in Appendix B. When repairs, replacement, or alterations of equipment are made, the following should be considered.

Piping

Black steel pipe is generally used in anhydrous ammonia installations. Galvanized pipe should never be used. If the joints are threaded, schedule 80 (extra heavy) pipe should be used; standard pipe may be used when joints are welded or welded flanges are used. Pipe joint compounds should be ammonia resistant. Piping should be adequately supported and protected from possible damage by vehicles.

Fittings

Fittings must be made of materials such as: steel; malleable, nodular, or high-strength gray iron; or certain nonferrous alloys that are suitable for use with anhydrous ammonia. They should be designed for a minimum working strength of 250 pounds per square inch. Ordinary cast iron fittings, bushings, and plugs should not be used. Ammonia in the presence of moisture rapidly corrodes zinc and copper; thus,

fittings must not be made of either these metals or alloys containing them.

Valves

Only valves designed for anhydrous ammonia service should be used. Handwheels or levers are for completely opening or completely closing valves only--they must not be used as handles or hand and footholds for climbing about the installation. Valves should be operated with the lever or handwheel only and never with a wrench, hammer, or other method to increase the leverage; to do so could damage the valve seat or break the valve stem.

Shut-off valves should be opened slowly to ensure connections are not leaking, and they should be completely open when transfer is taking place. If a shut-off valve is being used to throttle the flow, the excess flow valve may not function if a rupture should occur downstream from the valve.

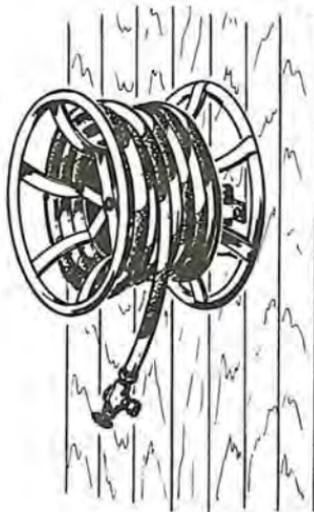
Excess flow valves should be properly sized for the flow capacity and should not be removed. Repair or adjustment of these valves should be done by the manufacturer and not by local, unauthorized persons.

This is also true for safety relief valves. They should be tested periodically (at least once each season) and be replaced immediately if they are defective. The date of installation should be logged into the maintenance records. They should be replaced routinely after two years. The safety relief valves should be conspicuously identified and should have dust and rain protection covers.

Bleeder valves should be used to ensure that there is no vapor or liquid between the hose end valve and the tank filler valve before the hose is disconnected. Personnel must keep their heads and bodies away from the openings of valves and fittings, especially safety relief and bleeder valves.

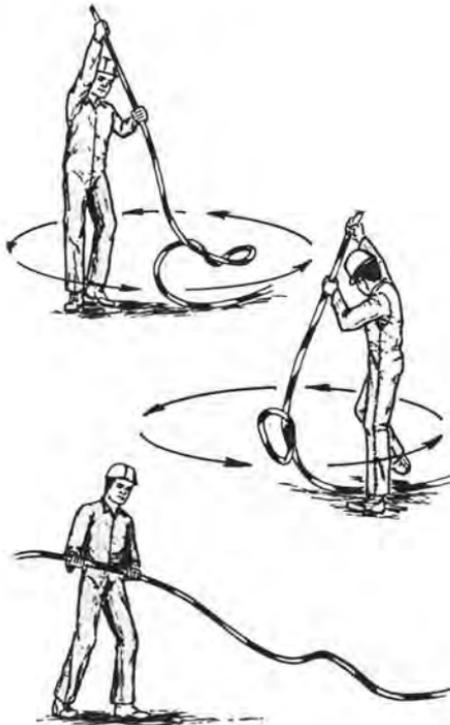
Hoses

Hoses are probably the weakest link in the ammonia system and are the most subject to abuse. Hose and hose couplings must be specifically designed for anhydrous ammonia. Such hose is marked at 5-foot intervals with the following: ANHYDROUS AMMONIA, maximum working pressure, manufacturer's name and trademark, and the year of manufacture. Anhydrous ammonia hose is designed for a working pressure of at least 350 psig and a minimum burst pressure of 1750 psig. Hose assemblies should withstand a test pressure of 500 psig. If a hose shows signs of weakening, weathering, checking, or general deterioration, it should be replaced immediately. Hose repairs should be made only by trained persons. The date a hose is put into service should be recorded and the hose should be retested according to the recommendations of the hose manufacturer. In lieu of a retesting program, one large operator of bulk fertilizer plants replaces all rayon braid hose after two years and stainless steel braid hose after five years of service. This is based on experience where hoses are used for only a few weeks during fertilizer seasons once or twice a year.



Employees should be instructed in the proper handling of hose. One major cause of accidents is the failure to disconnect and secure both ends of all hoses before a car, truck, or nurse tank is moved. When not in use hoses should be draped or wrapped over a suitable rack. Hanging on a nail or the narrow edge of a board will cause the hose to develop a sharp bend creating a weakness or even a break. Transfer hoses must not be left on the ground, especially where vehicles may roll over them or where dirt may get into the fitting openings.

All effort should be made to avoid kinking a hose. If a kink does occur, it must be unwound. This is done by holding the valve opening away from the body (and bystanders) and stepping over the hose while twisting the body and the hose simultaneously in the direction of the kink.



Hoses should be handled by the valve body and coupling -- never by the valve handwheel. This will prevent opening the valve accidentally. The valve handwheel should be touched only when intentionally opening or closing the valve. Hydrostatic relief valves must be installed in liquid hose or pipe lines which can be shut off by valves on each end.

The couplings between hoses and valves must be bled before they are disconnected. To avoid air pollution in highly populated areas, they may be bled carefully into water specifically provided for that purpose. NEVER BLEED AMMONIA CONNECTIONS INTO WATER PROVIDED FOR FIRST AID.

TRANSFER OPERATIONS

Only liquid pumps and vapor compressors specifically recommended and labeled for ammonia service should be used for transferring anhydrous ammonia. This assures that working pressures and seals will be suitable for ammonia. It should be noted that most ammonia transfer pumps are positive displacement pumps which can produce extremely high pressures when operating against a closed system. The pumping system must have, therefore, proper by-pass valves located so that these pressures can be relieved by directing them back into the tank being emptied or to the inlet port of the pump.

V-belt drives and flexible drive couplings should be equipped with guards to minimize the possibility of injury from these moving parts. As with any mechanical equipment, safety in the operation of ammonia transfer equipment depends on complete familiarity with the particular equipment. All instructions supplied by the equipment manufacturers should be carefully studied and kept for future reference. Transfer equipment should be inspected frequently to make sure that it stays in proper condition. Well-maintained pumping equipment is safer and less costly to operate than equipment that is allowed to deteriorate.

Procedures for transferring anhydrous ammonia depend upon the physical lay-out of the facilities and will

vary from plant to plant. A few general guidelines are:

- *Personnel performing transfer operations should wear suitable gloves and goggles while venting, connecting, or disconnecting the transfer hose connections. A fullface shield is also recommended.
- *If a storage tank is being filled, it should be gauged before starting the unloading operation to be certain that enough storage space is available to receive the shipment.
- *The transfer operator should be in attendance throughout the operation. If any difficulty arises or any leak develops, the operation must be stopped until the problem is corrected.
- *When the overall operation is completed, the unloading valves must be closed and the pump or compressor stopped. The hose connections should be vented before the hose is disconnected. During the venting, the operator should stand on the upwind side. The disconnected hoses should be racked or otherwise stowed to avoid damage.

As noted earlier, Appendix A outlines step-by-step procedures, developed by The Fertilizer Institute, for transfer under several conditions. A written procedure similar to these should be prepared for each transfer operation in a given facility. Employees should be thoroughly trained and rehearsed in the operations they must perform.

POTENTIAL ACCIDENTS

The sharp, pungent odor of ammonia is its own warning agent. There is no reason to fear working with it if proper equipment is used and safe operating procedures are followed. Practically all accidents involving anhydrous ammonia are the result of lack of knowledge, misunderstanding, carelessness, or poorly maintained or unsuitable equipment.

The following are some of the reported ways by which anhydrous ammonia has been accidentally released. These situations can occur in any facility if proper care and training are neglected.

- *Venting of ammonia via pressure relief valve while the victim was in line with the discharge.
- *Overfilling of nurse tank. This occurs when employee is distracted or is not in constant attendance during the filling operation.
- *Hose bursting during transfer. This is a failure usually occurring in old or mistreated hoses.
- *Hose breaking when nurse or transport tank is pulled away from storage. The tank hose was not disconnected from the riser.

*Hose end valve opening when it strikes an object or rolls across the tank. Hose was not handled or stowed properly.

*Hose coupling not being bled before disconnecting coupling.

Other examples from the experience of individuals within each organization can be used to test weak points in safe operating procedures.

Employees should be instructed to report all incidents in detail where ammonia is accidentally released. They should also be encouraged to report "near misses" so others can be alerted to avoid such situations, or so that procedures can be modified.

FURTHER INFORMATION

The following publications, which may be helpful in setting up training and safety and health programs at your plant, contain detailed information regarding the handling of anhydrous ammonia.

- A. Safety Requirements for the Storage and Handling of Anhydrous Ammonia; ANSI-K61.1-1972

American Standards Institute
1430 Broadway
New York, New York 10018

- B. Fertilizer Safety Guide

- C. Agricultural Anhydrous Ammonia Operators Manual

- D. Operational Safety Manual for Anhydrous Ammonia

The Fertilizer Institute
1015 18th Street N.W.
Washington D.C. 20036

- E. Chemical Safety Data Sheet SD-8: Anhydrous Ammonia

Manufacturing Chemists Association
1825 Connecticut Avenue, N.W.
Washington, D.C. 20009

F. Pamphlet G-2: Anhydrous Ammonia

Compressed Gas Association, Inc.
500 Fifth Avenue
New York, New York 10036

G. Criteria for a Recommended Standard: Occupational Exposure to Ammonia, GPO 017-033-00036

U.S. Government Printing Office
Washington, D.C. 20402

Training aids, such as posters, pamphlets, and slide and film programs, are available from:

The National Safety Council
425 N. Michigan Avenue
Chicago, Illinois 60611

The Fertilizer Institute
1015 18th Street, N.W.
Washington, D.C. 20036

Other trade associations, your insurance carrier, and the Department of Labor in some states may also have materials useful for training purposes.

A safe and healthful working environment is not just physical surroundings, but also a mental attitude. Frequently, the safe way is not the easy way or the quick way. Proper training and total commitment -- from the board of directors to the part-time laborer -- are required to reduce accidents and worker health problems. Since employees learn by example, supervisors and other management personnel must be scrupulous in their adherence to safe and healthful practices -- so that the way it's said is the way it's actually done.

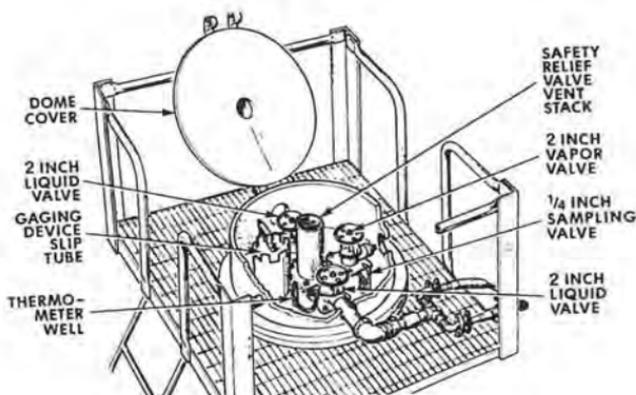
APPENDIX A

TRANSFER OPERATIONS

Safe working procedures and practices should always be used whenever anhydrous ammonia is transferred. While the basic safety practices are the same for any transfer, their application will vary somewhat between different types of operations.

Unloading Tank Cars by Compressor

Railroad tank cars are equipped with two connections for liquid withdrawal. The liquid valves are situated in the dome in line with the length of the car. One or more vapor valves are also located in the dome of the car. They are at a 90 degree angle to the axis of the car.



The sequence of operations to follow when unloading tank cars will vary to some extent depending on the physical features of each plant. The general procedure is as follows:

1. Make sure an adequate amount of clean first-aid water is readily available, either an emergency shower or at least 100 gallons in an open-top container.
2. Spot the tank car correctly in relation to the unloading riser.
3. Set the hand brakes on the railroad car.
4. Chock the wheels of the railroad car.
5. Install the standard railroad "Stop--Tank Car Connected" sign on the siding at least 25 feet from the end of the car nearest the switch. NOTE: If the siding has two openings to the main line, two signs are needed, one placed 25 feet from each end of the car.
6. Check the hoses for defects. Make certain all hoses are free of kinks. When a kink does occur, hold the coupling away from the body, out of line of bystanders, and step over the hose, twisting the body simultaneously in the direction of the kink. CAUTION: Do not attempt to throw a kink out of the hose--UNWIND IT!
7. Place the tools, tank car nipples, and hose ends on the deck of the tank car. NOTE: If there is no loading riser platform to permit direct access to the platform around or adjacent to the tank car dome or if the

riser platform is too low or far away, the operator should never attempt to carry the nipples, the hoses, or most tools while climbing the ladders on a tank car. These items should be placed together in a bucket and the bucket pulled up with a rope. To prevent any unnecessary damage to the hose, nipples, etc., they should also be let back down to the ground, or platform, with ropes.

8. Put on safety goggles and protective gloves. A fullface shield is also recommended. CAUTION: During unloading the safe operator always wears tight fitting safety goggles, a fullface shield, AND protective gloves made of rubber or other material impervious to anhydrous ammonia. Stand clear of valve openings and hose ends while connecting and disconnecting hoses. Never leave the immediate area during the entire unloading operation.
9. Remove the pin from tank car dome and open the cover.
10. Inspect the interior of the dome. Should a leak be found, put on the gas mask and try to determine the cause. Most leaks are minor and can be stopped. If the leak is excessive, call supplier for instructions. CAUTION: Always keep the head and body out of line with the safety relief valve which is situated in the center of the dome.
11. Remove the plugs from the valve opening.
12. Clean the threads on the tank car nipples, apply thread compound, and insert them, making sure they are started straight to

prevent cross threading. Turn up by hand as far as possible; then tighten with a pipe wrench. CAUTION: Make sure all nipples are lined up properly and bleeder valves are closed.

13. Connect the liquid hoses to the nipples in tank car liquid valves and the vapor hose to the nipple in the tank car vapor valve.
14. "Crack" one of the tank car liquid valves slowly (using a pipe wrench or a car wrench, if necessary) until the hoses are pressurized.
15. Check the liquid hoses and all of the connections for defects and leaks. Defective hoses and leaking connections must be repaired before proceeding with the unloading operation.
16. If no defects or leaks are apparent, slowly open both tank car liquid valves. NOTE: Liquid valves should always be opened slowly so that the sudden flow of liquid will not close the excess flow control valves in the tank car liquid piping connections. Should these valves close, they may be opened by closing the liquid valves on the tank car for about one minute or until a fairly audible click is heard. Then slowly open the liquid valves.
17. Follow the same procedure for the vapor line.
18. Slowly open the liquid valve on the tank car unloading riser.
19. Open the vapor valve on the tank car riser. Check the pressures on the tank car and the

storage tank. CAUTION: As the lines are opened, recheck all hoses, nipples, and connections for defects and leaks.

20. Open the vapor valve on the storage tank.
21. Slowly open the liquid valve on the storage tank.
22. Visually inspect the hose for knots or swelling, and hose coupling for leaks. Repair leaks and replace hoses, if necessary, before proceeding with the unloading of the tank car.
23. Observe liquid level gauge on the storage tank. This gauge should be checked from time to time while filling the storage tank. CAUTION: Do not overfill the tank.
24. Set the 4-way valve for unloading into the proper storage tank.
25. Observe the two gauges on the compressor. Three conditions can exist:
 - a. If the pressure is higher in the railroad tank car than in the storage tank, as indicated by the gauges on the compressor, allow the liquid to flow into the storage tank. When the pressure differential between the tank car and the storage tank is 5 to 10 pounds, start the compressor. Maintain a sufficient pressure differential to ensure a steady flow of liquid ammonia.
 - b. When pressure in the railroad tank car is equal to the pressure in the

storage tank, start the compressor. Maintain a sufficient pressure differential to ensure a steady flow of liquid ammonia.

- c. If the pressure in the storage tank is higher than in the tank car, equalize the vapor pressure on the two tanks and start the compressor. Maintain a sufficient pressure differential to ensure a steady flow of liquid ammonia. CAUTION: (1) If the gauge on the suction side of the compressor drops to zero, stop the compressor. Determine the cause. It could be either a filled liquid trap or a closed vapor valve on the suction side. Follow the trouble shooting instructions of the compressor's manufacturer. (2) Don't overfill the tank. Observe the variable liquid level gauge, as well as the fixed liquid level gauge, from time to time. NOTE: Do not try to unload the ammonia too fast or the excess flow valves in the tank car will close and stop the unloading operation. If this should happen, no liquid will flow through the unloading line flow indicator, if there is one. Or a noticeable increase in pressure in the tank car or an increase in the discharge pressure at the compressor will occur. If this should happen, stop the compressor and close the liquid valves on the tank car for about one minute or until a fairly audible click is heard, indicating that the excess flow valves have opened. Then

open the liquid valves slowly and resume unloading the tank car. A pressure differential of 10-20 psi should normally be sufficient to unload a tank car as fast as is possible.

26. Continue unloading operations until the liquid transfer is completed. If the liquid and vapor lines are of the proper size with no serious restrictions, unloading a 25-ton railroad tank car should take from 2 to 2 1/2 hours. There are several means of determining when the tank is empty:
 - a. The liquid hoses will start to surge.
 - b. The pressure gauges on the compressor will equalize.
 - c. The liquid level gauge in the storage tank will bounce, if it is of the float type, due to the bubbling of vapor up through the liquid ammonia.
 - d. If there is a flow indicator, it will show when there is no longer liquid flowing in the line.
 - e. The final check is to open the sample valve in the tank car dome. If the material escaping is not readily visible, all of the liquid has been unloaded from the tank car. Should a heavy white fog appear, the car still contains some liquid ammonia. In this case continue the operation of the compressor with all of the valves set for unloading and recheck the sample valve from time to time until there is no longer evidence of liquid in the tank car.
27. Shut off the compressor.

Recovery of Vapor from the Tank Car

Recovery of the greater part of ammonia vapor from an empty tank car is usually a profitable part of unloading. For example, 850 pounds of ammonia vapor will be left in an "empty" 25-ton tank car when the tank has a gauge pressure of 180 pounds.

The procedure is as follows:

1. With the compressor stopped, close the liquid valve on the tank car riser and on the tank car.
2. Make sure the vapor valves on the tank car riser and on the tank car are fully open.
3. Close the valve in the vapor lines entering the storage tank.
4. Open the valve in the vapor recovery line entering the liquid line that leads to the storage tank.
5. Change the 4-way valve on the compressor to pull the vapor from the tank car and force it into the liquid line entering the storage tank. This method is the most economical means of vapor recovery.
6. Start the compressor. CAUTION: The safe operator never leaves the immediate area while unloading.
7. Shut off the compressor when the pressure in the tank car is reduced to about 40 psig. This represents a recovery of 560 pounds of ammonia vapor from the 850 pounds remaining in the car after the liquid is removed. It is not usually economically

advantageous to attempt to recover additional ammonia vapor beyond this point.

8. Close the valve in the vapor recovery line entering the liquid line that leads to the storage tank.
9. Close the liquid valve on the storage tank.
10. Close the vapor line on the tank car riser.
11. Close the vapor line on the tank car dome.
12. Put on both tight fitting safety goggles and protective gloves made of rubber or other material impervious to anhydrous ammonia. A fullface shield is also recommended.
13. Relieve the pressure on the hoses leading from the tank car riser to the tank by opening the bleeder valves. CAUTION: In some plants, it may be desirable to vent these bleeder valves into water rather than to the atmosphere because of local conditions or requirements. In such instances, make sure that the emergency first-aid water supply is NEVER used for this purpose.
14. When there is no longer pressure on the hose connections, disconnect both the liquid and vapor lines.
15. Remove the nipples from both the liquid and vapor valves and replace the valve plugs. Be sure the slip tube gauge cover is in place.
16. Close tank car dome cover.

17. Place the locking pin in position.
18. Remove the hose ends, the car nipples, the tools, etc., from the deck of the car. See "NOTE" in Step 7, "Unloading Tank Car by Compressor."
19. Place the hoses on their respective racks.
20. Store the car nipples and tools.
21. Turn all four danger cards in the railroad car brackets to read "empty." NOTE: The black side will be out.
22. Remove the wheel chocks.
23. Remove the "Stop--Tank Car Connected" sign(s).
24. Schedule the railroad car immediately to the destination indicated on the "waybill."

The unloading has been completed.

Unloading Transport Trucks by Compressor

Unloading a transport truck is very similar to unloading a railroad tank car. All of the basic safety precautions should be observed, including chocking of wheels.

To unload a transport truck the suction side of the compressor is connected to the vapor valve on the storage tank and the discharge side to the vapor valve on the transport truck. The liquid ammonia line from the riser is connected to the liquid

discharge valve of the transport truck. When the liquid hose begins to pulsate or the volume gauge on the storage tank begins to bounce, the liquid ammonia is practically out of the truck tank and vapor is starting to move into the storage tank. To be sure that all liquid has been removed, the compressor should be allowed to run a little longer after it is indicated that the tank is empty.

After all the liquid anhydrous ammonia has been transferred to the storage tank, some plant operators recover the vapor from the transport. This is accomplished by changing the valves so they pull the vapor from the truck tank and discharge it through the liquid line into the storage tank. When the pressure in the truck tank is reduced to approximately 40 pounds, it is no longer economical to recover more vapor. After the compressor is shut down, close all valves and bleed the pressure from both the liquid and vapor hose lines leading from the truck riser before uncoupling the tank on the transport.

Unloading Transport Trucks by Liquid Pump

When anhydrous ammonia is delivered by transport truck and ammonia vapor is not to be recovered, liquid pumps are often used for unloading, since the liquid withdrawal valves are located at the bottom of the tank. This allows the ammonia to flow directly into the pump with a minimum chance of vaporization which could cause pump operation problems. Although many transport trucks are equipped with a liquid pump for unloading, the following procedure pertains to unloading with a stationary pump at the ammonia plant. (The same general procedure should be used in

unloading a transport truck equipped with its own pump.)

1. Make sure an adequate amount (at least 100 gallons) of clean first-aid water is easily accessible, either at an emergency shower or in an open-top container.
2. Park the truck correctly in relation to the plant truck unloading piping system.
3. Set the transport truck brakes.
4. Chock the wheels.
5. Inspect the hose connections. Remove any dirt or foreign material and replace all worn or missing gaskets.
6. Check the hoses for defects. Make certain all hoses are free of kinks. When a kink does occur, hold the valve opening away from the body, out of line of bystanders, and step over the hose, twisting the body and hose simultaneously in the direction of the kink. CAUTION: Do not attempt to throw a kink out of a hose--UNWIND IT!
7. Connect the liquid hose to the transport liquid valve and to the liquid valve of the plant transport unloading connector. CAUTION: While making and breaking connections, the safe operator always wears tight-fitting goggles, a fullface shield, and protective gloves made of rubber or other material impervious to anhydrous ammonia.
8. Connect the vapor hose to the vapor valve on the transport truck and to the vapor valve on the plant truck transport connector.

9. Open the liquid and vapor valves on the storage tank.
10. Open the storage tank valve connecting the by-pass line to the spring loaded by-pass valve on the pump.
11. Observe the liquid level gauge on the storage tank. This gauge should be checked from time to time while filling the storage tank. CAUTION: Don't overfill the tank.
12. Open the liquid and vapor valves on the plant transport connections.
13. Visually inspect the hose for knots or swelling and hose couplings for leaks. Repair leaks and replace the hose, if necessary, before proceeding with the unloading of the transport truck.
14. Slowly open the liquid valve on the tank truck. NOTE: Opening the liquid valve too rapidly can cause the excess flow valve to close. See Step 16 of the Tank Car Unloading Procedure.
15. Observe the pressures on the storage tank and the tank truck. Three conditions can exist. They are handled as follows:
 - a. If the pressure in the tank truck is considerably higher, allow the pressure to force the liquid ammonia into the storage tank until there is a 5- to 10-pound pressure differential. Then open the vapor valve on the transport truck and start the pump.

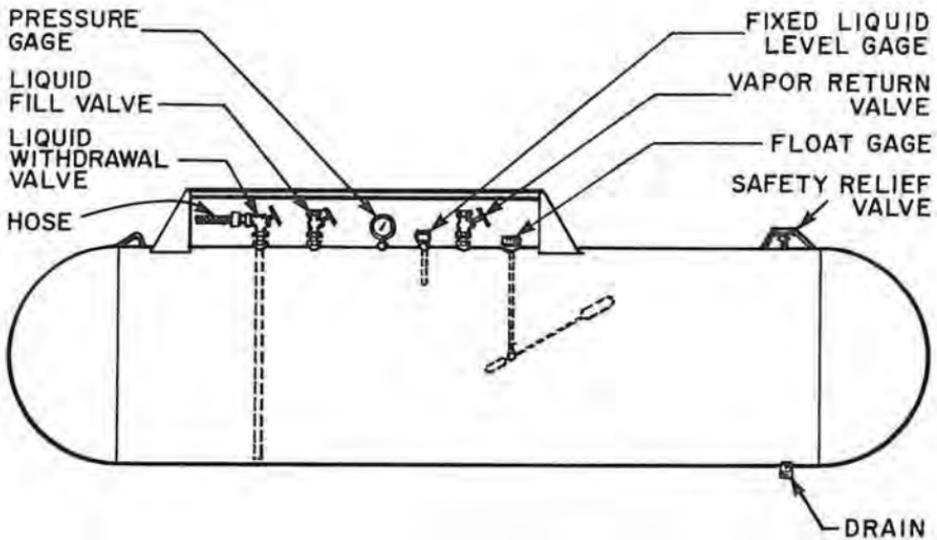
- b. If the pressure is higher in the storage tank than in the transport truck, open the vapor valve on the transport truck and allow the pressure to equalize. Then start the pump.
 - c. If the pressure in each tank is nearly equal, open the vapor valve on the transport truck and start the pump. CAUTION: The safe operator never leaves the area while filling a tank.
16. Check the progress of unloading from time to time by observing the liquid level gauges on the transport truck and the storage tank. CAUTION: While checking the ammonia level with a rotary or fixed level gauge, wear both tight-fitting safety goggles and gloves made of rubber or other material impervious to anhydrous ammonia. A fullface shield is also recommended.
17. If a flow indicator is in the liquid line, it will aid in determining if the transport truck is empty.
18. To determine if the transport truck is empty, open the bleeder valve on the plant liquid transport connector or the transport truck liquid hose. If the bleeder spews liquid ammonia and a white fog appears, continue unloading operations. If only ammonia vapor is released from the bleeder valve, the transport truck is empty.
19. Stop the pump.
20. Close the fixed liquid level gauge on the storage tank.

21. Close the liquid and vapor valves on the storage tank.
22. Close the storage tank valve connecting the by-pass line to the spring loaded by-pass valve on the pump.
23. Close the liquid and vapor valves at the plant transport connections.
24. Close the liquid and vapor valves on the transport truck.
25. Open the bleeder valves on the hose connections and bleed both the liquid and vapor hoses. CAUTION: When opening bleeder valves or breaking connections, the safe operator always wears tight-fitting safety goggles, a fullface shield, and protective gloves made of rubber or other material impervious to anhydrous ammonia. CAUTION: In some plants it may be desirable to vent these valves into water rather than into the atmosphere because of local conditions or requirements. In such instances make sure that the emergency first-aid water supply is NEVER used for this purpose.
26. Disconnect and rack hoses.
27. Remove the wheel chocks from the transport truck wheels.

The unloading has been completed.

Filling Nurse Tanks by Compressor

To safely fill the nurse tank, the operator must wear tight-fitting safety goggles and protective gloves made of rubber or other material impervious to anhydrous ammonia. A fullface shield is also recommended. In addition, he should stand clear of all valves and hose ends. The safe operator never leaves the immediate area during the filling procedure.



To fill the tank:

1. Make sure the emergency first-aid water supply container is full of clean water (at least 100 gallons) and readily available.
2. Park the nurse tank in a position for easy filling beside the nurse tank loading risers. Make certain the hoses easily reach the valves.
3. Chock the rear wheels to make certain the nurse tank remains in place during loading.
4. Check the hoses for defects. Make certain all hoses are free of kinks. When a kink does occur, hold the valve opening away from the body, out of line of bystanders, and step over the hose, twisting the body and hose simultaneously in the direction of the kink. CAUTION: Don't take hold of the valve hand wheel at any time while unsnarling a hose. Do not attempt to throw a kink out of a hose--UNWIND IT!
5. Prior to making the hookup, remove the cap from the valves on the nurse tank and clean the gaskets in the valves. Make sure all of the gaskets are in place. Replace all worn or damaged gaskets.
6. Connect both the liquid fill hose and the vapor return hose to their respective valves. Tighten these connections by hand. DON'T USE A WRENCH. CAUTION: Never attempt to stretch a hose. Move the nurse tank closer to the riser.
7. After making the connections, open both the liquid and vapor hose-end valves, leaving all bleeder valves closed.

8. Slowly open the liquid fill and the vapor return valves on the nurse tank.
9. Visually inspect the hose for knots or swelling and hose couplings for leaks. Repair leaks and replace hoses, if necessary, before proceeding with the loading of the nurse tank. CAUTION: If a fitting leaks and cannot be tightened by hand, shut off the hose-end valve and the nurse tank valve. Open the bleeder valve to relieve the pressure trapped between the two valves. Then, disconnect the hose, determine the cause of the leak or leaks, and correct the situation.
10. Slowly open the liquid and vapor valves on the nurse tank riser. CAUTION: Opening the liquid valve from the storage tank too rapidly may cause an excess flow valve to close.
11. Open the vapor valve on the storage tank.
12. Set the 4-way valve to pull vapor from the nurse tank into the storage tank. NOTE: Adjust any by-pass or manifold valve in the system so that the vapor will travel to the storage tank from the compressor.
13. Observe the gauges on the compressor. Three conditions can exist. They are handled as follows:
 - a. When there is equal pressure on each gauge, open the liquid valve on the storage tank and start the compressor.

- b. If the pressure is higher on the storage tank gauge, open the liquid valve on the storage tank and allow the ammonia to flow until the difference in pressure is not more than 5 to 10 pounds. Start the compressor. Maintain sufficient pressure differential to ensure a steady flow of liquid ammonia.
 - c. If the pressure in the nurse tank is higher than in the storage tank, equalize the vapor pressure in the two tanks, open the liquid valve on the storage tank, and start the compressor. Maintain a sufficient pressure differential to ensure a steady flow of liquid ammonia.
CAUTION: Never leave a nurse tank while it is being filled.
14. Partially open the fixed level gauge on the nurse tank until you hear vapor escaping. This gauge should remain partially open during the filling operation until a white fog appears which indicates that the proper liquid level has been reached. CAUTION: Don't overfill the tank.
 15. Close the liquid hose-end valve immediately.
 16. Stop the compressor.
 17. Close both the nurse tank liquid fill and vapor return valves on the nurse tank.
 18. Close the vapor hose-end valve and close the liquid and vapor valves on the nurse tank riser.

19. Open the bleeders on the nurse tank valves (both liquid and vapor) to relieve the pressure on the valve couplings. CAUTION: In some plants, it may be desirable to vent these bleeder valves into water rather than into the atmosphere because of local conditions or requirements. In such instances, make sure that the emergency first-aid water supply is NEVER used for this purpose.
20. When pressure has been relieved, disconnect the hoses and replace the valve protection caps.
21. Place the hoses on the rack. CAUTION: Handle each hose by the valve body and coupling--not the valve wheel. Keep the open end away from the body and out of line of bystanders.
22. Make sure the liquid transfer hose used to fill the applicator is secure and both valves closed.
23. Remove the wheel chocks and weigh the tank.
24. If the towing vehicle has been disconnected, connect the hitch and fasten the safety chains.
25. Make sure the first-aid water container on the nurse tank is full of clean water.

The tank is now ready for delivery.

Filling the Last Nurse Tank by Compressor

At the close of the day or if filling operations are to be discontinued for several hours, the following procedure should be used after the proper liquid level in the nurse tank has been reached:

1. Immediately close the liquid valve on the nurse tank riser.
2. Lift the liquid hose connected to the liquid fill valve and drain the liquid ammonia into the nurse tank.
3. Close the liquid hose-end valve.
4. Stop the compressor.
5. Close the vapor valve on the nurse tank riser.
6. Close the nurse tank liquid and vapor valves.
7. Close the vapor hose-end valve.
8. Open the bleeders on the nurse tank valves to relieve the pressure on the valve couplings. CAUTION: In some plants it may be desirable to vent these bleeder valves into water rather than into the atmosphere because of local conditions or

requirements. In such instances, make sure that the emergency first-aid water is NEVER used for this purpose.

9. Disconnect both hoses and place them on the rack.
10. Replace the valve protection caps.
11. Close the liquid and vapor valves on the storage tank. Lock or secure all primary valves.
12. "Throw" the electrical disconnect switch to "off." Lock or secure it.
13. Close and lock the compressor house (if provided). CAUTION: All locking devices should be put in place and secured. The above locking procedure is not necessary if the plant is protected from tampering by a locked fence.
14. Remove the wheel chocks after the hoses have been disconnected; then weigh the tank.

Filling Nurse Tanks by Liquid Pump

The procedure for using a liquid pump to fill a nurse tank is much the same as when a compressor is used. It is essential that the operator wear both tight-fitting safety goggles and protective gloves made of rubber or other material impervious to anhydrous ammonia. A fullface shield is also recommended. In addition, the operator should stand clear of all valves and hose ends. The safe operator never leaves the immediate area during the filling procedure.

To fill a nurse tank:

1. Make sure the emergency first-aid water container is full of clean water (at least 100 gallons) and readily accessible.
2. Set the nurse tank in a position for easy filling beside the nurse tank loading riser. Make sure the hoses easily reach the valves.
3. Chock the rear wheels to make certain the nurse tank remains in place during loading.
4. Make certain all hoses are free of kinks. When a kink occurs, hold the valve away from the body, out of line of bystanders, and step over the hose, twisting the body and hose simultaneously in the direction of the kink. CAUTION: Don't take hold of the valve hand wheel at any time while unsnarling a hose. Do not attempt to throw a kink out of a hose--UNWIND IT!
5. Prior to making the hookup, remove the caps from the valves on the nurse tank and clean the gaskets on the valves. Make sure all of the gaskets are in place. Replace all worn or damaged gaskets.
6. Connect both the liquid fill hose and the vapor return hose to their respective valves. Tighten these connections by hand. DON'T USE A WRENCH. CAUTION: Never attempt to stretch a hose. Move the nurse tank closer to the riser.
7. After making the connections, open both the liquid and vapor hose-end valves, leaving all bleeder valves closed.

8. Open the liquid fill and vapor return valves.
9. Open the liquid and vapor valves on the nurse tank riser.
10. Check the hoses for knots and swelling and hose couplings for leaks. Repair leaks and replace hoses, if necessary, before proceeding with the loading of the nurse tank. CAUTION: If a hose coupling leaks and cannot be tightened by hand, shut off the hose-end valve and the nurse tank valve. Open the bleeder valve to relieve the pressure trapped between the two valves. Then, disconnect the hose, determine the cause of the leak or leaks, and correct the situation.
11. Read the pressure gauge on the nurse tank.
12. Open the liquid valve on the storage tank slowly. CAUTION: Opening the liquid valve on the storage tank too rapidly may cause an excess flow valve to close.
13. Open the pump by-pass line valve on the storage tank.
14. Compare the pressure in the nurse tank with the pressure in the storage tank. (See Step 16 in the procedure for unloading tank cars.)
 - a. If the pressure in the storage tank and in the nurse tank is nearly equal, open the vapor valve on the storage tank and start the pump.
 - b. If the pressure in the storage tank is considerably higher than in the

nurse tank, allow the pressure to force the liquid ammonia into the nurse tank until there is a 5-10 psi pressure differential between the two tanks. Open the vapor valve on the storage tank and start the pump.

- c. If the pressure is higher in the nurse tank than in the storage tank, open the vapor valve on the storage tank and allow the pressure to equalize. Then, start the pump. CAUTION: Never leave a nurse tank while it is being filled.
15. Partially open the fixed liquid level gauge on the nurse tank until you hear vapor escaping. This gauge should remain partially open during the filling operation until a white fog appears, which indicates that the proper liquid level has been reached. CAUTION: Don't overfill the tank.
16. Stop the pump immediately.
17. Close the liquid hose-end and the nurse tank liquid fill valves.
18. Close the liquid and vapor valves on the riser.
19. Close the vapor hose-end and the nurse tank vapor return valves.
20. Open the bleeder valves on the nurse tank valves (both liquid and vapor) to relieve the pressure on the valve couplings. CAUTION: In some plants, it may be desirable to vent these bleeder valves into water rather than into the atmosphere

because of local conditions or requirements. In such instances, make sure that the emergency first-aid water supply is NEVER used for this purpose.

21. When the pressure has been relieved, disconnect the hoses.
22. Place the hoses on the rack. CAUTION: Handle each hose by the valve body and coupling--not the valve wheel. Keep the open end away from the body and out of line of bystanders.
23. Make sure the liquid transfer hose used to fill the applicator is secured and both valves closed.
24. Remove the wheel chocks and weigh the tank.
25. If the towing vehicle has been disconnected, connect the hitch and fasten the safety chains.
26. Make sure the first-aid water container on the nurse tank is full of clean water.

The tank is now ready for delivery.

Filling the Last Nurse Tank by Liquid Pump

At the close of the day or if filling operations are to be discontinued for several hours, the following procedure should be used after the proper liquid level in the nurse tank has been reached:

1. Stop the pump immediately.

2. Close the liquid and vapor valves on the nurse tank riser.
3. Lift the liquid hose connected to the liquid fill valve and drain the liquid ammonia into the nurse tank.
4. Close the liquid hose-end valve and the liquid fill valve on the nurse tank.
5. Close the vapor hose-end valve and the vapor return valve on the nurse tank.
6. Open the bleeders on the nurse tank valves to relieve the pressure on the valve couplings. CAUTION: In some plants, it may be desirable to vent these bleeder valves into water rather than into the atmosphere because of local conditions or requirements. In such instances make sure that the emergency first-aid water is NEVER used for this purpose.
7. Disconnect both hoses and place them on the rack.
8. Replace valve protection caps.
9. Close all liquid and vapor valves on the storage tank.
10. Throw the electrical disconnect switch to the "off" position. Lock or secure it.
11. Close and lock the pump house, if applicable. CAUTION: All locking devices should be put in place and secured. The above lock-up procedure is not necessary if the plant is protected from tampering by a locked fence.

12. Remove the wheel chocks after all hoses have been disconnected and weigh the tank.

Filling an Applicator Tank by the Vapor Transfer Method

A small ammonia vapor motor, an internal combustion engine, or the "PTO" shaft on a tractor can be used to drive the compressor. The method of filling is identical to the filling of a nurse tank at the plant when a compressor is used. Two lines are needed, one liquid and one vapor. The compressor draws the vapor from the applicator tank and forces it into the nurse tank, resulting in a pressure differential. The increased pressure in the nurse tank causes the liquid ammonia to flow into the applicator tank.

To fill an applicator tank:

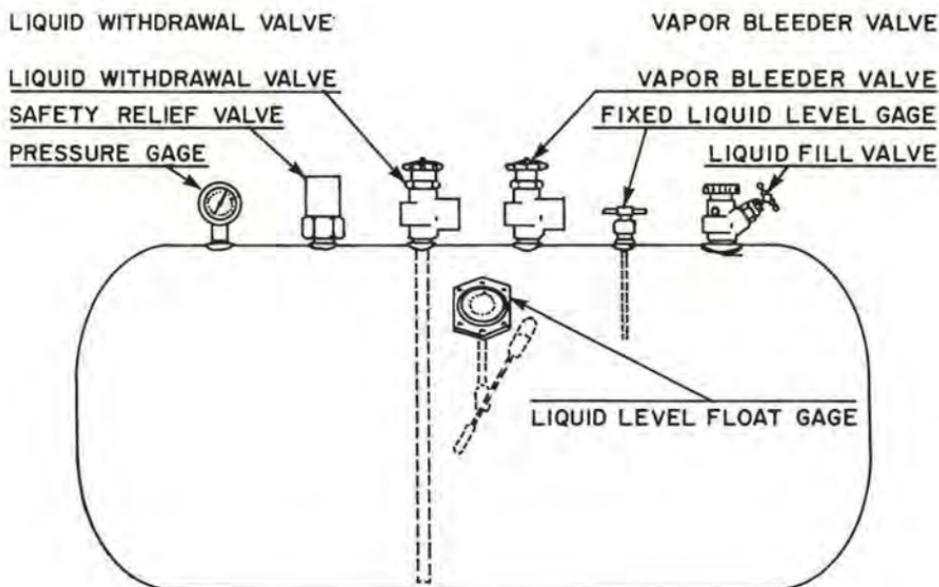
1. Make sure the water container on the nurse tank is filled with clean water. CAUTION: Never contaminate the first-aid water with ammonia.
2. Position the nurse tank and the applicator so that the wind will blow vapors away from homes and growing crops. Park the nurse tank on level ground. If necessary, chock the wheels.
3. Bring the applicator sufficiently close to the nurse tank so that hoses can be easily attached. CAUTION: Never stretch a hose.
4. Set the tractor brakes. Unless the "PTO" shaft will be used to power the compressor, stop the tractor engine.

5. Inspect the liquid fill hose-end valve and the two vapor return hose-end valves or connections for dirt. If necessary, clean the connectors. CAUTION: The safe operator always wears tight-fitting goggles, a fullface shield, AND protective gloves made of rubber or other material impervious to anhydrous ammonia. Never leave the applicator during filling.
6. Remove the caps from the liquid fill and the vapor return valves, and inspect both the valve openings for dirt and the gaskets or seal washers for wear or defects. If necessary, replace the gaskets and clean the valve openings.
7. Connect the vapor hose of the compressor to the vapor valve on the applicator tank. NOTE: Make all connections hand tight. NEVER USE A WRENCH.
8. Connect the vapor discharge hose of the compressor to the vapor return valve on the nurse tank.
9. Connect the liquid withdrawal hose of the nurse tank to the applicator tank fill valve.
10. Close all bleeders.
11. Open the vapor hose-end valve and the nurse tank vapor valve.
12. Open the nurse tank liquid withdrawal valve.
13. Slowly open the applicator tank fill valve.

14. Open the vapor hose-end valve and the applicator tank vapor valve.
15. Start the compressor. NOTE: The compressor should maintain approximately a 10-pound differential between the nurse tank and the applicator tank.
16. Open the fixed liquid level gauge. It should remain open during the filling operation until a white fog appears, which indicates that the proper liquid level has been reached. CAUTION: Don't overfill the tank.
17. Close the liquid withdrawal valve on the nurse tank and the fixed liquid level gauge on the applicator tank.
18. Stop the compressor.
19. Close the vapor valve on the nurse tank.
20. Close the liquid fill hose-end valve and the applicator fill valve.
21. Close the vapor hose-end valve and the vapor valve on the applicator tank.
22. Open the bleeders to relieve the pressure from the connectors.
23. Disconnect and store the hoses. CAUTION: Carry all hoses by the body of the valve and the hose coupling, not by the valve wheel. Avoid kinking and dragging the hose on the ground.

The applicator is now ready for use.

When the nurse tank is empty, replace all valve caps. Make sure the liquid fill hose-end valve and the liquid withdrawal valve on the nurse tank are closed tightly. Secure the hose, and return the tank to the dealer.



APPENDIX B

VALVES AND FITTINGS

By definition a valve is a device by which the flow of materials may be started, stopped, or regulated by a movable part which obstructs passage to the desired degree.

Line Valves - Globe valves are installed in a pipe line to start, stop, or regulate flow.

Fill Valves - These valves permit flow into the tank and usually discharge into the top of the tank. Most have back pressure checks with spring loaded seats to prevent the release of vapor if a line or hose should break. These valves are normally opened and closed with a manually operated handwheel. For ease of operation they are often connected to filler hoses with acme screw threads.

Liquid-Out Valves - These manually operated valves control the removal of liquid ammonia from a tank. Normally they are mounted on top of the tank and have a dip tube running down inside to near the bottom of the tank; however, some may be mounted on the bottom. The outside opening may have acme screw or female pipe threads, depending on the use of the valve.

Vapor Valves - These valves control the flow of vapor pressure from one tank to another. They are similar to fill or liquid-out valves.

Bleed Valves - These small valves remove liquid or vapor from a hose coupling or larger valve. Most of them have pinhole-sized outlets, 7/32 inch maximum, and open or close with a thumbscrew.

Pressure Relief Valves - These are also called pop-off or safety relief valves. They are spring loaded to open automatically when tank pressure exceeds a predetermined amount. Once activated, they stay open, allowing vapor pressure to escape to the atmosphere. When the excess pressure inside the tank has been vented, they close automatically. Most are set to open when heat or overfilling has raised the pressure to 250 psi. All tanks must have a safety relief valve directly connected to the vapor space, and it must be properly sized to suit the surface area of the tank. (The capacity of the valves is regulated by 29 CFR 1910.111, (b),(9),(i).) Valves are frequently manifolded on storage tanks so that they can be tested or replaced without taking the tank out of service. In such cases, the manifold has two or more relief valves, but only one can be shut off at a time. The manifold should be open to all valves except when a valve is being replaced or tested. These valves should be protected by a weather cap to keep out rain and dirt. The valve discharge must be unobstructed and directed upward, away from the container. Employees should work upwind of the relief valve as much as possible. Special small liquid (hydrostatic) relief valves are also used in hose or pipe line assemblies that can be closed at both ends.

Excess Flow Valves - These automatically shut off ammonia flow and prevent excessive discharge from a tank when a hose, line, or valve is

accidentally broken. Ordinary flow will not trip them, but they are designed to close automatically at a predetermined high flow rate. Once the broken line is repaired or intervening shut-off valves closed, a small equalizing port automatically equalizes the pressure on both sides of the valve and a spring returns the valve to the open position. Excess flow valves are connected to the portions of other valves or lines which protrude inside a tank or are installed separately in the tank opening. They are also required whenever the liquid lines are reduced in size.

Liquid Level Gauges - Three common types of gauges indicate the amount of ammonia in a tank.

a) The 85% bleed valve is a valve with a short tube extending into the tank to the level at which the tank is 85% full. When a tank is being filled, the bleed is opened. At the time liquid begins to spew from the bleed, the tank is 85% full.

b) The float gauge operates by means of a float and gear and lever linkage inside the tank. The end of the lever is magnetically coupled to a dial on the outside. Indications of the dial reflect the level of the liquid.

c) The rotary gauge has an indicator that rotates freely on the side or end of the tank. On the outside there is a bleed valve and on the inside a dip tube connected through the wall to the bleed valve. The dip tube is bent so that it rotates parallel to the outside indicator.

When the bleed valve is opened, gas is discharged; and as the indicator knob is turned, the tube is swung downward until its open end strikes the liquid surface. Liquid then flows out the bleed valve, and this is the point at which the reading is taken.

Pressure Gauges - These are mounted on tanks or other locations on ammonia equipment to show the pressure within. They are read in pounds per square inch from dial faces. The reading may be used to watch for excessive pressures, to determine when enough pressure differential has been created between two tanks of ammonia to produce flow, etc. Ordinary pressure gauges are constructed with copper elements and are unsuitable for use with ammonia. Only special gauges marked, "Suitable for Ammonia," must be used. To avoid possible confusion, it is recommended that all gauges have identical scales. This is especially important where two gauges are used to determine the pressure differential of the system.

Thermometers - These are mounted in wells in tanks to determine the temperature of the liquid to compute the density or weight per gallon. Mercury thermometers should not be used where anhydrous ammonia is present; reaction of ammonia with mercury from a broken thermometer could form fulminate of mercury -- a very unstable explosive.

APPENDIX C

CYLINDERS

In many industrial operations anhydrous ammonia is supplied in cylinders. There are two types of cylinders, tube and bottle. The tube type is normally used in a horizontal position. When the valve outlet or stem points up, the dip tube is under the surface and liquid ammonia will be discharged. Ammonia vapor is discharged when the valve outlet or stem points down.

Bottles may also be used in a horizontal position to supply either vapor or liquid. As with the tube type, liquid is discharged when the valve outlet points up. For easier flow of liquid, the butt end should be about 2 inches higher than the valve end. Bottles are normally used in the upright or vertical position to provide a source of ammonia vapor. Because of thermal expansion a full bottle may discharge a small amount of liquid when it is first opened. (When filled according to ICC specifications, a cylinder will be liquid full at 145 F.) It is recommended that a cylinder be allowed to reach room temperature (70-80 F) before the valve is opened.

The rate at which ammonia vapor can be discharged depends upon the temperature of the surrounding atmosphere and the surface area of the liquid ammonia. Horizontal cylinders provide greater flow rates due to the larger surface area. Under no circumstances should cylinders be warmed directly by

hot water, steam, or flame. When large quantities of vapor are needed, liquid should be withdrawn from the cylinders, then converted to vapor in a steam or electrically heated vaporizer equipped with approved safety devices. Cylinders may also be manifolded to supply greater volumes of vapor.

As vapor is withdrawn, the liquid cools and condensation will appear on the outside of the cylinder up to the level of the liquid ammonia. If vapor is withdrawn at a very rapid rate, the condensation will frost on the cylinder wall, indicating the temperature of the liquid is below 32 F. If a bottle type cylinder becomes frozen to another surface during discharge, it should not be loosened by prying under the valve end; it should be allowed to thaw naturally or by the application of water.

If cylinders are manifolded to supply liquid, they should be weighed immediately after the valves are reclosed. During manifolding, a temperature difference between the cylinders will cause liquid to flow from the warmer to the cooler container and may result in over-filling the latter. If an overfilled cylinder is blocked off, a temperature rise may cause hydrostatic rupture.

A cylinder is considered empty when the internal pressure is 25 psig or less and there is no condensation on the cylinder wall when the cylinder is at ambient temperature.

Following are suggestions for handling cylinders:

- *Do not store cylinders near sources of heat or potential sources of heat, such as flammable substances or in direct sunlight. Cylinders should never be allowed to reach a temperature above 125 F.

*Rack, block, or otherwise brace cylinders to ensure they are stored in a stable manner. They should be protected from moving vehicles and possible external damage.

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

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

*Do not tamper with numbers, markings, or test dates stamped into cylinders.

*When the cylinder is empty, disconnect it. Replace plug or nut on valve outlet, and secure valve protecting cap snugly.

*Be certain that both the cylinder valve and the manifold valve are closed before removing a cylinder from a manifolded system. A check valve should be installed at the manifold connection.

*Store empty cylinders separately from filled cylinders and fasten an EMPTY tag on cylinders immediately after emptying.

*Do not subject cylinders to rough handling or to abnormal mechanical shock, such as dropping or bumping.

*Do not use rope slings for unloading. When handling by crane or derrick, a suitable platform, cradle, or boat should be used. Do not use hooks, tongs, or similar fastening devices.

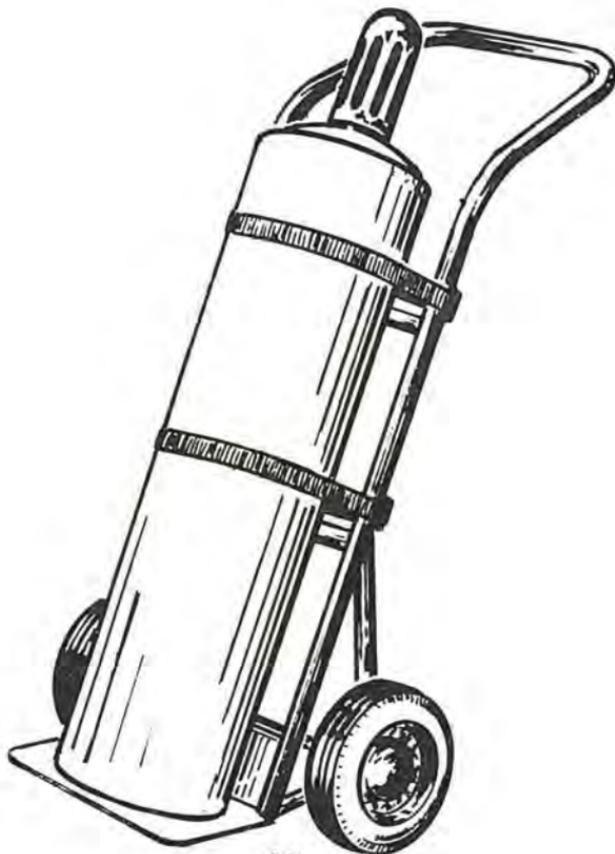
*Do not use electric magnets for unloading or handling.

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

*Use a suitable hand truck, fork truck, roll platform, or similar device with the cylinder firmly secured for unloading and transferring.

*Never use cylinders for ammonia (or any other compressed gas), whether full or empty, as rollers for moving heavy or bulky articles.

*Do not place or handle cylinders where they might form part of an electrical circuit.



APPENDIX D

AMMONIA PLANT SAFETY CHECK LIST

	YES/NO
1. Are all employees properly trained?	___ ___
2. Are all personnel assigned to work with anhydrous ammonia capable of working in a hazardous area?	___ ___
3. Are goggles used by all persons handling anhydrous ammonia?	___ ___
4. Are ammonia-resistant gloves used by all persons handling anhydrous ammonia?	___ ___
5. Is a safety water tank or an approved deluge shower available?	___ ___
6. Is a "First Aid Water" decal on the safety tank or shower?	___ ___
7. Is a rain suit or slicker available?	___ ___
8. Are boots available?	___ ___
9. Are two fullface masks available?	___ ___
10. Are canisters current?	___ ___
11. Are there two self-contained air masks available for emergencies?	___ ___

YES/NO

- | | | |
|--|---|---|
| 12. Are safety belts and life lines available? | — | — |
| 13. Is an approved first aid kit at the site? | — | — |
| 14. Is the fire extinguisher(s) in good condition? | — | — |
| 15. Have the local emergency authorities been trained in handling anhydrous ammonia emergencies? | — | — |
| 16. Are emergency telephone numbers conspicuously posted? | — | — |
| 17. Are the tanks approved for anhydrous ammonia? | — | — |
| 18. Is the paint on the tank in good condition? | — | — |
| 19. Are the "Caution -- Ammonia" or "Anhydrous Ammonia" decals in place? | — | — |
| 20. Are the "Warning" and "First Aid" decals in place? | — | — |
| 21. Are "Wear Your Goggles" decals located throughout the work area? | — | — |
| 22. Are all valves, etc., approved for anhydrous ammonia? | — | — |
| 23. Are the liquid and vapor valves properly identified? | — | — |

- | | | | |
|-----|--|---|---|
| 24. | Are excess flow checks in all openings where required? | — | — |
| 25. | Are relief valves checked and replaced regularly? | — | — |
| 26. | Are all relief valves capped? | — | — |
| 27. | Is all piping done with Schedule 80, black pipe (no galvanized or brass)? | — | — |
| 28. | Is all hose labeled for anhydrous ammonia? | — | — |
| 29. | Are all hoses and pipes equipped with relief valves where needed? | — | — |
| 30. | Are hoses inspected regularly and changed when age or condition require? | — | — |
| 31. | Are transfer connection areas (transport stubs, loading stations, etc.) marked "Caution-- Ammonia" or "Anhydrous Ammonia"? | — | — |
| 32. | Is there an automatic backcheck in the transport liquid line? | — | — |
| 33. | Are wheel chocks for nurse tanks, motor transports, and rail cars available? | — | — |
| 34. | Are "Stop--Tank Car Connected" signs available and used? | — | — |
| 35. | Is the site clean and well kept? | — | — |

NIOSH AND OSHA REGIONAL OFFICES

The following pages list NIOSH and OSHA regional offices. Either of these facilities serving the state can provide information on the Occupational Safety and Health Act including questions on standards interpretations, voluntary compliance information, copies of the OSHA Standards, OSH Act, Employee Rights Posting Notice, and other OSHA publications.



NIOSH REGIONAL OFFICES

DHEW, Region I
JFK Federal Bldg.
Room 1401
Boston, Massachusetts 02203
617/223-6668

DHEW, Region II
26 Federal Plaza, Room 3300
New York, New York 10007
212/264-2485

DHEW, Region III
P. O. Box 13716
Philadelphia, PA 19101
215/596-6716

DHEW, Region IV
101 Marietta Tower
Atlanta, GA 30323
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DHEW, Region V
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DHEW, Region VI
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Denver, Colorado 80294
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DHEW, Region IX
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San Francisco, CA 94102
415/556-3781

DHEW, Region X
1321 Second Ave., Mail Stop 502
Seattle, Washington 98101
206/442-0530

OSHA REGIONAL OFFICES

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U.S. Department of Labor
Occupational Safety and Health Administration
JFK Building, Room 1804
Boston, Massachusetts 02203 Telephone: 617/223-6712/3

Region II

U.S. Department of Labor
Occupational Safety and Health Administration
1515 Broadway (1 Astor Plaza), Room 3445
New York, New York 10036 Telephone: 212/971-5941/2

Region III

U.S. Department of Labor
Occupational Safety and Health Administration
15220 Gateway Center, 3535 Market Street
Philadelphia, Pennsylvania 19104 Telephone: 215/596-1201

Region IV

U.S. Department of Labor
Occupational Safety and Health Administration
1375 Peachtree Street, N.E., Suite 587
Atlanta, Georgia 30309 Telephone: 404/526-3573/4 or 2281/2

Region V

U.S. Department of Labor
Occupational Safety and Health Administration
230 S. Dearborn, 32nd Floor
Chicago, Illinois 60604 Telephone: 312/353-4716/7

Region VI

U.S. Department of Labor
Occupational Safety and Health Administration
555 Griffin Square Building, Room 602
Dallas, Texas 75202 Telephone: 214/749-2477/8/9 or 2567

Region VII

U.S. Department of Labor
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Federal Building, Room 3000, 911 Walnut Street
Kansas City, Missouri 64106 Telephone: 816/374-5861

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Occupational Safety and Health Administration
Federal Building, Room 15010, 1961 Stout Street
Denver, Colorado 80202 Telephone: 303/837-3883

Region IX

U.S. Department of Labor
Occupational Safety and Health Administration
9470 Federal Building, 450 Golden Gate Avenue
Post Office Box 36017
San Francisco, California 94102 Telephone: 415/556-0584

Region X

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Occupational Safety and Health Administration
8048 Federal Office Building, 909 First Avenue
Seattle, Washington 98174 Telephone: 206/442-5930

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Charge to my Deposit Account No. Order No. _____

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Street address _____

City and State _____ ZIP Code _____

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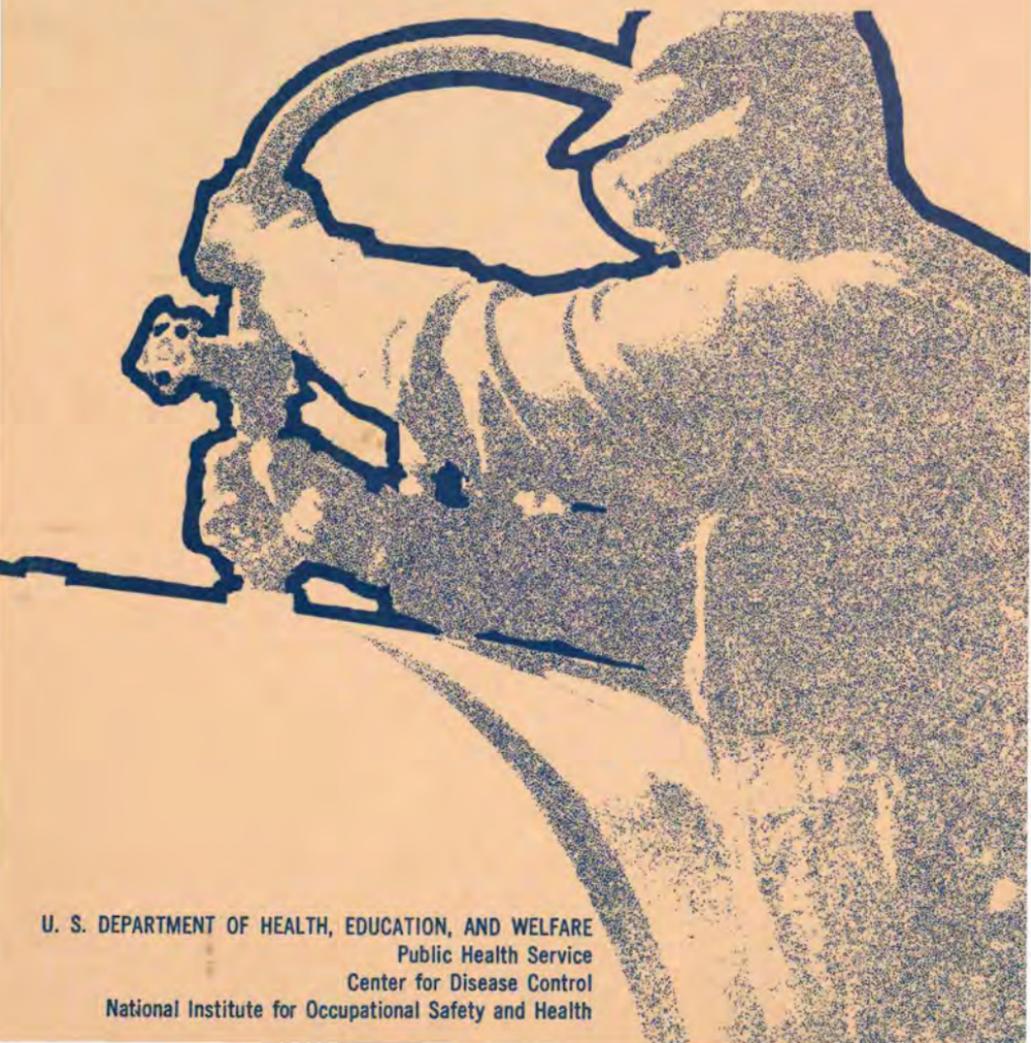
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NIOSH

**A Guide for Developing a
Training Program for**

**ANHYDROUS AMMONIA
WORKERS**



U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health

EMERGENCY INFORMATION

FIRE

Telephone Fire Department _____

Nearest Alarm Box at _____

CRIME

Telephone Police _____

INJURY/ILLNESSES

Avoid infection of minor injuries; always get medical attention or skilled first aid.

Doctor _____

Office _____ Tel. _____

Residence _____ Tel. _____

Hospital _____

Address _____ Tel. _____

Ambulance _____

Address _____ Tel. _____

(In emergencies, get medical attention and transportation elsewhere if necessary.)

In all cases of Fire, Crime, Accident, or Sickness, promptly notify:

1. Name _____ Office Tel. _____

Address _____ Res. Tel. _____

or

2. Name _____ Office Tel. _____

Address _____ Res. Tel. _____

**DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE**

PUBLIC HEALTH SERVICE

CENTER FOR DISEASE CONTROL

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

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