

NIOSH

WORKING SAFELY with ANHYDROUS AMMONIA



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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INTRODUCTION

This booklet has been written for employees who work with anhydrous ammonia. It briefly describes anhydrous ammonia's important physical properties, the effects of overexposure, first aid procedures, personal protective equipment useful to prevent exposure, and recommendations for working safely.

The sharp, pungent odor of ammonia is its own warning agent. There is no reason to fear ammonia 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.

Ammonia is the third largest volume chemical produced in the United States. About 80% is used in agricultural applications; 30% for direct application as fertilizer.



NIOSH estimates that about 500,000 workers in the United States work in jobs which may expose them to ammonia. These occupations range from aluminum workers to wool scourers.

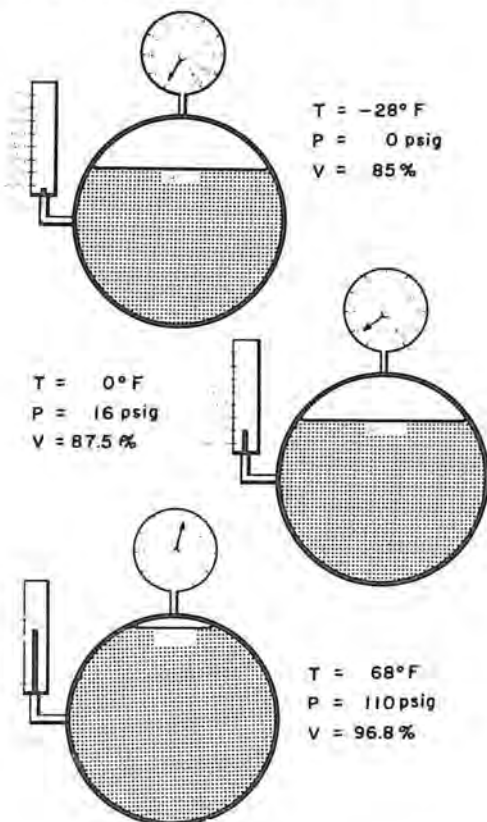
WHAT IS ANHYDROUS AMMONIA?

Ammonia is a chemical compound consisting of one atom of nitrogen and three atoms of hydrogen, and is designated in chemical notation as NH_3 . Ammonia is extremely soluble in water and is frequently used as a water solution called aqua ammonia. Ammonia chemically combines with water to form ammonium hydroxide. Household ammonia is a diluted water solution containing 5-10% ammonia. On the other hand, anhydrous ammonia is essentially pure (99+%) ammonia. "Anhydrous" is a Greek word meaning "without water"; therefore, anhydrous ammonia is ammonia without water.

Anhydrous ammonia is a clear liquid which boils at a temperature of -28°F . In some large storage facilities, liquid anhydrous ammonia is refrigerated and stored at atmospheric pressure. However, the liquid is normally stored in closed containers under pressure. When the pressure is released, the liquid evaporates rapidly, forming an invisible vapor or gas. The rapid evaporation causes the temperature of the liquid to drop until it reaches the normal boiling point of -28°F . This is why ammonia is used in some refrigeration systems.

Liquid anhydrous ammonia weighs less than water (about eight gallons of ammonia weighs the same as five gallons of water) and expands much more

rapidly than water when heated. For example, if liquid anhydrous ammonia in a partially filled closed container is heated from 0°F to 68°F , the volume of the liquid will increase by about 10%. If the tank is 90% full at 0°F , it will become 99% full at 68°F !! At the same time, the pressure in the container will increase from 16 pounds per square inch (psi) to 110 psi. Because of these properties -- unusual expansion of the liquid and rapid increase of the gas pressure when heated -- tanks should not be filled more than 85% full with cold liquid ammonia, nor should liquid ammonia be left trapped in hoses or pipelines. Unless the equipment is protected by pressure or hydrostatic relief valves, it could burst.



Ammonia, especially in the presence of moisture, reacts with and corrodes copper, zinc, and many alloys. Only iron, steel, and certain nonferrous alloys should be used for anhydrous ammonia containers and fittings.

Anhydrous ammonia gas is considerably lighter than air and will rise in dry air. However, ammonia has a tremendous affinity for water. It reacts immediately with the humidity in the air and may remain close to the ground. For this reason, you must be careful to stay upwind of spills, pressure relief valves, and other equipment from which ammonia may be vented.

HOW AMMONIA AFFECTS THE BODY

Small concentrations of ammonia vapor in the air can be extremely irritating to the eyes and to the throat and breathing passages when inhaled. At greater concentrations it can produce convulsive coughing, difficult and painful breathing, and in extreme cases, death.

Injury to the eyes is the most serious hazard of ammonia. Prompt and continued washing with water is essential to prevent permanent injury. In several accidents where persons have had ammonia splashed in their faces or eyes, the fortunate ones who received immediate eye washing suffered only temporary damage (or no damage at all). Others, unable to wash their eyes promptly, sustained permanent eye injury -- frequently resulting in blindness.

Ammonia is caustic to the skin. Skin burns and blisters have developed from exposure to a 2%

ammonia solution for 15 minutes or more. Liquid anhydrous ammonia causes not only chemical burns, but because of the very low temperature, causes the water in the skin to freeze and rupture the cells as it expands. These wounds can be terribly deep and slow healing.

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.

FIRST AID FOR EXPOSURE TO ANHYDROUS AMMONIA CONSISTS OF FLUSHING WITH LARGE QUANTITIES OF WATER FOLLOWED BY FLUSHING WITH MORE WATER -- IMMEDIATELY!! Never handle ammonia without having water easily available.

Inhalation

When ammonia gas is inhaled, the victim should immediately get to or be assisted to an uncontaminated area. If the exposure was to a low concentration of ammonia or very brief, further treatment is usually unnecessary. However, medical assistance should be obtained if the worker has chest or breathing passage pains, or a persisting cough. If the exposure is severe, a physician should be called immediately and informed as completely as possible about the overexposure to ammonia. If available, oxygen can be administered by a trained individual to relieve pain and symptoms of lack of oxygen. If the victim is not

breathing, artificial respiration should be started immediately. The victim should be kept warm and at rest until transported to a place where professional medical care can begin.

Eye Contact

Even if only a small amount of ammonia gets in your eyes, you should flush them for at least 15 minutes with clean, lukewarm water. The entire eye surface and inner lining of the eyelids must be flushed thoroughly. The lids close involuntarily; therefore, it is necessary to hold the eyelids open so that flushing will be thorough. Flushing must begin as soon as possible. One suggestion is to carry clean water on your person in a small eight ounce squeezable container (like a catsup or mustard container). This can be used to get some of the ammonia out of your eyes until you can get to a larger water supply. DO NOT CONSIDER THIS SMALL AMOUNT OF WATER SUFFICIENT -- YOU MUST RINSE YOUR EYES FOR AT LEAST 15 MINUTES.

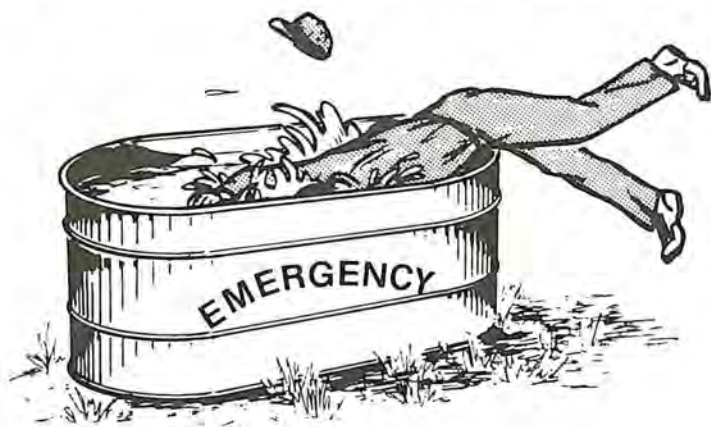


If medical help is not available by then, flushing should be continued for an additional 15 minutes! Another emergency eye flushing method is to duck your head in a bucket or larger container of clean water and rapidly blink and move your eyes around.

Contact lenses must not be worn when you work with anhydrous ammonia because they may trap the ammonia and hold it against the surface of the eye, increasing the hazard. They will also prevent immediate and thorough flushing of the eye surface.

Skin Contact

Any portion of your body which is splashed with or exposed to high concentrations of ammonia should be flushed thoroughly with water. If your clothes become saturated by liquid ammonia, they will probably freeze to your skin. In any case, get under a deluge shower or jump into a stock tank, pond, or other source of water immediately. Jump in with your clothes on and only remove them after they are unfrozen and can be pulled freely from the skin. Do not apply salves or ointments to ammonia burns. Get medical help as soon as possible.



Swallowing

It is very unlikely that anyone will swallow anhydrous ammonia, but if it should happen, again, first aid treatment involves water. Call a doctor immediately! If the victim is conscious, he should swallow large quantities of water. If vomiting begins, place the patient face down with the head lower than the hips to prevent vomitus from entering the lungs. If a victim is in shock, extreme pain, or unconscious, do not try to give him water or induce vomiting.

Summary

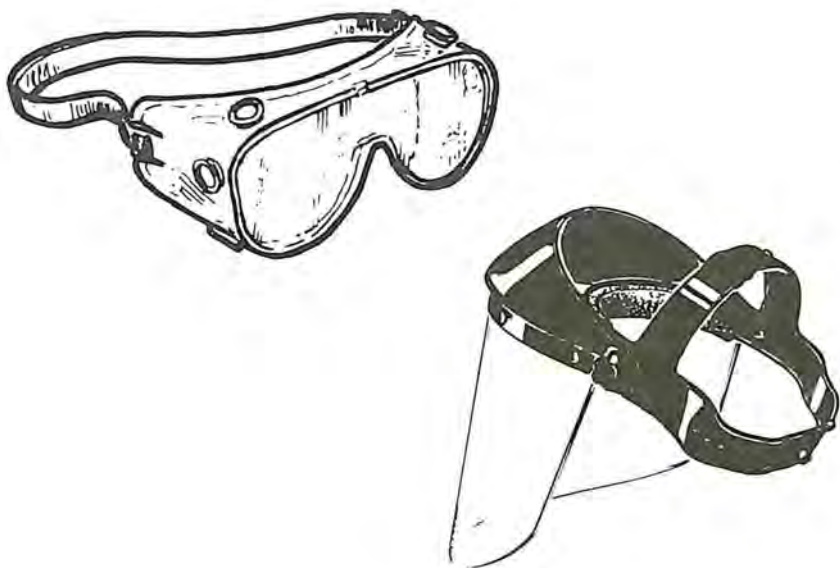
In any accident involving contact with ammonia, immediate flushing of the affected area with large quantities of clean water is essential. In cases of severe exposure, follow with first aid treatment and call a physician at once. Give the physician as much information as possible about the accident.

SECONDS COUNT -- WASH AMMONIA AWAY WITH WATER IMMEDIATELY!

SAFETY AND PERSONAL PROTECTIVE EQUIPMENT

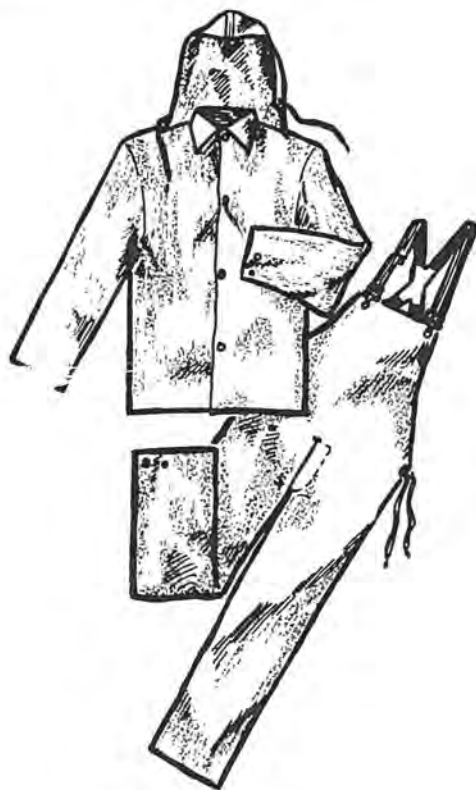
Your workplace must be constructed to prevent as much exposure to ammonia as possible. However, some necessary operations may place you in an area where the risk of contact with ammonia is very high. In such operations you must wear personal protective equipment. Because your vision is so

precious, you should wear eye protection whenever there is the slightest chance that ammonia may get into your eyes. Gas proof goggles are preferable since ammonia gas can dissolve in the tears and penetrate to the eye surface. However, unventilated goggles tend to steam up in both hot and cold weather. Ventilated, splashproof goggles are more comfortable and will provide adequate protection in most cases. In addition, when there is a risk of splashing, a fullface shield should be worn to prevent direct splashing of the face.



When filling or emptying tanks with liquid ammonia, wear goggles and gloves made of or coated with a substance which is resistant to ammonia, such as natural rubber or polyethylene. An emergency (deluge) shower or an open tank of clean water should be nearby for immediate flushing of the body should an exposure occur. If it is necessary to

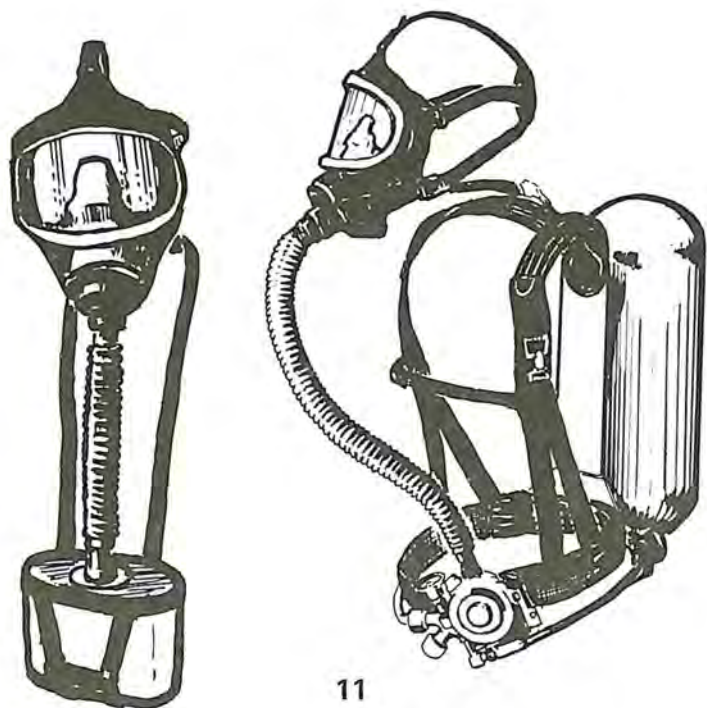
clean up a spill or whenever there is a great likelihood of contacting anhydrous ammonia, boots and a slicker or protective pants and jackets should be worn. If contaminated, the protective garments and gloves should be decontaminated by washing or hosing them off with water before they are removed.



In most bulk plants and other outdoor locations, intermittent releases of ammonia (for example, when couplings are vented) will dissipate immediately. In indoor facilities, general or local ventilation must be used to ensure airborne ammonia concentrations are not greater than the permissible

limit. While these ventilation controls are being installed or repaired, it may be necessary for you to wear a respirator (gas mask).

Your employer should sample and analyze the air in areas you are required to work in or pass through to determine the concentration of ammonia and if proper respiratory protection is required. If it is necessary for you to use respiratory protection, you must have a physical examination to be certain that you are physically capable of working in a respirator. Wearing a respirator can put an additional stress on your system. If you have a heart condition or breathing difficulty, it may be aggravated by wearing a respirator. You must know how to use, clean, and inspect the respirator, and know the limits of protection the respirator will provide. The employer must instruct his employees in these matters.



In order to protect you a respirator must fit properly. The straps should be tight enough to make a snug fit, but not so tight that the respirator digs into your face or that you feel a lot of pressure. If possible, try facepieces made by several different manufacturers to find the one that fits best.

- *Always inspect the respirator before you wear it. Be sure it is in good condition and working properly.

- *Check for air leaks around the edges when you breathe. If the respirator has a full facepiece, pinch off the hose leading into the facepiece and inhale. The facepiece will collapse if you have a good face seal.

- *Special glasses that clip on the fullface respirator should be used; otherwise the temples of your regular glasses will break the seal. Contact lenses must not be worn with your respirator.

- *Facial hair can cause a poor fit. Beards and mustaches which extend out of, or sideburns which extend into, the mask will cause leakage.

- *Wear your dentures while you are wearing a respirator. If you are missing teeth, you may not get a good fit.

- *Danger Signals--The following danger signals indicate potential respirator problems:

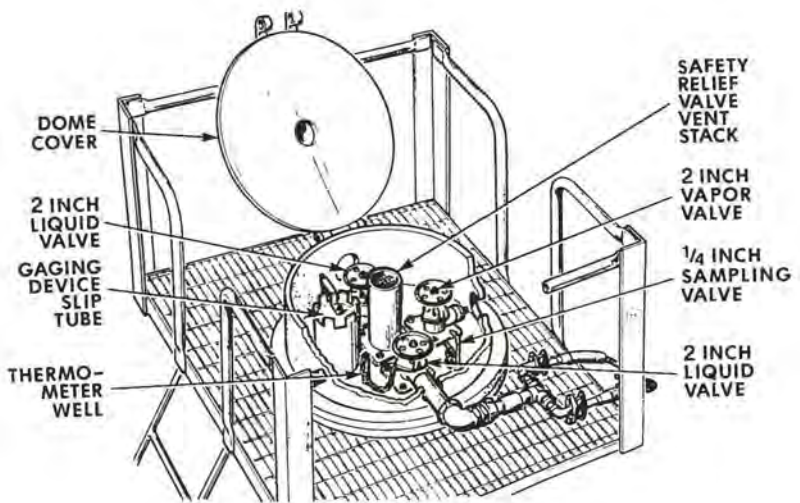
 - .If you smell ammonia or your eyes, nose, or throat become irritated;

- .If it becomes difficult to breathe;
- .If the air you are breathing becomes unusually warm;
- .If you feel like vomiting or become dizzy;
- .If the specified lifetime of the canister or cartridge is used.

If you notice any of these danger signals, get into fresh air immediately. Your canister or cartridge may be used up or abnormal conditions may be creating gas concentrations which are beyond the limit of your respirator.

PLANT OPERATIONS

It is impossible to discuss here how you are to perform the tasks assigned to you in your workplace. Equipment, physical layout, job responsibilities, etc., vary from plant to plant. Your employer must instruct you in the proper methods to perform your duties. However, here are some general guidelines about handling anhydrous ammonia -- especially in transfer operations.



Before you start a task, think it over. Be sure you know how to complete it. What could go wrong? What should you do if it does? If you have any doubts, be sure to ask your supervisor.

Learn how to operate each valve you must open or close. Know where each hose or pipeline goes.

Wear protective gloves and goggles whenever you hook up or disconnect hoses. A fullface shield is also recommended. Make certain emergency water is near by and know where it is.

When connecting liquid and vapor lines remember: liquid lines are larger.

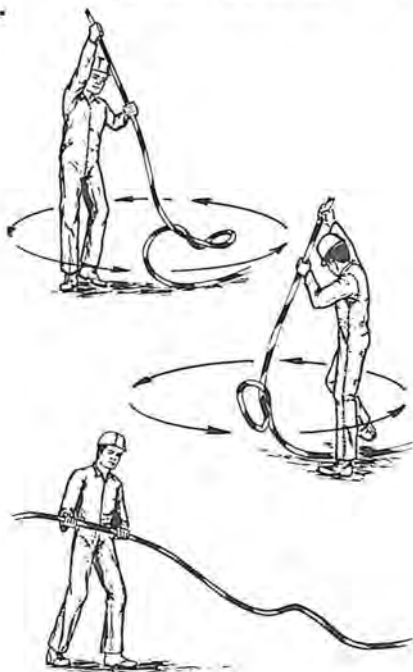
Whenever you can, work upwind of pressure relief valves, hose connections, and other equipment from which ammonia may be released. If you are working inside, be sure the

ventilation system is turned on and is operating properly.

Most ammonia fittings used for filling and transfer hoses are designed to be hand tightened. Do not use wrenches.

Filler hoses should be carried only by the valve body or coupling -- never by the valve hand wheel. Make sure the hose and fittings are free from rust or dirt. Hoses must not be stretched to make the connections.

Do not use a kinked hose. Do not try to "throw out" a kink -- unwind it by holding the valve opening away from your body and step over the hose while at the same time twisting your body and the hose in the direction of the kink. Stow hoses properly on racks to prevent kinking or damage by vehicles or from dragging.



Be sure all bleed valves (except the fixed liquid level gauge on the tank you are filling) are closed before opening the filling valves. Open fill valves slowly to prevent tripping the excess flow valve. Check the hose for "knots" or swelling and check the couplings for leaks. Replace damaged hoses and tighten couplings, if necessary, before proceeding. After the system is found ready, open the filling valve fully. When the flow is restricted by a partially open valve, the flow rate may not be great enough to trip the excess flow valve if a break in the system occurs downstream.

Know how to operate all gauges, meters, etc. Use them and stay in attendance to ensure that the transfer takes place properly. Do not overfill.

Six Sure Steps for Safe Transfer Operations

1. Be sure that ample clean water is available for first aid.
2. Be sure that the equipment is suitable for use with anhydrous ammonia; don't try to get by with substitutes. Never tamper with pressure relief valves or other safety devices.
3. Be sure to wear tight fitting safety goggles and protective gloves impervious to ammonia. A fullface shield should also be worn if splashing can occur.

4. Be sure to work upwind of and stay clear of hose and valve openings as much as possible.
5. Be sure that transfer operations are not left unattended. Never overfill a tank (normally, not greater than 85% of capacity).
6. Be sure the pressure is relieved before disconnecting hoses or parts. Always close valves, disconnect hoses and rack or store them properly, and secure locking devices before leaving the transfer site.

Bleed hoses before disconnecting them, making sure the escaping ammonia is directed away from you or into water provided for that purpose. NEVER VENT AMMONIA INTO WATER DESIGNATED FOR FIRST AID OR EMERGENCIES. If bleeding takes longer than usual, the shut off valve may be leaking. Do not disconnect the hose, but report it to your supervisor at once.

Unless you have received instructions, do not attempt to make repairs on equipment or fittings. Report anything out of the ordinary to your supervisor.

Report any injury you may receive -- cuts, bruises, overexposures to ammonia, etc. -- no matter how small. Also report any "near misses"--accidents which could have happened but didn't. It may be possible to prevent the circumstances from happening again by changing

a procedure or using different equipment. If they go uncorrected, the next time may not be a miss.

HANDLING AND USE OF CYLINDERS

If you work with anhydrous ammonia in cylinders, here are some things to keep in mind when handling or using them:

Cylinders should never be subjected to rough handling or to mechanical shock such as dropping or bumping. This is especially true during unloading or transporting operations. Use proper handling equipment -- suitable platforms, boats, or cradles for unloading by cranes. Use a hand truck, roll platform, fork truck, or similar device with the cylinders securely fastened to transport them. Avoid dragging, sliding, or rolling them on the bottom edges as much as possible.

Rack, block, or otherwise secure cylinders so that they are stored and used in a stable manner. Do not store or use cylinders near sources of heat, or potential sources, such as flammable substances or in direct sunlight. Cylinders should never reach a temperature above 125°F.

Do not remove the valve protection until you are ready to withdraw ammonia from the cylinder. When the cylinder is empty, disconnect it from the system, replace the plug or nut on the valve outlet, and replace the protecting cap securely. Mark or fasten

an EMPTY tag on it and store it separately from full cylinders.

Both tube and bottle type cylinders may be used in a horizontal position. When the valve outlet is uppermost, liquid is discharged; ammonia vapor is discharged when the valve outlet points down.

The rate at which ammonia vapor is discharged depends upon the surface area of the liquid ammonia and upon the temperature. Cylinders must never be warmed directly by hot water, steam, or flame. As vapor is withdrawn, the liquid cools; frost may form on the cylinder wall if vapor discharge is very rapid. Should a bottle type cylinder freeze to the floor or ground, never try to loosen it by prying under the valve end; it should be allowed to thaw naturally or by the application of water.

Cylinders are often manifolded when high flow rates -- either liquid or vapor -- are desired. If cylinders are manifolded for liquid delivery, they should be weighed immediately after the valve is closed. During manifolding, a temperature difference will cause liquid to flow from the warmer to the cooler container and may result in overfilling the latter. An over-filled container should be adjusted immediately; otherwise a temperature rise may cause a hydrostatic rupture. All lines for handling liquid anhydrous ammonia which can be closed off at each end must be protected with hydrostatic relief valves for the same reason. Be certain the valve on the manifold, as well as the cylinder valve, is closed before disconnecting the cylinder.

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

EMERGENCIES

Your employer must have a written procedure describing actions to be taken in cases of emergency. Know your responsibilities and follow them to the letter. Take seriously all emergency drills -- they are to ensure that everyone knows his part in the procedure. If you are to put on a gas mask, slicker, boots, and other protective equipment to close off certain valves, you should have had experience with such equipment before its use is really necessary. It's a good idea to practice using an eyewash fountain and to know what it's like to be under an emergency shower before an emergency situation should arise.

ACCIDENTS INVOLVING AMMONIA

Any unintended release of anhydrous ammonia must be considered a hazardous situation. According to accident reports, ammonia has been accidentally released in the following ways:

- *overfilling of tanks -- operator was distracted or forgot;

- *hose filling transport was left attached to the riser and was broken when transport pulled away;
- *hose-end valve was knocked open when it struck an object, or rolled across the tank or ground;
- *pressure relief valve was vented while a person was in line with the discharge;
- *hose burst during transfer -- usually because an old or mistreated hose was used;
- *hose coupling was not bled before it was disconnected;
- *cylinder was disconnected from manifold when manifold valve was open;
- *unsecured cylinder became a projectile when it toppled and valve was knocked off.

All these accidents could have been avoided if the operators had been more attentive or if the equipment had been maintained properly.

SAFE WORKING PRACTICES

This booklet was prepared for you in the hope that it will help you to better understand the hazards of anhydrous ammonia, and to give you some good pointers in working safely with it. It is also hoped that you will be stimulated to take the initiative to ensure safe working conditions

yourself. Know your job and the equipment you work with. When necessary, wear protective clothing and equipment provided and learn to adjust it for maximum protection. Be sure first aid water is close by. Keep your work area clean and orderly. Good housekeeping in the workplace is essential. Many people depend on you -- your employer, your fellow workers, but most of all, your family. Stay safe and healthy and don't let any of them down.

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.



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Room 1401
Boston, Massachusetts 02203
617/223-6668

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415/556-3781

DHEW, Region X
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Seattle, Washington 98101
206/442-0530

OSHA REGIONAL OFFICES

Region I

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

Region VIII

U.S. Department of Labor
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Federal Building, Room 15010, 1961 Stout Street
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Region IX

U.S. Department of Labor
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Post Office Box 36017
San Francisco, California 94102 Telephone: 415/556-0584

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