

Anhydrous Ammonia: Managing The Risks

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John Nowatzki, Ag Machine Systems Specialist

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Introduction

More anhydrous ammonia is used as fertilizer in North Dakota than any other nitrogen fertilizer source. Anhydrous ammonia is classified as a hazardous substance. Most accidents with anhydrous ammonia are due to uncontrolled releases. Few problems occur when the ammonia is being handled and applied as intended. Most uncontrolled releases are due to improper procedures, careless or untrained workers, or faulty equipment. Protective equipment is required by law to be available where anhydrous ammonia is handled or applied. Wearing protective equipment greatly reduces the chance of injury from an ammonia release. Countless tons of anhydrous ammonia are applied every crop year without problems; safe procedures and good-quality equipment do work.

Anhydrous ammonia has the potential to be one of the most dangerous chemicals used in agriculture today. It is used and stored under high pressures, which requires specially designed and well-maintained equipment. Those who work with anhydrous ammonia must be trained to follow exact procedures in handling it.

Chemistry of Anhydrous Ammonia

Ammonia is a chemical compound used as a fertilizer because it is rich in nitrogen. Its chemical formula is NH_3 , which means that it consists of one atom of nitrogen and three

atoms of hydrogen per molecule. Because the atomic weights of nitrogen and hydrogen are not the same, the weight ratio is 82.5 percent nitrogen to 17.5 percent hydrogen. Anhydrous means the ammonia is without water. This distinguishes it from ammonia/water solutions.

Characteristics of Anhydrous Ammonia

Odor

Anhydrous ammonia is a clear, colorless gas at standard temperature and pressure conditions and has a very characteristic odor. The odor is the strongest safety feature of the product. At a concentration of only 50 parts per million (ppm), one sniff tells what is in the air. Normally, the odor will drive a person away from the area. A concentration of more than 5,000 ppm will disable a person so that escape is impossible and suffocation results.

Pressure for Storage

Anhydrous ammonia is a liquid when compressed or cooled. It is stored under pressure to prevent vaporization so a large volume can be available for use. One cubic foot of anhydrous ammonia in a liquid state produces 855 cubic feet of ammonia gas. Retail storage tanks and nurse tanks for anhydrous ammonia are built to withstand internal pressures of at least 250 pounds per square inch (psi). Terminal storage tanks refrigerate ammonia to minus 28 degrees Fahrenheit. At this temperature, the storage pressure is less than 1 psi.

Temperature/Pressure Relationships

When anhydrous ammonia is released from compression in a storage tank (200 psi) to the atmosphere (0 psi), the temperature drops from 100 F to minus 28 F. At this temperature, ammonia freeze-burns human skin on contact. Clothing actually is frozen to the skin. Since anhydrous ammonia is stored under high pressure, a sudden rupture can shoot ammonia 10 to 20 feet from the point of release.

Table 1. Exposure Levels and The Human Body.

| Exposure (ppm) | Effect on the Body | Permissible Exposure |
|----------------|--------------------|----------------------|
|----------------|--------------------|----------------------|

| | | |
|-----------|--|--|
| 50 ppm | Detectable by most people | No injury from prolonged, or repeated exposure |
| 134 ppm | Irritation of nose and throat | Eight hours maximum exposure |
| 700 ppm | Coughing, severe eye irritation, may lead to loss of sight | One hour maximum exposure |
| 1,700 ppm | Serious lung damage, death unless treated | No exposure permissible |
| 2,000 ppm | Skin blisters and burns within seconds | No exposure permissible |
| 5,000 ppm | Suffocation within minutes | No exposure permissible |

Flammability

Anhydrous ammonia is generally not considered to be a flammable hazardous product because its temperature of ignition is greater than 1,560 degrees F and the ammonia/air mixture must be 16 percent to 25 percent ammonia vapor for ignition.

In spite of the difficulty of igniting such a mixture, never weld on any container or piping that has not been completely decontaminated and cleaned of all ammonia and its salts. Remember, never weld on a closed container of any kind; all containers must be completely cleaned and vented. Apply heat only to open containers, including all piping. Welding should be done only by a welding firm with a type "R" certification in compliance with the North Dakota Century Code.

Anhydrous

Anhydrous ammonia contains no water. Anhydrous is the Greek word for "without water." Anhydrous ammonia has a very strong affinity for water. It requires large quantities of water to neutralize its caustic effects on moist areas of the body. When anhydrous ammonia contacts water, it forms ammonium hydroxide. Living tissue is dehydrated quickly and the cells destroyed on contact. Anhydrous ammonia attacks any moist part of the body: eyes, ears, nose, throat, bronchia, lungs, any moist skin. Any tissue containing moisture is chemically burned.

Caustic Nature

When anhydrous ammonia comes in contact with water, it forms an alkali that chemically burns animal tissue. The chemical burns into the body tissue unless it is diluted by large quantities of water. Anhydrous ammonia is extremely destructive to animal tissue. Skin is reduced to a sticky, gooey substance as the chemical burn progresses. Skin that is chemically burned by the ammonia actually is killed and is not capable of healing or replacing itself. Damaged tissue must be removed surgically so that healing can proceed. The results often are disfiguring.

Types of Exposure

Skin

Anhydrous ammonia causes freezing and chemical burn wherever skin and clothing are moist. The subzero temperature of escaping anhydrous ammonia freezes clothing to the body. Do not attempt to remove any clothing that is frozen to the skin. It must be thawed loose first or skin tissue may be pulled from the victim.

The caustic nature of anhydrous ammonia causes skin and tissue burns similar to burns from heat. Do not apply salves, creams or ointments of any kind to the injury. The caustic burning can be stopped only by dilution with large quantities of water.

Eyes

Eyes are continually bathed in moisture. Anhydrous ammonia will seek this moisture. The burns will result in damage to the eyes, such as cataracts, glaucoma and possibly some permanent vision loss and disfigurement.

If eyes have been exposed to anhydrous ammonia, they must be flushed with water immediately and continually and the victim must be taken to a doctor immediately. Everyone who works with anhydrous ammonia should carry a 6- or 8-ounce squeeze bottle of fresh water on their person at all times. This small amount of water will last only long enough for the worker to get to a larger quantity of water, but it may make the difference between blindness and sight.

Initially, forcing the victim's eyelids open after the exposure may be necessary. The ammonia trapped under the eyelids must be flushed out with water or it will continue to burn the eye and related tissues.

Lungs

At low concentrations, the odor of anhydrous ammonia usually will drive the unprotected worker away from the scene. At a higher level of concentration (see Table 2), the worker may not escape without inhaling a dangerous dose. The entire respiratory system is very moist, so anhydrous ammonia will be attracted naturally to that part of the body. When a concentrated level of anhydrous ammonia is inhaled, it will burn the respiratory system quickly. The victim may hurt too much to breathe. The respiratory system essentially may be paralyzed due to the pain.

Table 2. Temperature and Pressure Relationships.

| Degrees F | Pressure (psi) |
|-----------|----------------|
| -28 F | 0 psi |
| 0 F | 16 psi |
| 32 F | 48 psi |
| 60 F | 93 psi |
| 100 F | 200 psi |

First-response rescue workers may not be able to treat a serious inhalation exposure. Medical technicians may be able to administer oxygen to aid breathing after their arrival on the scene. Maintaining adequate respiration for the victim until delivery to a medical facility may be difficult.

Respiratory protection is extremely important, but also limited in what equipment is available. A two-cartridge respirator is effective only for exposure levels of less than 300 ppm. Canister type respirators may be effective for longer periods at higher concentrations, but without skin protection, walking through an ammonia cloud is generally not advisable. A self-contained breathing apparatus (SCBA), which supplies the air to be breathed, and a sealed, protective HazMat suit are required for working in a cloud of escaping anhydrous ammonia. Anything less will not sufficiently protect a person in this situation.

First Aid Calls For Water + Water + Water

Start first aid treatment immediately when someone is exposed to anhydrous ammonia. The chemical burning starts instantly and the injury becomes worse as time passes. Treatment consists of flushing the affected body area(s) with large quantities of water.

One short flushing is not sufficient. Maintain a steady flow of water over the affected area(s) until the victim is delivered to medical help. The water provided with each nurse tank or other container will not be enough. Five gallons flowing in a pencil-sized stream will last approximately seven minutes. Additional water should be carried on every tractor used in field applications and in every field support motor vehicle. Collect as much water as possible and continue flushing while arrangements are being made to transport the victim to a medical facility. Do not reuse the water; it will not provide relief, having already absorbed anhydrous ammonia.

Transport To Medical Facility

Make arrangements to transport the victim to a doctor or hospital immediately after exposure. First aid can be given while transport arrangements are being made, but get the victim to medical care as soon as possible. Notify the hospital that the victim is being transported. First aid flushing should be continued while in transport.

Uncontrolled Releases

Clouds of anhydrous ammonia are subject to the unpredictability of air movement; they will change direction as quickly as the breeze. Clouds of ammonia may be nearly invisible in some atmospheric conditions, but they appear as white clouds when the atmosphere is damp. Rain will absorb the ammonia and remove it from the air.

Anhydrous ammonia is heavier than air and will settle in the low areas of the surrounding landscape, such as road ditches, sloughs and valleys. People in threatened areas must be warned of the release and advised to leave the area until the release has been controlled and the area is considered safe for re-entry. These decisions should be made by emergency personnel, such as a local fire department. Animals and livestock should be removed from the threatened area after people have been taken care of first. Most animals will do their best to leave the area long before ammonia concentrations become strong enough to cause them much discomfort.

Protective Equipment for Anhydrous Ammonia

Due to the seriousness of exposure to anhydrous ammonia, personal protective equipment must be well-maintained. This includes unvented goggles; rubber gloves; respirator; heavy-duty, long-sleeved shirt; and long pants.

The goggles and gloves are to be kept in a safety equipment container mounted on each nurse tank and be accessible from the ground. Having another set readily available on the tractor is an excellent idea. Suitable gloves are made of rubber and are impervious to ammonia, and have long cuffs that should be turned back to prevent drips from running

down the arm when hands are elevated. The fit should be loose enough for easy removal but snug enough for good protection.

Goggles must be unvented to keep the anhydrous ammonia away from the eyes. Only the un-vented type of goggles will minimize ammonia exposure to the eyes. Pesticide-type vented goggles are not suitable because ammonia can pass through the indirect vents. Open-vented shop goggles never should be used.

A respirator equipped with anhydrous ammonia cartridges approved by the National Institute for Occupational Safety and Health (NIOSH) is designed only for low-level exposures not to exceed more than 300 ppm. This type of respirator does not have the capacity to protect a person from high-level exposures.

Clothing should be heavy duty and of a tightly woven fabric. Light weight, thin fabrics will not slow down or prevent anhydrous ammonia from passing through. The clothing should be tightly closed at the cuffs and collar to restrict the entry of anhydrous ammonia.

Five gallons of fresh, clean water are to be kept in the emergency water reservoir on the nurse tank and accessible from the ground, according to North Dakota Century Code. Another 5 gallons should be maintained on the tractor for use when the nurse tank water may not be easily accessible or runs out. This water should be changed daily to keep it clean. Dirty water may not flow through the reservoir hose, preventing treatment of the exposure.

Every worker should carry a 6- or 8-ounce plastic squirt bottle in their shirt pocket for the first flushing of the eyes. It should be used immediately and is intended to give the victim time to get to the 5-gallon supply.

Protective Equipment For Bulk Storage Facilities

Additional protective equipment is required for bulk storage of anhydrous ammonia. A rain suit and two canister-type gas masks are required by law in the North Dakota Century Code (Figure 1). They will protect you only in areas of low ammonia concentrations. A cartridge-type respirator is not approved for use at a bulk storage facility.

Figure 1. Emergency Equipment (for Escape Only) (5KB b&w illustration)

Call the local fire department if a major leak occurs. The fire department has self-contained breathing apparatus (SCBA) and protective suits. SCBA units supply air to breath, rather than just filtering available air. The protective suits are sealed to keep anhydrous ammonia out.

A water reservoir of at least 150 gallons of clean water must be available at a bulk facility, which would enable a person to submerge in water should he or she be exposed

to anhydrous ammonia. A minimum 150-gallon stock water tank will meet this requirement.

Keep the informative decals on the equipment up to date. The decals indicate what each system component does and identifies the first aid water, other protective equipment and protective procedures.

Keep the operator's manual for the bulk storage unit in a readily available place for reference when handling the ammonia. Review the instructions when needed.

Nurse Tank Safety Check

Bleeder Valves

The bleeder valve is used to bleed or drain pressurized anhydrous ammonia from a closed hose or valve (Figure 2). Opening a bleeder valve will release pressurized anhydrous ammonia slowly to minimize the risk of a sudden release and exposure. Bleeder valves should be opened slowly. Always position yourself upwind or across wind from a bleeder valve to be opened. Never disconnect a nurse tank hose without first draining it with the bleeder valve. Bleeder valves are used in several processes of handling anhydrous ammonia.

[Figure 2. Bleeder Valve](#) (3KB b&w illustration)

Nurse Tank Hose

The nurse tank hose should be inspected daily. It must be maintained in a safe condition since it transfers anhydrous ammonia under high pressure from the nurse tank to the applicator tool bar. Although the hose is protected by an excess flow valve in the liquid withdrawal valve on the nurse tank, the hose must be in good condition to prevent an uncontrolled release (Table 3, Nurse Tank Hose Safety Checklist).

Table 3. Nurse Tank Hose Safety Checklist*

| Nurse Tank Hose | OK | Not OK |
|-------------------------|-----------|---------------|
| Cuts or Abrasions | | |
| Soft Spots/Bulges | | |
| Blistering/Loose Layers | | |
| Kinking/Flattening | | |

| | | |
|-----------------------------------|--|--|
| Coupler/Hose Slippage | | |
| Type of Fittings (correct metals) | | |
| Current Dated Hose | | |

* If any of these checklist items are "not OK," the nurse tank hose should be replaced.

** "Anhydrous Ammonia," maximum working pressure, manufacturer's name/trademark, year of manufacture.

The nurse tank hose must be made of approved materials and braiding, such as rayon, rylon/Kevlar or stainless steel. A hose made with rayon braiding is good for two years from date of manufacture while a hose with nylon/Kevlar is good for four years from date of manufacture and stainless steel is good for six years from date of manufacture (Figure 3).

Figure 3. Nurse Tank Hose (4KB b&w illustration)

The nurse tank hose always should be "parked" or attached to the Acme "parking" fitting on the nurse tank when not in use during the season. Do not drape a hose over any edge that allows the hose to become flat. During the off-season, the hose should be stored in a vertical position, hanging from the shoulder of a coupling in a cool, dry location.

Most hose failures occur within 12 inches of the hose end due to flexing of the hose while attached to the nurse tank or applicator. Select hose fittings that will provide the most support and minimize this type of flexing. Examine the hose carefully before making connections to find problems that may cause a hose failure.

Nurse Tank

The tank must conform to design guidelines provided by the American National Standards Institute (ANSI). The tank and all of its fittings, including pressure welds, fittings, gauges, hoses, safety valves and metering devices, must withstand a minimum working pressure of 250 psi (Figure 4).

Figure 4 – Applicator Tank and Valves (7KB b&w illustration) – **Nurse Tank and Valves** (9KB b&w illustration)

The tank should be painted silver or white to reduce temperatures and pressures resulting from solar heating. Surface defects, such as rust, dents and gouges, reduce the integrity of the tank as a high-pressure container and are not acceptable. North Dakota Century Code specifies that less than 10 percent of the surface may be corroded or missing paint.

The nurse tank hose should have an Acme "parking fitting" to be "parked" on when not in use. The fitting should be installed in such a position that prevents strain on the hose when it is "parked."

The tank must be labeled correctly on each end and side with the green diamond around the words DOT (Department of Transportation) "NON-FLAMMABLE GAS" and on each side and end with "Anhydrous Ammonia" in letters not less than 2 inches high. Safety and first aid instructions must be on the tank. All valves must be identified as to liquid or vapor service.

North Dakota law requires anhydrous ammonia nurse tanks, empty or full, to display either a slow moving vehicle (SMV) sign or a lighted rotating or flashing amber light while on a public roadway. Any vehicle or towed trailer/wagon displaying an SMV sign is restricted to a road speed of not more than 25 miles per hour. Anhydrous ammonia nurse tanks, therefore, cannot be towed at a speed exceeding 25 miles per hour.

The protective equipment kit, containing gloves and goggles, must be attached to the tank and accessible from the ground. The emergency water reservoir also must be attached to the nurse tank and be filled with 5 gallons of clean, fresh water. The water should be changed at least daily because it can absorb ammonia from the immediate environment.

Table 4. Nurse Tank Safety Checklist

| Nurse Tank | OK | Not OK |
|------------------------------|-----------|---------------|
| Paint | | |
| Rust | | |
| Dents | | |
| Gouges | | |
| Parking Fitting for Hose | | |
| DOT Decals | | |
| Anhydrous Ammonia Decals | | |
| Safety Decals | | |
| First Aid Decals | | |
| Valve Labeling Decals | | |
| Slow Moving Sign | | |
| Safety Kit (gloves, goggles) | | |
| First Aid Water | | |

Nurse Tank Gauges and Valves

Regularly scheduled maintenance must be conducted to ensure that the gauges and valves on a nurse tank are suitable for service. The degree of hazard increases as parts get older. A visual inspection should be completed before each use.

Some nurse tank components have a service life limitation based on time. The service life cannot be extended. Use a checklist to keep an accurate inventory when parts need to be replaced. A suggested checklist is provided in Table 5, Nurse Tank Valve and Gauge Safety Checklist. When a component is found to be defective, it must be repaired or replaced.

Table 5. Nurse Tank Valve and Gauge Safety Checklist*

| Nurse Tank Valves and Gauges | OK | Not OK |
|---|-----------|---------------|
| Liquid Withdrawal Valve (5 year replacement) | | |
| Excess Flow Valve (5 year replacement) | | |
| Liquid Fill Valve (5 year replacement) | | |
| Pressure Gauge | | |
| Vapor Return Valve (5 year replacement) | | |
| Liquid Level Float Gauge | | |
| Hydrostatic Relief Valve | | |
| Bleeder Valves | | |
| Pressure/Safety Relief Valve (5 year replacement) | | |
| Roll Cage for Valves/Gauges | | |
| Tank Drain | | |

* If any items are marked "Not OK," they should be replaced.

The liquid withdrawal valve (Figure 4) connects the nurse tank hose to the interior of the nurse tank for removal of the ammonia. The intake for this valve reaches nearly to the bottom of the tank so that liquid ammonia will be withdrawn until the tank is nearly empty. It contains an excess flow valve preventing anhydrous ammonia from flowing out of the tank too quickly if the nurse tank hose breaks (Figure 5). The excess flow valve has a five-year replacement requirement.

[Figure 5. Excess Flow Valve](#) (3KB b&w illustration)

The liquid fill valve (Figure 4) is used while filling the nurse tank from a bulk storage facility. It has an excess flow valve preventing anhydrous ammonia from flowing back out of the nurse tank if the hose breaks. This valve has a five-year replacement requirement.

The pressure gauge (Figure 4) indicates the interior pressure of the nurse tank. This interior pressure is affected by the quantity and temperature of the anhydrous ammonia in the tank. The pressure gauge does not have a time limit to its service life, so it needs to be replaced only when it fails to function properly.

The fixed liquid level gauge is a bleeder valve with a tube extending into the tank to a depth where the tank would be 85 percent full of liquid (Figure 6). The valve should be partially opened when the tank is being filled so it will bleed off, or spurt, liquid anhydrous ammonia when the tank is 85 percent full. The gauge is accurate only if the tank is level. Do not continue filling the tank after the valve releases liquid anhydrous ammonia.

Figure 6. Fixed Liquid Level Gauge (4KB b&w illustration)

The vapor return valve is used while filling the nurse tank at a bulk storage facility. As liquid anhydrous ammonia is transferred into the nurse tank, the vapor in the nurse tank is transferred to the bulk storage tank. The vapor valve has an excess flow valve (which has a five-year replacement requirement). The excess flow valve prevents release of anhydrous ammonia vapors from the nurse tank if the vapor valve fails.

A hydrostatic relief valve should be used anywhere anhydrous ammonia may be trapped in any section of the liquid or vapor lines of the system (Figure 7). It opens at 365 psi to relieve excess pressure due to liquid expansion.

Figure 7. Hydrostatic Relief Valve (2KB b&w illustration)

The liquid level float gauge indicates the level of liquid anhydrous ammonia in the tank (Figure 8). The fixed liquid level gauge (Figure 4) should be used to determine the 85 percent full level when filling the tank instead of the liquid level float gauge.

Figure 8. Float Gauge (3KB b&w illustration)

The safety relief valve also is known as the pressure-relief valve. This valve is on top of the tank (Figure 4) and prevents excessive pressure from building up in the tank caused by overfilling or expansion from heat (Figure 9). The valve opens directly to the atmosphere when the tank reaches 250 to 265 psi and closes when the interior pressure drops below 250 psi. It must be replaced every five years if it has nonmetallic seats and tested every five years in lieu of replacement if it has metallic seats. Repairs can be done only by a repair organization with a valid "VR" certificate of authorization from the National Board of Boiler and Pressure Vessel Inspectors. This valve must have a rain cap

in place to prevent damage from moisture and corrosion. The safety relief valve is not adjustable and should be replaced if it is inoperable.

Figure 9. Pressure-Relief Valve (4KB b&w illustration)

The rotary gauge (Figure 10) mounted on the end of an anhydrous ammonia tank, bulk tank, nurse tank or applicator tank consists of a dip tube inside the tank and a bleeder valve. This gauge is used to determine the actual level of anhydrous ammonia in the tank. It is accurate only if the tank is level. The indicator shows the liquid level in the tank when the bleeder valve is opened and the knob is rotated to the point where liquid spurts from the bleeder valve.

Figure 10. Rotary Gauge (3KB b&w illustration)

Back-check valves (Figure 11), part of the bulk storage facility, are used to control the direction of flow of anhydrous ammonia when unloading a truck or rail tank car, preventing a backflow from the bulk tank to the truck or rail tank car. A flow in the wrong direction causes the valve to snap shut. It will open only when the direction of flow is correct.

Figure 11. Back-Check Valve (3KB b&w illustration)

The emergency shut-off valve is another valve not found on a nurse or applicator tank (Figure 12). It also is part of the bulk storage facility used to stop the flow of anhydrous ammonia when the operator of the facility detects an emergency situation and decides to stop the transfer of anhydrous ammonia immediately. This valve is on the discharge side of the transfer pump.

Figure 12. Emergency Shut Off Valve (6KB b&w illustration)

The roll cage protects gauges and valves if the nurse tank rolls over. The roll cage must be strong enough to prevent damage to the gauges and valves.

Nurse Tank Running Gear

The nurse tank running gear should be inspected before each use. Refer to Table 6 for a suggested safety checklist.

Table 6. Nurse Tank Running Gear Components

| Items to Check | OK | Not OK |
|-------------------------|-----------|---------------|
| Hitch Pin & Safety Clip | | |
| Safety Chains & Hooks | | |

| | | |
|--------------------------|--|--|
| Lug Nuts Tight On Wheels | | |
| Tire Pressure | | |
| Good Tires | | |
| Solid Frame, No Cracks | | |
| Free-rolling Wheels | | |
| Proper Steering | | |
| Tank Secure | | |

The use of a safety clip on the hitch pin when towing anhydrous ammonia nurse tanks on and off the road is essential to your safety and that of the public. The safety clip will keep the hitch pin from working out and releasing the nurse tank.

Always attach safety chains when towing anhydrous ammonia nurse tanks on public roads. Safety chains are required by North Dakota law. The safety clip will keep the hitch pin from working out and releasing the nurse tank. The chains help ensure that the vehicle towing the nurse tank will remain in control of the nurse tank if the hitch pin fails.

Check the air pressure in the tires each time the nurse tank is used and inspect them for cuts, bruises and tread wear. Tires used on nurse tanks are designed for low-speed travel not to exceed 25 mph. Follow the restricted speed requirements for anhydrous ammonia both on and off the road.

Inspect the nurse tank wagon frame before each use, inspecting for cracks, broken welds and bent members. The bolts and nuts that attach the tank to the frame are especially subject to loosening or breaking.

Wheel bearings should be checked and repacked annually. Steering systems should be checked regularly and lubricated.

Anhydrous Ammonia Applicator Components

The breakaway coupler (Figure 13) is designed to prevent an uncontrolled release when a nurse tank releases from the applicator and the nurse tank hose separates. A spring-loaded valve closes when the coupler separates from the main body to prevent anhydrous ammonia from flowing out of the hose or the applicator. The breakaway coupler is dated and has a service life of three years. The replacement date is stamped on the coupler.

Figure 13. Breakaway Coupler (5KB b&w illustration)

Follow these steps to reconnect a breakaway coupler:

1. Put on the gloves and goggles from the emergency kit on the nurse tank. Make sure emergency water is available.
2. Check the wind direction. Always stand upwind when handling ammonia equipment so that ammonia vapors blow away from you.
3. Pick up the hose from the ground and place it on the tank or applicator so it is not in the way when reattaching the nurse tank and the applicator.
4. Make necessary hitch repairs or replacements and reattach the nurse tank to the applicator, using a safety clip on the hitch pin and the nurse tank safety chains.
5. Close the nurse tank liquid withdrawal valve, nurse tank hose valve and the applicator flow meter. Failure to close any of these valves may result in a dangerous spray of ammonia.
6. Point the hose end away from you and close the hose end valve. Point the bleed hole away from your face and slowly open the bleeder valve.
7. Stand so that your face is away from the opening of the bleeder valve on the breakaway coupler. Slowly open the bleeder valve on the breakaway coupler unit. Keep the bleeder valves open until all reconnections have been made. Liquid ammonia in the hose can vaporize and pressurize the hose after the hose valves are closed.
8. Open the applicator flow meter shut-off valve to prevent pressure from building in the applicator flow meter system.
9. AFTER the ammonia has been drained from the hose and breakaway coupler body, clean all soil and debris from the hose end and breakaway coupler fitting. Soil or debris can interfere with the applicator flow metering system.
10. Insert the male coupler (hose end fitting) back into the female coupler of the breakaway coupler unit. Be sure the couplers are securely reattached.
11. Close the applicator flow meter and all bleeder valves that were opened.
12. Open the nurse tank liquid withdrawal valve and hose end valve when ready. If all connections are tight and do not leak, replace the gloves and goggles in the nurse tank emergency kit.

Follow the instructions for your particular breakaway valve if they differ from the instructions listed above. However, never modify the written instructions by changing or eliminating steps.

Safety features should be checked each time before using the equipment in the field. See Table 7 for a checklist to prevent forgetting a safety check.

Table 7. Applicator Components

| Items to Check | OK | Not OK |
|---|-----------|---------------|
| Breakaway/Quick Coupler (3 year service life) | | |
| Safety Locking Hitch Pin | | |

| | | |
|--|--|--|
| Safety Chain Attached | | |
| Shut-Off Mechanism Valve and Controls | | |
| Applicator Knife Condition | | |
| Knives Not Plugged | | |
| All Fittings Tight | | |
| Low-pressure Tubes In Good Condition (no cuts, etc.) | | |
| Low-pressure Tubes Securely Coiled | | |
| No Sags in Coils of Low-pressure Tubes | | |
| No Kinks in Low-pressure Tubes | | |
| Manifold Secure and Mounted Level | | |
| Regulator Working Properly | | |
| Regulator Screen is Clean | | |

Always use a hitch pin with a safety clip to be sure the nurse tank will not detach from the applicator and the applicator will not detach from the tractor. Use the safety chains when moving equipment on public roads.

The condition of the applicator knives is important for safety reasons as well as quality application. Knives in poor condition may result in frequent stops for cleaning and unplugging, increasing exposure to anhydrous ammonia. Plugged knives can trap pressurized ammonia that will be released when the knife is cleared.

Sagging low-pressure discharge hoses are a source of exposure to anhydrous ammonia because the anhydrous ammonia in the sag will flow toward the applicator knife and be released when the machine is lifted out of the ground. All low-pressure tubes on the applicator should be of the same length for a uniform delivery to the knives. Extra hose lengths can be coiled and securely fastened to the frame to reduce sagging.

When unplugging metering screens, close the liquid withdrawal valve on the nurse tank and the hose valve on the applicator, open the bleeder valve on the applicator side of the nurse tank withdrawal valve and turn the applicator to bleed the distribution system. Leave the system open until the screen is cleaned and replaced.

Transport Safety Practices

Highway towing rules:

- Tow no more than two portable tanks behind one vehicle.
- The speed limit is 25 miles per hour.
- The overall length of the entire transporting unit may not exceed 75 feet.
- Nurse tanks can be transported only on public roads between sunrise and sunset.
- A slow moving vehicle (SMV) emblem or a lighted rotating or flashing amber light must be displayed on the rear of the towed nurse tank.
- Safety chains must be used if nurse tanks are towed faster than 15 miles per hour.
- Tanks must be identified in the front and rear and both sides with the words "ANHYDROUS AMMONIA" in letters not less than 2 inches high.
- Tanks must be placarded in the front and rear and on both sides with approved Department of Transportation (DOT) "NON-FLAMMABLE GAS" placards.
- The DOT "NON-FLAMMABLE GAS" placard ("1005" decals) are also required to be on the nurse tank.

Should a mishap occur while transporting anhydrous ammonia, the spill or leak should be approached from upwind whenever possible. To minimize the gas cloud, water should be sprayed on the point of discharge, not just on the tank. If emergency help is needed, call toll-free 1-800-472-2121 or 911.

Safe Field Practices

- Always have an 8-ounce squirt bottle of water available when working with any anhydrous ammonia equipment.
- Wear gloves and goggles when connecting or disconnecting nurse tanks and applicators.
- Always have a backup set of gloves, goggles, respirator with approved cartridge and 5 gallons of fresh water when applying or transporting anhydrous ammonia nurse tanks.
- Always work upwind of anhydrous ammonia equipment.
- Carry the nurse tank hose by the valve body or coupling rather than by the valve wheel or control handle.
- Clean hose/applicator connectors before connecting them.
- Hand tighten the valve wheel; overtightening can damage the valve or seals.
- Follow the recommended procedure for connecting and disconnecting nurse tanks and applicators.

Private Stationary Storage Facilities

Stationary storage facilities not used for retail sales or disbursement of anhydrous ammonia are required to have the same safety facilities as commercial stationary storage facilities. The requirements are based on the storage capacity of the facility, regardless of whether retail sales are being conducted or not.

Required Safety Equipment

The following items are required at anhydrous ammonia bulk storage facilities:

1. A loading platform because climbing or standing on the wheels of nurse tanks is not permitted while filling nurse tanks
2. A safety shower or an open water reservoir capable of holding at least 150 gallons of water for complete body immersion
3. A fire extinguisher
4. A telephone or a two-way FM radio

Personal Protective Equipment

The following five personal protective equipment items are required by the North Dakota Anhydrous Ammonia Law to be readily available at the storage site:

1. Two full-face gas masks with spare ammonia
2. One pair of ammonia-impervious, protective gloves
3. One pair of nonvented goggles that meet ANSI Z87.1 impact specifications
4. One pair of impervious protective boots
5. One "slicker suit," a rain suit that is impervious to ammonia

Operators of anhydrous ammonia storage facilities must be trained in safe operating procedures and the training documented by signed forms showing the type of training, the date of training, the persons trained and the person doing the training. These forms must be on record for at least three years and available for review at the facility during normal business hours.

Farm Transfer Facilities

Agricultural producers can transfer anhydrous ammonia only from cargo tanks to nurse tanks when the following safety requirements are met:

1. The transport tank must have complete, up-to-date certification and labeling.
2. Wheel chocks of adequate size must be used on the transport tank and the nurse tank before the transfer processes begin.
3. The following articles must be on the transport tank: 1) a 5-gallon reservoir of clean water, 2) ammonia-impervious gloves, 3) two full-face piece respirators with ammonia canisters and nonvented goggles.
4. The following articles must be on nurse tanks: 1) a 5-gallon reservoir of clean water, 2) a legal decal illustrating the step-by-step ammonia transfer process and

- 3) a legal decal explaining first aid procedures to follow when exposed to anhydrous ammonia.
5. The transfer process must be done on a firm, well-prepared, level surface during daylight hours on the owner's or consignee's property;

The following minimum setback distances apply to transfer facilities:

1. 50 feet from any adjoining property or any highway or railroad mainline
2. 450 feet from any residence or public assembly
3. 750 feet from any institutional residence
4. one mile from any city limits

Transport tank truck owners must provide written notice to the board of county commissioners of the intention to transfer anhydrous ammonia from any transport tank to nurse tanks in the particular county.

Rules for Anhydrous Ammonia Nurse Tank and Storage Container Locks

The North Dakota Legislature adopted the following rules as a pilot project for locking anhydrous ammonia tanks in several North Dakota counties. The pilot project is coordinated by the North Dakota Insurance Commission, Anhydrous Ammonia Inspection Office, State Capitol, Fifth Floor, 600 East Boulevard Ave., Bismarck, ND 58505-0320. These rules are included in this publication as recommended practices for anyone working with anhydrous ammonia in agriculture. More information can be obtained by contacting the Anhydrous Ammonia Inspection Office by telephone at (701) 328-0440 or e-mail at insurance@nd.gov.

1. An owner or operator of an anhydrous ammonia storage facility may not fill a nurse tank or applicator tank unless the tank is equipped with an approved locking device.
2. Unless an anhydrous ammonia nurse tank or applicator tank is empty, an owner or operator of an anhydrous ammonia storage facility may not store an unattended nurse tank or applicator tank at a facility unless the tank has an approved locking device installed.
3. Unless an anhydrous ammonia nurse tank or applicator tank is empty, a person in possession of the tank outside of an anhydrous ammonia storage facility must install an approved locking device on the tank if the tank is left unattended overnight.
4. Unless a locking device is integral to the liquid withdrawal valve, a person transporting a nurse tank or applicator tank must remove the locking device during transit.
5. An anhydrous ammonia storage facility owner or operator must be present at the pickup of a nurse tank or applicator tank at an anhydrous ammonia storage facility

unless the tank is empty or unless an approved locking device is installed on the tank.

6. A person in possession of a nurse tank or an applicator tank may not drop off the tank at an anhydrous ammonia storage facility if the owner or operator is not present unless the tank is empty or unless an approved locking device is installed on the tank.
7. Anhydrous ammonia may not be transferred from an anhydrous ammonia bulk delivery vehicle to a nurse tank or applicator tank unless the tank is equipped with an approved locking device.
8. A storage container must have approved locking devices installed on the main container stop valves whenever the storage facility is unattended unless the container is empty.

Summary

Anhydrous ammonia is a fertilizer commonly used in North Dakota agriculture. The risk of working with it is high because of its strong affinity for water, caustic nature, high pressure and very low temperature created when pressure is released. The caustic nature of anhydrous ammonia causes severe chemical burning injury. The extremely low temperature causes frostbite and frozen tissue.

Flushing with water is the best and only first aid treatment for an exposure. Exposure to the eyes and respiratory system presents the greatest challenge in administering first aid. The victim always should be taken to professional medical help as soon as possible. Continue to flush the exposure while in transport.

Many safety features must be built into the anhydrous ammonia handling and application system. Some safety features have service life limitations supported by state laws because these features are not repairable in the field and require trained technicians to service them. The purpose for these service life limitations is to keep these parts in good working condition and to minimize the risk of failure.

Storing anhydrous ammonia in large bulk containers on the farm presents hazards similar to storage at commercial installations. The need for particular safety equipment and procedures is the same, regardless of the location of the facility. All bulk storage facilities have specific required safety equipment and procedures.

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