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STORAGE & HANDLING – ANHYDROUS AMMONIA

<u>TABLE OF CONTENTS</u>	<u>1-2</u>
<u>INTRODUCTION</u>	<u>3</u>
<u>ANHYDROUS AMMONIA SAFETY</u>	<u>3</u>
<u>ANHYDROUS AMMONIA PROPERTIES</u>	<u>4</u>
<u>PHYSICAL CONSTANTS OF ANHYDROUS AMMONIA</u>	<u>5</u>
<u>PROPERTIES OF LIQUID ANHYDROUS AMMONIA AT VARIOUS TEMPERATURES</u>	<u>5</u>
<u>REACTIVITY OF ANHYDROUS AMMONIA</u>	<u>6</u>
<u>ANHYDROUS AMMONIA STORAGE TANK LOCATION AND DESIGN</u>	<u>6</u>
<u>ANHYDROUS AMMONIA STORAGE TANKS</u>	<u>7-8</u>
<u>ANHYDROUS AMMONIA VAPOR WITHDRAWAL</u>	<u>8-9</u>
<u>DISSOCIATED ANHYDROUS AMMONIA</u>	<u>9-10</u>
<u>ANHYDROUS AMMONIA VAPORIZERS</u>	<u>10</u>
<u>VAPORIZER ELECTRICAL CONNECTIONS</u>	<u>11</u>
<u>ANHYDROUS AMMONIA LIQUID WITHDRAWAL</u>	<u>11-12</u>
<u>ANHYDROUS AMMONIA SYSTEM RECOMENDATIONS</u>	<u>12-13</u>
<u>ANHYDROUS AMMONIA LEAKS</u>	<u>13-14</u>
<u>ANHYDROUS AMMONIA STORAGE TANK MAINTENANCE RESPONSIBILITIES</u>	<u>14-16</u>
<u>SUGGESTED PAINT SPECIFICATIONS FOR ANHYDROUS AMMONIA STORAGE TANKS</u>	<u>16</u>
<u>LABELING FOR ANHYDROUS AMMONIA STORAGE TANKS</u>	<u>16</u>
<u>NOTICE</u>	<u>17</u>

TANK INSPECTION CHECKLIST FORM	18
VAPORIZER WIRING DIAGRAM	19
TYPICAL STORAGE TANK WITH VAPORIZER	20
VAPORIZER SIZE CHART	21
ANHYDROUS AMMONIA VAPOR PIPE FLOW RATE CHART	22
STORAGE TANK INSTALLATION DRAWING	23
ANHYDROUS AMMONIA VAPOR PRESSURE-TEMPERATURE CURVE	24
NOTES	25

INTRODUCTION

The purpose of this brochure is to provide our customers with general information on the storage and handling of anhydrous ammonia.

This information is not all encompassing and should not be used for that specific purpose. Regulations can vary based on storage/process quantity, location, and specific uses.

Tanner Industries is a full service supplier for all of your anhydrous ammonia needs and we are available for the safe and reliable delivery of our products that has been our company tradition since 1890.

We are readily available for consultation, site visits, training programs, and recommendations based on your specific needs and requirements.

For more information please check out our website at <https://www.tannerind.com/> or if you have any questions or require assistance, please contact us at our toll free number 1-800-643-6226.

ANHYDROUS AMMONIA SAFETY

It is important that personnel understand the properties of ammonia and that they be thoroughly trained in safe practices for its storage and handling.

Please refer to the SAFETY DATA SHEET for safety information. If you do not have a copy, contact Tanner Industries, Inc at 1-800-643-6226 or this information can also be obtained from our web site at <https://www.tannerind.com/>.

Ammonia is regulated by various Federal, State, and local agencies. The following resources are good examples of information that should be referenced:

Compressed Gas Association,

CGA G-2.1 – 2014, Requirements for the Storage and Handling of Anhydrous Ammonia

United States Department of Labor (OSHA),

29 CFR 1910.111, Storage and Handling of Anhydrous Ammonia.

ANHYDROUS AMMONIA PROPERTIES

Anhydrous Ammonia is the compound formed by the combination of the 2 gaseous elements, nitrogen and hydrogen, in the proportion of 1 part of nitrogen to 3 parts of hydrogen by volume. Since 1 volume of nitrogen weighs 14 times as much as 1 volume of hydrogen, on a weight basis, the ratio is 14 parts of nitrogen to 3 parts of hydrogen, or about 82% nitrogen and 18% hydrogen.

At atmospheric temperature and pressures, anhydrous ammonia is a pungent colorless gas. Anhydrous ammonia boils at -28° F and freezes to a white crystalline mass at -108° F. When heated above its critical temperature of 270.34° F anhydrous ammonia exists only as a vapor regardless of the pressure. Between the boiling and critical points, liquid anhydrous ammonia exerts a vapor pressure which increases with rising temperature. When liquid anhydrous ammonia is in a properly rated container, it is in equilibrium with ammonia vapor and the pressure within the container bears a definite relationship to the temperature. See the table on the following page and drawing 8019 located on page 24.

Liquid anhydrous ammonia is lighter than water, having a density of 42.57 pounds per cubic foot at -28° F, while as a vapor, anhydrous ammonia is lighter than air, its relative density is 0.597 compared to air at atmospheric pressure and a temperature of 32° F. Under the latter conditions, 1 pound of anhydrous ammonia vapor occupies a volume of 20.78 cubic feet. At 70° F and at atmospheric pressure, 1 pound of anhydrous ammonia vapor occupies a volume of 22.5 cubic feet and yields 45 cubic feet of dissociated gas at a ratio of 25% nitrogen and 75% hydrogen.

Because of its great affinity for water, care must be taken in the storage and handling of anhydrous ammonia to keep it dry. "Anhydrous" means "without water". Anhydrous ammonia, by its very nature, invites contamination by moisture. It is a fact that moisture from the air will travel into an anhydrous ammonia system through a leak even while the anhydrous ammonia is coming out. In critical applications, it is of utmost importance that all leaks be promptly corrected.

Quality specifications for anhydrous ammonia are dependent on the quality grade of material utilized. Specifications will list assay content of anhydrous ammonia as well as some maximum (or minimum) content of moisture and a maximum content of oil. For example, Metallurgical Grade anhydrous ammonia is very dry and Commercial Grade anhydrous ammonia has a minimum of 0.2% water (moisture) content. Assay measurements are typically given in percent while moisture and oil content are generally given in parts per million (1 ppm – 0.0001%). Where quality control testing is deemed necessary, an analysis can be made using an evaporation method. Analyzing anhydrous ammonia by this method is difficult and hazardous and the procedure should not be attempted by unskilled personnel. Tanner Industries, Inc. can provide this service for you as needed, contact our office or your local sales representative for further information.

Please check out our website at <https://www.tannerind.com/> or feel free contact us at 1-800-643-6226 if further information is desired.

PHYSICAL CONSTANTS OF ANHYDROUS AMMONIA

Molecular symbol NH3
 Molecular weight 17.032
 Boiling point at one atmosphere..... -28° F
 Freezing point at one atmosphere -108° F
 Critical temperature 270.34° F
 Critical pressure..... 1,647.2 PSIA
 Vapor density at -28° F and one atmosphere 0.056697 LB/CUBIC FT
 Heat of Combustion..... 542 BTU/LB

PROPERTIES OF LIQUID ANHYDROUS AMMONIA AT VARIOUS TEMPERATURES

Liquid Density

Temp ° F		Lbs./ Cu.Ft.	Lbs./U.S. Gal.	Spec. Gr. Liq. Comp. Water 4° F	Latent Heat BTU per Lb.
-28°	0.0	42.57	5.69	.682	589.3
-20°	3.6	42.22	5.64	.675	583.6
-10°	9.0	41.78	5.59	.669	576.4
0°	15.7	41.34	5.53	.663	568.9
10°	23.8	40.89	5.47	.656	561.1
20°	33.5	40.43	5.41	.648	553.1
30°	45.0	39.96	5.34	.641	544.8
40°	58.6	39.49	5.28	.633	536.2
50°	74.5	39.00	5.21	.625	527.3
60°	92.9	38.50	5.14	.617	518.1
65°	103.1	38.25	5.11	.613	513.4
70°	114.1	38.00	5.08	.609	508.6
75°	125.8	37.74	5.04	.605	503.7
80°	138.3	37.48	5.01	.600	498.7
85°	151.7	37.21	4.97	.596	493.6
90°	165.9	36.95	4.94	.592	488.5
95°	181.1	36.67	4.90	.588	483.2
100°	197.2	36.40	4.87	.583	477.8
105°	214.2	36.12	4.83	.579	472.3
110°	232.3	35.84	4.79	.573	466.7
115°	251.5	35.55	4.75	.570	460.9
120°	271.7	35.26	4.71	.565	455.0
125°	293.1	34.96	4.67	.560	448.9
130°	315.6	34.66	4.63	.555	443.0
135°	339.4	34.35	4.59	.550	436.0
140°	364.4	34.04	4.55	.545	430.0

REACTIVITY OF ANHYDROUS AMMONIA

Common metals are not affected by anhydrous ammonia. Anhydrous ammonia will not corrode iron or steel, but will react rapidly with copper, brass, zinc and many alloys, especially those containing copper. Only steel or ductile iron should be used for anhydrous ammonia containers, piping and valves. Fittings should be forged steel.

ANHYDROUS AMMONIA STORAGE TANK LOCATION AND DESIGN

Stationary storage tanks for anhydrous ammonia are designed and built in accordance with OSHA (U.S. Department of Labor), 29 CFR 1910.111, Storage and Handling of Anhydrous Ammonia, ASME Boiler and Pressure Vessel Code, and CGA (Compressed Gas Association) G-2.1 – 2014, Requirements For the Storage and Handling of Anhydrous Ammonia to at least a minimum rating of 250 PSIG.

Anhydrous ammonia storage tanks should be located outdoors. When selecting an area for the vessel, care should be taken to ensure that the vessel is placed away from man doors, overhead doors, windows, air vents, high foot traffic areas, etc. and provides for 3 to 4 feet of clearance on all 4 sides of the vessel for maintenance purposes, and that the vessel be placed in an area that will not be exposed to damage by vehicular traffic. Access to the vessel for filling purposes must be within 100 feet and located within line of site for tank truck delivery. The area must remain clear of debris, weeds or any combustible materials. If being placed inside of a fenced in area, 2 means of ingress/egress must be incorporated in the fence design to allow for escape in the event of an emergency. All doors or gates should be unlocked and in the open position during deliveries, then closed and locked for security when not being occupied.

If the tank is located where summer sun conditions are severe, provisions should be made for sun shielding.

Diking may be required, check your state and local codes for any addition requirements.

Anhydrous ammonia storage tanks should be mounted on concrete, masonry or structural steel supports and on firm concrete or masonry foundations. All foundations should extend below the frost line.

Refer to the CGA G-2.1 – 2014, Requirements for the Storage and Handling of Anhydrous Ammonia for additional information.

ANHYDROUS AMMONIA STORAGE TANKS

Please consult with our sales department for assistance with sizing an anhydrous ammonia storage tank and frequency of deliveries. Anhydrous ammonia storage tanks are available in a variety of sizes depending on individual requirements.

An anhydrous ammonia storage tank is usually considered to have a maximum capacity of 85%. (A 15% vapor space must always be maintained when filling, to allow for expansion).

Anhydrous ammonia liquid weighs approximately 5 pounds per gallon, at 60°F.

A pound of liquid anhydrous ammonia will generate 22.5 SCF of ammonia vapor and 45 SCF of dissociated ammonia gas.

All openings on an anhydrous ammonia storage tank are protected by excess flow valves, excluding the level gauge and safety relief manifold(s). The pressure gauge and the 85% outage gauge have a .054" opening restricting flow, in place of an excess flow protection. The pressure gauge has an isolation valve which can be closed off in the event of a gauge failure or for routine replacement purposes.

An anhydrous ammonia storage tank is equipped with a dual safety relief valve system consisting of 2 safety relief valves mounted on a 3-way valve. The design of the 3-way valve permits shutting off one or the other, but not both, of the relief valves and allows for the replacement of either of the relief valves while maintaining protection of the vessel and without emptying the tank. Either relief valve alone is sized to adequately protect the tank, tanks above 1,000 gallons in capacity will require additional safety protection.

Different designs of 3-way valves have been used. The "Cyrus Shank" design has a hand wheel selector. Facing the hand wheel, to shut off the right hand safety, turn the hand wheel counter clockwise. To shut off the left hand safety, turn the wheel clockwise. The hand wheel should be left in full counter-clockwise position so that the valve stem packing and the right hand safety relief are isolated from the tank pressure.

The "Frick" or "Henry" design valves are of the "in-line" type and may have a conical cap covering the valve stem. If the valve is of this type, the valve stem has flats on it and a wrench must be used. Use caution when removing the cap as it may be under a slight pressure. Turning the valve stem clockwise will shut off the safety relief furthest from the valve stem. Turning the stem counter clockwise will shut off the safety relief nearest the valve stem. The valve should normally be left in the full counter clockwise position so that the valve stem packing is isolated from the tank pressure

The anhydrous ammonia storage tank liquid level content can be determined by means of a mechanical float gauge which reads in percent of the total tank volume. The gauge dial is usually on the top of the tank; however, it may be located at one end. When mounted on a 1,000 gallon tank and reading 60%, the tank would contain 600 gallons. At approximately 5 pounds per gallon, this would be equivalent to approximately 3,000 pounds.

Do not confuse this gauge with the pressure gauge. The pressure gauge would read the same whether there is 200 gallons in the tank or 800 gallons.

Telemetry systems can also be purchased for the level gauges discussed above that will e-mail daily level readings to the customer for tracking and usage purposes. The equipment is designed to also provide alerts for, time for delivery, recent fill and critical levels, all of which can be customized to fit each customer's needs.

The equipment is a battery operated, non-intrusive cellular/satellite unit that also allows for the storage tank level to read normally at the mechanical level gauge.

This equipment will fit most any sized tank equipped with either a Rochester style or Squibb Taylor style float gauge assembly.

Should a constant read out be preferred and the vessel is equipped with a level probe. A system can be installed with a read out digital display system that would work in conjunction with your equipment to provide daily readings via e-mail as well. This system would require additional wiring at the time of installation by the end user. The system can be purchased using 120 volt power source or solar powered.

ANHYDROUS AMMONIA VAPOR WITHDRAWAL

Anhydrous ammonia is shipped and stored in its liquid form, but is most commonly utilized in the form of a gas or vapor. You will note, under "Properties of Liquid Ammonia at Various Temperatures", that a certain amount of heat, called "Latent Heat of Vaporization", is necessary to convert each pound of liquid ammonia into a gas. If sufficient heat (approximately 500 BTU's per pound) is not available from the ambient air surrounding the tank to provide the latent heat of vaporization required for a certain gas withdrawal rate, this heat will be taken from the liquid remaining in the tank and the liquid temperature will drop. When the temperature drops, the vapor pressure also drops and a point can be reached where there is insufficient pressure available to operate the system.

The situation is further compounded when the outside temperature of the tank reaches freezing and the moisture in the surrounding air freezes on the tank surface. This ice acts as an insulator, further preventing heat from entering the tank.

To counteract this condition, in situations where withdrawal rates are such that the ambient heat available is not sufficient to sustain the flow, a vaporizer must be used.

As a general rule, for a 1,000 gallon tank, a vaporizer should be considered when vapor withdrawal rates exceed 500 SCFH.

When designing your anhydrous ammonia system, you will need to consider regulating the pressure exiting the vessel. Depending on what pressure is needed at the point of use, regulator sizing and regulating ranges need to be considered. It is best to drop pressures in stages to help minimize the potential for re-liquification of the vapor into liquid droplets on the downstream side of the piping system.

As an example, if the tank contains 115 PSIG (approximately 70-degree material) and the end use pressure needed is 10 PSIG (approximately -8 degrees), there is a 105 PSIG pressure drop across the regulated pressure. Remembering the temperature pressure curve inherent with the product, the temperature difference between the 2 pressures of the product would be a 78-degree temperature drop across the regulator. This extreme temperature drop can potentially cause re-liquification of the gas downstream of the regulated pressure.

Tanner Industries Inc., recommends the design should include 2 regulators into your piping system; one near the vessel, with a second unit installed downstream closer to the point of process. By staging the regulator pressures in 50% reduction increments, the temperature drops are much less significant and less likely to see the effects of re-liquification of the material.

Please note as the anhydrous ammonia vapor is withdrawn from the storage tank, the oil and moisture that is inherent in the anhydrous ammonia settles to the bottom of the storage tank or lowest point of the anhydrous ammonia system. Very little of the oil and moisture can be carried over into the process. Concentrations of oil and moisture can build up in a storage tank over time, and may require flushing of the storage tank and vaporizer assembly depending on the amount of anhydrous ammonia that has been used.

Tanner Industries, Inc. does not recommend the use of rubber hoses in permanent installations. If hoses are used, they must be rated for anhydrous ammonia service. These types of hoses have expiration dates and should be inspected routinely and replaced prior to the expiration date embossed on the hose.

DISSOCIATED ANHYDROUS AMMONIA

Under normal conditions, anhydrous ammonia is a very stable compound. It takes excessive temperatures (about 840° to 930° F) to cause it to dissociate slightly at atmospheric pressure. When this happens, the dissociated products are nitrogen and hydrogen. Anhydrous ammonia gas burns in a mixture with air within a limited range. The flammable limits at atmospheric pressure are 16% to 25% by volume of anhydrous ammonia in the air. Experiments conducted by Underwriters Laboratories indicate that an anhydrous ammonia-air mixture in a standard quartz bomb will not ignite at temperatures below 1570°F. When an iron bomb, having a catalytic effect, was used, the ignition temperature dropped to 1204°F.

Dissociated anhydrous ammonia is frequently used as a furnace atmosphere for heat treating metals. Dryness is an important factor. It is difficult to measure the moisture content of the ammonia; however, the moisture content of the dissociated gas can be readily determined by measuring its dew point

Where anhydrous ammonia is used in its dissociated form, as nitrogen and hydrogen, the moisture content may be measured by means of a dew point instrument. For critical applications, it is recommended that a dryer be installed.

ANHYDROUS AMMONIA VAPORIZERS

To understand how the vaporizer operates, refer to drawing 8010 located on page 19 of this booklet. As vapor is removed from the top of the tank, the pressure in the tank is reduced and the liquid ammonia vaporizes to replace the gas which is being withdrawn. Heat is required to accomplish this vaporization. If heat from the surrounding air is not sufficient or cannot penetrate through the walls of the tank fast enough to maintain the vaporizing rate, the pressure will continue to drop.

At some point, depending on the setting of the pressure switch, this pressure drop, closes the pressure switch electrical contacts, turning on the heating element(s) in the vaporizer shell(s). The liquid in the vaporizer shell(s) is maintained by the liquid level in the tank. The heating element(s), that is immersed in the liquid, warms the liquid, converting it to a gas as it exits the shell. This gas then flows into the top of the tank where it can be withdrawn to satisfy the needs of the system. The pressure switch is equipped with adjustable pressure setting capabilities which can be adjusted to meet the customer's requirements. Typically, the unit is set to maintain an operating pressure in the range of 70 to 90 PSIG. This range can be field adjusted by moving the adjustment screws located on the right side of the switch, these adjustment screws are located under a protective steel cap. The switch should always maintain a minimum of a 20 PSIG pressure differential, giving time for the element to cycle properly.

The requirement or need for this supplemental heat is dependent on several factors; the ambient temperature around the tank, the air movement around the tank, the volume of liquid within the tank and the rate of withdrawal of vapor.

A thermostat/over temperature switch is used to prevent overheating of the element. The switch is located inside the heating element terminal box. The setting of this equipment should be set between 100 and 120 degrees maximum.

The thermostat/over temperature switch is connected in series with the pressure switch and limits the operating temperature of the vaporizer. It shall be noted that this thermostat/over temperature switch is designed to protect the element from overheating and possible damage to the element when insufficient liquid is provided to the shell assembly.

Power should not be applied to the vaporizer element(s) when it does not contain liquid ammonia in the shell assembly.

This can happen before the tank is filled, if the vaporizer isolating valves are not open or if the system is allowed to run dry or completely empty. If power is applied under these circumstances, the heater element(s) could be damaged.

VAPORIZER ELECTRICAL CONNECTIONS

To more readily accommodate our customers, we stock units for both 240 Volt and 480 Volt services. All of the vaporizers being discussed are fabricated with 3 elements per assembly and may be connected for either 3 phase or single phase operation. Refer to drawing 8011 located on page 20 of this booklet for information on the electrical connections.

When operated at their rated voltage, the 7.5 KW heater is capable of vaporizing approximately 50 pounds of ammonia per hour (approximately 1125 SCFH of vapor without considering heat losses). Where larger quantities of vapor are required, multiple heater units or larger KW ratings are available.

Installation and electrical trouble shooting must be performed by qualified electrical contractors.

It is strongly recommended that conduit seal fittings and a barrier seal compound be used in the electrical conduit with a breather fitting to permit release of anhydrous ammonia vapors to the atmosphere. Although remote, there is always the possibility that a leak in the pressure switch or heating element could cause anhydrous ammonia vapors to be transmitted back through the electrical conduit to the electrical contact or back into the building. Crouse-Hinds EYS series fittings and sealing compound or equivalent are recommended.

ANHYDROUS AMMONIA LIQUID WITHDRAWAL

If the anhydrous ammonia is to be used in liquid form, the anhydrous ammonia storage tank fittings are arranged so that the customer's connection is located at the bottom of the tank. Tanks can be fitted for a top connection by providing a dip tube inside the tank which runs down to the tank bottom.

Care should be exercised in designing liquid anhydrous ammonia systems to be sure that a hydrostatic relief valve, rated at 350 psig, is used wherever there is the possibility that liquid anhydrous ammonia could be trapped between 2 valves within a closed system. Without such protection, liquid anhydrous ammonia's large coefficient of expansion with temperature could produce high pressure causing piping to rupture.

All piping should be tested for leaks after assembly by introducing anhydrous ammonia vapor. Do not introduce liquid anhydrous ammonia prior to leak testing with anhydrous ammonia vapor. If it becomes necessary to disassemble the piping to repair the leak, excessive bleed down time will be necessary to evacuate the liquid anhydrous ammonia from the affected area being repaired. Refer to the section covering anhydrous ammonia leaks.

Wherever there is the possibility of liquid anhydrous ammonia being trapped between 2 valves, provisions must be made to include a hydrostatic relief valve to protect the section of isolated pipe and valve. The relief valve should be installed in such a manner that should in the event of a discharge, the product flows down and away from any potential foot traffic, or piped up and away to a safe point of discharge. If the latter thought process is applied, be sure to consider some provision to allow for leak testing of the valve and for the ability to replace at the 5 year interval requirement.

Use only all steel gauges and valves made for anhydrous ammonia service. Tanner Industries, Inc. has available valves, liquid level gauges, pressure gauges ranging in sizes of -30-400 PSI, 0-60 PSI and 0-160 PSI sizes, heating elements and safety relief valves available for sale. Contact us at 1-800-643-6226 for your needs or visit our website at <https://www.tannerind.com/> for more information.

Tanner Industries, Inc. does not recommend the use of rubber hoses in permanent installations. If hoses are used, they must be rated for anhydrous ammonia service. These types of hoses have expiration dates and should be inspected routinely and replaced prior to the expiration date embossed on the hose.

ANHYDROUS AMMONIA SYSTEM RECCOMENDATION

PIPING SYSTEMS FOR ANHYDROUS AMMONIA

Piping for anhydrous ammonia systems should be Schedule 80 carbon steel extra heavy seamless construction when threaded joints are used, Schedule 80 Stainless steel pipe may also be utilized for this application. Standard weight (Schedule 40) carbon steel or stainless steel piping may be used when joints are either welded or joined by welding type flanges.

Depending on the length of piping being installed to the point of process, in-line excess flow protection should be considered, a good rule of thumb is to provide additional protection for every 100 feet of pipe.

Teflon tape along with Gas-Oila Pipe Thread Sealer has been used successfully as a pipe thread lubricant and sealer and is highly recommended.

All piping should be well supported and provisions should be made to protect the piping against the effects of expansion, contraction, jarring, striking, vibration, settling and external corrosion. When necessary, stainless steel flex hoses can be used between the vessel and the piping to allow for protection being discussed above. If Flex hoses are used, an inspection program and replacement schedule should be considered as part of the design.

All fittings should be forged steel; **non-malleable metals must not be used.** Unions should be of the ground joint type. Some unions have brass seats which must not be used.

All piping should be tested for leaks after initial assembly by introducing anhydrous ammonia vapor into the piping, Tanner Industries Inc., would recommend leak testing every 3 months thereafter. Using either litmus test paper or sulfur sticks, on all pipe joints, valve stems, valve bonnets, regulators; etc. should be tested for possible leakage.

If utilizing litmus paper, moisten the paper and wipe over each piece of equipment being tested, if leakage is present the paper will turn a dark purple/pink color. If sulfur sticks are being utilized, light one end of the stick, then wave the sulfur stick around the joint being tested, if a leak is present, a white clouding smoke will occur.

Do not introduce liquid anhydrous ammonia initially, because if it is necessary to disassemble the piping to repair a leak, excessive bleed down time will be necessary. Tanner Industries Inc. can provide Litmus Paper or Sulfur Sticks to you as needed, call us at 1-800-643-6226 for more information.

As discussed above, wherever there is the possibility of liquid anhydrous ammonia being trapped between 2 valves, provisions must be made to include a hydrostatic relief valve to protect the section of isolated pipe and valve. This equipment has a manufactured date on it and will need to be replaced every 5 years. Tanner Industries Inc. carries this equipment for resale and can assist the customer in changing out as needed.

AMMONIA LEAKS

An anhydrous ammonia leak is easily detected by the sharp, pungent odor of the vapor. All leaks should be approached with caution. When a leak is detected, the first step should be to determine the size of the leak, its location and whether it is continuous or a single release such as would occur when a hose is vented before being disconnected.

Leaks may be accurately located by using sulfur sticks or moist litmus test papers. Sulfur sticks are designed so that when the smoke from the lighted stick comes in contact with any leaking area, a white smoke will be produced. When using moistened Litmus paper, should a leak be noted, the paper will turn a dark purple/ pink color.

Ask your area representative or request a supply when you are placing an order for anhydrous ammonia. Where small leaks are detected, they should be repaired. Leaks never get better; they always get worse. Don't wait for an emergency situation to occur before fixing leaks or requesting assistance.

Anhydrous ammonia vapors from small leaks may be absorbed by covering the area with a water soaked towel. The towel must be rinsed out and replaced when saturated. Anhydrous ammonia impervious gloves and other appropriate PPE must be worn. Refer to our safety data sheet.

When working on anhydrous ammonia vapor leaks, stand up wind from the leak. Indoors, a portable fan is recommended to aid ventilation.

Many small leaks are as a result of seasonal temperature fluctuations. There are various components and materials used in an anhydrous ammonia system. Since many of these materials have different rates of expansion and contractions (i.e., elastomer used as gaskets and steel used as valve body) the result can be occasional leaks in the areas where these materials come in contact.

Small leaks can often be corrected by tightening a nut or a bolt as in the case of a flange style connection. Valve stem leaks (where no packing nut is available) can often be corrected by the application of a penetrating oil (WD-40) and opening and closing the valve a few times. Leaks at the float gauge gasket may be eliminated by tightening the 4 screws. First, loosen 1 screw, apply some penetrating oil, and then tighten. Continue this process in a cross pattern for the remaining screws. If this does not work, the gasket must be replaced and a “pump-out” is required.

Where relatively large leaks are encountered, eliminate the ammonia source, if possible, by closing off a valve from a safe distance. If the situation is beyond your control, call 911 for immediate assistance. For additional assistance Tanner Industries Inc. can be reached at 1-800-643-6226. In the unlikely event that we cannot be reached, contact CHEMTREC, the Chemical Emergency Center at 1-800-424-9300.

STORAGE TANK MAINTENANCE RESPONSIBILITIES

To prevent external corrosion, responsibility for the maintaining the exterior or paint system of the anhydrous ammonia storage tank, piping and appurtenances lies with the user. The tank and piping should be visually inspected on a regular basis; Tanner Industries Inc. would recommend this being done quarterly. The “Tank Inspection Check List” located on page 18 in this manual can be utilized for this. All piping, pipe joints, tanks and tank fittings should be examined for signs of corrosion, damage, wear and leaks.

Areas of corrosion should be cleaned, primed and painted. The tank should be painted with a good grade of white gloss marine grade epoxy paint. Above ground non-insulated containers should have a reflective surface maintained in good condition. White is recommended for paint surfaces, but other colors having similar reflecting characteristics are acceptable, see below for typical paint preparation and material specifications used on your tank.

Tanner Industries Inc. liquid valves should be painted orange and the vapor valves should be painted yellow. Valves are designated liquid or vapor by what form of anhydrous ammonia will be released when opened.

Do not paint the valve stems as it can get in the stem packing and cause leaks.

Valve stems should be protected and occasionally lubricated with a light coating of grease or petroleum jelly.

Do not paint the small stainless steel vent valves or the safety relief valves.

All markings, warning labels, etc. must be legible and should be replaced as needed. Contact us for your replacement needs.

Do not paint or damage the manufacturer's data plate, this information must remain legible at all times.

Safety relief and hydrostatic relief valves are provided with caps to keep out rain, snow, dirt, etc. Make sure these caps are in place and request replacements if needed.

Safety relief and hydrostatic relief valves are stamped with a manufacture date, the information will appear as follows: 5C19. This means that the valve was produced in May (C stands for third week of the month) in 2019. These valves have a 5 year service life and must be replaced prior to the expiration of this date. Under this condition, the valve is usable until May of 2024. Contact Tanner Industries, Inc. for replacement.

Safety relief valves can also be fitted with pipe away adapters to allow for remote discharge capability. If this design is implemented, unions or flanges will need to be installed in close proximity of the relief valves to allow for removal and replacement. You should also consider in the design how the valve can be tested to ensure leak free during the life of its service. One means that can be incorporated into the system would be to install rupture disks into the design, these assemblies are equipped with a gauge that will provide a visual indicator of any leakage of the valve. Please note that this equipment is not to be installed in place of a safety relief valve, only in conjunction with the safety relief system. It shall also be noted that in this application, the rupture disks will also follow the same replacement schedule as the relief valves

Hose connections must have protective caps. They provide a "secondary" closure and will sustain tank pressure as well as keeping out rain, snow, etc. Make sure they are in place, request replacements as needed.

When bleeding down an anhydrous ammonia system prior to making repairs or alterations, advantage may be taken of anhydrous ammonia's great affinity for water. Anhydrous ammonia vapors from the bleed point can be transferred by means of a hose to a container of water where they will be absorbed. When anhydrous ammonia is dissolved in water to form ammonium hydroxide solution, there is liberation of heat from the exothermic reaction which takes place. The solubility of anhydrous ammonia in water is strongly affected by the solution temperature resulting in decreased solubility at higher temperatures; therefore, the water should be replenished as necessary.

A well maintained system will ensure a continuous, economical and safe source of anhydrous ammonia. Our drivers are trained to supplement your inspection procedures on each delivery. Upon request, they, or our technical personnel, will lend assistance in any inspection or maintenance problems you may encounter.

SUGGESTED PAINT SPECIFICATIONS

Should the tank be in a condition beyond simple wire brushing and spot painting, the following process is suggested. The tank should be sandblasted in accordance with NACE No. 3 / SSPC-SP 6 Commercial Blast Cleaning. Before blast cleaning, all visible oil and grease shall be removed in accordance with SSPC-SP 1 Solvent Cleaning. **It is suggested that under this condition, the tank be emptied of liquid and pressure for safety concerns.**

All valve appurtenances must be protected during the blasting process against damage, duct tape applied to the equipment will provide sufficient protection. Make sure the manufacturers data plate is protected during this process. A primer coat should be applied with one coat of Sherwin Williams Macropoxy 646 or equivalent. Consult drying and re-coat times located on the product label.

A finish coat will be achieved by applying 2 coats of Sherwin Williams Sherloxane 800 epoxy mastic gloss or equivalent. This 3 coat system should achieve a dry coat thickness of approximately 8 mils. Allow sufficient dry time between coats as stated in the product data sheets. If utilizing spray equipment, it should be cleaned immediately after each coating with proper cleaning agent. Valves on Tanner Industries Inc. anhydrous ammonia storage tanks are color-coded, liquid valves are painted orange and vapor valves are painted yellow. All valves are to be color coded with the exception of the stainless steel needle valves.

STORAGE TANK REQUIRED LABELING

- Anhydrous Ammonia (both sides of tank)
- Liquid valves labeled with liquid decals
- Vapor valves labeled with vapor decals
- Globally Harmonized System (GHS) Hazard/First Aid Warning Label

Additional Labeling Provided by Tanner Industries

- National Fire Protection Agency (NFPA) 704 Label
- 30% Order Reminder
- Customer Service Connection

Additional labeling may be required by state or local regulations.

NOTICE

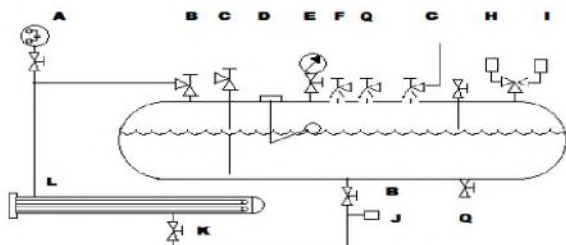
We believe the information contained in this manual to be accurate and reliable. However, Tanner Industries, Inc. assumes no liability or responsibility in connection with the information or suggestions herein contained. Moreover, it should not be assumed that every acceptable test or safety procedure or method, precaution, equipment or device is contained within, or that abnormal or unusual circumstances may not warrant or suggest further requirements or additional procedures. The Company neither represents nor warrants the excerpted material from said pamphlets, and the pamphlets themselves should be read for a complete statement of their contents.

The information contained in this manual should not be confused with federal, state, municipal or insurance requirements, or with national safety or building codes, and no representations nor warranties are made with respect thereto.

TANNER INDUSTRIES, INC.

Tank Inspection Check List(Form# TICL-1) Sales Order #

Customer:	<input type="text"/>	Cust#:	<input type="text"/>	Date:	<input type="text"/>
City:	<input type="text"/>	State:	<input type="text"/>		
Tank Size:	<input type="text"/>	Serial#:	<input type="text"/>	N.B. #:	<input type="text"/>
Tank Manufacturer	<input type="text"/>	Date of Manufacture:	<input type="text"/>	Tank OK:	<input type="text"/>



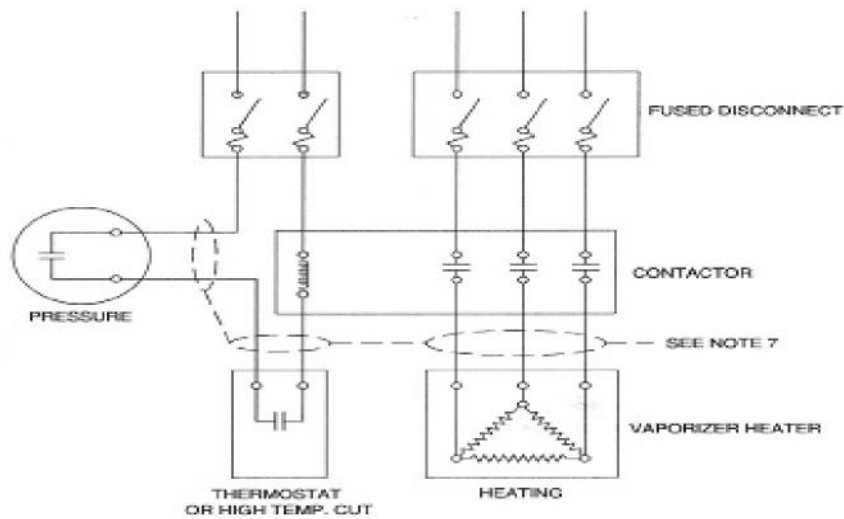
Below: Mark all problem with an X and explain. Mark Replaced if part replaced at time of inspection.

		Problem	Replaced			Problem	Replaced
A	Pressure Switch Type Isolating Value: Part#	<input type="text"/>	<input type="text"/>	I	Pressure Relief Valves 3 Way Valve (1) PRV 1 Part# PRV 2 Part# Mfg Date: Exp Date:	<input type="text"/>	<input type="text"/>
B	Vaporizer Isolating Valves: TOP BOTTOM	<input type="text"/>	<input type="text"/>		3 Way Valve (2) PRV 1 Part# PRV 2 Part# Mfg Date: Exp Date:	<input type="text"/>	<input type="text"/>
C	Liquid Fill Valve: Part#	<input type="text"/>	<input type="text"/>	J	Hydrostatic Relief Valves Valve 1 Part# Valve 2 Part# Mfg Date: Exp Date:	<input type="text"/>	<input type="text"/>
D	Float Gauge: Top/Side Mount Float Gauge Part# Tank Diameter Float Gauge Dial	<input type="text"/>	<input type="text"/>	K	Vaporizer Drain Valve: Part#	<input type="text"/>	<input type="text"/>
E	Pressure Gauge: PSI range * Isolating Valve: Part#	<input type="text"/>	<input type="text"/>	L	Vaporizer Heating Element KW/Volts/Phase	<input type="text"/>	<input type="text"/>
F	Vapor Fill Valve: Part#	<input type="text"/>	<input type="text"/>	M	Anhydrous Ammonia Decals	<input type="text"/>	<input type="text"/>
G	Customer Supply Valve: Part#	<input type="text"/>	<input type="text"/>	N	Hazard Warning Decals	<input type="text"/>	<input type="text"/>
H	85% Valve If None, is opening available? Opening Size	<input type="text"/>	<input type="text"/>	O	Acme Valve Caps	<input type="text"/>	<input type="text"/>
	Were all connections leak checked with Litmus Paper?	<input type="text"/>	<input type="text"/>	P	Safety Relief Valve Caps	<input type="text"/>	<input type="text"/>
	Valve stems lubricated and exercised during inspection?	<input type="text"/>	<input type="text"/>	Q	Auxiliary/Drain/Spare	<input type="text"/>	<input type="text"/>
	Is data plate Intact?	<input type="text"/>	<input type="text"/>		Was the three Way Valve tested for operation?	<input type="text"/>	<input type="text"/>
	Any Excessive Corrosion, Dents, Pitting, Etc?	<input type="text"/>	<input type="text"/>		Is it Legible?	<input type="text"/>	Condition of Paint
	Condition of vaporizer assembly(shell and piping)	<input type="text"/>	<input type="text"/>		<input type="text"/>	<input type="text"/>	<input type="text"/>
	Tank Inspected By:	<input type="text"/>	<input type="text"/>		<input type="text"/>	<input type="text"/>	<input type="text"/>
	Tank Type:	<input type="text"/>	Computer Updated By:	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

Form# DM-6.6-TICL-950401.00.02

Revision Date: 12/07/16 (January 9/10)

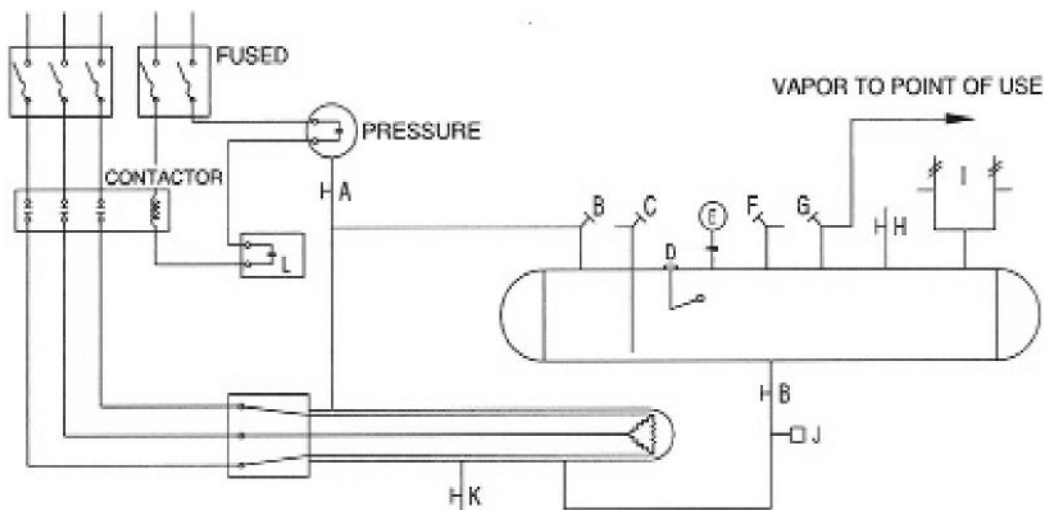
Approved by: Director of Trans.



NOTES:

1. 120 VOLTS, 60 CYCLES IS REQUIRED FOR THE CONTROL CIRCUIT. THE VAPORIZER HEATING ELEMENTS ARE DESIGNED FOR 240 VOLT OR 480 VOLT, SINGLE OR 3 PHASE OPERATION AND ARE USUALLY RATED FOR 7.5 KW. THE FUSE REQUIREMENTS UNDER THESE CONDITIONS ARE 20 AMPS FOR 240 VOLT OPERATION AND 10 AMPS FOR 480 VOLT OPERATION.
2. THE FUSED DISCONNECT AND CONTACTOR ARE TO BE SUPPLIED BY THE CUSTOMER.
3. THE PRESSURE SWITCH CLOSSES ON LOW PRESSURE. SET THE LOWER SET POINT ABOUT 10 PSI HIGHER THAN THE LOWEST PRESSURE REQUIRED. SET THE UPPER POINT ABOUT 20 PSI ABOVE THE LOWER SET POINT.
4. **IMPORTANT** – POWER MUST NOT BE APPLIED TO THE VAPORIZER ELEMENT UNLESS THE VAPORIZER SHELL CONTAINS LIQUID AMMONIA. OTHERWISE, DAMAGE TO THE ELEMENT MAY OCCUR.
5. THE THERMOSTAT SHOULD BE SET BETWEEN 100 AND 120 DEGREES.
6. VAPORIZER EQUIPPED STORAGE TANKS SHOULD BE ELECTRICALLY GROUNDED.
7. CONDUIT SEAL FITTINGS AND BARRIER SEAL COMPOUND IS RECOMMENDED.

TANNER INDUSTRIES, INC
TYPICAL VAPORIZER WIRING DIAGRAM
DATE: AUGUST 2020 DWG. NO. 8010



- A: PRESSURE SWITCH ISOLATING VALVE
- B: VAPORIZER ISOLATING VALVE
- C: LIQUID FILL CONNECTION
- D: FLOAT GAUGE
- E: PRESSURE GAUGE WITH ISOLATING VALVE
- F: FILL CONNECTION, VAPOR RETURN
- G: CUSTOMER SERVICE CONNECTION
- H: 85% OUTAGE GAUGE
- I: SAFETY RELIEF VALVES & 3-WAY VALVE
- J: HYDROSTATIC RELIEF VALVE
- K: VAPORIZER DRAIN VALVE
- L: THERMOSTAT

NOTES ON OPERATION

1. VAPORIZER ISOLATING VALVES MUST BE OPEN AND LIQUID AMMONIA IN THE TANK BEFORE POWER IS APPLIED TO THE HEATERS.
2. THE PRESSURE SWITCH LOWER SET POINT SHOULD BE SET 10 PSI ABOVE THE MINIMUM OPERATING PRESSURE REQUIRED. THE UPPER SET POINT SHOULD BE SET ABOUT 20 PSI ABOVE THE LOWER SET POINT. THE PRESSURE SWITCH ISOLATING VALVE MUST BE OPEN.
3. THE THERMOSTAT SHOULD BE SET BETWEEN 100 AND 120 DEGREES.
4. SHOULD 1 OF THE SAFETY RELIEF VALVES START TO LEAK, IT MAY BE ISOLATED USING THE 3-WAY VALVE. THE OTHER SAFETY RELIEF VALVE IS ADEQUATE, BY ITSELF, TO PROTECT THE TANK.
5. TANKS THAT ARE EQUIPPED WITH VAPORIZERS SHOULD BE ELECTRICALLY GROUNDED.

TANNER IND., INC
TYPICAL STORAGE TANK W/VAPORIZER
DATE: AUGUST 2020 DWG. NO. 8011

VAPORIZER SIZE CHART

Rating	Element		CFH of DA	480 V Amps	240 V Amps
	NH3 LBS	CFH of NH3			
7.5kW	47 LBS	1058 CFH	2115 CFH	9.1	18
10kW	63 LBS	1418 CFH	2835 CFH	12.1	4.1
12 kW	75 LBS	1688 CFH	3375 CFH	14.5	28.9
15 kW	94 LBS	2115 CFH	4230 CFH	18.2	36.2
20 kW	126 LBS	2835 CFH	5670 CFH	24.2	48.2

These do not take into consideration any heat loss to atmosphere.

Facts to Remember

1 Pound NH3 = 22.5 Standard Cubic feet Per Hour of Straight Ammonia Gas (CFH)

1 Pound NH3 = 45 Standard Cubic feet Per Hour of Dissociated Ammonia Gas (CFH)

1 Kilowatt = 3414 BTU's

1 Pound NH3 = Approximately 542 BTU's

1 Kilowatt = 1.21 Amps @ 480v 3PH; 2.41 Amps @ 240v 3PH Balanced Load

EXAMPLE

A customer needs 350 LBS/HR on NH3 into a Process. What vaporizer will be needed.

350 LB/HR x 542 BTU's/LB = 189,700 BTU's; Divided By 3414 = 55.5 kW

3 - 20- kW Units Could be Used and Provide an Additional 10% or 2-20kW and 1-15kW

Using the Table Above

350 Divided by 126LB/HR (20kw) = 2.8 or 3 - 20kW Elements will be Needed

350 Divided by 94LB/HR (15kw) = 3.7 or 4 - 15kW Elements will be Needed

Allow some extra for heat loss and miscalculation in volume or growth

Latent heat in the tank will supply some vapor but it's better to not count on it to be safe

Below is a quick guide to expected vapor flow rates at different pressure ranges depending on the overall length of piping being installed to the point of process. It shall be noted that the information below is based on the use of a first stage regulator located in the piping system close to the point of origin and second regulator being located downstream closer to the point of use.

We have provided a reference chart for the most common sized piping in smaller bulk tank applications.

Should additional information be needed with size calculations for pipe sizes other than listed below, contact Tanner Industries for assistance.

VAPOR PIPE SCFH FLOW RATE CHART WITH TANK AT 70 PSI

1/2" Schedule 80 Pipe Flow Rate with Tank Pressure of 70 PSI

Length of Pipe Run in Feet

Pressure at End of Pipe	100 FT	200 FT	300 FT	400 FT	500 FT	600 FT
10 PSI	4768	3371	2753	2384	2132	1946
20 PSI	4616	3264	2665	2308	2064	1885
30 PSI	4352	3078	2513	2176	1946	1777
40 PSI	3953	2795	2282	1977	1768	1614
50 PSI	3371	2384	1946	1686	1588	1376
60 PSI	2481	1754	1433	1241	1110	1013

3/4" Schedule 80 Pipe Flow Rate with Tank Pressure of 70 PSI

Length of Pipe Run in Feet

Pressure at End of Pipe	100 FT	200 FT	300 FT	400 FT	500 FT	600 FT
10 PSI	10,265	7,258	5,926	5,132	4,590	4,190
20 PSI	9,939	7,028	5,738	4,969	4,445	4,057
30 PSI	9,370	6,626	5,410	4,685	4,190	3,825
40 PSI	8,511	6,018	4,914	4,255	3,806	3,425
50 PSI	7,258	5,132	4,190	3,629	3,246	2,963
60 PSI	5,342	3,777	3,084	2,671	2,389	2,181

1" Schedule 80 Pipe Flow Rate with Tank Pressure of 70 PSI

Length of Pipe Run in Feet

Pressure at End of Pipe	100 FT	200 FT	300 FT	400 FT	500 FT	600 FT
10 PSI	19,392	13,712	11,196	9,696	8,672	7,917
20 PSI	18,776	13,276	10,840	9,388	8,397	7,665
30 PSI	17,702	12,517	10,220	8,851	7,917	7,227
40 PSI	16,079	11,369	9,283	8,039	7,191	6,564
50 PSI	13,712	9,696	7,917	6,856	6,132	5,598
60 PSI	10,092	7,136	5,826	5,046	4,513	4,120

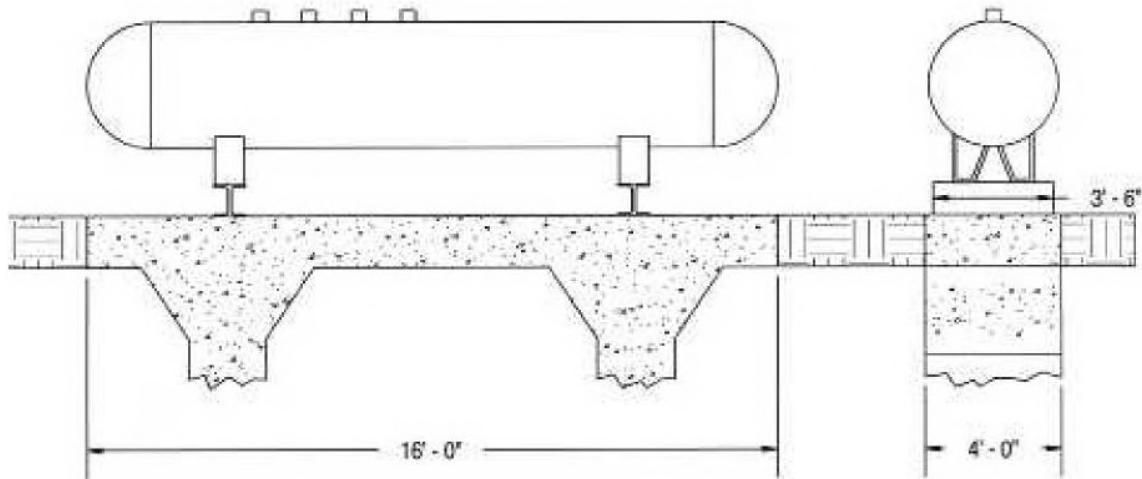
1-1/4" Schedule 80 Pipe Flow Rate with Tank Pressure of 70 PSI

Length of Pipe Run in Feet

Pressure at End of Pipe	100 FT	200 FT	300 FT	400 FT	500 FT	600 FT
10 PSI	39,963	28,258	23,073	19,982	17,872	16,315
20 PSI	38,694	27,361	22,340	19,347	17,305	15,797
30 PSI	36,481	25,796	21,062	18,241	16,315	14,893
40 PSI	33,136	23,340	19,131	16,568	14,819	13,528
50 PSI	28,258	19,982	16,315	14,129	12,637	11,536
60 PSI	20,797	14,706	12,007	10,399	10,399	8,991

TYPICAL 1,000 GALLON ANHYDROUS AMMONIA TANK

PROVIDE A 3 TO 4 FOOT. MINIMUM CLEARANCE ON ALL SIDES FOR INSPECTION AND MAINTENANCE PURPOSES.



THE DISTANCE BETWEEN THE TANK LEGS (APPROXIMATELY 9 FT. - 11 FT.) AND WILL VARY WITH TANK MANUFACTURER.

APPROXIMATE OVERALL DIMENSIONS: 3'-6" DIAMETER X 16'-1" LONG

APPROXIMATE WEIGHT EMPTY: 2,750 LBS.

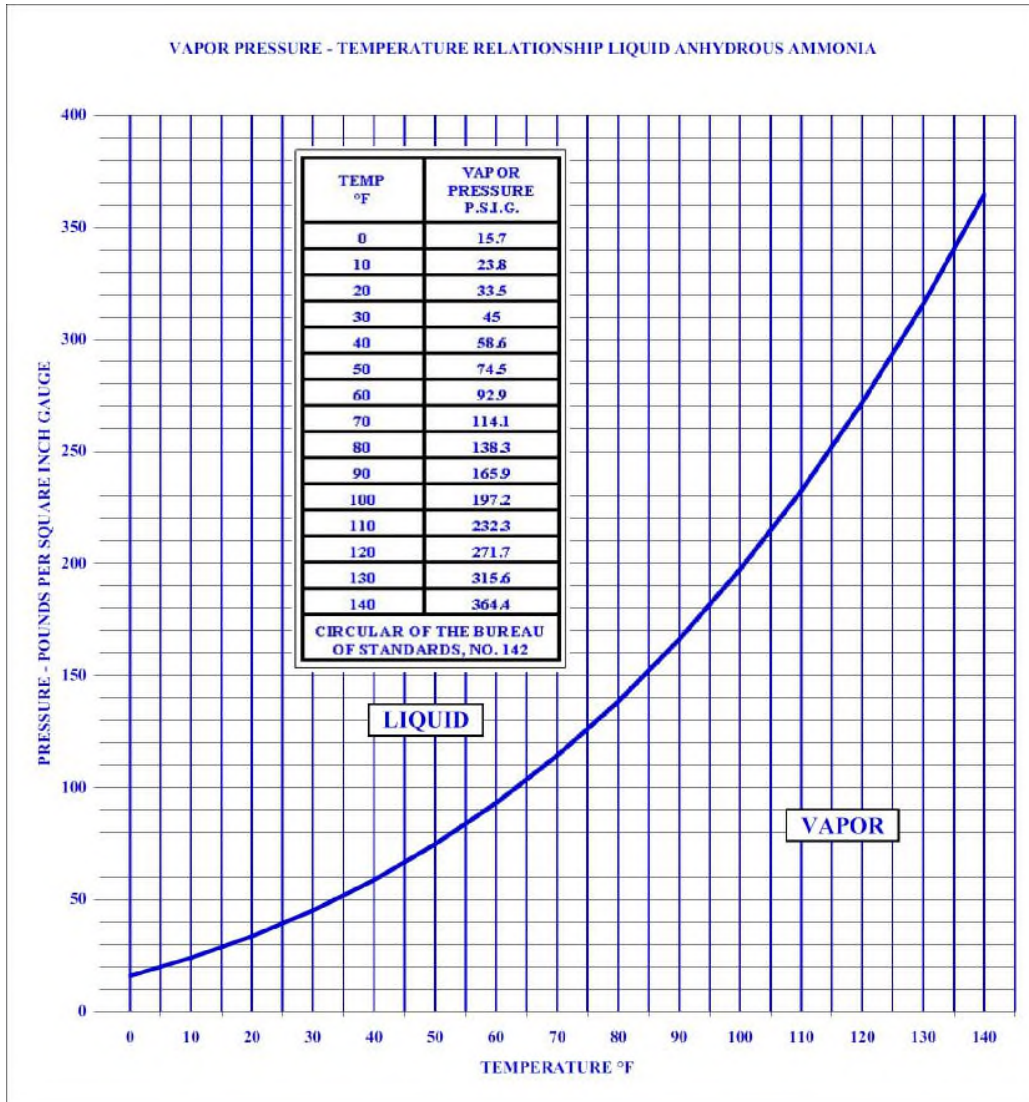
APPROXIMATE WEIGHT AT 85%: 7,000 LBS.

INSTALLATION NOTES:

1. INSTALL THE TANK IN A LOCATION WHERE IT WILL NOT BE SUBJECTED TO DAMAGE BY VEHICLES, CORROSIVE MATERIALS OR FALLING OBJECTS.
2. A PROTECTIVE ENCLOSURE (CHAIN LINK FENCE) SHOULD BE PROVIDED IF THE TANK COULD BE SUBJECTED TO VANDALISM.
3. THE TANK SHOULD BE LOCATED AWAY FROM BUILDING AIR INTAKES, OPEN WINDOWS OR ANYWHERE THAT THE ODOR OF AMMONIA COULD CAUSE PROBLEMS.
4. PIPING CONNECTIONS TO THE TANK SHOULD ALLOW FOR TANK MOVEMENT DUE TO SETTLING, EXPANSION OR CONTRACTION
5. TANKS EQUIPPED WITH VAPORIZERS SHOULD BE ELECTRICALLY GROUNDED.

TANNER INDUSTRIES, INC
TANK INSTALLATION DRAWING
DATE: AUGUST 2020 DWG. NO. 8014

VAPOR PRESSURE - TEMPERATURE RELATIONSHIP LIQUID ANHYDROUS AMMONIA



TANNER INDUSTRIES, INC.	
VAPOR PRESSURE-TEMPERATURE CURVE	
DATE: MAY 1995	DWG. NO. 8019

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