ANSI K61.1-1999
CGA G-2.1-1999

FINAL

AMERICAN NATIONAL STANDARD SAFETY REQUIREMENTS FOR THE STORAGE AND HANDLING OF ANHYDROUS AMMONIA

Fifth Edition, 1999

Nebraska State Fire Marshal

Title 153 N.A.C. Chapter 14

"Storage and Handling of Anhydrous Ammonia (NH3)"

Summer 2007

Secretariat

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Amendments
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FOREWORD

(This Foreword is not a part of *American National Standard Safety Requirements for the Storage and Handling of Anhydrous Ammonia,* K61.1-1999.)

This standard represents the consensus of interested parties concerning minimum safety requirements for the storage, transportation, and handling of anhydrous ammonia. It is intended to serve as a guide for regulatory authorities in writing their own regulations as well as to assist designers of ammonia installations and others having an interest in its requirements, such as safety engineers, insurance organizations, and transportation carriers.

The first edition of the K61.1 Standard was published in 1960 and was based on a standard of the Compressed Gas Association, Inc. (CGA) completed in 1950, and submitted to the then American Standards Association for adoption as an American Standard. The CGA
standard was used to assist in developing regulations during the early period of the expanded use of anhydrous ammonia for agricultural purposes. This took place in the late 1940s and early 1950s.

In 1953 the Agricultural Ammonia Institute (AAI) published its first standard (M-1) for the storage and handling of agricultural ammonia, which has been revised at frequent intervals to remain current with progress in the agricultural ammonia industry.

When the first American Standard for ammonia was approved in 1960, it made available to those concerned two standards on ammonia from which to choose. Many of the states had already adopted as their regulations, the M-1 standard of the AAI, and from then on the ammonia industry was continually faced with the conflict of having two differing standards available dealing with safety requirements for
anhydrous ammonia.

The American Standard was revised in 1966 under the sponsorship of the CGA, and the second edition was made available to interested parties along with revised editions of the similar standards of AAI.

In 1968 the Agricultural Nitrogen Institute (ANI), successor to AAI, requested cosponsor ship of the K61 project. CGA supported cosponsor ship to achieve the endorsement of a single American National Standard that could be supported jointly by ANI and CGA.

The ANI has since merged with the National Plant Food Institute to become The Fertilizer Institute (TFI).

As cosecretariats of the K61 Project, CGA and TFI reconciled the differences between the American National Standard K61.1-1966 and the M-1 Standard of The Fertilizer Institute. A revision was prepared and submitted to the K61 Committee for consideration.

The 1972 and subsequent editions of the K61.1 Standard not only replace the 1966 edition of the American National Standard K61.1, but also supersede the 1966 edition of CGA G-2.1 and the 1968 edition of The Fertilizer Institute M-1 Standard.

Following the 1984 revision of the 1981 edition of the K61.1 Standard, The Fertilizer Institute withdrew from cosponsor ship of the K61.1 Standard in 1987, however, TFI elected to continue as an active participant on the K61 Committee.

The 1989 edition represented a substantial reorganization and expansion of material contained in prior editions with individual sections devoted to ammonia safety and the use of water in emergencies. A new section regarding tank cars was added in recognition of the importance of the rail transportation mode. Other sections were updated to reflect major changes in the areas of technology and regulatory matters.

The 1999 edition incorporates the International System of Units (SI) in recognition of the global harmonization movement. The Pressure Relief Device section underwent a major rewrite to provide consistency and account for excessive heat or fire protection. There have also been some marking and labeling changes in the regulatory area. To ease identification of the changes in this publication,, the paragraphs containing changes have been shaded.

Suggestions for improvements of this standard will be welcome. They should be sent to the American National Standards Institute, Inc., 11 West 42nd Street, New York, NY 10036, or to the ANSI K61 Committee Secretariat, Compressed Gas Association, Inc., 1725 Jefferson Davis Highway, Suite 1004, Arlington, VA 22202.

This standard was processed and approved for submittal to ANSI by American National Standards Committee on Safety Requirements for the Storage and Handling of Anhydrous Ammonia (ANSI K61.1). Committee approval of the standard does not necessarily imply that all committee members voted for its approval. At the time it approved this standard, the K61 Committee had the following members:

Lovic W. Ridenhour, Jr., Chairman
Ronald J. McGrath, Secretary

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U.S. Environmental Protection Agency	(Liaison) Craig Matthiessen
U.S. Department of Transportation	(Liaison) James K. O'Steen
	(Alternate) Ronald Kirkpatrick

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1. Introduction

1.1 Scope

1.1.1 This standard is intended to apply to the design, construction, repair, alteration, location, installation, and operation of anhydrous ammonia systems.

1.1.2 This standard does not apply to: 1.1.2.1, 1.1.2.2, 1.1.2.3, 1.1.2.4.

1.1.2.1 Ammonia manufacturing plants;

1.1.2.2 Refrigeration systems where ammonia is used solely as a refrigerant. Such systems are covered in ANSI/ASHRAE 15, American National. Standard Safety Code for Mechanical Refrigeration [1][11] and ANSI/IIAR 2; American National Standard for Equipment, Design and Installation of Ammonia Mechanical Refrigerating Systems [2];[2]

1.1.2.3 Ammonia transportation pipelines; and

1.1.2.4 Ammonia barges and tankers.

1.2 General

1.2.1 Where certain provisions of this standard impose undue hardship or where literal adherence to such provisions fails to provide adequate safety in the opinion of the authority having jurisdiction, the authority having jurisdiction may permit deviation from the standard.

1.2.2 The values stated in customary units are to be regarded as standard. Metric equivalents where shown in this standard may not be exact, and follow ANSI/IEEE *Metric Practice* procedures in this regard [3].

1.3 Physical/chemical properties of ammonia

1.3.1 Gaseous ammonia liquefies under pressure at ambient temperature. Ammonia is usually shipped or stored as a liquid under pressure. When refrigerated to or below its normal boiling point of -28.17 °F (-33.43 °C), it can be shipped or stored as a liquid at or near atmospheric pressure.

1.3.2 Some physical properties of ammonia are listed in table 1.

1.3.3 During liquid releases, ammonia aerosol may form. This aerosol can reach temperatures approaching -100°F (-73°C) near the point of release [4].

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[1]References in this document are shown by bracketed numerals and are listed in the order of appearance. See: Section 13. References

1.3.4 Ammonia is extremely hard to ignite and is a relatively stable compound. It begins to dissociate into nitrogen and hydrogen at approximately 850°F (454°C) at atmospheric pressure. Experiments conducted by a nationally recognized laboratory showed that an ammonia-air mixture in a standard quartz test container does not ignite at less than 1562°F (850°C). Ammonia gas is flammable in the air in the range of 16% to 25% by volume. Conditions favorable for ignition are seldom encountered during normal operations due to the high ignition temperature required. However, the release of ammonia gas into a tightly enclosed or inadequately ventilated space may result in the accumulation of a flammable mixture that can cause a combustion explosion if a high temperature ignition source is present.

1.3.5 Under some circumstances ammonia and ammonium compounds can react with other chemicals to form explosive products. Ammonia should never be combined with other chemicals unless the possible reactions have been adequately investigated and appropriate precautions taken. Refer to NFPA 45, Hazardous Chemicals Data

1.3.6 Although most metals are not attacked by ammonia, zinc, copper, and copper base alloys such as brass are subject to rapid deterioration by ammonia. Certain high tensile strength steels have developed stress-corrosion cracking in ammonia contaminated with small quantities of air. Such cracking can be minimized by the consistent use of 0.2% water by weight in the ammonia as an inhibitor. Weld heat affected zones can be areas of high hardness, which are susceptible to stress corrosion cracking. U.S. Department of Transportation (DOT) regulations require that ammonia cargo tanks constructed of such steels be post-weld heat treated. See 49 CFR 173.315 [6].

1.4 Ammonia exposure

1.4.1 At low concentrations, ammonia gas is irritating to the eyes, skin and mucous membranes of the nose, throat, and lungs. At higher concentrations, ammonia is corrosive to human tissue and possibly life threatening. Table 2 indicates human physiological responses to various concentrations of ammonia in air. See 4.1 regarding exposure to liquid ammonia.

1.4.2 In accordance with U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) regulations as set forth in 29 CFR 1910.1000 [7], an employee's exposure to ammonia shall not exceed an 8-hour Time-Weighted Average (TWA) concentration limit of 50 ppm (35mg/ml) in contaminated air by volume during any 8-hour work shift of a 40-hour work week. The pungent odor of ammonia is readily detectable by most people and serves as its own warning. Concentrations in the range of 20 ppm to 50 ppm are readily detectable and it is therefore unlikely that any individual would become overexposed unknowingly.

1.5 Federal, state, and local regulations. The provisions of this code shall be considered necessary to provide a reasonable level of protection. They shall reflect situations and the state of the art prevalent at the time the code was adopted. Unless otherwise noted, it shall not be intended that the provisions of this code be applied to facilities, equipment, structures, or installations that were in existence or approved for installation prior to the effective date of the code, except in those cases where it is determined by the authority having jurisdiction that the existing situation involves a distinct hazard to life or adjacent property.

1.5.1 Regulations of the DOT and OSHA are referenced in this standard.

Table 1 - Physical properties of ammonia

	Customary Units	SI Units
Chemical formula	NH_3	NH_3
Molecular weight	17.031	17.031
Boiling point	-28°F	-33.3°C
Critical density	14.7 lb/ft^3	235 kg/m^3
Critical pressure	1657 psia	11.43 MPa
Critical temperature	271.4°F	133.0°C
Density of liquid at 70°F (21.1°C)	38.00 lb/ft^3	608.7 kg/m^3
Density of vapor at 32°F (0°C) and I atm	0.0481 lb/ft^3	0.770 kg/m^3
Flammable limits (in air by volume and 1 atm)	16% to 25%	16% to 25%
Freezing point at 1 atm	-107.9°F	-77.72°C
Heat of solution extrapolated to 0% concentration by weight	347.4 Btu/lb	0.8081 MJ/kg
at 28% concentration by weight	214.9 Btu/lb	0.4999 MJ/kg
Ignition temperature		
(in presence of iron catalyst)	1204°F	651.1°C
(in standard quartz container)	1562°F	850.0°C
Latent heat of fusion at -107.9°F (-77.72°C)	142.8 Btu/lb	0.3322 MJ/kg
Latent heat of vaporization at boiling point and 1 atm	589.3 Btu/lb	1.371 MJ/kg
Liquid density at -28°F (-33.3°C) and 1 atm	42.57 lb/ft^3	681.9 kg/m^3
Solubility in water vol(liq.)/vol(liq.) at 68°F (20.0°C)	0.848	0.848
Specific gravity of liq. at -28°F (-33.3°C) [water @ 39.2°F (4°C = 1]	0.6819	0.6819.
Specific gravity of vapor at 32°F (0°C) and 1 atm (air = 1)	0.5970	0.5970
Specific heat of vapor at 59°F (15.0°C) and 1 atm		
constant pressure, C_P	0.5232 Btu/(lb °F)	2.191 kJ/(kg °C)
constant volume, C_V	0.3995 Btu/(lb °F)	1.673 kJ/(kg °C)
Ratio of specific heats (C_P/C_V)	1.3096 1.3096	
Specific volume of vapor at 32°F (0°C) and 1 atm	20.78 ft /lb	1297 m'/kg
Vapor density at -28°F (-33.3°C) and 1 atm	0.0555 lb/ft	0.8890 kg/m^3
Vapor pressure at 70°F (21.1°C)	114.1 psig	786.7 kPa
Triple point	-107.86°F at 0.88 psia	-77.70°C at 6.1 kPa abs
Weight of liquid per gallon at 60°F (15.6°C)	5.147 lb/gal	616.8 kg/m^3

Source: Handbook of Compressed Gases, pp 259-260. 3rd Edition, 1990.
Compressed Gas Association, Inc.

1.5.2 Prior to April 1, 1967, the DOT regulations were promulgated by the interstate Commerce Commission (ICC). This standard or any part thereof shall not be construed by the user as recommending action in any manner that is not in full compliance with applicable federal, state, and local laws and regulations that are in effect at any given time.

1.6 Hazardous material classification. DOT - designates the hazard class for anhydrous ammonia as 2.2 for domestic shipments and lists ammonia as a hazardous substance with a reportable quantity (RQ) of 100 pounds (45 kg). The words "Inhalation Hazard" must be included on shipping papers and on containers and cylinders as required by special provision 13 noted in column 7 of the hazardous material table. Refer to 49 CFR 172.101 and 172.102 (c) [6]. The four-digit United Nations (UN) identification number for ammonia is 1005. In Canada, regulations are published in Transport Canada's Transportation of Dangerous Goods Regulations and Regulations for, the Transportation of Dangerous Commodities by Rail [8,9]. Under Canadian Transportation of Dangerous Goods Regulations ammonia is classified as a "Corrosive Gas 2.4 (9.2)" and may be transported to, through, and from the United States into Canada using this, description with proper, markings and placarding.

2. Definitions

2.1 ***Alteration***: It is a change in any item described in the original manufacturer's data report that affects the pressure-containing capability of .the container. Reading a container by increasing maximum allowable working pressure or by increasing or decreasing allowable working temperature shall be considered an alteration.

Table 2 - Human physiological response to various concentrations of ammonia in air

Response	Concentration (ppm)
First perceptible odor[1)]	≥ 5
Immediate throat irritation[2)]	≥ 400
Eye irritation[2)]	≥ 700
Coughing[2)]	≥ 1700
Life threatening for short exposure (0.5 hr)[2)]	2500-6500
Rapidly fatal for short exposure (0.5 hr)[2)]	5000-10 000

[1)] Generally accepted, but varies between individuals.
[2)] *Ammonia*, by the Subcommittee on Ammonia, Committee on Medical and Biological Effects of Environmental Pollutants of the National Research Council Copyright"1979 by University Park Press, Baltimore, MD.

2.2 ***Ammonia or anhydrous ammonia***. (These terms are used interchangeably .in this standard.) The compound formed by the chemical combination of the elements nitrogen and hydrogen in the molar proportion of one part nitrogen to three parts hydrogen. This relationship is shown by the chemical formula, NH_3. On a weight basis, the ratio is 14 parts nitrogen to three parts hydrogen or approximately 82% nitrogen to 18%g hydrogen. Ammonia may exist in either a gaseous, liquid, or solid state. It. is not to be confused with aqua ammonia (ammonium hydroxide) which is a solution of ammonia in water.

2.3 *Approved*. In this standard the word "approved" means:
- Listed by a recognized testing laboratory;
- Recommended by the manufacturer as suitable for use with anhydrous ammonia and so marked;
- Accepted by the authority having jurisdiction.

NOTE: The phrase "authority having jurisdiction" is used in a broad manner since jurisdictions and "approval" agencies vary, as do their responsibilities. Where public safety is primary, the "authority having jurisdiction" may be a federal, state, local, or other regional department or individual such as a fire chief, fire marshal, chief of a fire prevention bureau, labor department, health department, building official, electrical inspector, or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the "authority having jurisdiction." In many circumstances, the property owner or his designated agent assumes the role of the "authority having jurisdiction;" at government installations, the commanding officer or departmental official may be the "authority having jurisdiction."

2.4 *Appurtenance.* This refers to all devices such as pressure relief devices, liquid level gauging devices, valves, pressure gauges, pressure regulators, fittings, metering, or dispensing devices designed to be attached to an ammonia container.

2.5 *Codes*

2.5.1 *ASME Code*: This code refers to either Paragraphs U-68, U-69, U-200, or U-201 of Section VIII of the Boiler and Pressure Vessel Code of the American Society. of Mechanical Engineers, 1949 Edition, or Section VIII Division I of the Boiler and Pressure Vessel Code of the American Society of Mechanical Engineers; 1950 Edition, through the current edition including addenda and applicable Code Case Interpretations: Where referenced in this standard only Division I of the ASME Code shall apply [10].

2.5.2 *API-ASME Code*: This code refers to the *Code for Unfired Pressure Vessels for Petroleum Liquids and Gases of the American Petroleum Institute and the American Society of Mechanical Engineers* (API-ASME). The API-ASME Code, as joint publications and interpretation service, was discontinued as of December 31, 1956, and construction of containers to the API-ASME Code has not been authorized since July 1, 1961.

2.6 *Capacity*. The total volume of the container measured in standard U.S. gallons unless otherwise specified.

2.7 *Cargo tank*. Any container designed to be permanently attached to, or forming a part of, a highway motor vehicle, or any container not permanently attached to a highway motor vehicle, that by reason of the container's size, construction, or attachment to a highway motor vehicle, shall be loaded or unloaded without being removed from the highway motor vehicle. This definition does not apply to cylinders and implements of husbandry (nurse tanks) or containers normally used for storage.

2.8 *Chemical splash goggles* (or goggles). Flexible fitting chemical protective goggles with a hooded indirect ventilation system to provide primary protection of the eyes and eye sockets from the splash of

hazardous liquids, which are designed to meet the requirements of ANSI 287.1; *Practice for Occupational and Educational: Eye and Face Protection* [11]. Direct vented goggles do not comply with this definition.

2.9 ***Container***. All tanks, except cylinders as defined in 2.10, used for the transportation or storage of anhydrous ammonia.

2.10 ***Cylinder***: A pressure vessel of 1000 lb (450 kg) water capacity or less constructed in accordance with DOT specifications for cylinders and authorized for the transportation of ammonia. This definition does not include: storage tanks, cargo tanks, portable tanks, implements of husbandry, or tank cars.

2.11 ***Design pressure***. Identical to the term "Maximum Allowable Working Pressure" used in the ASME Code.

2.12 ***DOT regulations***. Refers to the Hazardous Materials Regulations of the DOT. (See the Code of Federal Regulations, 49 CFR Parts 100 to 180, Transportation, including "Specifications for Shipping Containers") [6].

2.13 ***Emergency shower***. A shower unit permanently connected to a source of clean water that enables the user to have water cascading over the entire body and otherwise meeting the requirements of ANSI 2358.1, *Emergency Eyewash and Shower Equipment* [12].

2.14 ***Eye wash unit***. A device used to irrigate and flush the eyes with clean water. Depending upon the requirements set forth in this standard, the device may be a plumbed unit, permanently connected to a source of clean water, or it may be a self- contained unit, not permanently installed that must be refilled or replaced after use. Any eyewash device must otherwise meet the requirements of ANSI 2358.1 [12].

2.15 ***Filling density***. The percent ratio of the weight of the ammonia permitted in a container to the weight of water at 60°F (15.6°C) that the container will hold when full. One pound of water = 27.74 cubic inches (455 ml) at 60°F (15.6°C). For determining the water capacity of the tank in pounds, the weight of one gallon (231 cubic inches) (3.785 L) of water at 60°F (15.6°C) in air shall be 8.328 lb (3.778 kg).

2.16 ***Full face shield***. A device, meeting the requirements of ANSI 287.1, designed to provide protection to all of the face from hazards but shall only be worn as secondary eye protection, supplementing the primary eye protection afforded by chemical splash goggles [11].

2.17 ***Gas mask***. An air-purifying 11 device with a full face-piece approved by NIOSH under the provisions of 30 CFR Part II, Subpart I [13] for use in an ammonia contaminated atmosphere in compliance with 29 CFR 1910.134 [7] and selected; in accordance with ANSI 288.2, *Respiratory Protection* [14]. A gas mask of the air-purifying type must be used only in an atmosphere containing 19.5% to 22.0% oxygen by volume.

2.18 ***Hydrostatic relief valve***. A pressure relief device for liquid service designed to prevent excessive pressure due to thermal expansion when a pipe or hose is filled with liquid such as between block valves or blinds.

2.19 ***Immediately dangerous to life or health***, (IDLH). The maximum concentration from which unprotected persons are able to escape within 30 minutes without escape-impairing symptoms or irreversible health effects. The IDLH for ammonia is 300 ppm (210 mg/m') by volume in accordance with the NIOSH Pocket Guide to Chemical Hazards [15].

2.20 ***Implement of husbandry***. A system, including a nurse tank, with a capacity of 3000 gal (11.35 m') or less or an applicator tank, used for transporting and applying anhydrous ammonia containing 0.2% water exclusively for agricultural purposes.

2.21 ***kPa***. In this publication kPa shall indicate gauge pressure unless otherwise noted as (kPa, abs) for absolute pressure and (kPa, differential) for differential pressure. All kPa values "are rounded off per CGA P-11, *Metric Practice Guide for the Compressed Gas Industry* [16].

2.22 ***National Board Inspection Code***. If refers to the manual published by the National Board of Boiler and Pressure Vessel inspectors that provides the rules and guidelines for inspection by a Commissioned Inspector of the repair, alteration, and reading of containers after being placed into service. [17]

2.23 ***Permissible Exposure Limit*** **(PEL).** The limit developed by OSHA for the maximum airborne concentration of a contaminant to which an employee may be exposed over the duration specified by the type of PEL assigned to that contaminant. PELs are set, forth in 29 CFR 1910.1000.

2.24 ***Permanent storage installation***. A system employing a stationary (fixed) container used exclusively for storage or supply.

2.25 ***Positive pressure Self-contained Breathing Apparatus*** **(SCBA)**. A full face piece respirator approved by NIOSH/MSHA for respiratory protection for both entry into, or escape from, oxygen-deficient atmospheres or a concentration of gases or vapors that are immediately dangerous to life or health where the supply of air is carried by the wearer. The air pressure inside the face piece is positive in relation to the air pressure of the outside atmosphere during exhalation and inhalation.

2.26 ***Pressure relief valve***. A device designed to open to prevent an increase in internal fluid pressure in excess of a specified value due to an emergency or abnormal condition and to close and prevent further flow after normal conditions have been restored.

2.27 ***Protective gloves, boots, and suits***. Items made of rubber or other material impervious to ammonia. Gloves refer to gauntlet-style of sufficient length to allow for cuffing, and which provide thermal protection suitable for ammonia exposure.

2.28 ***Pounds per square inch gauge*** (psig) and *pounds per square inch absolute* (psia)

2.29 ***Repair***. The work necessary to restore a container, cylinder, or system to a safe and satisfactory operating condition provided there is, in all cases, no deviation from the original design. Repairs include the addition of replacement of pressure or non-pressure parts, which do not change the design temperature or pressure of the container, cylinder, or system,

2.30 *Semi-trailer*. Any highway motor vehicle with or without motive power designed to be drawn by another motor vehicle and so constructed that some part of its weight and that of its load rests upon or is carried by the towing vehicle.

2.31 *Shall or must*. A mandatory requirement.

2.32 *Should*. A recommendation or that which is advised, but not required.

2.33 *Short term exposure limit* (STEL). A 15 minute time-weighted average exposure to an air contaminant that should not be exceeded at any time during a work day and should not be repeated more than four times a day. Exposures at the STEL should not occur at less than 60-minute intervals.

2.34 *System*. Refers to an assembly of equipment consisting essentially of the container or containers, hoses, appurtenances, pumps, compressors, and interconnecting piping.

2.35 *Trailer*. Any highway motor vehicle with or without motive power designed to be drawn by another motor vehicle and so constructed that no part of its weight except the towing device rests upon the towing vehicle. Normally called a "full trailer."

2.36 *Transfer, fill, and charge*. These terms may be used interchangeably and mean movement of a quantity of ammonia from one container to another container or cylinder. This does not include feeding ammonia to an application device or process.

3. 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. Some of the important physical properties of ammonia are listed in table 1.

3.1 Training. NOTE: It is not the responsibility of the agriculture retailer or Authority Having Jurisdiction to provide or approve the training listed in this section to the end user.
Any person required to handle, transfer, transport, or otherwise work with ammonia shall be trained to understand the properties of ammonia, to become competent in safe operating practices, and to take appropriate actions in the event of a leak or an emergency. NOTE.

3.2 Normal conditions

Any person making, breaking, or testing any ammonia connection, transferring ammonia, or performing maintenance or repair on an ammonia system under pressure, shall wear protective gloves and chemical splash goggles. A full face shield may be worn over the goggles. However, a face shield shall not be worn as a substitute for a primary eye protection device (goggles).

3.3 Emergency conditions

Only personnel trained for and designated to handle emergencies should attempt to stop a leak. Refer to 29 CFR 1910.120 j7]. Respiratory equipment of a type suitable for ammonia must be worn. All persons not so

equipped must leave the affected area until the leak has been stopped. Refer to CGA G-2, Anhydrous Ammonia, Sections 9 and 10, regarding recommended exposure, emergency, safety, security, and training procedures [18].

3.4 Permanent storage installations

3.4.1 All permanent storage installations shall have on hand, at minimum, the following equipment for emergency and rescue purposes:

3.4.1.1 Two full-faced gas masks jointly approved by NIOSH and MSHA, each with one spare ammonia canister in a readily accessible location, or two high visibility full head hoods, each with a minimum of a five minute pressurized air supply. This also includes a full face respirators or self contained breathing apparatuses (SCBAs) as appropriate emergency equipment alternatives. See 2.17.

NOTE: A full face-piece ammonia gas mask will provide effective respiratory protection in concentrations of ammonia in air that are not immediately dangerous to life or health for short periods of time. A gas mask is not recommended for respiratory protection in concentrations exceeding the IDLH except for escape purposes. In concentrations above the IDLH a positive pressure, an SCBA shall be fused in accordance with the provisions of ANSI Z88.2 [14].

3.4.1.2 One pair of protective gloves impervious to ammonia.

3.4.1.3 One pair of protective boots impervious to ammonia.

3.4.1.4 One protective slicker and/or protective pants and jacket, all impervious to ammonia.

3.4.1.5 Easily accessible emergency shower and a plumbed eyewash unit or at least 100 gal (380 L) of clean water in an open top container.

NOTE: It is recommended that the distance from the point of greatest potential exposure to ammonia to the emergency water supply should not exceed ten seconds travel time or 100 ft (30 m).

3.4.1.6 Chemical splash goggles or chemical splash goggles with full face shield to be worn over the device (goggles).

NOTE: A full face shield, if used, shall only be worn as secondary eye protection supplementing the primary eye protection afforded by the chemical splash goggles. A face shield is not to be worn as a substitute for a proper primary eye protection device (goggles).

3.5 Cargo tanks

3.5.1 Each cargo tank transporting ammonia, except an implement of husbandry (nurse tank)
- shall carry for first aid purposes, at least 5 gal (20 L) of clean water in a container designed to provide ready access to the water for flushing any area of the body contacted by ammonia;

- one pair of protective gloves impervious to ammonia;
- a full face-piece gas mask with an ammonia canister and at least one spare canister or one high visibility full head hood, with a minimum of a five minute pressurized air supply; and
- chemical splash goggles, or chemical splash goggles with full face shield, to be worn over the goggles.

3.5.2 A full face shield, if used, shall only be worn as secondary eye protection supplementing the primary eye protection afforded by the chemical splash goggles. A face shield is not to be worn as a substitute for a proper primary eye protection device (goggles).

3.6 Leaks in transportation equipment. If a leak occurs in transportation equipment and it is not practical to stop the leak, the driver should make every effort possible, including moving the vehicle to an isolated location downwind from populated communities or heavily traveled highways, to transfer the contents to another approved ammonia container. Local authorities should be notified and assistance requested as needed.

3.7 Cylinder and DOT portable tank installations. At ammonia installations comprising cylinders and DOT portable tanks, the employer shall provide ready access to a supply of clean, running water for emergency use or a self-contained eye-wash unit with clean water, including provision for flushing of the eyes by an employee in the event of contact with ammonia.

4.0 Use of water in emergencies

4.1 Human exposure

4.1.1 If liquid ammonia comes in contact with the skin or eyes, the affected area should be promptly and thoroughly flushed with clean water for at least 15 minutes total with the eyes receiving first attention. Eyelids must be held open during flushing. Skin irrigation should include the ears, chin, neck, armpit, and groin areas as appropriate. Contaminated clothing should be removed only after it is thawed. Do not use neutralizing solutions or ointments on the affected areas. Water used for flushing should be within a temperature range and at a controlled flow rate to avoid causing the patient additional injury or discomfort [12]. A physician should treat all cases of exposure to liquid ammonia. An ophthalmologist should be consulted immediately after flushing in the event of eye exposure.

4.1.2 Nose and throat. If ammonia has entered the nose or throat and the patient can swallow, have him drink large quantities of water. Never give anything by mouth to an unconscious person.

4.2 Accidental release

4.2.1 In the event of an accidental release, the concentration of ammonia vapor in the air can be reduced effectively by the use of adequate volumes of water applied through spray or fog nozzles. Downwind control should be achieved by directing water fog nozzles toward the point of ammonia release from a downwind position. See 3.3.

4.2.2 Water should not be used on liquid ammonia spills. Water should only be directed in the form of fog or spray at the cloud emanating from the liquid pool. See 3.3.

4.2.3 In the event of a large vapor release from a container, the tank should not be sprayed with water. Under these circumstances, water fog or spray should be applied to the vapor following the procedures outlined in 4.2.1.

4.3 Fire exposure. If an ammonia container is exposed to fire and cannot be moved, water fog or spray should be used to cool it. Use caution if flame impinges on the vapor space of the container because violent rupture of the container is possible. Water fog or spray should always be applied to the tank from the sides, as the heads usually are first to rupture. If the fire cannot be controlled and it appears the tank may rupture; the surrounding area should be evacuated to a minimum distance of 2000 ft (610 m) in all directions.

4.4 Absorption in water

4.4.1 If ammonia is leaking from a container, the safest, practical means should be taken to stop or abate the leak. If the leak cannot be stopped, the ammonia should be fed to the point of use or transferred to another suitable ammonia container. Small quantities of ammonia from a leaking container can be absorbed by discharging into a vessel containing at least 1 gal (4 L) of water to 1 lb (0.5 kg) of ammonia. The ammonia should be injected into the water as near the bottom of the vessel as practical. If a hose is used to inject ammonia into water, the hose must be weighted or secured so that the end of the hose will remain near the bottom of the vessel.

4.4.2 Runoff of ammonia contaminated water into streams or other bodies of water should be avoided when possible. Releases of ammonia shall be reported to environmental protection and other regulatory authorities as may be appropriate and required by law.

5.0 Basic rules This section applies to all sections of this standard unless otherwise noted.

5.1 Equipment and systems

5.1.1 The provisions of 5.2 shall not be construed as prohibiting the continued use or reinstallation of containers constructed and maintained in accordance with the 1949, 1950, 1952, 1956, 1959, 1965, 1968, 1971, 1974, 1977, 1980, 1983, 1986, 1989, 1992, 1995, and 1998 editions of the ASME Code, or any revisions thereof, in effect at the time of fabrication.

5.1.2 Systems and components that were fabricated, installed, and maintained in accordance with the American National Standard K61.1, *Safety Requirements for the Storage and Handling of Anhydrous Ammonia*, or the Compressed Gas Association *Standards for the Storage and Handling of Anhydrous Ammonia and Ammonia Solutions - Part 1, Anhydrous Ammonia*, or The Agricultural Nitrogen Institute, Standard M-1, *Standard for Storage and Handling of Agricultural Ammonia*, in effect at the time of installation, are acceptable for continued use. Existing facilities should make an effort to conform to the current standard, taking into consideration cost, physical, and legal constraints. Facilities in existence on the effective date of these regulations shall comply with these regulations within three years following the effective

date of these regulations.
NOTE: The latter two standards are no longer published.

5.2 Requirements for new construction and original test, repair, and alterations of containers (including DOT portable tanks), other than refrigerated storage tanks. See exception in 7.1.3.

5.2.1 Containers used with systems covered in Sections 6, 9, 11, and 12 shall be made of steel or other material compatible with ammonia and tested in accordance with the current ASME Code. An 'exception to the ASME Code requirements is that construction under Table UW 12 at a basic joint efficiency of under 80% is not authorized.

5.2.2 Containers designed and constructed in accordance with the ASME Code, other than refrigerated storage containers, shall comply with the following additional requirements:

5.2.2.1 The entire container shall be post weld heat treated after completion of all welds to the shells and heads. The method employed shall be as prescribed in the ASME Code, except that the provisions for extended time at lower temperature for post weld heat treatment shall not be permitted. Welded attachments to pads may be made after post weld heat treatment [10]. Exception: implements of husbandry will not require post weld heat treatment if they are fabricated with hot-formed heads or with cold-formed heads that have been stress relieved.

5.2.2.2 Steels used in fabricating pressure containing parts of a container shall not exceed a specified tensile strength of 70 000 psi (483 Mpa) (does not apply to Sections 8, 9, and 10). Exception: Implements of husbandry may be fabricated from steel having a specified tensile strength of 75 000 psi (517 Mpa).

5.2.3 Containers shall be inspected by a person who holds a valid National Board Commission [17]. Exception: Refrigerated storage tanks with a design pressure of 15 psig (103 kPa) or less and containers covered in Section 8.

5.2.4 Repair or alteration of pressure-containing parts of a container shall be performed in compliance with the applicable provisions of the current edition of the National Board Inspection Code [17]. Where specific procedures are not given, it is intended that, subject to acceptance of the inspector, all repair or alteration shall conform as much as possible to the ASME Code section and edition to which the container was constructed.

5.3 Location of containers

5.3.1 Selection of a location for a storage container shall be made considering the potential physiological and environmental effects of ammonia on the surroundings of the proposed site. Containers shall be located outside of buildings except in buildings or sections thereof specially approved for the purpose.

5.3.2 Containers shall be located at least 50 ft (15 m) from a dug well or other sources of potable water supply, unless the container is a part of a water treatment installation.

5.3.3 The minimum distance of a storage container to dwellings or to population centers shall be in

accordance with the requirements of the local jurisdiction having authority.

5.3.4 In the absence of specifications of minimum distance by local jurisdictions, separation distance for ammonia storage containers and placements of containers covered by Sections 9, 10, 11, and 12 after January 1, 2002 shall be in accordance with table 3. Existing facilities, shall make efforts to conform to Table 3 with consideration of cost, physical and legal constraints, etc.

Table 3 - Minimum Separation Distance for Location of Ammonia Storage Containers [1)]
(Customary Units and SI units)

Nominal Capacity of Container (gal or m^3)	For new facilities constructed after the effective date of these regulations. Mainline of Railroad [2)]	For facilities in existence at the effective date of these regulations. Mainline of Railroad [2)] Highway [3)] or Line of Adjoining Property which may be built upon.	Place of Public Assembly [4)]	Institutional Occupancy [5)]
over 500 to 2,000 gal	100 ft	25 ft	150 ft	250 ft
over 2,000 to 30,000 gal	100 ft	50 ft	300 ft	500 ft
over 30,000 to 100,000 gal	100 ft	50 ft	450 ft	750 ft
over 100,000 gal	100 ft	50 ft	600 ft	1000 ft
over 2 to 8 m^3	30 m	8 m	45 m	75 m
over 8 to 110 m^3	30 m	15 m	90 m	150 m
over 110 to 400 m^3	30 m	15 m	140 m	230 m
over 400 m^3	30 m	15 m	180 m	300 m

1) Separation distances referred to are approximate and based on experience with minor releases.
2) Class II Track or better. Refer to 49 CFR 213.9 [19].
3) A highway is defined as a public way for purposes of vehicular travel, including the entire area within the right-of-way. Refer to Transportation Glossary (1983) American Association of State, Highway and Transportation Officials.
4) Any building or area used by the public for deliberation, worship, education, entertainment, amusement, awaiting transporting or other similar activities.
5) Hospital, jail or similar institution.
6) For 500 gallons (2 m^3) or less, see Sections 5.3.1 and 5.3.3.

5.3.5 Container storage areas shall be accessible to emergency vehicles and personnel. Excess equipment shall not be stored in container area in order to provide access at all times.

5.3.6 Areas within 10 ft (3 m) of a storage container shall be maintained clear of dry grass and weeds and other combustible materials.

5.4 Markings of non-refrigerated containers and systems other than DOT containers.

5.4.1 Each system nameplate, when required, shall be made of a noncorroding metal permanently attached to the system by continuous welding around its perimeter and located so as to be readily accessible for inspection. Nameplates shall be maintained in legible condition and include markings as prescribed in 5.4.2.

5.4.2 Each container or system covered in Sections 6, 9, 10 (except "ton containers" and cylinders), 11, and 12 shall be marked as follows:

5.4.2.1 With a marking as required by paragraph UG-116 of the ASME Code and identifying compliance with the rules of the ASME Code under which the container is constructed;

5.4.2.2 With National Board of Boiler and Pressure Vessel Inspectors stamping to indicate registration of the container with this organization;

5.4.2.3 With a notation on the container and system nameplate to indicate whether the system is designed for aboveground or underground installation or both;

5.4.2.4 With the minimum and maximum temperatures in degrees Fahrenheit (°F) or degrees Celsius (°C) for which the container is designed;

5.4.2.5 With the wall thickness of the container shell and heads in inches (in) or millimeters (mm);

5.4.2.6 With the water capacity of the container in pounds or kilograms (kg), or U.S. standard gallons or cubic meters (m^3) at 60°F (15.6°C);

5.4.2.7 With the outside surface area of the container in square feet (ft^3) or square meters (ml);

5.4.2.8 With marking required by paragraph UG-116 of the ASME Code shall be applied in accordance with the requirements of UG-118 or UG-119. Marking required by 5.4.2.3 through and including 5.4.2.7 must be stamped on the nameplate required in 5.4.1, following the marking arrangement specified by UG-118 or on a separate nameplate immediately adjacent to the ASME Code nameplate [10]. Requirements of.5.4.1 shall also apply to the separate nameplate.

5.4.3 All container openings except for pressure relief valves, pressure indicating devices, thermometer wells, or liquid level indicators shall be marked, stenciled, tagged, or decaled to indicate whether the opening is in contact with the liquid or vapor phase when the container is filled to the maximum allowable filling density.

5.5 Container appurtenances

5.5.1 All appurtenances of each system shall be approved. See 2.3.

5.5.2 All appurtenances shall be designed for no less than the maximum working pressure of the portion of the system on which they are installed. All appurtenances shall be fabricated from materials proved suitable for anhydrous ammonia service.

5.5.3 All connections to containers except connections for pressure relief devices, thermometer well, liquid level gauging devices, or connections fitted with No. 54 (0.055 inches or 1.40 mm) drill size orifice or those plugged, shall have shut-off valves located as close to the container as practical.

5.5.4 Excess flow valves shall close automatically at the rated flows of vapor or liquid as specified by the manufacturer. The piping, including valves and fittings in the same flow path as the excess flow valve, shall have a greater capacity than the rated flow of the excess flow valve.

5.5.5 Liquid level gauging devices that require bleeding of the product to the atmosphere and that are so constructed that outward flow will not exceed that passed by a No. 54 (0.055 in or 1.40 mm) drill size opening need not be equipped with excess flow valves.

5.5.6 An opening in a container to which a pressure gauge connection is made need not be equipped with an excess flow valve if the opening is not larger than No. 54 (0.055 inches or 1.40 mm) drill size.

5.5.7 An excess flow or back-pressure check valve, where required in this standard, shall be installed directly in the container opening or a 'point outside where the line enters the container. In the latter case the installation shall be made in such a manner that any undue strain beyond the excess flow or back pressure check valve shall riot cause breakage between the valve and the container.

5.5.8 Excess flow valves shall be designed with by-pass, not to exceed a No. 60 (0.040 inches or 1.02 mm) drill size opening, to allow equalization of pressure.

5.5.9 Shut-off valves with an integral excess flow valve shall be designed for proper installation in a container opening so that the excess flow valve will close in the event that the valve body, extending above the coupling, is sheared or broken off.

5.5.10 All excess flow valves shall be plainly and permanently marked with the name or trademark of the manufacturer, the catalog number, and the rated capacity.

5.5.11 Each filling connection on non-refrigerated containers shall have a positive shut-off valve in conjunction with either an approved internal back-pressure check valve or an approved internal excess flow valve. Vapor connections on non-refrigerated containers shall have a positive shut-off valve together with an approved internal excess flow valve.

5.5.12 Quick opening (1/4 turn) valves shall not be used on nurse tank filling hoses. Some types of 1/4 turn valves with spring return to close operations may be used depending upon placement and usage.

5.6 Piping, tubing, and fittings

5.6.1 All piping, tubing, and fittings shall be made of steel or other material suitable for anhydrous ammonia service. Brass, copper, or galvanized steel pipe or tubing shall not be used.

5.6.2 All piping, tubing, and fittings shall be designed for a pressure no less than the maximum pressure to which they may be subjected in service.

5.6.3 All piping shall be supported in accordance with good piping practices, and provisions shall be made as necessary for expansion, contraction, impact vibration, and settling. All piping shall conform to ANSI/ASME B31.3, *Process Piping* except ANSI/ASME B31.5, *Refrigeration Piping* may be used for refrigeration piping systems within its scope [21, 22].

5.6.4 Piping used on non-refrigerated systems shall be at least ASTM A53 Grade B seamless or Electric Resistance Welded Pipe [23]. Pipe joints shall be threaded, welded, or flanged. Pipe shall be at least Schedule 40 when, joints are welded or welded and flanged. Pipe shall be at least Schedule '80 when joints are threaded. Threaded nipples shall be seamless. Welding shall be done by a 'welder certified in accordance with the ASME Code, Section IX, "Welding Qualifications" [24]. Tubing joints shall be made up with flared, flareless or compression type fittings complying with ANSI/SAE J513f [25], ANSI/ASME B31.3 [21], or ANSI/ASME B31.5 [22J.

5.6.5 All metal flexible connections for permanent, non-refrigerated installations shall have a minimum working pressure of 250 psig (1720 kPa) (safety factor of 4). For temporary installations, hose meeting the requirement of 5.7 may be used.

5.6.6 Cast iron fittings shall not be used. Those parts of valves that are subjected to gas pressure should be made of steel, ductile (nodular) iron, or malleable iron. Valves, in this case, include shutoff valves, excess-flow valves, back-check valves, emergency shut-off valves, and remotely controlled valves. Ductile iron shall meet the requirements of ANSI/ASTM A395 and malleable iron the requirements of ANSI/ASTM A47 [26].

5.6.7 Adequate provisions shall be made to protect all exposed piping from physical damage, which might result from impact by moving machinery, automobiles or trucks, or any other equipment at the facility.

5.6.8 Joint compounds shall be resistant to ammonia at the maximum pressure and temperature to which they may be subjected in service.

5.6.9 After assembly, all piping, fittings, and 'tubing shall be tested and proved to be free from leaks at a pressure no less than the normal operating pressure of the system.

5.7 Hose specification

5.7.1 Hose used in ammonia service and subject to container pressure shall conform to the American National Standard RMA IP-14, Specifications for Anhydrous Ammonia Hose (see Appendix A).

5.7.2 Hose subject to container pressure shall be designed for a minimum working pressure of 350 psig (2410 kPa) and a minimum burst pressure of 1750 psig (12 070 kPa). Hose assemblies, when made up, shall be capable of withstanding a test pressure of 500 psig (3450 kPa).

5.7.3 Hose and hose connections located on the low-pressure side of flow control, or pressure-reducing valves on devices discharging to atmospheric pressure, shall be designed for the maximum low-side working pressure. All connections shall be designed, constructed, and installed so that there will be no leakage when connected. Shut-off valves on the end of liquid and vapor transfer hoses shall be equipped with bleed valves to enable the operator to bleed off pressure prior to disconnecting the hoses.

5.7.4 Where liquid transfer hose is not drained of liquid upon completion of transfer operations, such hose shall be equipped with an approved shut-off valve at the discharge end. Provision shall be made to prevent excessive hydrostatic pressure in the hose. See 5.8.12.

5.7.5 On all hose 0.5 inch (13 mm) O.D. and larger used in ammonia service and subject to container pressure, there shall be etched, cast, or impressed at 5 ft (1.5 m) intervals on the outer hose cover the following information:

Anhydrous Ammonia
XXX psig (Maximum Working Pressure)
Manufacturer's Name or Trademark
Year of Manufacture

5.7.6 Hose in service shall be requalified periodically in accordance with requirements specified in CGA P-7, Standard for Requalification of Cargo Tank Hose Used in the Transfer of Carbon Dioxide Refrigerated Liquid [27].

5.8 Pressure relief devices

5.8.1 Every container used in systems covered by Sections 6, 11, and 12 without permanent supply, piping to another source of excess pressure shall be protected from excess pressure generated by fire by providing one or more pressure relief valves of the spring loaded type conforming with applicable requirements of ASME UG-125(c)(3); UL-132, *Standard on Safety Relief Valves for Anhydrous Ammonia and LP Gas*, or other equivalent pressure relief valve standard. For other sources of excess pressure, use ASME UG-125 through UG-136 [10]. A rupture disk may be used under a relief valve if good engineering practice is used to design the combined system, and there is a means of regularly checking for disk leakage by monitoring pressure in the space between the devices. Refer to Section 19.4.1.1 of CGA G-2-1995 [18]. A leaking disk shall be replaced because pressure downstream of the disk will prevent rupture at the desired pressure. Under no circumstances shall a rupture disk device be used as the sole, or as a supplemental, pressure relief device on an ammonia container. The opening provided through the rupture disk, after burst, must be sufficient to permit a

flow rate at least equal to the capacity of the relief valve, and there is no interference with the proper functioning of the pressure relief valve.

5.8.2 Pressure relief valves shall be in direct communication with the vapor space of the container, unless a combination rupture disk and relief valve are used. If a combination rupture disk is used, the rupture disk shall communicate with the vapor space. Non-reclosing relief devices shall not be used as the sole means of protection. .

5.8.3 The discharge from pressure relief valves shall be vented away from the container, upward, and unobstructed to the atmosphere unless connected to a control device as defined in 5.8.4. All pressure relief valve discharge openings shall have suitable rain caps that will allow free discharge of the vapor and prevent the entrance of water. Provision shall be made for draining condensate that may accumulate.

5.8.4 When the discharge of ammonia from a pressure relief valve to the open air or atmosphere is impractical, or it is otherwise undesirable due to safety, health, or environmental considerations, ,pressure relief valve discharge may be routed to a properly designed, installed, inspected, tested, and maintained control device such as an ammonia recovery unit, absorption unit or flare system. This is only provided:

5.8.4.1 The flow capacity of the pressure relief :valve is not reduced below the required rate

5.8.4.2 The start to discharge pressure of the pressure relief valve is not changed from the setting marked on the pressure relief valve by its manufacturer or outside the range of settings prescribed in 5.8.5.

5.8.4.3 Backflow of any material from the control device to the discharge side of the pressure relief valve is prevented; and

5.8.4.4 The control device transmits no undue mechanical strain upon the pressure relief valve.

5.8.5 Container relief device pressure shall be set to discharge at no more than 125% maximum allowable working pressure for containers built by the 1949 ASME Code Sections U-68 and U-69, and no more than 100% for those built by all subsequent ASME Codes. Set pressure tolerance is +10% to 0% for non-refrigerated containers.

5.8.6 Pressure relief valves for excessive heat or fire protection used on containers covered by Sections 6, 11, and 12 shall be constructed to discharge at not less than the rates required in Appendix B before the pressure is in excess of 121 % of the maximum allowable working pressure of the container. Relief protection for any other reason shall use ASME UG-125 through UG-136 [10].

5.8.7 Pressure relief valves shall be so arranged that the possibility of tampering will be minimized. If the pressure setting adjustment is external, the relief valves shall be provided with means for sealing the adjustment.

5.8.8 Shut-off valves shall not be installed between the pressure relief valves and the containers or systems covered by Sections 6, 11, and 12 except that a shut-off valve may be used where the arrangement of the

shut-off valve is such as always to afford the full capacity flow specified in 5.8.6 through a non-isolated pressure relief valve(s), which shall remain operative.

NOTE: The previously mentioned exception is made to cover such cases as a three-way valve installed under two pressure relief valves, each of which has the required rate of discharge and is so installed as to allow either of the pressure relief valves to be closed off but does not allow both pressure relief valves to be closed off at the same time. Another exception may be where two separate pressure relief valves are installed with individual shut-off valves. In this case, the two shut-off valve stems shall be mechanically interconnected in a manner that will allow full required flow of one pressure relief valve at all times. Still another exception is a pressure relief valve manifold that allows one valve to be closed off with the remaining unblocked valve or valves providing not less than the rate of discharge shown on the manifold nameplate.

5.8.9 Each pressure relief valve used with systems covered by Sections 6, 11, and 12 shall be plainly and permanently marked as follows:

a. With the letters "AA" or the symbol "NH,";
b. The pressure in psig at which the valve is set to start-to-discharge;
c. The rate of discharge of the valve in cubic feet per minute of air at 60 F (15.6 ▒C) and atmospheric pressure;
d. Year of manufacture; and
e. The manufacturer's name and catalog number.

For example, a pressure relief valve marked "AA250-4200 (air) 4/95" would mean that this valve is set to discharge at 250 psig (1720 kPa), 4200 cubic feet per minute (120 m³/min) of air, and was manufactured in April, 1995.

5.8.10 Piping or connections on either the upstream or downstream side shall not restrict the flow capacity of the relief valve.

5.8.11 The manufacturer or supplier of a pressure relief valve manifold shall publish complete data showing the flow rating through the combined assembly of the manifold with pressure relief valves installed. The manifold flow rating shall be determined by testing the manifold with all but one valve discharging. If one or more openings have restrictions not present in the remaining openings, the restricted opening or openings, or those having the lowest flow, shall be used to establish the flow rate marked on the manifold nameplate. The marking shall be similar to that required in 5.8.9 for individual valves.

5.8.12 A hydrostatic relief valve shall be installed in each section of piping (including hose) in which liquid ammonia can be isolated between shut-off valves to relieve the pressure that could develop from the trapped liquid. The discharge opening from any pressure relief valve shall not terminate inside any building or below the highest roof line of any such building.

5.8.13 A pressure relief device shall be subject to a systematic, periodic, visual external inspection at least annually to determine that it

- meets the applicable requirements specified in 5.8;
- is free of evidence of tampering, damage, corrosion, or foreign matter that might prevent proper

operation;
- is free of leakage when subject to pressures below the minimum allowable start-to-discharge setting;
- has a properly installed rain cap or other device to avoid entry of moisture or other matter into the relief valve outlet; and
- has an open weep hole to permit moisture to escape.

5.8.14 Any deficiency as may be found in 5.8.14 shall require immediate corrective action, replacement, or repair of the pressure relief device as may be appropriate.

5.8.15 No container pressure relief device shall be used after the replacement date as specified by the manufacturer of the device. If no date is specified, a pressure relief valve shall be replaced no later than five years following the date of its manufacture or last repair unless it has first been disassembled, inspected, repaired, and tested by the manufacturer, or by a qualified repair organization in a manner such that the valve's condition and performance is certified as being equivalent to the standards for the original valve. The data regarding repairs or reassembly shall be indicated by stamping the body or attaching a tag pertaining to the valve with the month and year to replace or recertify. Example: 4/01.

5.9 Filling densities. (See 2.15 for detailed definition.)

5.9.1 The DOT Hazardous Materials Regulations [6] require that, the liquid portion of the ammonia lading not completely fill an insulated car tank, portable tank or cargo tank at 105°F (41 ° C), an uninsulated portable tank, cargo tank, single unit tank car tank or multi-unit tank car tank at 15°F (46°C); or .a cylinder at 130°F (54°C). In the case of a tank car tank, the HMR require an outage for the liquefied gas of at least two percent of the total capacity of the tank at the reference temperature of 115°F (46°C) for a noninsulated tank and 105°F (41°C) for an insulated tank. These filling limitations may be expressed in terms `of a calculated maximum filling density designated by weight percentage. The term "filling density" for liquefied compressed gases is defined as "the ratio of the weight of a liquefied compressed gas in .a container or cylinder to the weight of water at 60°F (15.6°C) that the container or cylinder will hold." Refer to 49 CFR 171.8, 173.24b, 173.304(a)(2) table note 1, 173.314(c) table notes 1 and 2, 173.315(a) table note I and 173.315(c)

5.9.2 Maximum allowable filling densities for ammonia shipping containers and cylinders in common usage are as shown in table 8-1 and table 15-1 of CGA G-2-1995 [18].

5.9.3 If containers other than refrigerated containers are to be filled according to liquid level by any gauging method other than a fixed length dip, tube gauge, each container should have a thermometer well and thermometer so that the internal liquid temperature can be easily determined and 'the amount of liquid and vapor in the container corrected to a 60°F (15.6°C) basis.

5.10 Transfer of liquids

5.10.1 Anhydrous ammonia shall always be at a temperature suitable for the material of construction and design of the receiving containers. Certain steels are not suitable for refrigerated ammonia. See Appendix R of API Standard 620, *Design and Construction of Large, Welded, Low-Pressure Storage Tanks*, for materials for low temperature service [28].

5.10.2 At least one qualified operator experienced in the procedures shall monitor the transfer of ammonia from the time the connections are first made until they are finally disconnected. Such monitoring may be performed by a person on site, or from a remote location, or by electronic means. Capability shall be provided to halt the transfer in the event of an emergency.

5.10.3 Cargo tanks and tank cars shall not be unloaded with gas pressure other than from an ammonia source.

5.10.4 Containers and cylinders shall be filled or used only upon the owner's authorization.

5.10.5 Containers and cylinders shall be gauged and charged only in the open atmosphere or in buildings provided for that purpose.

5.10.6 Pumps used for transferring ammonia shall be recommended and labeled for ammonia service by the manufacturer.

5.10.6.1 Positive displacement pumps shall be equipped with a pressure actuated by-pass valve on the discharge side of the pump. This valve shall operate to limit the pressure developed by the pump to the maximum for which the pump is rated. Piping or tubing sized to carry the full capacity of the pump at the actuation pressure of this valve shall connect the discharge of this valve with the container from which ammonia is being pumped. If this line is capable of being closed off by a valve, an additional by-pass device shall be incorporated in the pump to by-pass back to the suction port. The pressure actuated by-pass valve and the return piping or tubing shall be installed in accordance with the pump manufacturer's recommendations.

5.10.6.2 On the discharge side of the pump, before the by-pass valve line, install a pressure gauge graduated from 0 psig to 400 psig (0 kPa to 2760 kPa).

5.10.6.3 Plant piping shall contain shut-off valves located as close as practical to pump connections.

5.10.7 Compressors used for transferring or refrigerating, ammonia shall be recommended and labeled for ammonia service by, the manufacturer or certified for such service by the owner/operator, using recognized and generally accepted good engineering methods.

5.10.7.1 Compressors, except those used for refrigeration, shall be designed for at least 250 psig (1720 kPa) working pressure. Crank cases of compressors not designed to withstand system pressure shall be protected with a suitable pressure relief valve.

5.10.7.2 Plant piping shall contain shut-off valves located as close as practical to compressor connections.

5.10.7.3 A pressure relief valve large enough to discharge the full capacity of the compressor shall be connected to the discharge side before any shut-off valve.

5.10.7.4 Compressors shall have pressure gauges at suction and discharge graduated to at least one and one-half times the maximum pressure that can be developed.

5.10.7.5 Adequate means, such as a drainable liquid trap, shall be provided on the compressor suction to minimize the entry of liquid into the compressor.

5.10.7.6 Where necessary to prevent contamination, an oil separator shall be provided on the discharge side of the compressor.

5.10.8 Loading lines for non-refrigerated containers shall be protected by a suitable back-flow check valve, and unloading lines for non-refrigerated containers shall be protected by a suitable in-line excess flow valve. Piping shall be sized so as not to restrict flow rates to the extent that-protective devices will not function.

NOTE: Facilities in existence at the effective date of these regulations shall be in compliance with this section within three years after the effective date of these regulations.

5.10.8.1 The definition of an Emergency Shut-Off Valve is a valve which when placed in the piping will stop the flow of product by spring closure, gravity, or pressure and can be activated by an outside means, such as a cable pull, hose pull, air assists, electrical closure or back pressure. This Emergency Shut-Off Valve must be placed in the piping to work properly from a remote or stationary automatic, location and/or when activated at the valve.

5.10.8.2 A Bulkhead Load-In shall be utilized for load-in operations and shall not include rail or load-out transfer systems. The load-in bulkhead shall be placed in an area of the facility for load-in of anhydrous ammonia into the main storage tanks. Load-in refers to acceptance from a semi transport truck where the operator would connect the hose to the fixed piping of the facility in order to transfer the anhydrous ammonia. The bulkhead shall consist of metal and/or concrete. The bulkhead shall be built to withstand the side pull of approximately five thousand pounds without moving or damaging the piping that the bulkhead is protecting. The bulkhead shall be built with good engineering practices and shall be approved by the authority having jurisdiction.

NOTE: The State Fire Marshal's Office does not design bulkheads. Guidelines may be obtained from your equipment distributor, a structural engineer or your trade association office.

5.10.8.3 Liquid Piping - The basic system for the liquid line shall consist of an excess flow valve or a combination excess flow shut-off valve, installed in the bottom of the tank followed by a hand operated valve. The liquid line shall also have either a back flow check valve or an emergency shut-off valve installed on the protected side of the bulkhead within five feet of where the liquid hose is connected to the bulkhead. If an emergency shut-off valve is used, a cable or other means shall be attached to the trip arm of this valve and then laid out for at least twenty feet to a remote location and attached to a fixed object.

6.4 Installation of storage containers

6.4.1 Containers installed aboveground, shall be provided with substantial reinforced concrete footings and foundations or structural steel supports mounted on reinforced concrete foundations. In either case, the reinforced concrete foundations or footings shall extend below the established frost line and shall be of sufficient width and thickness to support the total weight of the containers and contents adequately. Where required by local codes, seismic loads shall be considered in the design of the footings and foundations. The foundation shall maintain the lowest point of the tank not less than 18 inches (0.46 m) above the ground. Floating type foundations shall also be acceptable providing the foundations are designed to adequately support the tank, contents, and piping. See 5.6

NOTE: Skid tanks shall be adequately supported and installed as listed in 6.4.1.

6.4.2 Horizontal aboveground containers shall be mounted on foundations in such a manner as to permit expansion and contraction. Every container shall be supported so as to prevent the concentration of excessive loads. If supports of the saddle type are employed, the bearing afforded by the saddles shall extend over at least one third of the circumference of the shell. Suitable means for preventing corrosion shall be provided on that portion of the container in contact with the foundations or saddles.

NOTE: Facilities in existence at the effective date of these regulations shall meet a minimum saddle requirement of twenty percent of the circumference of the shell within three years after the effective date of these regulations.

6.4.3 Secure anchorage or adequate pier height shall be provided against container flotation wherever sufficiently high flood water might occur.

6.4.4 The location and installation of an underground container and the type of corrosion control employed shall have approval of the appropriate jurisdictional authority. Containers buried underground shall be placed so that the top of the container is at least 1 ft (0.3 m) below the surface. Should ground conditions make compliance with these requirements impractical, precautions shall be taken to prevent physical damage to the container. It is not necessary to cover the portion of the container to which a manhole and other connections are axed. When necessary to prevent floating, containers shall be. securely anchored or weighted.

6.4.5 As a minimum, underground containers shall be set on firm foundations (firm earth may be used) and be surrounded by at least six inches of noncorrosive, inert materials, such as soft earth, sand, or gravel well compacted into place. As a further means of resisting corrosion the container and its piping, prior to placement in the ground, shall be provided with the following:

- a suitable protective coating applied after proper surface preparation in accordance with the coating manufacturer's recommendations;
- cathodic protection; and
- electrical isolation of the container from ancillary equipment.

Corrosion-resistant materials of construction may be used as an option. A container, which has been coated, shall be lowered into place in such a manner as to prevent abrasion or damage to the

coating. Selection of the type of protection should be based upon the judgment of a qualified engineer having knowledge of the corrosion history of the area.

6.4.6 The horizontal distance between aboveground and underground containers of over 1200 gal (4.5 m^3) capacity shall be at least 5 ft (1.5 m).

6.4.7 A groundwater monitoring program meeting local, state, or federal regulatory requirements shall be established at the storage site by the owner of the underground storage system.

6.4.8 Underground tanks pose additional requirements for owners and operators. These include installation and maintenance requirements, regulatory notifications, and financial responsibilities: The appropriate jurisdictional authority should be consulted. See 40 CFR Part 280 [30]

6.5 Reinstallation of containers

6.5.1 Containers, once installed underground, shall not later be reinstalled aboveground or underground, unless they successfully withstand hydrostatic pressure retests at the pressure specified for the original hydrostatic test as required by the ASME Code under which the tank was constructed. It shall also show no evidence of serious corrosion.

6.5.2 Where containers are reinstalled underground, the corrosion protection shall meet the requirements of 6.4.5. Where containers are reinstalled aboveground, pressure relief devices or gauging devices shall comply with 5.8, 5.11, and 6.3 as applicable to aboveground containers.

6.6 Marking containers

6.6.1 Each container or group of containers shall be marked on at least two sides, which are visible with the words, ANHYDROUS AMMONIA-in sharply contrasting colors with letters not less than 3.9 inches (100 mm) high. Each container or group of containers shall be marked on at least two sides, which are visible with the words, INHALATION HAZARD, in sharply contracting colors with letters not less than 2 inches high.

6.6.2 Each container or group of containers shall be conspicuously marked with a hazard warning label complying with 29 CFR 1910.1200 [7].

6.6.3 Each container or group of containers that are installed underground shall have a sign bearing marks and labeling as required in 6.6.1 and 6.6.2 located adjacent to the cover described in 6.7.2.

6.7 Protection of container and appurtenances

6.7.1 Container appurtenances shall be located or protected by suitable barriers so as to avoid damage by trucks or other vehicles. Main container shut-off valves shall be kept closed and locked when the installation is unattended. If the facility is protected against tampering by fencing, or other suitable means, valve locks are not required. Suitable barriers may include, but are not be limited to; concrete/steel posts (minimum 4" diameter pipe, 3 feet above ground, 3 feet below ground, set 4 feet apart) guardrails, concrete road barriers,

vehicle warning devices or other barriers providing protection.

NOTE: Facilities in existence at the effective date of these regulations shall be in compliance with 6.7.1 within three years of the effective date of these regulations.

6.7.2 All connections to underground containers should be located within a suitable dome, housing, or manhole fitted with a substantial removable cover.

6.7.3 Storage containers need not be electrically grounded.

6.8 Identification for emergency. A legible sign shall be displayed on the premises at which a storage system is located, so as to be readily visible to emergency response personnel, stating the name, address and telephone-number of the nearest representative, agent, or owner of the storage system.

8. Systems mounted on railcar structures (tank cars), other than DOT class 106A, for transportation of ammonia

This section applies specifically to systems using DOT single-unit pressure tank car tanks mounted on railcar structures and used for the rail transportation of ammonia. Systems for tank cars transporting ammonia, in addition to complying with the requirements of these standards, shall comply, where required, with the requirements of DOT and also be approved by the Association of American Railroads (AAR).

8.1 Design and construction. Tank car tanks and tank cars shall be designed, constructed, and tested in compliance with current DOT specifications as are applicable and must receive approval from the AAR Committee on Tank Cars before being placed into service.

8.2 Pressure relief valves

8.2.1 Tank cars shall be provided with a pressure relief valve as required by DOT regulations.

8.2.2 Pressure relief device equipment used on DOT containers shall be inspected, repaired, or replaced in accordance with applicable DOT regulations.

8.3 Marking and placarding

8.3.1 Each tank car transporting ammonia or ammonia residue shall be marked with the proper shipping names, and the words inhalation, *Inhalation Hazard* on two opposing sides of the tank car, except that bulk packages marked prior to October 3, 1991 need not be remarked *AMMONIA, ANHYDROUS LIQUEFIED* if the tank car otherwise complies with the provisions of 49 CFR 172:302(f). Markings must be at least 3.9.inches (100mm) in height and must have a width of at least 0.24 inches (6.1mm). The markings; must be

displayed on a background of sharply contrasting color on both sides of the tank car and near the stenciled DOT specifications markings. Each tank car must also be marked or displayed either on an orange panel or on a placard per the provisions of 49 CFR 73.332(a), with the UN identification number, 1005, on each side and each end in a manner prescribed by DOT regulations. Refer to 29 CFR 72.302 [6].

8.3.2 Each tank car transporting ammonia must be provided with placarding in accordance with DOT requirements on each side and each end in accordance with DOT regulations.

8.3.3 Each tank car transporting ammonia shall be marked with a hazard warning label complying with 29 CFR 1910.1200 unless such label is provided with the shipping document for the tank car conforming with 49 CFR Part 172, Subpart C as appropriate [7, 6].

8.4 Tank car loading and unloading locations and operations

8.4.1 The loading, unloading, and shipping of tank cars shall conform with the requirements of DOT regulations [6].

8.4.2 Anhydrous ammonia tank cars shall be loaded and unloaded only at approved locations meeting the requirements of 3.4 and 5.10.1 through and including 5.10.9.2.

8.4.3 Loading and unloading operations shall be performed by qualified personnel meeting the requirements of .3.1, properly trained in the procedures involved, and made responsible for careful compliance with such procedures.

8.4.4 Rail track at tank car loading and unloading positions shall be essentially level.

8.4.5 Brakes shall be set and the wheels blocked in both directions on all tank cars being loaded or unloaded.

8.4.6 Caution signs shall be so placed on the track or car to give necessary warning to persons approaching the car from the open end or ends of the siding. The signs must be of metal or other comparable material at least 12 inches (300 mm) high by IS inches (380 mm) wide in size, and bear the words, STOP - TANK CAR CONNECTED, or STOP - MEN A T WORK, the word, STOP being in letters at least 4 inches (100 mm) high. Other words should be in letters at least 2 inches (50 mm) high. The letters must be white on blue background. A car so protected must not be coupled or moved. The signs must remain in place until the tank car valves have been closed and the transfer lines have been disconnected.

8.4.7 A standard derail must be properly set and secured in the derailing position between the car being loaded or unloaded and other cars being moved on the same track.

8.4.8 A tank car must not be loaded. or shipped unless it meets DOT specifications for the shipment of ammonia.

8.4.9 A tank car that has been loaded must not be shipped unless it has been loaded by, or with the consent of, the tank car owner or owner's agent.

8.4.10 A tank car used to transport a commodity other than ammonia shall be purged completely of the previous commodity before being loaded with ammonia. Markings and placarding must be changed accordingly.

8.4.11 Before connecting loading lines to a tank car and before releasing a tank car to the carrier, a visual inspection for obvious defects should be made for the following conditions:

8.4.11.1 To determine whether the tank car undercarriage, safety appliances (handrails, grab irons; etc), walk surfaces; ladders, steps, air and hand brake systems, trucks, head shields, and couplers appear to be in a safe condition.

8.4.11.2 To determine if the tank car tank and pressure relief valve periodic retest dates are current;

8.4.11.3 To determine if the tank car tank, or jacket if the tank is insulated, shows evidence of abrasion, dents, gouges, severe corrosion, or other damage; and

8.4.11.4 To determine whether man way bolts and gaskets, external valves, pressure relief valves, gauges, and fittings appear to be in serviceable condition and free of leakage.

8.4.12 If leakage occurs at any man way, valve, gauge, gasket, or fitting during loading, the loading must stop and the cause of the leak corrected before loading can be resumed. If necessary to effect leak repairs, the tank car shall be emptied and repairs made at the loading terminal or a qualified repair facility.

8.4.13 A damaged or defective tank car shall be forwarded to a carrier repair track or to a qualified repair shop before it is returned to service. Structural repairs to a tank car, including welding repairs on the tank car tank, shall be performed only at a repair facility authorized by the AAR and by a qualified welder following authorized procedures.

8.4.14 An ammonia tank car must be consigned for delivery and unloaded on a private track. State and local regulations regarding unloading operations shall be observed.

8.4.15 If a private track is unavailable, an ammonia tank car equipped with excess flow valves may be consigned for delivery and unloaded on a carrier track, provided it is unloaded into a permanent storage facility with a method approved by the authority having jurisdiction.

8.4.16 After loading or unloading a tank car, all valves shall be closed and transfer lines disconnected. Caps or plugs on tank car sample valves, liquid valves, vapor valves, and gauging device valves shall be replaced and made wrench tight. Slip tube gauging devices shall be secured, and gauge housings screwed in place. Protective housing covers must be secured, pinned, and proper seals put in place when required. Leaks from any source on a tank car shall be stopped before a car may be released to the carrier.

8.4.17 Each tank car loading and unloading location shall have on hand as a minimum, for emergency and rescue purposes, all of the equipment specified in 3.4.

9. **Systems mounted on trucks, semi-trailers, and trailers for transportation of ammonia.** This section applies specifically to systems mounted on trucks, semi-trailers and trailers (other than those covered under Sections 11 and 12) used for the transportation of ammonia. Section 5, Basic rules. applies to this section unless otherwise noted. Systems for trucks and trailers for transportation of anhydrous ammonia, in addition to complying with the requirements of these standards, shall also comply. where required, with the requirements of DOT and those of any other regulatory body, which may apply.

9.1 Design pressure of containers

9.1.1 Containers used in interstate commerce shall be designed and constructed in accordance with the ASME Code. have a minimum design pressure of 265 psig (1830 kPa), and meet other applicable requirements of DOT regulations. Containers designed and constructed in accordance with earlier ASME Code editions having a minimum design pressure of 250 psig (1720 kPa) and meeting certain limiting conditions prescribed by DOT regulations. are authorized for use in intrastate commerce [10, 6].

9.1.2 The shell or head thickness of any container shall not be less than 0.1875 inch (4.8 mm).

9.1.3 All container openings, except pressure relief valves, liquid level gauging devices, and pressure gauges, shall be labeled to designate whether they communicate :with liquid or vapor, space with the container filled to the maximum permitted filling density. Labels shall be readily visible and may be on or adjacent to the valves closing the openings.

9.1.4 Baffles are not required for cargo tanks.

9.2 Container mounting

9.2.1 The means of attachment of any container to the cradle, frame, or chassis of a vehicle shall be designed on a basis of 2 "g" loading in either direction. using a safety factor of not less than 4, based on the ultimate strength of the material used. For the purpose of this requirement, 2 "g" of load support is equivalent to three times the static weight of the articles supported; 2 "g" of loading and bending, acceleration, and torsion is equivalent to twice the static weight support applied horizontally at the road surface.

9.2.2 "Hold-down" devices, when used, shall anchor the container to the cradle, frame, or chassis in a suitable and safe manner, which will not introduce undue concentration of stresses. These devices shall incorporate positive means for drawing the container down tight, and suitable stops or anchors shall be provided to prevent relative movement between the container and framing due to stopping, starting, or changes in direction.

9.2.3 Vehicles designed and constructed so that the cargo tanks constitute in whole or in part the stress member used in lieu of the frame shall be supported by external cradles subtending at least 120° of the shell circumference. The design calculation shall include beam stress, shear stress, torsion stress, bending moment, and acceleration stress, in addition to those covered by the code under which the cargo tank was designed.

9.2.4 If a liquid withdrawal line is installed in the bottom of a container, the connections thereto, including hose, shall not be lower than the lowest horizontal edge of the motor vehicle axle.

9.2.5 Provision shall be made to secure both ends of the hose while in transit.

9.2.6 When the cradle and the container are not welded together; suitable material shall be used between them to reduce abrasion,

9.3 Container appurtenances

9.3.1 Non-recessed container fittings and appurtenances shall be protected against physical damage by either
- a protected location;
- the vehicle frame or bumper; or
- a protective housing.

The protective housing, if used, shall comply with the requirements under which the containers are fabricated for design and construction. It shall be designed to withstand static loadings in any direction equal to twice the weight of the container and attachments when filled with the lading, using a safety factor of not less than 4, based on the ultimate strength of the material to be used. The protective housing, if used, shall be protected with a weather cover, if necessary, to ensure proper operation of valves and pressure relief devices.

9.3.2 With the exception of pressure relief valves, liquid level gauges, pressure gauges, and thermometer wells, every opening in each container shall be:

9.3.2.1 Closed with a plug, cap, bolted blind, flange, or plate; or

9.3.2.2 Provided with an excess-flow valve and manual shut-off valve; or

9.3.2.3 Provided with a back-flow check valve and manual shut-off valve; or

9.3.2.4 Provided with a remotely controlled internal shut-off valve as described in 9.3.3.

9.3.3 Every liquid or vapor discharge opening in each container shall be provided with a remotely controlled internal shut-off valve. For every such opening of less than 1.25 inches NPT, an excess flow valve with a manual shut-off valve may be used instead. The internal shut-off valve may be operated by mechanical means, by hydraulic means, or by air or gas pressure.

9.3.3.1 On a container of 3500 gal (13 m') water capacity or less, each internal shut-off shall be provided with at least one remote control station and the actuating means may be mechanical. This station must be at one end of the tank, away from the discharge connection area.

9.3.3.2 On a container over 3500 gal (13 m^3) water capacity, each internal shut-off valve shall be provided with remote means of closure, both mechanical and thermal, which are installed at the ends of the tank in at

least two diagonally opposite locations. If the discharge connection at the tank is not in the general vicinity of one of the two locations specified above, one additional fusible element must be installed so that heat from a fire in that area will activate the emergency control system. Fusible elements may not have a melting point exceeding 250°F (121°C).

9.3.4 The requirements of 9.3.3 do not apply to a 1.25 (32 mm) inches NPT liquid or vapor discharge opening equipped with an excess flow valve and manually operated shut-off valve installed before October 1, 1984.

9.3.5 All containers shall be equipped with an approved vapor-equalizing valve of adequate capacity.

9.3.6 All containers shall be equipped with a fixed maximum liquid level gauge.

9.3.7 All containers shall be equipped with a pressure gauge having a dial graduated from 0 psig to 400 psig (0 kPa to 2760 kPa).

9.4 Piping, fittings, and hose

9.4.1 All piping, tubing, hose, and fittings shall be securely mounted and protected against physical damage.

9.4.2 Piping used on non-refrigerated systems shall be at least ASTM A-53 Grade B seamless or Electric Resistance Welded Pipe. Pipe joints shall be threaded, welded, or flanged. Pipe shall be at least Schedule 40 when joints are welded or welded and flanged. Pipe shall be at least Schedule 80-when joints are threaded. Brass, copper, or galvanized steel pipe or tubing shall not be used [23]. Threaded nipples shall be seamless. Welding shall be done by a welder certified in accordance with the ASME Code, Section IX, "Welding Qualifications" [24]. Tubing joints shall be made up with flared, flareless or compression type fittings complying with SAE J513f [25], ANSI/ASME B31.3 [21].or ANSI/ASME B31.5 [22].

9.4.3 The truck unloading line shall be provided with an excess flow valve at the hose connection unless an approved quick closing internal valve is provided in the container unloading connection. See 9.3.2.

9.4.4 Liquid propane hose shall not be used for ammonia service. See 5.7.

9.5 Pressure relief valves

9.5.1 The discharge from container pressure relief valves shall be vented away from the container upward and unobstructed to the open air in such a manner as to prevent any impingement of escaping gas upon the container. Loose fitting rain caps shall be used to prevent moisture or foreign material from entering the relief valve outlet. The size of discharge lines from pressure relief valves shall not be smaller than the nominal size of the pressure relief valve outlet connection. Suitable provision shall be made for draining condensate which may accumulate in the discharge pipe.

9.5.2 Pressure relief device equipment used on DOT containers shall be inspected, repaired, or replaced in accordance with applicable DOT regulations.

9.6 Placarding and marking of containers

9.6.1 Every container, whether loaded or empty, shall be conspicuously and legibly marked on each side and each end, on a background of sharply contrasting, color with the proper shipping name, except than containers marked prior to October 1, 1991, need not be remarked ANHYDROUS AMM0NIA, LIQUEFIED if the container otherwise complies with the provisions of 49 CFR 172.302(f). Markings shall have a width of at least 0.24 inches (6.1 mm) and a height of at least 2.0 inches (50 mm). Each container shall also be marked with the UN identification number for ammonia, 1005, on each side and each end in a manner prescribed by DOT regulation [6]. Under the provision of 49 CFR 172.332 (a) the UN identification number may be displayed on an orange panel or by a placard showing the UN 1005 number. If an orange panel is used, then a placard reading Nonflammable Gas is also required on all four sides of the container.

9.6.2 Each container, whether empty or loaded, shall be provided with placarding on each side and on each end in accordance with DOT regulations

9.6.3 Each container shall be marked with a hazard warning label complying with 29 CFR 1910.1200 unless such label is provided with the shipping papers for the cargo tank conforming with 49 CFR Part 172 subpart C as appropriate [7,6].

9.7 Transfer of liquids

9.7.1 The content of a cargo tank container shall be determined by weighing, suitable liquid level gauging device, or another approved method.

NOTE: If the volume content of a container is to be determined by liquid level measurement, the container shall have a thermometer well and thermometer so that the internal liquid temperature can be easily determined. This volume when converted to weight shall not exceed the filling density specified by DOT regulations [6].

9.7.2 Pumps or compressors shall be designed and installed in accordance with 5.10 and protected against physical damage when mounted upon ammonia tank trucks and trailers.

9.7.3 A cargo tank container of greater than 3500 gallons (13 m') water capacity shall be unloaded only at approved locations meeting the requirements of 3.4 and 5.10.8.

9.7.4 A cargo tank shall only be unloaded into a container capable of holding the entire load, or a method approved by the authority having jurisdiction.

9.8 Trailers and semi-trailers

9.8.1 When two or more vehicles are operated in combination, the vehicles shall be designed and constructed, and the coupling devices connecting the vehicles shall be designed, constructed, and installed, so that, when the combination is. operated in a straight line on a smooth, level, paved surface, the path of the towed vehicle

shall not vary more than 3 inches (80 mm) from the path of the towing vehicle.

9.8.2 Each trailer and semi-trailer shall be equipped with an emergency braking system to be activated in the event of separation from the towing vehicle.

9.8.3 Each trailer shall be equipped with a tow-bar and means of attaching the tow-bar to the towed and towing vehicles. The tow-bar and means of attachment must be structurally adequate, properly and securely mounted, provide for adequate articulation, and be provided with a locking device to prevent accidental separation of the towed and towing vehicles. One or more safety devices such as a safety chains) or safety cables) shall also be properly installed to prevent the towed vehicle from breaking loose in the event of tow-bar failure or disconnection.

9.8.4 Where a fifth wheel assembly is employed for towing a semi-trailer, the lower half of the assembly shall be properly and securely attached to the frame of the towing vehicle. The upper half of the assembly shall be fastened to the towed vehicle in a manner providing at least the same security required for installation of the lower half. Each fifth wheel assembly shall have a positive locking mechanism, which shall apply automatically on coupling, and which will prevent separation of the upper and lower halves except by activation of a manual release.

9.9 Electrical equipment and lighting

9.9.1 Tank trucks. tank trailers, and tank semi trailers may not be equipped with any artificial light other than electric light. Electric lighting circuits shall have suitable over current protection (fuses or automatic circuit breakers). The wiring shall have sufficient carrying capacity and mechanical strength, and shall be suitably secured, insulated, and protected against physical damage.

9.9.2 Tank trucks, tank trailers, and tank semi trailers shall be provided with lighting devices and reflectors in accordance with the applicable provisions of 49 CFR 393 Subpart B [19].

9.10 Protection against collision. Each tank motor vehicle shall be provided with properly attached bumpers or chassis extensions arranged to protect the tank, piping, valves, and fittings from physical damage in case of collision.

9.11 No ammonia shall be loaded into or unloaded from any tank truck, tank semi-trailer, or tank trailer unless the handbrake and/or other brake mechanism and wheel chocks on both sides of at least one drive wheel are securely set to prevent motion of the vehicle during the loading or unloading process.

9.12 Portable tanks (including skid tanks). When portable tanks are used in lieu of cargo tanks and are permanently mounted on highway motor vehicles for the transportation of ammonia, they shall comply with the requirements of Section 9. Where portable tanks, including those built to DOT Specification 51 or 106A, are used for farm storage they shall comply with Section 6. When portable tanks are used as shipping containers in interstate commerce they shall comply with Section 10.

9.13 Safety equipment. All tank trucks, trailers, and semi-trailers (or attached power units) shall be

furnished with the equipment specified in 3.5 for emergency purposes.

10. Systems using DOT portable tanks and cylinders. This section applies specifically to systems using cylinders (see 2.10), portable tanks (DOT51), or "ton containers" (DOT-106A) constructed in accordance with DOT specifications. Section 5, Basic rules, applies to this section unless otherwise noted.

10.1 Containers and cylinders

10.1.1 Containers and cylinders shall comply with current DOT specifications and shall be maintained, filled, packaged, marked, labeled, and shipped to comply with current DOT regulations, OSHA regulations, and CGA C-7 Guide to the Preparation of Precautionary Labeling & Marking of Compressed Gas Containers [31]

10.1.2 Containers and cylinders shall be stored in an area free from ignitable debris and in such a manner as to prevent external corrosion. Storage may be indoors or outdoors. Cylinders stored out doors should be protected against accumulation of ice and snow. Cylinders in hot climates should be protected from the continuous direct rays of the sun.

10.1.3 Containers and cylinders shall not be buried below ground.

10.1.4 Containers and cylinders shall be set upon firm, level surfaces or otherwise firmly secured. The possible effect of settling or frost heave on the outlet piping shall be guarded against by appropriate use of a flexible connection or special fitting.

10.1.5 Containers and cylinders shall be protected from heat sources such as radiant flame and steam pipes. Heat shall not be applied directly to containers or cylinders to raise the pressure. A cylinder filled in accordance with DOT regulations will become liquid full at 145°F (62.8°C) and will rupture upon further temperature rise.

10.1.6 Containers and cylinders shall be stored in such a manner as to protect them from moving vehicles or external damage.

10.1.7 Any container or cylinder that is designed to have a valve protection cap or device shall have the cap or device securely in place when the container or cylinder is not in service. This requirement need not apply at a facility specifically designated for filling containers or cylinders.

10.1.8 Any process system connected to a container or cylinder shall be equipped with a suitable trap or back-pressure check valve to prevent the entry of foreign matter into the container or cylinder.

10.2 Container and cylinder valves and regulating equipment

10.2.1 Container and cylinder valves and pres sure-regulating equipment shall be protected against tampering when installed for use.

10.2.2 Container and cylinder valves shall be protected while in transit, in storage, and while being moved

prior to connection to the process line, as follows:

10.2.2.1 By setting them into a recess of the container; or

10.2.2.2 By ventilated metal cap or collar, fastened to the container, capable of withstanding a blow from any direction equivalent to that of a 30 lb (14 kg) weight dropped 4 ft (1.2 m). Construction must be such that a blow will not be transmitted to the valves or other connections; or

10.2.2.3 A valve on a cylinder that is enclosed in a suitable box or crate of sufficient strength to protect the valve from damage during transit or storage need not be provided with a protective cap or collar.

10.2.3 When containers or cylinders are not connected for service, the outlet valves shall be kept tightly closed and protected even though containers are considered empty. This requirement need not apply at a facility specifically designated for filling containers or cylinders.

10.2.4 Cylinder valves shall be in accordance with the connection standard for ammonia as contained in ANSI/CGA V-1, *American National, Compressed Gas Association Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections* [32].

10.3 Pressure relief devices

10.3.1 Containers shall be provided with pressure relief devices as required by DOT regulations. A cylinder containing less than 165 lb (75 kg) of ammonia is not required to have a pressure relief device.

10.3.2 Pressure relief device equipment used on DOT containers shall be inspected, repaired, or replaced in accordance with applicable DOT regulations.

11.0 Systems mounted on farm wagons (implements of husbandry or a nurse tank) for the transportation of ammonia

This section applies to containers of 3000 gal (11 m^3) water capacity or less and related equipment mounted on farm wagons (implements of husbandry), which are used for the transportation of ammonia. Section 5, Basic rules, applies to this section unless otherwise noted.

11.1 Design of containers. Containers shall be constructed in accordance with 5.2.

11.2 Mounting of containers

11.2.1 A suitable "stop" or "stops" shall be mounted on the farm wagon or on the container in such a way that the container shall not be dislodged from its mounting due to the farm wagon coming to a sudden stop. Back slippage shall also be prevented by proper methods.

11.2.2 A suitable "hold-down" device shall be provided that will anchor the container to the farm wagon at one or more places on each side of the container.

11.2.3 When containers are mounted on four wheel farm wagons, care shall be taken to ensure that the weight is distributed evenly over both axles.

11.2.4 Where the cradle and the container are not welded together; suitable material shall be used between them to reduce abrasion. See 5.2:2.1 and 5.2.4 with regard to welding on a container.

11.3 Container appurtenances

11.3.1 All containers shall be equipped with a fixed maximum liquid level gauge.

11.3.2 All containers shall be equipped with a pressure gauge having a dial graduated from 0 psi to 400 psi (0 kPa to 2760 kPa).

11.3.3 The filling connection of each container shall comply with the requirements of 5.5.11.

11.3.4 All containers shall be equipped with an approved vapor-equalizing valve unless equipped for spray loading.

11.3.5 All vapor and liquid connections, except pressure relief valves and those specifically exempt in 5.5.5 and 5.5.6, shall be equipped with approved excess flow valves or may be fitted with quick-closing internal valves, which shall remain closed except during operating periods.

11.3.6 Fittings shall be protected from physical damage by means of a rigid guard designed to withstand static loading in any direction equal to twice the weight of the container and lading using a safety factor of 4 based upon the ultimate strength of the material used. If the guard encloses the pressure relief valve, the valve shall be properly vented through the guard.

11.3.7 If a liquid withdrawal line is installed in the bottom of a container, the connections thereto, including hose, shall not be lower than the lowest horizontal edge of the farm wagon axle. The hose shall be drained and depressurized prior to the container being moved or towed on a public road.

11.3.8 Provision shall be made to secure both ends of the hose in transit.

11.3.9 Systems covered under Section 11 shall comply with all requirements as prescribed in 49 CFR 173.315(m) [6]

11.4 Placarding and marking of containers

11.4.1 There shall appear on each side and on each end of the container in letters at least two inches (50 mm) high, the words, ANHYDROUS AMMONIA.- Each container shall be marked with the words Inhalation Hazard on two opposing sides (see 49 CFR 172.102 Special Note 13). If the container has a capacity of 1000 gallons, (3785 L) or more, markings and placards shall appear on each end and each side. If the container has a capacity less than 1000 gal (3785 L), markings and placards shall appear on two opposing sides. Markings

shall have a width of at least 0.24 finches (6.1 mm) and a height of at least 2.0 inches (50 mm). The 'container need not be marked or `placarded on one end if that end contains valves, fittings, regulators, or gauges when those appurtenances prevent the markings and placard from be properly placed and visible. Refer to 49 CFR 302 and 173.315 (m) [6]

11.4.2 Slow-moving (25 mph [40 km/h] or less) wagons operating on public roads shall be provided with a slow-moving vehicle emblem consisting of a fluorescent orange triangle with a red effective border. A driver of a slow-moving motor vehicle may activate the vehicular hazard warning signal flashers to warn other drivers of the presence of a potential traffic hazard if permitted to do by state or local ,regulations. For information regarding construction, location, and mounting of the emblem, refer to ASAE 5276.4, *Slow-Moving Vehicle Identification Emblem*: See also 29 CFR 79.10.145(d)(10) [33, 7].

11.5 Farm wagons (implements of husbandry or a nurse tank)

11.5.1 Farm wagons (implements of husbandry) shall conform with state regulations.

11.5.2 All farm wagons shall be securely attached to the vehicle drawing them by means of drawbars supplemented by suitable hitch pins and ,safety chains, which meet the requirements of ASAE S338.2, *Safety Chain for Towed Equipment*. _A suitable hitch pin shall mean a pin which is secured by a safety latch. Safety chains shall be designed to carry the entire load of the tank.

11.5.3 A farm wagon shall be constructed so that it will follow substantially in the path of the towing vehicle and will prevent the towed farm wagon from whipping or swerving dangerously from side to side. No more than two farm wagons shall be towed by the same towing vehicle.

11.5.4 A farm wagon shall not be towed in public places such as school yards, malls, or hospital grounds without approval of local authorities.

11.6 Safety equipment

NOTE: It is not the responsibility of the agriculture retailer or Authority Having Jurisdiction to provide or approve the training listed in this section to the end user.

11.6.1 Each person operating, repairing appurtenances, or inspecting a nurse tank must comply with the following requirements:

- Any person required to handle, transfer, trans port, or otherwise work with ammonia shall be trained to understand the properties of ammonia to become competent in safe operating practices, and to take appropriate actions in the event of a leak or an emergency; and
- Any person making, breaking, or testing any ammonia connection, transferring ammonia, or performing maintenance or repair on an ammonia system under pressure shall wear protective gloves impervious to ammonia, and chemical splash goggles. A full face shield may be worn over the goggles. However, a face shield shall not be worn as a substitute for a primary eye protection device (goggles).

11.6.2 Each nurse tank shall be equipped with the following safety equipment and features:
- For first aid purposes, at least 5 gal (20 L) of clean water in a container designed to provide ready access to the water for flushing any area of the body contacted by ammonia;
- A legible decal depicting step-by-step ammonia transfer instructions.
- A legible decal listing first aid procedures to follow if injured by ammonia; and - A hazard warning label complying with the requirements of 29 CFR 1910.1200 [7].

11.6.3 Decals depicting instructions for quick couplers shall be placed on the nurse tank or on the tool bar.

11.7 Chemical additive compatibility. Prior to the addition of a chemical additive, its compatibility with system components shall be verified by the manufacturer of the additive.

12. Systems mounted on farm equipment (implements of husbandry or nurse tanks) for the application of ammonia

This section applies to systems mounted on farm equipment and used for the field application of ammonia. Section 5, Basic rules, applies to this section unless otherwise noted.

12.1 Design of containers. The minimum design for containers shall be in accordance with 5.2.

12.2 Mounting of containers. All containers shall be securely mounted.

12.3 Container valves and appurtenances

12.3.1 Fixed maximum liquid level gauges shall be used that are designed to indicate when the container has been filled to 85% of its water capacity. The dip tube of this gauge shall be installed in such a manner that it cannot be readily removed.

12.3.2 The filling connection of each container shall comply with the requirements of 5.5.11.

12.3.3 An excess-flow valve is not required in the vapor connection, provided the controlling orifice is not in excess of 0.4375 inch (11.1 mm) in diameter and the valve is a hand-operated (attached hand wheel or equivalent) shut-off valve.

To assist in filling applicator tanks, it is permissible to bleed vapors to the open air, provided the preceding requirements are met.

12.3.4 Metering devices may be connected directly to the tank withdrawal valve. A union-type connection is permissible between the tank valve and the metering device. Remote mounting of metering devices is permissible using hose that meets with specifications in Appendix A.

12.3.5 When the applicator or nurse tank is trailed and the metering device is remotely mounted, such as on

the tractor tool bar, an automatic break-away, self-closing coupling device shall be used. The coupling device shall be made from, or coated with, a corrosion resistant material. The coupling device shall be mounted in a manner that will permit the device to swivel freely. A coupling device shall be maintained in accordance with the manufacturer's recommendations.

NOTE: An angle valve shall not be used as a hose end valve connecting to the coupling device.

12.3.6 No excess-flow valve is required in the liquid withdrawal line provided the controlling orifice between the contents of the container and the outlet of the shut-off valve (see 5.5.3) does not exceed 0.4375 inch (11.1 mm) in diameter.

12.3.7 Any control valve installed between the regulator and the break-away coupling device shall indicate whether the valve is open or closed.

12.3.8 Where a ball valve is used to control flow to the metering device, the ball shall be drilled with an opening smaller than No. 54 (0.055) inches or 1.40 mm) drill size on the downstream side to prevent trapping ammonia "in the ball" when in the closed position:

12.4 Safety equipment

NOTE: It is not the responsibility of the agriculture retailer or the Authority Having Jurisdiction to provide or approve the training listed in this section to the end user.

12.4.1 Each person operating, repairing appurtenances or inspecting an applicator tank shall com ply with the following requirements:

- Any person required to handle, transfer, trans port, or otherwise work with ammonia shall be trained to understand the properties of ammonia, to become competent in safe operating practices, and to take appropriate actions in the event of a leak or an emergency; and
- Any person making, breaking, or testing any ammonia connection, transferring ammonia, or performing maintenance or repair on an ammonia system under pressure shall wear protective gloves impervious to ammonia, and chemical splash goggles. A full face shield may be worn over the goggles. However, a face shield shall not be worn as a substitute for a primary eye protection device (goggles).

12.4.2 Each applicator tank shall be equipped with the following safety equipment and features:

12.4.2.1 For first aid purposes, at least 5 gal (20 L) of clean water in a container designed to provide ready access to the water for flushing any area of the body contacted by ammonia;

- A legible decal depicting step-by-step ammonia transfer instructions;
- A hazard warning label complying with the requirements of 29 CFR 1910.1200 [7].

12.4.3 Instructions for connecting and disconnecting the coupling device shall be displayed in a manner as to be readily visible near the break away coupling device.

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References

[1] ANSI/ASHRAE 15 1994, *American National Standard Safety Code for Mechanical Refrigeration*, American Society of Heating, Refrigerating and Air Conditioning Engineers, 1791 Tulle Circle, NE, Atlanta, GA 30329.

[2] ANSI/IIAR 2, *American National Standard for Equipment, Design and Installation of Ammonia Mechanical Refrigerating Systems*, International Institute of Ammonia Refrigeration, 1200 19th St. NW, Washington, DC 20036

[3] ANSI/IEEE Std 268-1992, *Metric Practice*, Institute of Electrical and Electronics Engineers, 345 East 47th St., New York, NY 10017.

[4] Blanked, JM ., Behavior of Ammonia in the Event of Spillage, 01-49-3701-80-3963 American Institute of Chemical Engineers, 345 East 47th St. New York, NY 10017.

[5] NFPA 45, *Hazardous Chemicals Data,* National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02269.

[6] *Code of Federal Regulations,* 49 CFR Parts 100-180 (Transportation), Chapter l- Research and Special Programs Administration, U.S. Department of Transportation. Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

[7] *Code of Federal Regulations,* 29 CFR Parts 1900-1910 (Labor), Chapter XVII-Occupational Safety and Health Administration, U.S. Department of Labor. Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

[8] *Transportation of Dangerous Goods Regulations, Supply* and Services Canada, Canadian Publications Centre, Ottawa, Ontario, Canada KIA OS9.

[9] *Regulations for the Transportation of Dangerous Commodities by Rail, Supply and Services Canada.* Canadian Publications Centre, Ottawa, Ontario. Canada K1A OS9.

[l0] ASME *Boiler and Pressure Vessel Code,* Section VIII. American Society of Mechanical Engineers, 345 East 47th Street, New York, NY 10017.

[11] ANSI 287.1, *Practice for Occupational and Educational Eve and Face Protection,* American National Standards Institute. Inc., 11 West 42nd Street. New York, NY 10036.

[12] ANSI Z 358.1, *Emergency Eyewash and Shower Equipment,* American National Standards Institute, Inc., 11 West 42nd Street, New York, NY 10036.

[13] *Code of Federal Regulations,* 30 CFR Parts 1-199, (Mine Safety and Health Administration),

Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402, .

[14] ANSI 288.2, *Respiratory Protection,* American National Standards Institute, Inc., 11 West 42nd Street, New York, NY 10036.

[15] *NIOSH Pocket Guide to Chemical Hazards, 1994,* (SN 017-033-00448-0), Superintendent of Documents, U.S. Government Printing Office, P.O. Box 371954, Pittsburgh, PA 15250.

[16] CGA *P-11, Metric Practice Guide for the Compressed Gas Industry,* Compressed Gas Association, Inc., 1725 Jefferson Davis Highway, Arlington, VA 22202.

[17] ANSI/NB-23, *National Board Inspection Code,* National Board of Boiler and Pressure Vessel Inspectors, 1055 Crupper Avenue, Columbus, OH 43229.

[18] CGA G-2, *Anhydrous Ammonia,* Compressed Gas Association, Inc., 1725 Jefferson Davis Highway. Suite 1004, Arlington, VA 22202.

[19] *Code of Federal Regulations,* 49 CFR Parts 200-399 (Transportation) Chapter III- Federal Highway Administration, U.S. Department of Transportation. Superintendent of Documents. U.S. Government Printing Office, Washington, DC 20402.

[20] Transportation Glossary 1983, *American Association of State Highway and Transportation Officials,* 444 North Capitol Street, N.W., Suite 225, Washington, DC 20001.

[21] ANSI/ASME B31.3, *American National Standard for Process Piping,* American Society of Mechanical Engineers, 345 East 47th Street, New York, NY 10017.

[22] ANSI/ASME B31.5, *American National Standard for Refrigeration Piping,* American Society of Mechanical Engineers, 345 East 47th Street, New York, NY 10017.

[23] ASTM Specification A53, *Annual Book of ASTM Standards,* ASTM, 100 Barr Harbor Dr., West Conshohocken, PA 19428.

[24] ASME *Boiler and Pressure Vessel Code Section IX,* American Society of Mechanical Engineers, 345 East 47th Street, New York, NY 10017.

[25] ANSI/SAE J513f, *Refrigeration Tube Fittings,* Society of Automotive Engineers, 400 Commonwealth Dr., Warrendale, PA 15096.

[26] ANSI/ASTM Specification A47 and Specification A395, *Annual Book of ASTM Standards,* ASTM, 100 Barr Harbor Dr., West Conshohocken, PA 19428.

[27] CGA P-7, *Standard for Requalification of Cargo Tank Hose Used in the Transfer of Carbon Dioxide Refrigerated Liquid,* Compressed Gas Association. Inc., 1725 Jefferson Davis Highway, Suite 1004, Arlington, VA 22202.

Amendments
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