

# Anhydrous Ammonia System Piping Requirements

This fact sheet was prepared by the Minnesota Department of Agriculture to provide information on some of the State of Minnesota requirements for facilities, which store, handle and use anhydrous ammonia on their premises. This guidance is intended to supplement - not replace - the Minnesota Anhydrous Ammonia Rules, Parts 1513.0010 to 1513.1100 and other applicable standards.

## AMMONIA-RATED SYSTEM PIPING

Minnesota Rules, Part 1513.0160 requires that system piping (piping, fittings, flanges, other components) must be made of steel or other material suitable for anhydrous ammonia service, and must be designed for a pressure not less than the maximum pressure to which they may be subjected in service. System piping components made of, or in part of, brass, copper, zinc, galvanized steel, or cast iron may NOT be used for ammonia service.

## NON-REFRIGERATED SYSTEM PIPING

Non-refrigerated ammonia system piping must conform to the ANSI B31.3 and K61.1 standards. The most common system piping components meeting the minimum standards for non-refrigerated ammonia systems are:

### PIPE/NIPPLES/FLEXIBLE CONNECTOR SPECIFICATIONS

ASTM/API Specification	Tensile Strength	Schedule Rating (Wall Thickness)	Quality Factor
<i>Piping &amp; Seamless Nipples:</i>			
ASTM A53, Grade B, ERW	60,000 psi	40 & 80	85%
ASTM A53, Grade S, Seamless	70,000 psi	40 & 80	100%
ASTM A106, Grade B, Seamless	60,000 psi	40 & 80	100%
ASTM A106, Grade C, Seamless	70,000 psi	40 & 80	100%
API 5L, Grade B, ERW	60,000 psi	40 & 80	85%
<i>Seamless Swage Nipples:</i>			
ASTM A234, Grade WPB	60,000 psi	40 & 80	
<i>Stainless Steel, Ammonia-Rated Flexible Connectors:</i>			
250 psi/NH3-rated with a safety factor of four			

### NOTES RELATING TO PIPE/NIPPLES/FLEXIBLE CONNECTORS:

- + Welded or welded/flanged joints: At least Schedule 40, Standard (STD) rated piping.
- + Threaded joints: At least Schedule 80, Extra Heavy (XH) rated piping.
- + Threaded nipples must be seamless of Schedule 80, Extra Heavy (XH) rated.

### FITTING/FLANGE SPECIFICATIONS

ASTM Specification	Pressure Class or Schedule Rating	Fitting Type
<i>Fittings :</i>		
A105, (Forged Carbon Steel)	Class 2000 & greater	Threaded & Socket Weld
A234, Grade WPB	Schedule 40 & 80	Butt Weld
*A197	Class 300 & greater	Black Malleable Iron (MI)
*(1). Malleable iron (MI) fittings are NOT RECOMMENDED for ammonia service because of its marginal applications.		
*(2). MI fittings allowed for use are Class 300 & greater-rated elbows, tees, crosses, reducing 90°s, street 90°s, reducing couplings.		
*(3). Do not use MI plugs and bushings (only available in Pressure Class 150).		
*(4). Do NOT weld on MI fittings. Use of MI fittings is limited to threaded joints.		
*(5). Do NOT use MI fittings for low temperature, refrigerated ammonia service.		
<i>Flanges:</i>		
A105, (Forged Carbon Steel)	Class 300 & greater	

### OTHER SYSTEM PIPING COMPONENT SPECIFICATIONS

ASTM Specification	Component Type
A395 Ductile Iron	Valves
A193, Grade B7	Flange Stud Bolts
A194, Grade 2H	Flange Hex Nuts

### NOTES RELATED TO FITTINGS, FLANGES, VALVES, & COMPONENTS:

- + Unions must be *steel to steel* sealed.
- + Components, flanges, and fittings marked with, "FORGED", ASTM/ASME "A/SA###", "MI" (malleable iron), and/or Class "####" specification designation(s). Specifications not marked or solely noted must meet the requirements for non-refrigerated ammonia service.

## REFRIGERATED SYSTEM PIPING

Low temperature (colder than -20° F.), refrigerated ammonia system piping must conform to the ANSI B31.3, B31.5, and K61.1 standards. The most common system piping components meeting the minimum standards for refrigerated ammonia systems are:

### PIPE & SEAMLESS NIPPLE SPECIFICATIONS

ASTM Specification	Grade Rating	Type	Tensile Strength	Schedule Rating	Quality Factor
A333	1 & 6	Seamless	60,000 psi	40 & 80	100%

### NOTES RELATED TO PIPE/NIPPLES:

- + Piping and nipples not meeting the specification for low temperature piping is subject to Charpy impact testing as prescribed in ASME B31.3 and ASTM A370.
- + Welded or welded & flanged joints: At least schedule 40, Standard (STD) rated piping.
- + Threaded joints: At least schedule 80, Extra Heavy (XH) rated piping.
- + Threaded nipples must be seamless of Schedule 80, Extra Heavy (XH) rated.

### FITTING/FLANGE SPECIFICATIONS

ASTM Specification	Pressure Class or Schedule Rating	Fitting/Flange Type & Diameter
<i>Fittings:</i>		
A350, Grade LF-2	Class 2000 & greater	Threaded & Socket Weld
A420, Grade WPL-6	Schedule 40	Butt Weld, ≥ 2.0 inch diameter
A420, Grade WPL-6	Schedule 80	Butt Weld, ≤ 1.5 inch diameter
<i>Flanges:</i>		
A350, Grade LF2	Class 150 & greater	Raised Face Flange

### OTHER SYSTEM PIPING COMPONENT SPECIFICATIONS

ASTM Specification	Component Type
A352, Grade LCB or LCC	Valves (3 inches or larger)
A350, Grade LF-2	Valves (2 inches or smaller)
A193, Grade B7M	Flange Stud Bolts
A194, Grade 2H	Flange Hex Nut

### NOTES RELATED TO FITTINGS, FLANGES, VALVES, & COMPONENTS:

- + Components, flanges, and fittings marked with, "FORGED", ASTM/ASME "A/SA###", and/or Class "####" specification designation(s). Specifications not marked or solely noted must meet the requirements for low temperature, refrigerated ammonia service.
- + Unions must be *steel to steel* sealed.

## WELDING ROD SPECIFICATIONS

### NON-REFRIGERATED SYSTEMS

E6010 or E6011 for root pass and E7018 (low hydrogen rod) for cover passes.

### LOW TEMPERATURE, REFRIGERATED SYSTEMS

E6010 or E6011 for the root pass and E7018, E8018, or E8018-G for the cover passes.

### NOTES RELATING TO WELDING RODS:

*Precautions for Handling Low-Hydrogen Welding Rods:* Rods must come in *hermetically* sealed containers/packaging. To minimize moisture, once removed from sealed packaging, rods must be kept in a heating oven. Welded joint porosity is increased to unacceptable levels when low hydrogen rods are not kept dry. Rods cannot be out of oven for over four hours or as specified in the ASME Code, Section IX.

### WELDING/WELDER QUALIFICATIONS

Welding on ammonia system piping must be performed by a **qualified welder** utilizing **qualified welding procedures** in accordance to the ASME Code, Section IX. For further details review MDA fact sheet entitled, Anhydrous Ammonia Pipe Welding.

Periodic inspection must be performed to determine if hydrostats are free of evidence of tampering, damage, corrosion, leakage, or foreign matter that might prevent proper operation. Hydrostats must be equipped with secured rain caps to avoid entry of moisture or foreign matter.

### CORROSION PROTECTION

Corrosion protection is recommended whenever system piping is placed at or below ground level. Cathodic protection and ammonia-compatible coatings or tape are means to provide corrosion protection for underground system piping.

### TRAFFIC PROTECTION

Adequate provisions must be made to protect all **exposed** system piping from physical damage that might result from impact by moving machinery, automobiles, trucks, and any other equipment at the facility. Posts or other barriers of adequate strength must be installed to protect exposed system piping.

### PULL-AWAY & FLOW CONTROL PROTECTION

Truck transport and nurse tank loading and unloading piping must be provided with adequate pull-away and flow control protection. For further information, consult the MDA anhydrous ammonia fact sheet entitled, Truck/Nurse Tank Riser Area Pull-Away Protection.

### SECURITY PROTECTION FOR STORAGE SYSTEM

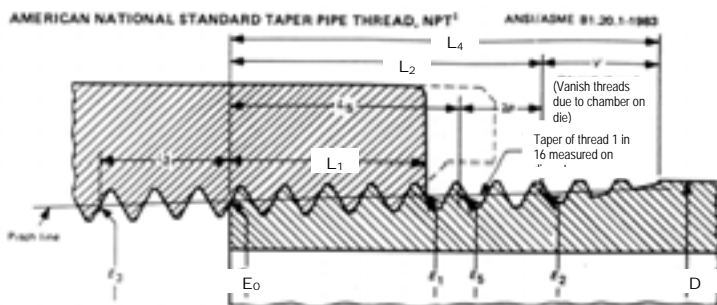
Main tank shut-off valves and nurse tank loading riser hose-end valves must be kept closed and locked when installation is unattended. Valve locks are not required if facility is protected against tampering by means of adequate fencing.

### THREAD JOINT SPECIFICATIONS

Thread dies and taps must conform to ANSI/ASME Standard B1.20.1, Pipe Threads, General Purpose (Inch). Taper pipe threads are used for ammonia service. Basic taper thread data for common pipe diameters:

NPS (in)	O.S. Dia. D	Threads per inch	** Handtight Engagement L <sub>1</sub>	Total Thread Length L <sub>4</sub>	Effective Thread Length L <sub>2</sub>	Unutilized Thread L <sub>4</sub> minus L <sub>2</sub>	Pitch Diameter @ Handtight Plane E <sub>0</sub>
1 ¼	1.660	11 ½	0.420	1.0085	0.7068	.3017	1.58338
1 ½	1.900	11 ½	0.420	1.0252	0.7235	.3017	1.82234
2.0	2.375	11 ½	0.436	1.0582	0.7565	.3017	2.29627
3.0	3.500	8	0.766	1.6337	1.2000	.4337	3.38850

\*\*Rule of Thumb: Properly made thread should allow a hand tightening range of 2 to 4 turns.



### EXAMINATION/TESTING OF SYSTEM PIPING

In-process examination of welded and threaded joints must be performed and documented as part of the Certification of Completion by contractor/installer and/or owner of system piping.

Pressure testing is required after system piping is installed. System piping must be pressure tested and proved to be free of leaks at a pressure not less than the normal operating pressure.

### SHUT-OFF VALVE INSTALLATION

Shut-off valves must be positioned as close as practical to each tank port. Exceptions are pressure relief valves, thermometer wells, liquid level gauging

devices, with a No. 54 (0.055 inch) drill size orifice, or plugged ports. The shut-off valve must be installed so that the ammonia in the tank is under or behind the disc holder or valve seat when the valve is closed. This requirement also applies to shut-off valves located in nurse tank loading riser ports.

Shut-off valves in other segments of the system piping may be installed in either direction, unless the manufacturer specifies otherwise.

### PROTECTION OF SYSTEM PIPING

#### SUPPORT PROTECTION OF SYSTEM PIPING

System piping shall be designed, arranged and supported so as to eliminate excessive vibration and loading. Ammonia-rated flexible connectors protect system piping from inadvertent movement. Flexible connectors, positioned above ground level, must be used whenever buried system piping is not positioned below the frost line. However, flex connectors are recommended any time system piping is installed below ground level or excessive vibration is encountered.

Pipe supports also provide protection to system piping. As a general guide, install pipe supports every 10 feet, plus one foot for each inch of pipe diameter. For example, for 2 inch diameter piping:

$$10 \text{ feet} + [2 \text{ inch diameter pipe} \times 1 \text{ foot/inch pipe diameter}] = 12 \text{ feet.}$$

#### PRESSURE RELIEF PROTECTION

Pressure relief protection for system piping and hosing must be provided by means of 350-400 psi/NH<sub>3</sub>-rated hydrostatic relief valves or hydrostats. Hydrostats must be installed in each section of liquid and vapor system piping and hosing in which ammonia could be isolated between shut-off valves.

### IDENTIFYING LIQUID & VAPOR PHASES

All non-refrigerated system openings and appurtenances (tank ports, truck, rail, nurse tank riser loading and unloading areas), except for pressure relief valves, pressure indicating devices, thermometer wells, liquid level indicators, or hosing must be marked, stenciled, tagged, or decalced, to indicate whether the opening is in contact with the liquid or vapor phase.

If paint is used to identify the phases, liquid must be orange and vapor yellow. The valves and lines must be painted to within three feet, except for hosing, of the system openings.

### HOSING

Use of ammonia-rated hosing in a system is **limited** to the transfer connections between the fixed loading and unloading system piping and nurse tank, rail, and truck transports. In other words, hosing may **not** be used in place of fixed system piping.

Ammonia-rated hosing must have a minimum working pressure of 350 psig (1750 psig burst pressure). Hose assemblies, when made up, must be capable of withstanding a test pressure of 500 psig. Hose-end valves must be equipped with bleeder valves or other suitable bleed off devices.

The outer cover of ammonia-rated hosing with an outside diameter of ½ inch outside diameter or larger must be etched, cast, or impressed with the following information:

1. anhydrous ammonia-rating endorsement;
2. manufacturer;
3. 350 psig (minimum working pressure); and
4. year manufactured or expiration date.

In Minnesota requirements for replacement of ammonia-rated hosing is based exclusively on **CONDITION**. Immediately replace hosing if bulges, cracks or cuts to the hose cords/braiding, or other defects are apparent.

### FOR MORE INFORMATION

Contact the Minnesota Department of Agriculture at (651) 201-6275 or e-mail ed.kaiser@state.mn.us.