

ANHYDROUS AMMONIA

Anhydrous Ammonia System Piping Requirements

This factsheet was prepared by the Minnesota Department of Agriculture (MDA) 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 ARE NOT ALLOWED for ammonia service.

Non-Refrigerated System Piping

Non-refrigerated ammonia system piping must conform to the ANSI B31.3 standard. 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
Piping & Seamless Nipples			
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%
Seamless Swage Nipples			
ASTM A234, Grade WPB	60,000 psi	40 & 80	
Stainless Steel, Ammonia-Rated Flexible Connectors			
250 psi/NH3-rated with a safety factor of four			

Notes Related 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, Schedule 80, Extra Heavy (XH) rated.

Fitting/Flange Specifications

ASTM Specification	Pressure Class or Schedule Rating	Fitting Type
Fittings		
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 ammonia service are Class 300 and 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.		
Flanges		
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 seated.
- 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 and B31.5 standards. The most common system piping components meeting the minimum standards for refrigerated ammonia systems are:

Pipe and 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 are 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).
- 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
Fittings		
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
Flanges		
A350, Grade LF2	Class 150 & greater	Raised Face Flange

Notes Related to Fittings/Flanges:

- Socket weld fittings in system piping of 2 inches or less is preferred.

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 seated.

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

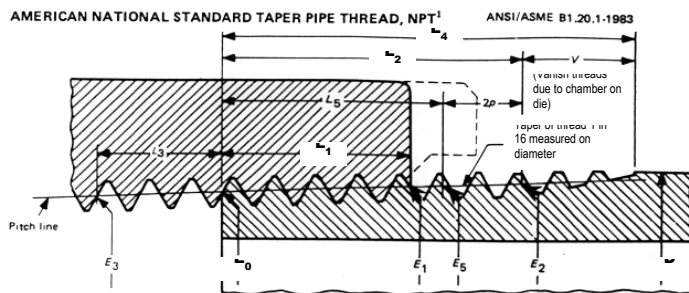
Welding on ammonia system piping must be performed by a **qualified welder** utilizing **qualified welding procedures** in accordance to the ASME Code, Section IX. For further details review MDA fact sheet entitled, **Anhydrous Ammonia Pipe Welding and Welder Qualifications**.

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 L1	Total Thread Length L4	Effective Thread Length L2	Unutilized Thread L4 minus L2	Pitch Diameter @ Handtight Plane E0
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.



Shut-Off Valve Installation

Shut-off valves must be positioned as close as practical to each tank opening. 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.

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. Maintain record of pressure testing.

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

Hosing may **NOT** be used in place of fixed system piping. Use of ammonia-rated hosing in a system is **limited** to the transfer connections between the fixed storage system piping and nurse tank, rail, and cargo tank. Hosing must be ammonia-rated, 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 when bulges, cracks or cuts to the hose cords/braiding, or other defects are visible.

System Piping Protection

Corrosion Protection

Corrosion protection is essential whenever system piping is placed near or below ground level. Cathodic protection, ammonia-compatible coatings or tape, placing piping in washed sand and pea rock are ways to provide corrosion protection for system piping.

Frost, Support, and Vibration Protection

System piping shall be designed, arranged and supported to eliminate excessive vibration and loading. Ammonia-rated flexible connectors protect system piping from inadvertent movement and vibration. Install flexible connectors in a horizontal position above ground level whenever buried system piping is not positioned below the frost line, or there is the potential of frost heaving and excessive vibration.

As a rule of thumb pipe supports are installed every 10 feet, plus one foot for each inch of pipe diameter. For example, for 2-inch diameter piping;

10 feet + [2 in. diameter pipe X 1 ft./in. pipe diameter] = 12 feet

Hydrostatic Relief Protection

Hydrostatic relief protection for system piping and hosing must be provided by means of 350-400 psig/NH₃-rated hydrostatic relief valves or hydrostats. Hydrostats must be installed in each section of liquid and vapor system piping and hosing in which ammonia liquid could be isolated between shut-off valves.

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.

Flow Protection

Each tank and transfer area opening must be protected by flow protection by means of backflow check, excess flow valves or other equivalent devices in the event of a hose/line rupture or pull-away incident.

Pull-away Protection

Flow protection devices must be installed in the system piping so that any break will occur on the side of the hose or swivel connection. Pull-away protection by a bulkhead or weakness/shear fittings provides the breaking point in the hose or swivel connection, permitting flow protection devices and system piping to remain intact during a pull-away incident. For further information, consult the MDA anhydrous ammonia fact sheet entitled, **Anhydrous Ammonia Cargo Tank & Nurse Tank Riser Transfer Area Flow and Pull-Away Protection**.

Security Protection

Main tank shut-off valves and nurse tank loading riser hose- end valves must be kept closed and locked (i.e. unable to remove or operate valve when in lockouts) when the installation (i.e. storage facility) is unattended. Valve locks are not required if storage facility is protected against tampering by means of adequate fencing when storage facility is unattended.

Traffic Protection

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

For further information, consult the MDA factsheet entitled, ***“Anhydrous Ammonia Storage Facility Traffic Protection.”***

Want More Information or Have Questions

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