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 & SEAMLESS NIPPLE SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Grade Rating</th>
<th>Type</th>
<th>Tensile Strength</th>
<th>Schedule Rating</th>
<th>Quality Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>A333</td>
<td>1 &amp; 6</td>
<td>Seamless</td>
<td>60,000 psi</td>
<td>40 &amp; 80</td>
<td>100%</td>
</tr>
</tbody>
</table>

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 non-refrigerated ammonia service.
- 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.**

**PIPE/NIPPLES/FLEXIBLE CONNECTOR SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Tensile Strength</th>
<th>Schedule Rating (Wall Thickness)</th>
<th>Quality Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piping &amp; Seamless Nipples:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASTM A53, Grade B, ERW</td>
<td>60,000 psi</td>
<td>40 &amp; 80</td>
<td>85%</td>
</tr>
<tr>
<td>ASTM A53, Grade S, Seamless</td>
<td>70,000 psi</td>
<td>40 &amp; 80</td>
<td>100%</td>
</tr>
<tr>
<td>ASTM A105, Grade B, Seamless</td>
<td>60,000 psi</td>
<td>40 &amp; 80</td>
<td>100%</td>
</tr>
<tr>
<td>ASTM A105, Grade C, Seamless</td>
<td>70,000 psi</td>
<td>40 &amp; 80</td>
<td>100%</td>
</tr>
<tr>
<td>API 5L, Grade B, ERW</td>
<td>60,000 psi</td>
<td>40 &amp; 80</td>
<td>85%</td>
</tr>
<tr>
<td>Seamless Swage Nipples:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASTM A234, Grade WPB</td>
<td>60,000 psi</td>
<td>40 &amp; 80</td>
<td></td>
</tr>
<tr>
<td>Stainless Steel, Ammonia-Rated Flexible Connectors:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>250 psi/NH3-rated with a safety factor of four</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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**

<table>
<thead>
<tr>
<th>ASTM Specification</th>
<th>Pressure Class or Schedule Rating</th>
<th>Fitting Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>A105, (Forged Carbon Steel)</td>
<td>Class 2000 &amp; greater</td>
<td>Threaded &amp; Socket Weld</td>
</tr>
<tr>
<td>A234, Grade WPB</td>
<td>Schedule 40 &amp; 80</td>
<td>Butt Weld</td>
</tr>
<tr>
<td>*A197</td>
<td>Class 300 &amp; greater</td>
<td>Black Malleable Iron (MI)</td>
</tr>
</tbody>
</table>

NOTES RELATING TO TIGHTNESS:

- Malleable iron (MI) fittings are NOT RECOMMENDED for ammonia service because of its marginal applications.
- MI fittings allowed for use are Class 300 & greater-rated elbows, tees, crosses, reducing 90°’s, street 90°’s, reducing couplings.
- MI plugs and bushings (only available in Pressure Class 150).
- MI welds are limited to threaded joints.
- MI welds for low temperature, refrigerated ammonia service.

**WELDING ROD SPECIFICATIONS**

**LOW TEMPERATURE, REFRIGERATED SYSTEMS**

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

NOTES RELATING TO WELDING RODS:

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."

An equal opportunity employer
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.

**CORRUGATION PROTECTION**
Cathodic protection and ammonia-compatible coatings or tape are means to provide corrosion protection for underground system piping.

**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 at 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.

**PRESSURE RELIEF PROTECTION**
Pressure relief protection for system piping and hosing must be provided by means of 350-400 psi/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 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.

---

**Thread Joint Specifications**

<table>
<thead>
<tr>
<th>NPS (in)</th>
<th>O.S. Dia.</th>
<th>Threads per inch</th>
<th><strong>Handtight</strong> Engagement</th>
<th>Total Thread Length</th>
<th>Effective Thread Length</th>
<th>Unutilized Thread L4 minus L2</th>
<th>Pitch Diameter @ Handtight Plane Plane Die O.S. Dia. E0 L1 L2 L4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1½</td>
<td>1.660</td>
<td>11 ½</td>
<td>0.420</td>
<td>1.0085</td>
<td>0.7068</td>
<td>0.3017</td>
<td>1.88338</td>
</tr>
<tr>
<td>1½</td>
<td>1.900</td>
<td>11 ½</td>
<td>0.420</td>
<td>1.0252</td>
<td>0.7235</td>
<td>0.3017</td>
<td>1.82234</td>
</tr>
<tr>
<td>2.0</td>
<td>2.375</td>
<td>11 ½</td>
<td>0.436</td>
<td>1.0582</td>
<td>0.7565</td>
<td>0.3017</td>
<td>2.29627</td>
</tr>
<tr>
<td>3.0</td>
<td>3.500</td>
<td>8</td>
<td>0.766</td>
<td>1.6337</td>
<td>1.2000</td>
<td>0.4337</td>
<td>3.38850</td>
</tr>
</tbody>
</table>

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