Bulletin No. 107 12/97

Guidelines for:

Suggested Safety and Operating Procedures When Making Ammonia Refrigeration Plant Tie-ins

International Institute of Ammonia Refrigeration

NOTICE

The information contained in these guidelines have been obtained from sources believed to be reliable. However, it should not be assumed that all acceptable methods or procedures are contained in this document, or that additional measures may not be required under certain circumstances or conditions.

The International Institute of Ammonia Refrigeration makes no warranty or representation, and assumes no liability or responsibility, in connection with any information contained in this document.

While the Institute recommends use of and reference to this document by private industry, government agencies and others, this publication is intended to be voluntary and not binding.

The Institute does not “approve” or “endorse” any products, services or methods. This document should not be used or referenced in any way which would imply such approval or endorsement.

Note that the various building codes and regulations referenced in this document may be amended from time to time, and it should not be assumed that the versions referenced herein are the most current versions of such codes and regulations. Please consult the appropriate regulatory authorities for the most up to date versions.

Table of Contents

Guidelines for: Suggested Safety and Operating Procedures When Making Ammonia Refrigeration Plant Tie-Ins

1. Introduction

These guidelines discuss suggested procedures for making connections to existing ammonia refrigeration systems. The use of appropriate procedures for such “tie-ins” will assist in maintaining a safe ammonia refrigeration system.

2. Scope

The scope of this bulletin is to provide guidelines for routine operations. All procedures should be reviewed by a competent person, as additions or omissions may be necessary for any given situation.

2.1 Pump-out of a system (or portion of a system) shall be preformed by the facility refrigeration operation personnel. If outside contractors are involved in the work, they may assist in the pump-out as authorized by the facility management.

2.2 Prior to any tie-ins or system expansion, the facility ammonia system operator, as well as any contractor who may be involved, must have a thorough knowledge and understanding of the system, of the effects of a change or addition to the system, and of the safety and emergency response procedure for dealing with possible releases of ammonia, fire, or other hazardous conditions.

3. Reference Sources

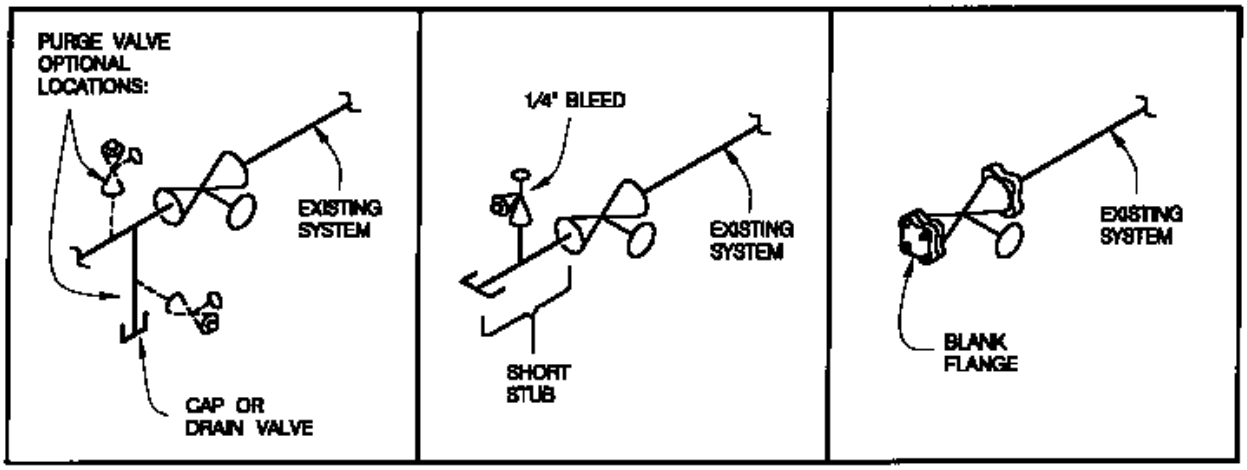
IIAR Bulletin 114, *Guidelines for Identification of Ammonia Refrigeration Piping and System Components*
IIAR *Guide to the Implementation of Process Safety Management for Ammonia Refrigeration*
OSHA 29 CFR 1910.119, *Process Safety Management of Highly Hazardous Chemicals*
American Petroleum Institute (API) Publication 2201 *Procedures For Welding or Hot Tapping on Equipment in Service*

4. Planning for Future Expansion

4.1 Determine locations and size for extra valves that could facilitate future expansion. Consider what portions of the system or equipment might have to be isolated or shut down to make a tie-in if an extra valve is not installed during original construction.

4.2 Determine locations for purge/pumpout connections. For those portions of the system or equipment that will have primary isolation valves, install purge valves to assist in the pump-out of that section of piping or equipment.

4.3 Size dead-end valves on main line stubs to which future connections are to be made. The size of the valve should be large enough to handle expected future capacity at an acceptable pressure loss. Consider the direction of flow and valve orientation when installing valves. If possible, the source of pressure or flow should come up under the valve seat. Main line dead-end valves should be plugged, blank-flanged, or have a short stub with a 1/4” bleed valve with gauge. See examples and Notes below:



Note:
1. For dead-end valves, if a pipe stub is connected to the valve it should be approximately 12” long. The added length of the stub, plus the use of a heat sink (like a wet rag) will reduce the possibility of damage to the valve seat when a future connection is made to the pipe stub.
2. Ensure that safe operating procedures (including lockout/tagout) are established and adhered to for dead-end valves.
3. For a dead-end liquid valve, **do not** open the valve and then close the valve leaving liquid trapped, unless some means is provided to relieve pressure.

4.4 Analyze possible future facility load additions that could reasonably be expected to occur. Consider providing future tie-in valves at the following locations:

a. End of main headers.

b. Connection off of main headers for future compressors, condensers, vessels, and other equipment.

c. Future processing equipment.

d. Future mechanical refrigerant pumps or liquid transfer units.

Consider locating valves in the system so that they could be closed to facilitate future expansion.

Consider installing additional valves which could reduce the possibility of an extended or difficult shutdown.

Consider locating valves to avoid the trapping of liquid during future expansion.

4.5 During the installation verify that all refrigerant lines and valves are properly identified. See IIAR Bulletin 114.

4.6 Make tie-in locations so that proper refrigerant flow will be aided by gravity. An alternative is to design for added pressure losses where return lines are trapped.

5. Planning Individual Load Additions

5.1 Verify line and valve sizes. Check the capacity of additional loads against the capacity of the existing line(s). Determine that the pressure loss in the lines is in accordance with acceptable standards and practices.

5.2 Develop written operating procedures for the system addition. Add revisions as necessary to the Emergency Response and Planning program. Incorporate into the

facility training program the operation and maintenance of new equipment and system additions. Amend process flow, P&ID, electrical, and architectural drawings to reflect changes to be made.

5.3 Determine the location for tie-in and the size of isolation valve(s) to be added. When connecting into an existing system, consider installing a shut-off valve at the tie-in point. Consider installing tie-in valve(s) first, so planned system modifications can proceed without interrupting the system operation.

5.4 Coordinate the tie-in with plant operations. Consider the shutdown time necessary to make the required tie-in and the effect on facility production or storage temperatures.

5.5 Develop written procedures for testing the newly installed piping and equipment.

5.6 For all system modifications, follow “Management of Change” procedures. (See IIAR *Process Safety Management Guidelines*; OSHA 29 CFR 1910.119 *Process Safety Management of Highly Hazardous Chemicals*.) Ensure that all designs and installations are reviewed by the jurisdictional authority.

6. Pumping Out Prior to Tie-in

Always reduce the system and equipment internal pressure to 0 psig before the tie-in process is started. “Hot Tap” tie-ins are a **last resort** option. “Hot Tapping,” if necessary, shall follow industry published guidelines, for example, API Publication 2201.

6.1 Prepare the equipment required for the pump-out procedure. Verify that all personal protective equipment is functional. Consider the following, as applicable:

a. Location and readiness of respiratory protection equipment (SCBA or other respirator). Select respiratory protection as appropriate for escape, response, or nuisance exposure.

b. Goggles, safety shields, gloves.

c. Water hose.

d. Portable ventilation equipment.

e. Fire extinguisher.

f. Appropriate protective clothing.

g. Two-way radios.

h. Availability of trained back-up personnel in case of emergency.

All personnel involved in the work shall be properly trained in the use of necessary personal protective equipment.

6.2 Review the pump-out procedure and tie-in procedure with personnel. Also review the facility Emergency Planning and Response Plan, making sure all personnel involved know what they are to do if an emergency occurs.

6.3 Identify the valves, piping, and connected equipment that will be shut down. Use Lockout/Tagout procedures in shutting down any portion of the system or equipment. Be careful not to isolate any portion of the system piping or equipment that may trap liquid ammonia. **Do not force valves open or closed.**

6.4 Pump-out

a. Pump-out of a system (or portion of a system) shall be performed by the facility refrigeration operating personnel. If outside contractors are involved in the work, they may assist in the pump-out as authorized by the facility management. Monitor temperatures and pressures during the pump-out process.

b. Shut off the liquid feed to the portion of the system in which the tie-in is to be made.

c. Continue operating any evaporators that will facilitate refrigerant evaporation.

d. Have a 30 inches Hg to 150 psig (compound) gauge connected to the portion of the system being pumped out.

(1) Pump-out until the pressure is below 0 psig, and (if appropriate) down to 15-20 inches Hg. Let the pump-out compressor(s) continue to pump, until they shut down on low pressure several times. A rise in pressure may indicate an incomplete pump-out.

(2) Let the system stand for several hours, overnight if possible. This will allow remaining liquid refrigerant to vaporize.

(3) Any signs of frost on uninsulated piping or valves may indicate that liquid ammonia is present. If this condition persists after several pump-out attempts, check for leaking stop valves.

e. After the pump-out process, the system pressure shall be adjusted to near 0 psig before any cut-in is made. It is not advisable to have a deep vacuum when the system is cut into because air mixed with any residual oil and ammonia can form an explosive mixture. It is recommended that dry nitrogen be used to raise the pressure to just above 0 psig.

6.5 Pump-out when system liquid storage capacity is inadequate

a. If the system does not have liquid storage capacity to pump-out existing piping and equipment, it will be necessary to transfer excess ammonia into a temporary storage vessel or tanker truck.

b. Develop written procedures for the safe transfer of ammonia from the system. In the procedure consider the following:

(1) All personnel involved shall use personal protective equipment: SCBA, or other appropriate respiratory protection, protective gloves, protective boots, and protective goggles.

(2) Barricade area from traffic and unauthorized personnel while transfer is occurring.

(3) Visually inspect and pressure test all transfer hoses and fittings.

(4) There should be a functional permanent or portable eye wash and shower available.

(5) Know what to do, and where to go if an ammonia release occurs.

(6) Never leave the transfer process unattended. Monitor temperatures and pressures during the pump-out and transfer.

7. Tie-in

7.1 Piping insulation should be removed in the vicinity of the tie-in point. Approximately 3 feet on each side of the tie-in point is recommended.

7.2 Follow Hot Work Permit Procedures before any cutting, burning or welding is done.

7.3 Use appropriate personal protective equipment, even if the line is believed to be entirely pumped down. Never assume that a line has been completely emptied of residual water, oil, and ammonia.

7.4 Portable fans are useful to direct vapors away from the work area.

7.5 Have all materials ready. Flange style isolation valves should have a short pipe section connected to it or a piece of pipe with valve flange connected.

7.6 Introduce a slow flow of dry nitrogen into the isolated section, allowing the pressure to escape through a small vent valve located at the opposite end of the piping section. Do not use air in the place of nitrogen. There should be a slightly positive nitrogen pressure in the system during the hot work. If nitrogen is not available, open a valve to atmosphere so pressure remains near atmospheric.

7.7 The actual cut-in and welding work should be done by certified and experienced persons.

8. Testing

8.1 For an initial test, introduce dry nitrogen into the new portion of the system. Test for leaks at pressures specified in the design or governed by applicable codes. Test for leaks using soap bubble solution. Hold the pressure for 24 hours when feasible. If the pressure falls more than five psi (compensating for temperature changes that may occur), re-check system for leaks. Repair all leaks and re-test as necessary.

After the system has been pressure tested, release pressure and re-pressurize with approximately 30 psig of ammonia, then boost the system pressure to at least 100 psig with nitrogen. Test for leaks using litmus paper or sulfur sticks.

Where the use of dry nitrogen is not practical, use ammonia for the leak test. Use sulfur sticks or litmus paper to locate leaks.

8.2 After the pressure test and leak test are documented, release the ammonia/nitrogen mixture according to applicable codes. Notify appropriate authorities and utilities. Remove all Lockout/Tagout tags.

8.3 Complete all Management of Change, Pre-Startup Safety procedures, and Training necessary for system addition. Perform Mechanical Integrity Audit (safety check) of all new equipment, piping, vessels, etc.

9. Bring On-Line

9.1 Before bringing the new system addition on-line, purge the non-condensible gas.

9.2 Following testing, the system addition should already be at or near 0 psig. If not, purge the remaining pressure. Again, notify appropriate authorities and utilities.

a. Pump-out the system using a vacuum pump that is appropriate for ammonia. This should not be done with the system compressors. If available, use a water jet style pump, which absorbs ammonia.

b. Before bringing the system addition on-line, properly label and tag new piping, valves, and equipment.

9.3 New equipment should be brought on-line in a logical and sequential order so as to not overload compressor capacity.

9.4 Slowly adjust the system suction pressure. Monitor the effect on the original system.

9.5 Set and calibrate the new controls installed.

9.6 When starting new processing equipment, slowly lower temperature so as to not create excessive thermal stress to the equipment. Follow manufacturer's recommendations.

9.7 For new rooms added to the system, lower the room temperature according to the following recommendations, or follow guidelines of room material supplier(s):

a. **LEAVE DOORS AJAR** - To prevent negative pressure damage to the facility.

b. **Phase I** - To 35°F. Lower temperatures with the following time schedule.

Time	Maximum Temperature Reduction	Minimum Room Temperature
24 hours	10°F	75°F
24 hours	15°F	60°F
24 hours	15°F	45°F
24 hours	5°F	40°F
24 hours	5°F	35°F

c. 35°F shall be maintained in rooms that will operate below freezing until a dew point of 0°F (35°F dry bulb, 26°F wet bulb) is reached in the rooms.

d. Allow units to defrost through at least two (2) cycles and do not start Phase II until coils have remained dry for at least 24 hours or a dew point of 0°F has been reached.

e. **Phase II** - Use the following time schedule for lowering temperature to room operating temperature.

Time	Maximum Temperature Reduction	Minimum Room Temperature
24 hours	5°F	30°F
24 hours	10°F	20°F
24 hours	10°F	10°F
24 hours	10°F	0°F
24 hours	10°F	-10°F
24 hours	10°F	-20°F

9.8 Every few days (for a few weeks), re-check tie-in and all added system equipment and piping for leaks.

International Institute of Ammonia Refrigeration
1200 19th Street, N.W., Suite 300
Washington, DC 20036-2422
(202)857-1110