Comments must be submitted on the attached Public Review Comment Form. Comments should only be on altered language.

Draft 2011 Edition

Deleted items are designated by strikethrough.
Additions are designated by double underline.

THE NATIONAL BOARD OF BOILER AND PRESSURE VESSEL INSPECTORS

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National Board of Boiler and Pressure Vessel Inspectors
National Board Inspection Code
Submission of Public Review Comment
2011 Draft Edition Cycle A

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Source: □ Own Experience/Idea □ Other Source/Article/Code/Standard _____

Submit Form To: Robin Hough, Secretary, NBIC Committee, The National Board of Boiler & Pressure Vessel Inspectors, 1055 Crupper Avenue, Columbus, OH 43229, fax 614-847-1828, email, rhough@nationalboard.org

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Directory of Revisions

Part 1 Installation

- 2.2
  Revised definition of Power Boilers.

Part 2 Inspection

- 2.3.6.4
  Revised and added wording to Liquid Ammonia Vessels section.

Part 3 Repairs and Alterations

- 4.4.1 a)
  Added wording to address notch toughness of steel to avoid brittle fracture.

Glossary

- All three parts
  Added definitions to address specific types of tests.

The National Board of Boiler and Pressure Vessel Inspectors

Part 1 Installation

2.2 DEFINITIONS

A power boiler is a closed vessel in which water or other liquid is heated, steam or vapor generated, steam or vapor is superheated, or any combination thereof, under pressure for use external to itself, by the direct application of energy from the combustion of fuels or from electricity or solar energy. The term boiler includes fired units for ~~heating or~~ vaporizing liquids other than water but does not include fired process heaters and systems. The term boiler also shall include the apparatus used to generate heat and all controls and safety devices associated with such apparatus or the closed vessel.

2.3.6.4 LIQUID AMMONIA VESSELS

Vessels in liquid ammonia service are susceptible to stress corrosion cracking (SCC) (see 3.3.2[b]) in areas of high stress. High strength and coarse-grained materials seem to be more at risk of SCC than are fine-grained or more moderate strength materials, although no commonly used steels appear to be immune to the problem. Postweld heat treatment of new or weld-repaired vessels or cold formed heads is beneficial in reducing the incidence of SCC. The presence of 0.2% minimum water in the liquid ammonia also inhibits SCC. Any leak should be thoroughly investigated and the necessary corrective action initiated.

a) Internal Inspection ~~of Parts and Appurtenances~~

1) Where existing openings permit, perform a visual internal inspection of the vessel. Look for any obvious cracks (very advanced SCC) and note areas that are subject to high stress such as welds, welded repairs, head-to-shell transitions, sharp interior corners, and interior surfaces opposite external attachments or supports. ~~Alternatively, an internal inspection may be conducted from the outside utilizing suitable NDE,e.g., ultrasonic techniques.~~

~~3~~2) Fittings such as liquid level gage floats and excess flow valves, should be removed or otherwise protected from power buffing or light sandblasting when preparing the interior surface of the vessels for inspection.

3) Vessels in services where liquid ammonia is used as a reactant or is being preheated/vaporized should be inspected for localized corrosion in the reaction or vaporizing zones.

b) Examination and Detection of SCC

4~~1~~) All interior welds and highly stressed areas should be examined by the wet fluorescent magnetic particle-testing method (WFMT) using an A/C yoke for magnetization. Note that weld cracks are often transverse in orientation. It is extremely important to ensure that the NDE method used will disclose cracks in any orientation.

2~~5~~) If cracks are discovered, a calculation ~~must~~ shall be made to determine what depth of grinding may be carried out for crack removal (without encroaching on the minimum thickness required by the ~~construction standard or equivalent~~original code of construction).

~~6~~3) Where possible, crack removal by grinding is the preferred method of repair. Since the stresses at the crack tips are quite high, even very fine cracking ~~should~~ shall be eliminated.

~~7~~4) Where crack depth is such that removal requires welded repair, a weld procedure ~~should~~ shall be employed that will minimize HAZ hardening and residual stresses. ~~Whenever possible~~, ~~weld~~ Welded repairs, regardless of ~~their size~~the depth of the repair, ~~should~~ shall be postweld heat treated. The use of alternative welding methods in lieu of PWHT is permitted. Any repairs required and associated post-weld heat treatment shall be completed in accordance with NBIC, Part 3.

~~8~~5) Re-inspection by WFMT after welded repair shall be done to ensure complete crack removal.

~~9~~6) It is not intended to inhibit or limit the use of other NDE evaluation methods. It is recognized that acoustic emission and fracture mechanics are acceptable techniques for assessing structural integrity of vessels. Analysis by fracture mechanics may be used to assess the structural integrity of vessels when complete removal of all ammonia stress cracks is not practical. If alternative methods are used, the above recommendation that all cracks be removed, even fine cracks may not apply.

In addition to NDE and repair of liquid ammonia vessels that are susceptible to SCC, it is acceptable to use fitness for service evaluation methods to determine acceptability of a pressure retaining item to perform its intended function. These methods shall be consistent with NBIC Part 2, Section 4.4, "Methods To Assess Damage Mechanisms And Inspection Frequency For Pressure-Retaining Items".

~~b~~c) Inspection of ~~Insulated Vessels~~Parts and Appurtenances

1) If valves or fittings are in place, check to ensure that these are complete and functional. Parts made of copper, zinc, silver, or alloys of these metals are unsuitable for ammonia service and ~~should~~ shall be replaced with parts fabricated of steel or other suitable materials.

2) Check that globe valves are installed with the direction of flow away from the vessel.

3) Observe that excess flow valves are properly installed and in good repair.

4) Check that hydrostatic relief valves are installed in the system piping where required.

5) Piping shall be observed to be a minimum of Schedule 80 if threaded and Schedule 40 if welded. Seamless or ERW piping is acceptable. Type F piping shall not be used for ammonia service.

6) Fittings shall be forged or Class 300 malleable. Seal welding is permitted only with forged fittings.

7) The Inspector ~~should~~ shall note the pressure indicated by the gage and compare it with other gages on the same system. If the pressure gage is not mounted on the vessel itself, it should be ascertained that the gage is installed on the system in such a manner that it correctly indicates actual pressure in the vessel.

8) The Inspector shall note the liquid level in the vessel by observing the liquid level gage or other liquid level indicating device.

d) Inspection of Pressure Relief Devices

~~2~~1) See Section 2.5 for the inspection of ~~safety~~ pressure relief devices (~~pressure relief valves~~) used to prevent the overpressure of liquid ammonia vessels. Pressure-relief devices in ammonia service shall not be tested in place using system pressure. Bench testing or replacement is required, depending on the type of pressure relief device used ~~is required.~~

2) The Inspector shall note the replacement date marked on vessel safety valves and piping system hydrostatic relief valves requiring replacement every five years.

e) External Inspection of Insulated Vessels

1) Insulated pressure vessels can suffer from aggressive external corrosion that is often found beneath moist insulation. The Inspector should closely examine the external insulation scaling surfaces for cold spots, bulges, rust stains, or any unusual conditions in previous repair areas. Bulging or distorted insulation on refrigerated vessels may indicate the formation of ice patches between the vessel shell and insulation due to trapped moisture. Careful observation is also required where the temperature of insulated vessels cycle continually through the freezing temperature range.

2) The lower ~~1/3 to 1/2~~ half and the bottom portions of insulated vessels should receive special focus, as condensation or moisture may gravitate down the vessel shell and soak into the insulation, keeping it moist for long periods of time.

Penetration locations in the insulation or fireproofing such as saddle supports, sphere support legs, nozzles, or fittings should be examined closely for potential moisture ingress paths. When moisture penetrates the insulation, the insulation may actually work in reverse, holding moisture in the insulation and/or near the vessel shell.

3) Insulated vessels that are run on an intermittent basis or that have been out of service require close scrutiny. In general, a visual inspection of the

~~external~~ vessel's insulated surfaces ~~of insulated vessels~~ should be conducted once per year.

4) The most common and superior method to inspect for suspected corrosion under insulation damage (CUI) is to completely or partially remove the insulation for visual inspection. The method most commonly utilized to inspect for CUI without insulation removal is by x-ray and isotope radiography (film or digital) or by real time radiography, utilizing imaging scopes and surface profilers. The real time imaging tools will work well if the vessel geometry and insulation thickness allows. Other less common methods to detect CUI include specialized electromagnetic methods (pulsed eddy current and electromagnetic waves) and long range ultrasonic techniques (guided waves).

5) There are also several methods to detect moisture soaked insulation, which is often the beginning for potential CUI damage. Moisture probe detectors, neutron backscatter, and thermography are tools that can be used for CUI moisture screening.

6) Proper surface treatment (coating) of the vessel external shell and maintaining weather tight external insulation are the keys to prevention of CUI damage.

f) Acceptance Criteria

The following is the acceptance criteria for liquid ammonia vessels. Vessels showing indications or imperfections exceeding the conditions noted below are considered unacceptable.

1) Cracks

Cracks in the pressure vessel boundary (heads, shells, welds) are unacceptable. When a crack is identified, the vessel shall be removed from service until the crack is repaired by an "R" stamp holder or the vessel permanently removed from service. (See NBIC, Part 3, Repairs and Alterations.)

2) Dents

When dents are identified that exceed the limits set forth below, the vessel shall be removed from service until the dents are repaired by an "R" stamp holder, a fitness for service analysis is performed, or the vessel permanently retired from service.

a) Dents in Shells

The maximum mean dent diameter in shells shall not exceed 10% of the shell diameter, and the maximum depth of the dent shall not exceed 10% of the mean dent diameter. The mean dent diameter is defined as the average of

the maximum dent diameter and the minimum dent diameter. If any portion of the dent is closer to a weld than 5% of the shell diameter, the dent shall be treated as a dent in a weld area, as shown in (b) below.

b) Dents in Welds

The maximum mean dent diameter on welds (i.e., part of the deformation includes a weld) shall not exceed 10% of the shell diameter. The maximum depth shall not exceed 5% of the mean dent diameter.

c) Dents in Heads

The maximum mean dent diameter on heads shall not exceed 10% of the shell diameter. The maximum depth shall not exceed 5% of the mean dent diameter. The use of a template may be required to measure dents on heads.

3) Bulges

When bulges are identified that exceed the limits set forth below, the vessel shall be removed from service until the bulges are repaired by an "R" stamp holder or a fitness for service analysis is performed, The vessel may also be permanently retired from service.

a) Bulges in Shells

If a bulge is suspected, the circumference shall be measured at the suspect location and at several places remote from the suspect location. The variation between measurements shall not exceed 1%.

b) Bulges in Heads

If a bulge is suspected, the radius of the curvature shall be measured by the use of templates. At any point the radius of curvature shall not exceed 1.25% of the diameter for the specified shape of the head.

4) Cuts or Gouges

When a cut or gouge exceeds 25% of the thickness of the vessel, the vessel shall be removed from service until it is repaired by an "R" stamp holder or a fitness for service analysis is performed. The vessel may also be permanently retired from service.

5) Corrosion

a) For line or crevice corrosion, the depth of the corrosion shall not exceed 25% of the original wall thickness.

b) Isolated pits may be disregarded provided that their depth is not more than 50% of the required thickness of the pressure vessel wall (exclusive of any corrosion allowance), provided the total area of the pits does not exceed 7 sq. in. (4500 sq. mm) within any 8 in. (200 mm) diameter circle, and provided the sum of their dimensions along any straight line within that circle does not exceed 2" (50mm).

c) For a corroded area of considerable size, the thickness along the most critical plane of such area may be averaged over a length not exceeding 10 in (250 mm). The thickness at the thinnest point shall not be less than 75% of the required wall thickness. When general corrosion is identified that exceeds the limits set forth in this paragraph, the pressure vessel shall be removed from service until it is repaired by an "R" stamp holder or a fitness for service analysis is performed, the vessel may be permanently retired from service.

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Part 3 Repairs and Alterations

NB10-0801

4.4.1 TEST OR EXAMINATION METHODS APPLICABLE TO REPAIRS
Based on the nature and scope of the repair activity, one or a combination of the following examination and test methods shall be applied to repairs and replacement parts used in repairs.

a) Liquid Pressure Test
Pressure testing of repairs shall meet the following requirements:

3) The metal temperature for the pressure test shall be in accordance with the original code of construction, but not less than 60°F (16°C) unless the owner provides information on the toughness characteristics of the material to indicate the acceptability of a lower test temperature. For thick walled pressure retaining items, it is recommended to seek technical guidance in establishing the notch toughness characteristics of the steel prior to pressure testing so that the metal temperature may be warmed above 60° F (16°C) to avoid brittle fracture. During close examination the metal temperature shall not exceed 120°F (49°C), unless the owner specified requirements for a higher test temperature, and it is acceptable to the Inspector.

4.4.2 TEST OR EXAMINATION METHODS APPLICABLE TO ALTERATIONS
Based on the nature and scope of the alterations activity, one or a combination of the following examination and test methods shall be applied to alterations and replacement parts used in alterations.

a) Liquid Pressure Test
Pressure testing of alterations shall meet the following requirements:

4) The metal temperature for the pressure test shall be in accordance with the original code of construction, but not less than 60°F (16°C), unless the owner provides information on the toughness characteristics of the material to indicate the acceptability of a lower test temperature. For thick walled pressure retaining items, it is recommended to seek technical guidance in establishing the notch toughness characteristics of the steel prior to pressure testing so that the metal temperature may be warmed above 60°F (16°C) to avoid brittle fracture. During close examination the metal temperature shall not exceed 120°F (49°C), unless the owner specifies requirements for a higher test temperature and it is acceptable to the Inspector.

NB10-0301

S3 5.4.1

5) Viscosity per ASTM ~~D 2393~~D445-09, D2196-05 D4212-09, or ISO 3104:1994.

NB07-0905

Definitions to add to the Glossary of all three parts

Liquid Pressure Test – A pressure test using water or other incompressible fluid as a test medium.

Hydrostatic Test - A liquid pressure test which is conducted using water as the test medium.

Pneumatic Test- A pressure test which uses air or another compressible gas as the test medium.

Pressure Test-A test that is conducted using a fluid (liquid or gas) contained inside a pressure retaining item.