

The following information is from:

**RECOMMENDED GUIDE FOR THE INSPECTION
OF PRESSURE VESSELS IN LP GAS SERVICE**

Nonmandatory Appendix H

1/26/01

Published by:

**THE NATIONAL BOARD OF BOILER AND
PRESSURE VESSEL INSPECTORS**

The National Board of Boiler & Pressure Vessel Inspectors

1055 Crupper Avenue
Columbus, Ohio 43229-1183

Recommended Guide for the Inspection of Pressure Vessels in LP Gas Service

H-1000 General Conditions

- (a) Pressure vessels designed for storing LP gas can be stationary or can be mounted on skids. LP gases are generally considered to be noncorrosive to the interior of the vessel. This part is provided for guidance of a general nature for the owner, user or jurisdictional authority. There may be occasions where more detailed procedures will be required.
- (b) The application of this section to underground vessels will only be necessary when evidence of structural damage to the vessel has been observed, leakage has been determined or the tank has been dug up and is to be reinstalled.

H-2000 Pre-Inspection Activities

A review of the known history of the pressure vessel should be performed. This should include a review of information, such as:

- a. Operating conditions
- b. Normal contents of the vessel
- c. Results of any previous inspection
- d. Current jurisdictional inspection certificate, if required
- e. ASME Code Symbol Stamping or mark of code of construction, if required
- f. National Board and/or jurisdictional registration number, if required.

The vessel should be sufficiently cleaned to allow for visual inspection.

H-3000 Assessment of Installation

The type of inspection given to pressure vessels should take into consideration the condition of the vessel and the environment in which it operates. The inspection may be external or internal, and use a variety of nondestructive examination methods. Where there is no reason to suspect an unsafe condition or where there are no inspection openings, internal inspections need not be performed. The external inspection may be performed when the vessel is pressurized or depressurized, but shall provide the necessary information that the essential sections of the vessel are of a condition to operate.

H-3100 Definitions

DENTS Deformations caused by a blunt object coming in contact with the vessel in such a way that the thickness of the metal is not materially reduced.

CUTS OR GOUGES Deformations caused by a sharp object coming in contact with the vessel in such a way as to cut into or upset the metal reducing the thickness of the metal at that point.

CORROSION OR PITTING The loss of wall thickness by corrosive media, for example:

ISOLATED PITTING Small diameter voids separated from other pits or corrosion that do not effectively weaken the vessel.

LINE CORROSION A loss of wall thickness (corrosion) in a continuous pattern or pitting connected in a narrow band or line.

CREVICE CORROSION A loss of metal in the area of the intersection of skirts (footrings), collars (headrings), saddle bands and other attachments with the vessel.

GENERAL CORROSION A loss of metal over a considerable surface area of the vessel.

CRACK Any surface or subsurface separation of base-metal or weld material whose extent must be determined by nondestructive examination methods (see H-3510).

DISTORTION Any change in the original shape of the vessel, for example:

BULGES Permanent deformations caused by excessive internal pressure that results in the pressure vessel's surface being outside its original symmetry.

H-3200 External Inspection

All parts of the vessel shall be inspected for corrosion, distortion, cracking or other conditions as described in this section. In addition, the following should be reviewed, where applicable:

a) **Insulation**

If the insulation is in good condition and there is no reason to suspect an unsafe condition behind it, then it is not necessary to remove the insulation in order to inspect the vessel. However, it may be advisable to remove a small portion of the insulation in order to determine its condition and the condition of the vessel surface.

b) **Evidence of Leakage**

Any leakage of vapor or liquid shall be investigated. Leakage coming from behind insulation, supports, or evidence of past leakage shall be thoroughly investigated by removing any insulation necessary until the source is established.

c) **Structural Attachments**

The pressure vessel mountings should be checked for adequate allowance for expansion and contraction, such as provided by slotted bolt holes or unobstructed saddle mountings. Attachments of legs, saddles, skirts or other supports should be examined for distortion or cracks at welds.

d) **Vessel Connections**

Components which are exterior to the vessel and are accessible without disassembly shall inspected as described in this paragraph. Manholes, reinforcing plates, nozzles, or other connections shall be examined for cracks, deformation or other defects. Bolts or nuts should be examined for corrosion or defects. Weep holes in reinforcing plates shall remain open to provide visual evidence of leakage as well as to prevent pressure build up between the vessel and the reinforcing plate. Accessible flange faces should be examined for distortion. It is not intended that flanges or other connections be opened unless there is evidence of corrosion to justify opening the connection.

e) **Fire Damage**

Pressure vessels shall be carefully inspected for evidence of fire damage. The extent of fire damage determines the repair that is necessary, if any.

H-3300 Internal Inspection

When there is a reason to suspect an unsafe condition, the suspect parts of the vessel shall be inspected and evaluated. (See NBIC, RB-2030)

H-3400 Nondestructive Examination (NDE)

Listed below are a variety of methods that may be employed to assess the condition of the pressure vessel. These examination methods should be implemented by experienced and qualified individuals. Generally, some form of surface preparation will be required prior to the use of these examination methods: visual, magnetic particle, liquid penetrant, ultrasonic, radiography, radioscopy, eddy current, metallographic examination, and acoustic emission. When there is doubt as to the extent of a defect or detrimental condition found in a pressure vessel, additional NDE may be required.

H-3500 Acceptance Criteria

H-3510 Cracks

Cracks in the pressure boundary (heads, shells, nozzles, welds joining parts and attachment welds) are unacceptable. When a crack is identified, the vessel shall be removed from service until the crack is repaired by a qualified repair organization or permanently retired from service. (See NBIC, Part RC)

H-3520 Dents

a. 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 100 % 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, see paragraph H-3520(b).

b. Welds

The maximum mean dent diameter on welds (ie: part of the deformation includes a weld) shall not exceed 10% of the shell diameter. The maximum depth shall not exceed one twentieth of the mean dent diameter.

c. Heads

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

When dents are identified which exceed the limits set forth in these paragraphs, the vessel shall be removed from service until the dents are repaired by a qualified repair organization or permanently retired from service.

H-3530 Bulges

a. Shells

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

b. Heads

If a bulge is suspected, the radius of 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.

When bulges are identified which exceed the limits set forth in these paragraphs, the vessel shall be removed from service until the bulges are repaired by a qualified repair organization or permanently retired from service.

H-3540 Cuts or Gouges

When a cut or a gouge exceeds 1/4 of the thickness of the vessel, the vessel shall be removed from service until it is repaired by a qualified repair organization or permanently retired from service.

H-3550 Corrosion

a. Line and Crevice Corrosion

For line and crevice corrosion, the depth of the corrosion shall not exceed 1/4 of the original wall thickness.

b. Isolated Pitting

Isolated pits may be disregarded provided that:

1. Their depth is not more than one-half the required thickness of the pressure vessel-wall (exclusive of corrosion allowance);
2. The total area of the pits does not exceed 7 sq. in. within any 8 in. diameter circle; and
3. The sum of their dimensions along any straight line within this circle does not exceed 2 in.

c. General Corrosion

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 20 in. The thickness at the thinnest point shall not be less than 50% of the required wall thickness and the average shall not be less than 75% of the required wall thickness. When general corrosion is identified which exceeds the limits set forth in this paragraph, the pressure vessel shall be removed from service until it is repaired by a qualified organization or permanently retired from service.

H-3560 Leaks

Leakage is unacceptable. When leaks are identified, the vessel shall be removed from service until repaired by a qualified repair organization or permanently retired from service.

H-3570 Fire Damage

a. Vessels in which bulging exceeds the limits of H-3530(a) or distortion which exceeds the limits of the original code of construction (e.g.: Section VIII, Division I of the ASME Boiler and Pressure Vessel Code) shall be removed from service until repaired by a qualified organization or permanently retired from service.

b. Common evidence of exposure to fire is:

1. charring or burning of the paint or other protective coat,
2. burning or scarfing of the metal,
3. distortion, or
4. burning or melting of the valves.

c. A pressure vessel which has been subjected to the action of fire shall be removed from service until it has been properly evaluated. The general intent of this requirement is to remove from service pressure vessels which have been subject to the action of fire which has changed the metallurgical structure or the strength properties of the steel. This is normally determined by visual examination as described above with particular emphasis given to the condition of the protective coating. If there is evidence that the protective coating has been burned off any portion of the pressure vessel surface, if the pressure vessel is burned, warped, or distorted, it is assumed that the pressure vessel has been overheated. If, however, the protective coating is only smudged, discolored, or blistered and is found by examination to be intact underneath, the pressure vessel shall not be considered affected within the scope of this requirement. Vessels that have been involved in a fire and show no distortion shall be requalified for continued service by retesting using the hydrostatic test procedure applicable at the time of original fabrication.

H-4000 Records

A permanent record shall be maintained for each vessel repaired by a qualified organization. The record shall include the following:

- a. An ASME Manufacturers' Data Report or, if the vessel is not ASME Code stamped, other equivalent specifications.

- b. Form R- I Report of Welded Repair or other equivalent document describing the extent of all repairs to the vessel.

H-5000 Conclusions

Any defect or deficiency in the condition, operating and maintenance practices of the pressure vessel should be evaluated at the time of inspection and decision made for the correction of such defect or deficiency.

1/26/01