THE NATIONAL BOARD
OF BOILER AND PRESSURE VESSEL INSPECTORS

NATIONAL BOARD SUBGROUP INSPECTION

MINUTES

Meeting of July 14, 2015
Columbus, OH

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The National Board of Boiler & Pressure Vessel Inspectors
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1. **Call to Order – 8:00 a.m.**

The meeting was called to order at 8:30 AM on July 14, 2015, by the acting Chairman, Mr. M. Mooney.

2. **Announcements**

- Lunch will be provided every day
- Reception Wednesday at the Pavilion - 5pm
- Writing guide is still being worked on. Once complete it will be emailed out.
- Action Items - Make sure the description of each action item is clear & make sure each item has a task group with a Project Manager.
- Using time during the SG meeting to meet in task groups to try and work on/close out action items, and then present them again if time allows. (take an hour or so in groups then meet back up)

3. **Adoption of the Agenda**

- Check for new action items on the Cloud (add as new business)
    - Add NB15-2304 to New Business
    - Add NB15-2701 to New Business

A motion was made to adopt the revised agenda. The motion was unanimously approved.

4. **Approval of Minutes of January 20, 2015**

A motion was made to approve the Subgroup on Inspection minutes from January 20, 2015. The motion was unanimously approved.

5. **Review of the Roster (Attachment Page 1)**

The attendees are identified on Attendance sign in sheet (Attachment pages 1-2). With the attached attendance listing, a quorum was established.

6. **Action Items**

Item Number: NB07-0910	**NBIC Location: Part 2, S6**	**Attachment Page 3**
General Description: Review of Part 2 S6 for completeness and accuracy **Subgroup:** Inspection **Task Group:** S. Staniszewski (PM), G. McRae, J. Riley, C. Withers **July 2015 Meeting Action:** Mr. Staniszewski presented a written progress report.		

Item Number: NB12-1501	**NBIC Location: Part 2**	**No Attachment**
General Description: Review inspection requirements to ensure they align with installation requirements in NBIC Part 1 **Subgroup:** Inspection **Task Group:** V. Newton (PM), M. Horbaczewski, J. Daiber, J. Safarz **July 2015 Meeting Action:** Mr. Newton made a motion to close this item because the work has been completed and any unresolved issues resulted in new action items. The motion was passed unanimously.		

Item Number: NB13-1002	NBIC Location: Part 2	Attachment Pages 4-6

General Description: Review inspection requirements against ASME B31.1 Power Piping code
Subgroup: Inspection
Task Group: M. Schwartzwalder (PM), J. Frey, V. Newton, M. Mooney, D. Canonico, M. Horbaczewski, B. Dobbins

July 2015 Meeting Action:
Mr. Horbaczewski gave a progress report. He will be contacting Mr. Mike Webb to resolve a few issues.

Item Number: NB13-1301	NBIC Location: Part 2	Attachment Pages 7-10

General Description: Review finite element analysis methods and how they pertain to inspection
Subgroup: Inspection
Task Group: J. Riley (PM), S. Staniszewski, M. Schwartzwalder, M. Mooney, R. Pate

July 2015 Meeting Action:
Mr. Riley presented new changes based on Public Review Comments. During discussion a few more changes were made by the SG on Inspection. A motion was made to accept all changes. The motion was passed unanimously.

Item Number: NB13-1302	NBIC Location: Part 2	Attachment Pages 11-12

General Description: Review inspection requirements for cryogenic pressure vessels
Subgroup: Inspection
Task Group: J. Riley (PM), A. Renaldo, R. Dobbins, R. Bartley, R. Pate, D. Graf

July 2015 Meeting Action:
Mr. Riley presented new changes based on Letter Ballot Disapprovals from Mf. D. Graff and Mr. V. Newton. During discussion a few more changes were made by the SG on Inspection. A motion was made to accept all changes. The motion was passed unanimously.

Item Number: NB13-1303	NBIC Location: Part 2	Attachment Pages 13-15

General Description: Review inspection requirements for biomass fired boilers
Subgroup: Inspection
Task Group: M. Mooney (PM), M. Horbaczewski, D. Canonico, J. Safarz

July 2015 Meeting Action:
Mr. Mooney presented a revised document to the SG on Inspection. After discussion of the changes, a motion was mode to accept the changes. The motion was passed unanimously.

Item Number: NB13-1409	NBIC Location: Part 2, S1	Attachment Page 16-30

General Description: Address method for analyzing bulges created by overheating in stayed boiler surfaces
Subgroup: Inspection
Task Group: R. Stone (PM)

July 2015 Meeting Action:
Mr. Mooney reviewed the item with the SG on Inspection. A task group of Mr. M Horbaczewski (PM) and J. Getter was assigned to review and finish the work that has been started by Mr. R. Stone.

Item Number: NB13-1701	NBIC Location: Part 2, 2.3.6.6	Attachment Pages 31-34

General Description: Review inspection requirements for wire wound pressure vessels
Subgroup: Inspection
Task Group: R. Dobbins (PM), M. Mooney, J. Riley, V. Scarcella, G. Galanes

July 2015 Meeting Action:
Per B. Besserman, this item was letter balloted to SC on Inspection and needs to move through to Main Committee for a vote. Item was closed with no action at SG on Inspection.

Item Number: NB14-0901	NBIC Location: Part 2	No Attachment

General Description: Review inspection requirements for pressure vessels designed for high pressures
Subgroup: Inspection
Task Group: M. Horbaczewski (PM), M. Schwartzwalder, D. Graf, G. Scribner

July 2015 Meeting Action:
Mr. Horbaczewski gave a progress report. He is reviewing various documents before putting a guideline together.

Item Number: NB14-1001	NBIC Location: Part 2, 5.2.1	Attachment Pages 35-36

General Description: Add requirements to address replacement of duplicate nameplates where the original nameplate is intact and attached to an inner vessel, where it may or may not be visible
Subgroup: Inspection
Task Group: J. Larson (PM), P. Welch, D. Ford, R. Pate, J. Getter, G. McRae, M. Horbaczewski, B. Petersen

July 2015 Meeting Action:
Mr. Welch and Mrs. Petersen presented new wording. There was a motion made to accept the document as presented. The motion passed unanimously.

Item Number: NB14-1101	NBIC Location: Part 2	Attachment Pages 37-39

General Description: Diaphragm weld inspection.
Subgroup: Inspection
Task Group: R. Stone (PM)

July 2015 Meeting Action:
Mr. B. Ferrell reviewed the item with the SG on Inspection. A task group of Mr. P. Welch (PM) and Mr. D. Graf was assigned to review the work SG on Locomotive has done. Mr. Welch will contact Mr. Stone to further discuss this item.

Item Number: NB14-1701	NBIC Location: Part 2	No Attachment

General Description: Add diagrams for local thin areas (LTAs) for low pressure propane tanks
Subgroup: Inspection
Task Group: G. McRae (PM), T. Vandini, J. Getter, M. Mooney

July 2015 Meeting Action:
Mr. McRae did not attend the meeting; therefore, there was nothing to report. Mr. Vandini will follow up with Mr. McRae and have something to present in January 2016.

Item Number: NB14-1801	NBIC Location: Part 2	Attachment Pages 40-42

General Description: Ferrules
Subgroup: Inspection
Task Group: R. Stone (PM)

July 2015 Meeting Action:
Mr. Mooney presented the action item to SG on Inspection. He will talk with Mr. Stone for documents on the suggested language and where the proposed language should be inserted.

Item Number: NB14-1802	NBIC Location: Part 2	Attachment Pages 43-44

General Description: Riveted staybolt head dimensions and Figure S1.2.2-c
Subgroup: Inspection
Task Group: R. Stone (PM)

July 2015 Meeting Action:
Mr. Mooney presented the action item to SG on Inspection. He will talk with Mr. Stone for more information.

Item Number: NB15-0201	NBIC Location: Part 2	Attachment Pages 45-46

General Description: Provide consistent language in all areas of the NBIC affected by the closure of NB13-0701
Subgroup: Inspection
Task Group: J. Riley (PM), M. Mooney, T. Vandini, M. Clark, G. McRae

July 2015 Meeting Action:
Mr. Riley gave a progress report. He presented a new document to show the progress that has been made. The task group is still working to see what, if anything, needs to be changed.

Item Number: NB15-0204	NBIC Location: Part 2, 5.5.2	Attachment Pages 47-48

General Description: Investigate Part 2, 5.5.2 and 5.5.3 for consistency with requirements about replacement of stamping during inservice inspection generated from NB12-1801
Subgroup: Inspection
Task Group: B. Petersen (PM), P. Welch, C. Withers

July 2015 Meeting Action:
Mrs. Petersen gave a progress report stating revisions are still being made. She addressed her concerns and will make the necessary revisions and present the document again in January 2016.
P. Welch and C. Withers have been added to the task group.

Item Number: NB15-0501	NBIC Location: Part 2, 7.10 h)	Attachment Page 49

General Description: Result of PR15-0142, should an R-1/R-2 form by required for underground service change?
Subgroup: Inspection
Task Group: T. Vandini (PM), G. McRae, J. Getter, D. Graf

July 2015 Meeting Action:
Mr. Vandini reviewed action item with the SG on Inspection and proposed the item be sent to Part 3 SG on Repairs & Alterations with a draft of his recommendation. A motion was made. The motion passed unanimously.

Item Number: NB15-0502	NBIC Location: Part 2, 7.10 k)	Attachment Page 50

General Description: Result of PR15-0143, examine requirements for welding qualifications as it relates to pressure vessels in LPG service
Subgroup: Inspection
Task Group: T. Vandini (PM), G. McRae, J. Getter, D. Graf

July 2015 Meeting Action:
Mr. Vandini reviewed action item with the SG on Inspection and proposed the item be sent to Part 3 SG on Repairs & Alterations with a draft of his recommendation. A motion was made. The motion passed unanimously.

Item Number: NB15-0503	NBIC Location: Part 2, CO2 Supplement	Attachment Page 51

General Description: Result of PR15-0704, the term "Examination" is used throughout S10.6, S10.7, and S10.9, was this intended to read "Inspection" instead, which is a duty of the Inspector?
Subgroup: Inspection
Task Group: B. Dobbins (PM), R. Pate, P. Welch

July 2015 Meeting Action:
A motion was made to close this item with no action to be taken. A response to the commenter will be made to refer to NBIC Part 2, Section 4.2.1. The motion passed unanimously.

Item Number: NB15-0504	NBIC Location: Part 2, S11.10	Attachment Pages 52-54

General Description: Result of PR15-0701, PR15-0702 and PR15-0703, clarify what the National Board Commissioned Inspector's specific duties are when inspecting high pressure composite vessels
Subgroup: Inspection
Task Group: E. Brantly (PM), M. Mooney, M. Horbaczewski, , V. Newton

July 2015 Meeting Action:
Mr. Mooney gave a progress report, no progress to report. Mr. E. Brantly is now the Project Manager. A correction was made to the NBIC Location of the action item.

Item Number: NB15-0701	NBIC Location: Part 2, 2.3.6.8	Attachment Pages 55-57

General Description: Result of PR15-0204, PR15-0601 and PR15-0401, clarify inspection requirements for pressure vessels for human occupancy (PVHOs)
Subgroup: Inspection
Task Group: M. Mooney (PM), Buechel, Bechal

July 2015 Meeting Action:
Mr. Mooney presented changes to the SG on Inspection. The changes were discussed and modified. A motion was made to accept the changes. The motion passed unanimously.

Item Number: NB15-0801	NBIC Location: Part 2, CO2 Supplement	Attachment Page 58-62

General Description: Result of PR15-0602, clarify which inspection requirements for CO2 pressure vessels apply specifically to the National Board Commissioned Inspector
Subgroup: Inspection
Task Group: M. Mooney (PM), P. Welch, V. Newton, T. Barker

July 2015 Meeting Action:
A new document was presented to the SG on Inspection. The document was reviewed and many changes were made. The document will address both NB15-0801 & NB15-0901. The motion passed unanimously. A motion was made to accept the document with the changes.

Item Number: NB15-0901 **NBIC Location: Part 2, CO2 Supplement** **Attachment Pages 58-62**

General Description: Result of PR15-0205, PR15-0206, PR15-0207, PR15-0208, PR15-0209, PR15-0210, PR15-0211 and PR15-0402, address issues in the CO2 supplement regarding requirements for inspection of equipment that are outside of the scope of insurance policies that insurance companies issue
Subgroup: Inspection
Task Group: M. Mooney (PM), P. Welch, V. Newton, T. Barker, E. Brantly

July 2015 Meeting Action:
This action item was combined with NB15-0801. A new document was presented to the SG on Inspection. The document was reviewed and many changes were made. A motion was made to accept the document with the changes. The motion passed unanimously.

Item Number: NB15-1002 **NBIC Location: Part 2** **No Attachment**

General Description: Update "stamp" vs. "certification" language to maintain consistency with ASME code
Subgroup: Inspection
Task Group: D. Graf (PM), P. Welch

July 2015 Meeting Action:
Mr. Mooney reviewed the action item with SG on Inspection. A task group was assigned. The task group will go through NBIC Part 2 & have proposed changes for the January 2016 meeting.

Item Number: NB15-2102 **NBIC Location: Part 2, 2.1 & 2.2.1** **No Attachment**

General Description: Combine scopes found in 2.1 and 2.2.1
Subgroup: Inspection
Task Group: None assigned

July 2015 Meeting Action:
Mr. Mooney presented the action item to the SG on Inspection. The scopes in this section are done the same throughout the section. A motion was made to close this item with no action needed. The motion passed unanimously.

Item Number: NB15-2103 **NBIC Location: Part 2, S7.8.6 & S7.9** **No Attachment**

General Description: Update Part 2, S7 for consistency with new requirements in Part 2, S9
Subgroup: Inspection
Task Group: D. Buelchel (PM), T. Vandini

July 2015 Meeting Action:
Mr. Mooney reviewed this action item with the SG on Inspection. A task group was assigned.

Item Number: NB15-2301 **NBIC Location: Part 2, S6** **No Attachment**

General Description: Edit supplement 6 glossary term "Flammable Gases" for greater clarity
Subgroup: Inspection
Task Group: None assigned

July 2015 Meeting Action:
Mr. Mooney reviewed this action item with the SG on Inspection. The definition of Flammable Gasses is a commonly accepted definition. A motion was made to close this item with no action. The motion was passed unanimously.

Item Number: NB15-2302	NBIC Location: Part 2, Section 5	Attachment Pages 63-64

General Description: Edit NB forms to say "pressure test" instead of "hydro test"
Subgroup: Inspection
Task Group: None assigned

July 2015 Meeting Action:
Mr. Mooney reviewed this action item with the SG on Inspection. A motion was made to change the wording from "hydro test" to "pressure test". The motion was passed unanimously.

7. New Business

Item Number: NB15-2304	NBIC Location: Part 2	Attachment Pages 65-70

General Description: Review NBIC footnotes; remove as footnotes? Code language; incorporate in the body of the code. Put definitions in the glossary.
Subgroup: Inspection
Task Group: C. Withers (PM), M. Horbaczewski

July 2015 Meeting Action:
The action item was discussed and a task group was assigned.

Item Number: NB15-2701	NBIC Location: Part 2	No Attachment

General Description: Options for making references interactive in the NBIC
Subgroup: Inspection
Task Group: None assigned

July 2015 Meeting Action:
Per G. Scribner, this item needs to be discussed at the Executive Committee meeting. No action was taken.

8. Future Meetings

January 11-14, 2016 – Corpus Christi, Texas
July 18-21, 2016 – Columbus, Ohio

9. Adjournment

The meeting was adjourned at 3:55 PM on July 14, 2015.

Respectfully Submitted,

Jodi Metzmaier
NBIC Secretary, Part 2 Inspection

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SG Inspection Attendance Sheet - 7/14/15

Name	Company	Phone Number	Email	Signature
Jim Getter				
Mike Schwartzwalder				
Jodi Metzmaier	NBBI	614-888-8320	Jmetzmai@nationalboard.org	[signature]
Timothy Barker	FM GLOBAL	860 801 3740	TIMOTHY.BARKER@FMGLOBAL.com	[signature]
Ernest Brantley	XL CATLIN INSURANCE	337-842 7044	ERNEST.BRANTLEY@BPCLLCGA.COM	[signature]
Domenic Canonico				
Robert Dobbins				
David Ford				
Darrell Graf	AIR PRODUCTS [illegible]	601-569-0534	GRAFDR@AIRPRODUCTS.COM	[signature]
Mark Horbaczewski	DTS	773 582 7727	mhorbaczewski@DIAMONDTECHNICALSERVICES.COM	[signature]
Greg McRae				
Mark Mooney	Liberty Mutual	781-697 7218	MARK.MOONEY@LIBERTYMUTUAL.Com	[signature]
Venus Newton	One CIS	678-457-1310	venus.newton@onecis.com	[signature]
~~Ralph Pate~~				
Jim Riley	Phillips 66	510-245-5895	jim.riley@P66.com	[signature]
Jason Safarz				
Stanley Staniszewski	US DOT			[signature]
Thomas Vandini	Quality Steel	419-455-3933	tvandini@propanetank.com	[signature]
Paul Welch	ARISE	678-446-5290	paul.WELCH@ariseinc.com	[signature]

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Name	Company	Phone	Email	Signature
ADAM RENALDO	PRAXAIR	~~[illegible]~~ 7168792928	Adam_Renaldo@Praxair.com	adam Renaldo
Josh Schmoyer	CNA	(610) 348 0526	Joshua.Schmoyer@CNA.com	[signature]
STEPHEN KAPNIS	CNA	978 210 4093	Stephen.Kapnis@CNA.com	Stephen Kapnis
DAVE BUECHEL	HSB	412-885-8120	David_Buechel@HSB.COM	David M Buechel
Bonnie Petersen	MWU LLC	715-339-2191	bonnie.Petersen@Marquipwardunited.com	Bonnie Petersen
CHARLES WITHERS	NB			[signature]

NB07-0910 July 2015

Status Report on DOT Rulemaking Activities:

DOT is in the final stages of editing a Supplemental Notice of Proposed Rulemaking (SNPRM) (HM-241) to incorporate by reference into regulations the latest edition (2015) of the NBIC and ASME Section XII. DOT anticipates the SNPRM to be published in the Federal Register by mid-year 2015 and a final rule by the end of the year. The SNPRM will address, in part, some of the comments received in the prior Notice of Proposed Rule Making published December 30, 2013 (78 FR 79363), and indicate the government's preferred regulatory approach with specific regulatory text and request for additional comments.

National Board Inspection Code Action item NB13-1002- Revision Dated 1/20/15

NB13-1002 - Part 2, SG Insp. Spec. – Review inspection requirements for B31.1 Power Piping. A Task Group consisting of Mike Schwartzwalder (Lead), Joe Frey, Venus Newton, Mark Mooney, Marshall Clark, Domenic Canonico, Mark Horbaczewski and Robbie Dobbins were assigned.

For Discussion, I propose the following additions to the Part 2- Inspection, 2013 edition Section 1.3 add paragraph 1.3(v) ASME B31.1, Power Piping, Chapter VII, Operation and Maintenance.

Add to Part 2- Section 9 Inspection, Glossary of Terms Definitions; 9.1 Definitions**; Covered piping systems (CPS):** These are piping systems on which condition assessments ~~are to~~ should be conducted. As a minimum for piping designed to B31.1, the CPS are to include NPS 4 and larger of the main steam, hot reheat, cold reheat steam and boiler feedwater systems. In addition to the above, CPS also includes NPS 4 and larger piping in other systems that operate above 750° F (400° C) or above 1025 psi (7100 kPa). The owner-user may include other piping systems.

Insert new Section 2.4.8 –Covered Piping Systems (CPS)

Covered piping systems are piping systems, designed to B31.1, on which condition~~s~~ assessments ~~are to~~ should be conducted. It is recognized that all of the documentation, data and records listed in the following may not be available for a specific plant, particularly older plants. In these cases, the owner or user should ensure to the extent possible that Covered Piping Systems do not represent unnecessary safety risks.

a) In addition to boiler external piping, which is addressed under the original construction codes, the owner or user should consider establishing operation and maintenance procedures for ~~Covered Piping Systems~~ CPS which could fail as a result of creep, fatigue, wall thinning, corrosion fatigue and graphitization. The consequences of failure of CPS could pose a safety risk to personnel and equipment ~~result in death, injury and loss of property~~. The following guidance is provided as examples of written operation and maintenance procedures that owners or users prepare to ensure safe operation of these components;

1) Operation of piping systems within design limits,

2) Documentation of actual operating temperatures,

3) Documentation of significant system transients or excursions including thermal hydraulic events,

4) Documentation of alterations and repairs,

5) Documentation of maintenance of pipe supports for piping operating within the creep regime,

6) Documentation of maintenance of piping system elements such as vents, drains, relief valves, desuperheaters, and instrumentation necessary for safe operation,

7) Assessment of degradation mechanisms, including but not limited to creep, fatigue, graphitization, corrosion, erosion, and flow accelerated corrosion,

8) Quality of flow medium,

9) Documentation of the condition assessment, and

10) Other required maintenance

b) A condition assessment program should be established to provide assessment and documentation of the condition of all CPS. This program should contain (but not limited to) as many of the following elements as appropriate;

1) System name,

2) Listing of original material specifications and their editions,

3) Design diameters and wall thicknesses,

4) Design temperature and pressure,

5) Normal operating temperatures and pressures,

6) Operating hours, both cumulative and since last assessment,

7) Actual modes of operation since last condition assessment (such as number of hot, warm, and cold starts),

8) Pipe support hot and cold walkdown readings and conditions since last conditions assessment for piping systems that are operated within the creep regime,

9) Alterations and repairs since last condition assessment,

10) Description and list of any dynamic events, since last condition assessment,

11) Actual pipe wall thickness and outside diameter measurements since last condition assessment,

12) Summary of pipe system inspection findings including areas of concern, and

13) Recommendations for re-inspection interval.

c) Record of CPS should be maintained for the life of the piping system and should include those items listed in items a and b, applicable to the component, in addition to original as-built drawings, and repaired piping drawings.

d) It is also recommended that the owner or user should have a program, which documents pipe support readings, piping system displacements and modifications, which are taken during hot and cold walk downs. The owner or user should evaluate the effects of unexpected piping position changes, significant vibrations, and malfunctioning supports on the piping system's integrity and safety and record results and or corrective action taken in accordance with c).

~~d)~~e) Records of repairs or alterations to ~~Covered Piping Systems (CPS)~~ CPS shall be ~~recorded~~ documented on the applicable R form, if required, or another suitable document.

Revision date: July 14, 2015 ~~January 7, 2015~~ ~~July 14, 2014~~
NB 13-1301 FEA Task Group

PART 2, SECTION 4

INSPECTION – EXAMINATIONS, TEST METHODS, AND EVALUATIONS

4.6 QUANTITATIVE ENGINEERING ASSESSEMENTS INCLUDING FINITE ELEMENT ANALYSIS (FEA)

4.6.1 CALCULATIONS

This Section describes **criteria to be considered** ~~review~~ by the Inspector **in the review** of calculations prior to acceptance of quantitative engineering assessments per industry standards (such as fitness-for-service) for in-service equipment, ~~and~~ repairs and alterations.

4.6.~~1~~2 ENGINEER EXPERIENCE

For quantitative engineering **used ~~for~~in** assessments[ss1], repairs and alterations, all calculations shall be completed prior to the start of any physical work or fitness-for-service acceptance. All design calculations shall be completed by an engineer (as designated by the manufacturer, R-stamp organization, owner or user) experienced in the design portion of the ~~standard~~code used for construction of the item. Refer to NBIC Part 3, Sections 3.2.4, 3.2.5, and 3.2.6 for design and calculations requirements for repairs and alterations.

4.6.3~~1.2~~ FINITE ELEMENT ANALYSIS (FEA) ENGINEER EXPERIENCE

Finite Element Analysis (FEA) may be used to support quantitative engineering assessments or design for repairs and alterations as follows.

a) When quantitative engineering analysis is used to demonstrate the structural integrity of an in-service component containing a flaw or damage.

b) Where the configuration is not covered by the available rules in the ~~standard~~code used for construction.

c) When there are complicated loading conditions or when a thermal analysis is required.

Because the FEA method requires more extensive knowledge of, and experience with, pressure equipment design and the FEA software package involved, the analysis and report submitted to the Inspector for review shall be completed and certified by a Professional Engineer (PE) licensed and registered as required by the manufacturer, R-stamp organization, owner or user and the jurisdiction if applicable.

The Inspector may require an initial explanation of why the FEA is applicable before the analysis is performed. The I~~i~~nspector ~~shall~~ should verify ~~that~~ the validity of the FEA report:~~,~~ that it has been certified by a licensed and registered Professional Engineer:~~,~~ and that it is available for review by the manufacturer, R-stamp organization, owner or user and the jurisdiction. Owing to the specialized nature of FEA, the report must be clear and concise. Further guidelines are found in NBIC Part 2 Sx. INSPECTOR REVIEW GUIDELINES FOR FINETE ELEMENT ANALYSIS (FEA).

Revision date: July 14, 2015 ~~January 7, 2015~~ ~~July 14, 2014~~
NB 13-1301 FEA Task Group

SX.1 SCOPE

This Supplement provides guidelines to be followed when a finite element analysis (FEA) is submitted as part of a quantitative engineering assessment for in-service equipment, or a repair or alteration ~~package~~ for a pressure retaining item for review by the Inspector, and the ~~local~~[ss2] jurisdiction if required. Refer to NBIC Part 2 Section 4.6.

SX.2 TERMINOLOGY

a) Finite element analysis (FEA) as applied in engineering is a computational tool for performing engineering analysis. It includes the use of mesh generation techniques for dividing a complex problem into small elements for simulation, as well as the use of software program coded with finite element method algorithms.

b) Quantitative engineering assessment refers to methodologies whereby flaws contained within a pressure retaining item are assessed in order to determine the adequacy of the structure for continued service without failure. The result of the assessment provides guidance on structural integrity, inspection methods and intervals, and shapes decisions to operate, repair, monitor or replace the structure[ss3]/pressure retaining item.

SX.3 CHECKLIST

The following ~~presents~~is a ~~thought-provoking~~ checklist of areas to consider and discuss with the FEA practitioner engineer performing the analysis and may be used to familiarize the Inspector with the FEA approach and method as part of validating the FEA report.~~and aid in preparing an analysis specification~~.

SX.3.1 PRESSURE RETAINING ITEM INFORMATION

a) Vessel type, size, region/section and component(s) under FEA consideration
b) Materials of construction and materials properties (including those as a function of temperature)
c) Original code of construction
d) Repair and alteration history
e) Known extent of degradation and associated damage mechanisms (if available/any)
f) Operating conditions (temperature and heat flux, pressure including vacuum, cyclical service, etc.)
g) Other loads (seismic, earthquake, etc.)

SX.3.2 SCOPE OF THE FEA

a) The objective of the FEA analysis (to be used to support quantitative engineering analysis, repair, alteration, etc.)
b) The justification for use of FEA rather than rules in the code of construction. Refer to NBIC PART 2 4.6.1.2

SX.3.3 FEA SOFTWARE AND MODELLING

a) The software version to be used for the analysis
b) The type of analysis (i.e. stress, static, dynamic, elastic, plastic, small or large deformations, heat transfer, etc.)
c) The modelling approach that will be used (solids, shells, simplification of geometry, mesh generation, solver technique, division into elements and element size, boundary restraints, etc.)
d) The geometries to be modeled (non-corroded, corroded and future corrosion allowance, bulge, dent, groove, crack, etc.)

SX.4 REPORT REQUIREMENTS

The following checklist of areas to consider and discuss with the FEA practitioner engineer completing the certified report may be used to define what should be included in the report. An alternate useful reference is the following presentation: Proceedings of the ASME 2014 Pressure Vessels & Piping Conference, PVP2014-28958, Writing and Reviewing FEA Reports Supporting ASME Section VIII, Division 1 and 2 Designs – Practical Considerations and Recommended Good Practice.

SX.4.1 SECTIONS TO BE INCLUDED IN THE REPORT

a) An introduction and/or executive summary
b) A description of the model
c) A presentation of the results
d) An analysis of the results and conclusions

SX.4.2 LISTING OF INFORMATION THAT MAY BE INCLUDED IN THE FEA REPORT

SX.4.2.1 ANALYSIS METHOD

a) State the scope of the FEA and the justification for using it; give the program and version
b) Note whether or not the problem is linear.
c) Give an overview of how the analysis is conducted, for example:
   1) Calculations are done to simplify radiation boundary conditions so that the problem is linear.
   2) Thermal loads are applied to the FEA model and temperatures generated
   3) Temperatures at select locations are compared to the radiation simplification calculations
   4) Mechanical loads are added
   5) Stresses are generated
   6) Stress classification results are generated
   7) Results are verified by comparison to something (for example BPVVC Section VIII Division 2 Part 5 Design by Analysis)
   8) Results are compared to the construction code
d) Note if any of the geometry is not included in the stress model

SX.4.2.2 STRUCTURAL DESCRIPTION / MESH / STRESS CLASSIFICATION LINE LOCATIONS

a) Reference the geometry source or show a drawing or sketch with dimensions that relate the model geometry to the actual structure in the FEA analysis
b) Name all the parts, usually best done with a sketch
c) Note any symmetry
d) Give the type of element used for each component
e) Describe the mesh type (h, p , 2D, 3D), shape, and order (2^{nd} order or above) and show plots of the mesh
f) Show the top and bottom of shells or beam orientations and indicate if they are thick or thin elements
g) Show the cross sections with stress recovery points for beams
h) Describe any boundary conditions such as supports, restraints, loads, and forces as well as the method of restraining the model to prevent rigid body motion.
i) Describe parts that are connected by node sharing or contact and tell whether the connections are thermal, mechanical, or both
j) Give the stress classification line locations (usually best done with a sketch)

SX-4.2.3 Material Properties

a) List properties used for every component, references to other sources are not sufficient. They must be explicitly listed. Show the values of any properties modified for the sake of the model. For example, the model density is often modeled.
b) Show calculations for properties that are modified for the sake of the model.
c) Discuss any given artificial properties for the analysis (for example the modulus was set to 1000 psi so that the component would not influence the mechanical model. Or, above 1200F the properties are assumed to be constant).
d) Reference the source for all material properties.

SX-4.2.4 Restraints and loads

a) Show all restraints and loads
b) Discuss the justification for all restraints and loads, and give calculations if they were done to determine the restraints or loads (for example, end pressure).
c) Discuss any contact regions.
d) Give initial or default temperatures.

SX-4.2.5 Validation

a) Describe how the model was validated.
b) Describe the accuracy of the model digitization either by use of convergence or to the accuracy of previous successful models.

SX-4,2,6 Results

For each model the following should be presented

a) Give temperature plots.
b) Give deformed geometry plots
c) Give stress classification line results and comparison to Code allowable.
d) Relate the results of the model to the defined allowable stresses of the original Code of construction.
e) Refer to ASME Section VIII, Division 2, Part 2, Section 2.3.3.1(c)(2) Documentation requirements of design-by-analysis calculations in Part 5.

SX-4.2.7 Reference Documents Used:

Typical reference documents could include:

a) ASME BPVC II-D
b) ASME BPVC Section VIII Division 1
c) ASME BPVC Section VIII Division 2
d) ASME/API-579
e) Drawings
f) User Design Specification (UDS)
g) ASCE ~~7-05~~

NB 13-1302 Inspection of Static Vacuum Insulated Cryogenic Vessels

This section covers the periodic inspection and testing of static vacuum insulated cryogenic pressure vessels used in the storage of ~~refrigerated~~ cryogenic liquefied gases. Owner-users should inspect static cryogenic vacuum-insulated storage tanks to ensure that the equipment is in safe serviceable condition.

Definition:
Cryogenic liquid products are products stored at or below -238 F and as low as -452°F
Liquid oxygen, argon, nitrogen and hydrogen & helium are cryogenic liquids stored at temperatures these temperatures.

Low temperature tanks can store products at temperatures as low as -60°F (-51°C);
Liquefied gases including butadiene, butane, ammonia, carbon dioxide, chlorine, propane, propylene, LNG, LPG, ethylene, are ~~low temperature products~~not considered cryogenic.

A static vacuum insulated cryogenic vessel is a vessel that is thermally insulated for use with one or more cryogenic fluids, consisting of: 1) an inner vessel holding the cryogenic fluid, 2) an outer jacket that serves as an air tight enclosure which supports the inner vessel, holds the insulation and enables the vacuum to be established, and 3) the associated piping system.

~~Outdoor installation general observation:~~General Observations on Outdoor Vessels

Check that the following conditions or ~~safe guards~~safeguards are adequate prior to doing a periodic external inspection of the vessel:

- Surface water drainage is directed away from the location of installation. Proximity of storage tank to sewer inlets shall comply with local ~~fire code~~jurisdictional requirements.
- ~~Installations are in place, such as a wall, to prevent gases from spreading across the location if there is a slope between vessels (and lower rooms if any)~~
- Protective measures are in place for the vessels and components from mechanical impact damage (such as barricades, safe set-back distances, ~~polls~~ poles and bars.
- Any fire proofing for external supports is in acceptable condition. ~~Protection is in place for the external vessel supports from leaking cryogenic fluid~~
- Any gas from pressure relief devices or vents is discharged to a safe place. Relief valve discharges are not aimed directly at external supports or the outer jacket wall.
- There is sufficient ventilation to avoid the formation of explosive gas-air mixtures or an oxygen deficient/enriched atmosphere.

Periodic Visual Inspection:

A periodic external visual inspection of the vessel and equipment should be made to ensure that the vacuum between the inner vessel and outer jacket has not been compromised. If the vessel has lost vacuum, the owner-user of the cryogenic storage vessel shall immediately investigate the cause. Any loss of vacuum should be investigated as this could affect the integrity of the vessel and support system. If the cause is due to an internal pipe failure as evidenced by vapor escaping from the vacuum relief device, the pressure should be immediately reduced to atmospheric pressure followed by emptying of all of the cryogenic liquid in a safe manner.

External visual inspections are possible at all accessible parts of the vessel and piping. The following inspections should be included as part of the periodic external visual inspection.

NB 13-1302 Inspection of Static Vacuum Insulated Cryogenic Vessels

- A functional check of essential and critical valves and their operability.
- Leak tests under operating conditions of the vessel and piping.
- Assessing if there have been any significant changes in the operational conditions of the installation and its surroundings.
- Check that there is no excessive out-of-roundness or deformation of the outer vessel
- Check all nozzles for corrosion or damage. attachments
- Check the vessel supports to make sure there is nofor structural damage.
- Check that any attachments to the outer jacket are not damaged or affecting the vessel condition.
- Verification of periodic testing and repair (or replacement) of the pressure relief device(s)
- Check that the pressure relief device(s) are not continually venting. PRD's may vent periodically under normal circumstances but should be reported for maintenance testing and repair if venting continually.
- Checking the condition of the outer vesseljacket, piping and accessories
- Check for abnormal frosting on outer vessel jacket surface. Under normal usage, frost and ice will develop around pipes, valves, controls and vaporizers-. Inspect the outer skin of the outer vessel jacket for any new or abnormal signs of excessive frosting.
- Confirm that the duplicate ASME nameplate is attached to the outer jacket or tank leg.

Extended Interval Pressure Testing

The Owner-User should consider conducting a pressure test of the vessel at extended intervals, such as every 8 to 15 years. An example is a pneumatic pressure test at 110% of design pressure. At the same time, a vacuum test, such as for 3 hours, may also be conducted.

1.2 - Administration

Add to end of Part 2, Section 1.2

Unless otherwise specifically required by the jurisdiction, the duties of the Inspector do not include inspection to other standards and requirements (environmental, construction, electrical, operational, undefined industry standards, etc) for which other regulatory agencies have authority and responsibility to oversee.

Proposed New Supplement for Part 2

Inspection of Biomass Fired Boiler Installations (Section 6, Supplement 9)

S9.1 - Scope

a) This supplement provides ~~rules~~ guidelines for continued inspection of biomass fired boilers and the additional equipment utilized in these installations. In this context Biomass is intended to mean various types of wood wastes, or wood byproducts.

b) Many of the requirements of the earlier Sections of Part 2 are common to all boiler installations irrespective of the fuel being fired; therefore this supplement will address the differences that occur when solid fuels, such as Biomass, are being used. Thus the primary thrust of this section will be directed toward the inspection of the fuel handling and distribution systems, and the impact these systems may have on the pressure vessel itself.

S9.2 – Assessment of Installation

a) A general assessment of the complete installation shall be undertaken, in terms of observable results of operating and maintenance practices. Indicators include the general boiler room cleanliness, for example significant quantities of fuel particles (dust) should not be apparent in the boiler room, including rafters and beams.

b) The combustion air inlet shall be free of any debris or dust particle build up, and where moveable louvered intakes exist, the actuating mechanisms shall be clean and operate freely. Corrective action is required when non-compliance is noted.

c) The flue gas venting system shall be checked for tightness, with no observable signs of leakage. Corrective action is required if leakage is noted.

d) The intakes of the various fans or blowers shall be free of fuel particle build up or signs of other debris. Corrective action in terms of cleaning is required when discrepancies are noted.

e) The fuel metering equipment and the fuel transportation system shall be free from signs of particulate or dust leakage. Corrective action in terms of cleaning and repair work is required as necessary.

f) Electrical equipment and controls shall be properly protected from the ingress of dust, by ensuring that all cover plates are properly installed and all panel doors are intact, operable and closed.

g) Verify that all guards for rotating equipment (shafts, bearings, drives) are correctly installed and fan inlet screens are in place.

h) On the boiler, generally check for signs of potential problems, including but not limited to;

- Water leaks
- Ash Leaks
- Condition of insulation and lagging.
- Casing leaks or cracks
- ~~Check a~~All safety valves for bypass and ensure the inspection plugs are capped and the drain lines are piped away from traffic areas.
- Missing or misaligned pieces or parts (ie twisted, misaligned or bound up buck stays, missing linkage bolting).
- Condition of support systems
- Provision of “Danger” or “Caution” signs
- Excess vibration
- Excess noise.

i) Verify that the Owner/User has established function test, inspection, requirements, maintenance and testing of all controls and safety devices in accordance with the manufacturer’s recommendations. Verify that these activities are conducted at assigned intervals in accordance with written procedures, non-conformances which impact continued safe operation of the boiler are corrected and the results are properly documented. These activities shall be at a frequency recommended by the manufacturer, or frequency required by the jurisdiction. Where no frequencies are recommended, or prescribed, the activity should be conducted at least annually

S9.3 – Boiler Room Cleanliness

a) While boiler room cleanliness is of primary importance in all boiler rooms it is of particular importance in biomass fired boiler rooms. Biomass can contain fine particulate, which if allowed to leak from the transportation system into the surrounding boiler room, will eventually be drawn into fans, resulting in the possibility of combustion air systems becoming plugged.

b) Boiler rooms containing quantities of fine dusts are susceptible to fire or explosion, again emphasizing the need for high standards of cleanliness.

S9.4 – Emission Control Requirements

a) Emission control is dependent upon the fuel being fired and the emission requirements prevailing at the location of the boiler installation. As such they are a part of the initial design and installation process, and apart from ensuring that they are kept in top working condition, so that emission requirements are not violated; there is little that can be done from the inspector's point of view.

b) When Continuous Emissions Monitors (CEM's) are in use, they should be demonstrated to be functioning properly and have a current calibration sticker.

c) Delta-P pressure gauges which measure the pressure drop across the various elements of the emission control system should all be functioning correctly.

d) There should be no sign of erosion caused by entrained particulate matter, in any part of the breaching, ductwork, stack or the individual emission control elements.

e) On systems in which the emissions control system incorporates a baghouse, appropriate fire detection and suppression systems shall be incorporated and functioning properly.

Subgroup Locomotives National Board Item No. NB13-1409

Current Level: Subgroup New Business

NBIC Part 2 Paragraph(s): To be determined

Title: Method for Analyzing Bulges Created by Overheating In Stayed Boiler Surfaces

Date Opened: April 16,2013

This item is submitted by Richard Stone

As you know, my "Calculation Method For Analyzing Bulges In Stayed Firebox Sheets" has been used by the historic boiler and locomotive boiler groups to set limits for the allowable bulge depth on the stayed firebox sheets of their particular boiler types. I suggest the National Board incorporate my method's principle calculations into the "Inspection Section" of the NBIC as a way to assist National board inspectors and repair firms with the evaluation of bulges caused by the overheating of the stayed boiler surfaces of other boiler types. My method would be useful for analyzing bulges caused by overheating on the stayed surfaces of boilers made by manufacturers that are now out of business since the engineering resources of these firms would not be available for consultation. The benefits of my method and calculations for analyzing bulges caused by overheating on the stayed surfaces are :

1) It provides a simple way to determine the normal deflection (bulge depth) of the stayed surface during normal operation in order to compare it to the as-found bulged condition.

2) It provides a simple and fast way to determine the extent of the weakening that occurred to produce the as -found bulged condition.

3) It provides a simple and fast method to determine the temperature that the overheated stayed surface was heated to as the bulge formed.

This in turn will serve to aid boiler owners and operators to understand the seriousness of the bulging event. I've included additional information about how a National Board inspector would perform their inspection and use my calculations within my report. It is listed in the Section "Recommended Use Of This Inspection Method By The NBIC Inspector**.** I've attached a copy of my report, the illustrations and the reference documents at the bottom of this e-mail.

Background:
Bulging of the firebox sheet between the staybolt rows while the staybolts and staybolt heads remain in satisfactory condition is a serious condition. If the bulging action continues, it can result either in the firebox sheet rupturing or pulling completely off of numerous staybolts.

Bulging usually is caused by the firebox sheet becoming overheated as result of the inability of the sheet to transfer the combustion heat rapidly into the water.

The common causes for the loss of heat transfer and overheating are:

- Scale buildup on sheet waterside.
- Poor heat transfer caused by problems with water chemistry.
- Excessive heat on the sheet fireside caused by over-firing.
- Loss of water circulation on sheet waterside. This can result from conditions such as foaming of the boiler water or an obstruction on the waterside that reduces the rate of water circulation over the sheet.
- Operation with insufficient water to cover the waterside surface of the sheet.

The bulging stops when the firebox sheet becomes cool after water circulation resumes over it. The resumption of the water circulation and cooling likely are the result of the following:

- The obstruction or scale breaks off the firebox sheet waterside.
- The foam bubbles become dissipated by the change in the water circulation pattern that the firebox sheet bulge creates.
- The firing rate is reduced.

Proposed Action: Submit to Part 2 SC Pages 50-
RECOMMENDED USE OF THIS INSPECTION METHOD BY THE NBIC INSPECTOR

1. National Board inspectors can use my two formulas when inspecting and evaluating bulges on stayed firebox sheets of historic and locomotive boilers.

   The formulas and terms are explained in detail in the section "Analysis Method. The calculations for results listed in Table #1 are in the section "Calculations for Table #1". In addition, see Figures #1 & #2.

2. The primary formula is:

   $$\text{def} = \text{maximum bulging (deflection) of firebox sheet} = \frac{5 \times W \times p^3}{384 \times E \times I}$$

   (Ref: Machinery's Handbook, 20^{th} edition, 1978, Industrial Press, Page 412)

   This is the formula for calculating the deflection of a simply supported beam under uniform load. The deflection is calculated at the center of the beam and is the maximum value.

   The beam formula equates the bulge (the deflection of the firebox sheet) to the reduction to the modulus of elasticity of the firebox sheet material that the overheating causes.

   The modulus of elasticity, which is the ratio between unit stress to unit strain within the proportional limit of the firebox steel, is dependent on the firebox sheet temperature and becomes lower as the firebox sheet temperature increases. Therefore, by using the reduction of the modulus of elasticity as the primary variable for the calculation, the temperature that the firebox sheet was overheated to during the bulging event can be estimated.

   In addition, this method does not require the staybolt diameter be included in the calculations. Although for some configuration including the staybolt diameter would shorten the beam length and strengthen the beam, the staybolts are ignored to be both conservative and to simplify the work.

   The terms and symbols used in the formula are:

   I = calculated moment of inertia of the beam for deflection at its outermost face. For the bulged firebox plate the beam width (b) represents a 1 in. (25 mm) wide section of the bulged firebox section. The beam thickness (d) equals the firebox plate thickness (t). The beam length (b) equals the staybolt pitch (p).

   For reference the beam cross sectional area equals the 1 in. (25 mm) beam width (b) times the firebox plate thickness (t).

The beam moment of inertia "I" is calculated by the following formula:

$$I = \underline{b \text{ x } d^3} = b \text{ x } t^3$$

Bulge Depth = the bulge depth found on the firebox sheet.

The first formula then is re-written to solve for the $E_{x/x"}$:

$$E_{x/x"} = \frac{5 \times W \times p^3}{384 \times \text{Bulge Depth} \times I}$$

NOTE:

Should it be necessary to determine bulge depth (deflection) of the firebox sheet at the first transition temperature of the firebox steel [approximately 1100° F (593°C)], a lower value of the modulus of elasticity of the standard firebox steel (E1) must be used in the first formula.

The strength reduction to the modulus of elasticity of the firebox steel at the first transition temperature is 28% of the standard E value. (Ref: Machinery's Handbook, 20th edition, 1978, Industrial Press, Page 454 "Table For Influence Of Temperature On The Strength Of Metals").

Therefore E1 = 28% x 29,000,000 = 8,120,000 psi (55985 MPa)

ANALYSIS METHOD

Reference: Machinery's Handbook, 20th edition, 1978, Industrial Press, Pages 358, 379, 412, 452 & 454

1. The bulged section of the firebox sheet is analyzed as a simply supported beam that is uniformly loaded by the boiler pressure. Each end of the beam is assumed to be supported by the staybolt located at each end of it.

2. The beam width (b) is taken as a 1 in. (25 mm) wide section of the firebox sheet. The beam length (p) is the horizontal or vertical pitch distance of the staybolt pattern (the centerline distance of the two staybolts at the bulge location on the firebox sheet). The choice between the use of the horizontal or vertical pitch distance is dependent on the orientation of the bulge.

   For reference the beam cross sectional area is a rectangle and equals the 1" beam width (b) times the firebox plate thickness (t).

3. The bending load on the beam (the bulged plate section) equals the staybolt pitch length (p) times the boiler pressure (MWAP). To obtain the maximum bending stress

for this analysis the concentrated bending load is assumed to be positioned at the beam centerline. This places it in the center (middle) of the staybolt pitch length.

4. The deflection of the beam (the bulged plate section) is calculated at its fireside surface. Therefore the reference location for the extreme fiber section of the beam is taken at the firebox plate's fireside surface.

5. The staybolt diameter is not needed for this analysis method. Although including the staybolts would shorten the beam length and strengthen the beam, to be conservative the staybolts are ignored.

6. The variable for the beam calculation is the modulus of elasticity of the firebox steel. The modulus of elasticity, which is the ratio between unit stress to unit strain within the proportional limit of the firebox steel, is dependent on the firebox sheet temperature and becomes lower as the sheet temperature increases. This enables the bulging and weakening of the firebox steel by the overheating to be calculated by using the reduction of the modulus of elasticity as the primary variable for the calculation.

7. The primary formula is:

   def = maximum bulging (deflection) of firebox sheet = $\dfrac{5 \text{ x } W \text{ x } p^3}{384 \text{ x } E \text{ x } I}$

   This is the formula for calculating the deflection of a simply supported beam under uniform load. The deflection is calculated at the center of the beam and is the maximum value.

   The beam moment of inertia "I" for deflection at its outer face is calculated by the following formula:

   $I = \dfrac{b \text{ x } d^3}{3} = \dfrac{b \text{ x } t^3}{3}$

   b = 1 in. (25 mm) width of the firebox sheet at the bulged section. This represents the beam width.

   t = thickness of bulged firebox sheet. This represents the beam depth "d"

   p = longitudinal or vertical pitch of staybolts at the bulged firebox section

   MAWP = maximum allowable boiler pressure

   W = total load on the pitch length of the firebox sheet = MAWP x p x 1 in. (25 mm) width

E = modulus of elasticity of the firebox steel at ambient temperature and normal operating temperature = 29,000,000 psi (199950 MPa). (Ref: Machinery's Handbook, 20th edition, 1978, Industrial Press, Page 452 -see the value for common structural carbon steel)

E1 = modulus of elasticity of the firebox steel at the first transition temperature [approximately 1100° F (593°C)] and is 28% of the standard E value. (Ref: Machinery's Handbook, 20th edition, 1978, Industrial Press, Page 454 "Table For Influence Of Temperature On The Strength Of Metals").

Therefore E1 = 28% x 29,000,000 = 8,120,000 psi (55985 MPa)

$E_{x/x"}$ = the reduced value of the modulus of elasticity of the firebox steel needed to obtain the deflection (bulge depth) listed in the example.

EXAMPLE:
CALCULATIONS FOR TABLE #1
Analysis of a 3/8 in. (10 mm) thick steel firebox sheet with a 4 in. (100 mm) staybolt pitch operating at 200 psi (1.5 MPa).

b = 1 in. (25 mm) width of the firebox sheet at the bulged section. This represents the beam width.

t = thickness of bulged firebox sheet. This represents the beam depth "d" = 3/8 = .375 in. (10 mm)

p = longitudinal pitch of staybolts at the bulged firebox section = 4 in. (100 mm)

MAWP = maximum allowable boiler pressure = 200 psi (1.5 MPa)

W = total load on the pitch length of the firebox sheet = MAWP x p x 1 = 200 x 4 x 1" = 800 lb (362 kg)

E = modulus of elasticity of the firebox steel at ambient temperature and normal operating temperature = 29,000,000 psi (199950 MPa)

E1 = modulus of elasticity of the firebox steel at the first transition temperature (approximately 1100° F) = 28% x 29,000,000 = 8,120,000 psi. (55985 MPa)

E2 = modulus of elasticity of the firebox steel at the second transition temperature (approximately 1500° F) = 10% x 29,000,000 = 2,900,000 psi. (19995 MPa)

$E_{x/x''}$ = the reduced value of the modulus of elasticity needed to obtain the bulge deflection value listed in the example.

I = moment of inertia of the 1 in. (25 mm) **wide firebox plate section that represents the beam**

$$= \frac{b \times d^3}{3} = \frac{b \times t^3}{3} = \frac{1 \times (.375)^3}{3} = .0176\ in^4\ (7316\ mm^4)$$

def = maximum deflection at center of bulge = $\frac{5 \times W \times p^3}{384 \times E \times I}$

Deflection At MAWP & Normal Operating Temperature

E = 29,000,000 psi (199950 MPa)

$$= \frac{5 \times W \times p^3}{384 \times E \times I}$$

$$\frac{5 \times 800\ lb \times (4)^3}{384 \times 29{,}000{,}000 \times .0176} = .001306\ in.\ (1.30\ mm)$$

Deflection At 1st Transition Temperature

E1 = .28 x E = .28 x 29,000,000 = 8,120,000 psi (55985 MPa)

$$\frac{5 \times W \times p^3}{384 \times E1 \times I}$$

$$\frac{5 \times 800 \times (4)^3}{384 \times 8{,}120{,}000 \times .0176} = .00466\ in.\ (0.118\ mm)$$

Deflection At 2nd Transition Temperature

E2 = .10 x E = .10 x 29,000,000 = 2,900,000 psi (19995 MPa)

$$\frac{5 \times W \times p^3}{384 \times E2 \times I}$$

$$\frac{5 \times 800 \times (4)^3}{384 \times 2{,}900{,}000 \times .0176} = .013 \text{ in. } (0.33 \text{ mm})$$

Modulus of Elasticity Required To Obtain 1/16 in. (1.5 mm) Deflection

def = 1/16 = .0625 in. (1.5 mm)

$$E_{1/16''} = \frac{5 \times W \times p^3}{384 \times def \times I}$$

$$\frac{5 \times 800 \times (4)^3}{384 \times .0625 \times .0176} = 606{,}060 \text{ psi } (164718 \text{ MPa})$$

Modulus of Elasticity Required To Obtain 1/8 in. (3 mm) Deflection

def = 1/8 = .125 in. (3 mm)

$$E_{1/8''} = \frac{5 \times W \times p^3}{384 \times def \times I}$$

$$\frac{5 \times 800 \times (4)^3}{384 \times .125 \times .0176} = 303{,}030 \text{ psi } (82360 \text{ MPa})$$

Modulus of Elasticity Required To Obtain ¼ in. (6 mm) Deflection

def = 1/4 = .250 in. (6 mm)

$$E_{1/4''} = \frac{5 \times W \times p^3}{384 \times def \times I}$$

$$\frac{5 \times 800 \times (4)^3}{384 \times .250 \times .0176} = 151{,}515 \text{ psi } (1046 \text{ MPa})$$

Modulus of Elasticity Required To Obtain 3/8 in. (10 mm) Deflection

def = 3/8 = .375 in. (10 mm)

$$E_{3/8''} = \frac{5 \times W \times p^3}{384 \times def \times I}$$

$$\frac{5 \times 800 \times (4)^3}{384 \times .375 \times .0176} = 101{,}010 \text{ psi } (697 \text{ MPa})$$

Percentage Reduction of Modulus of Elasticity Required To Obtain .00466 in. (0.113 mm) Deflection of Firebox Sheet At 1st Transition Temperature

$$\frac{29{,}000{,}000 - 8{,}120{,}000}{29{,}000{,}000} \times 100 = 72\%$$

Percentage Reduction of Modulus of Elasticity Required To Obtain .013 in. 0.33 mm) (Deflection of Firebox Sheet At 2nd Transition Temperature

$$\frac{29{,}000{,}000 - 2{,}900{,}000}{29{,}000{,}000} \times 100 = 90\%$$

Percentage Reduction of Modulus of Elasticity Required To Obtain 1/16 in. (1.5 mm) Deflection of Firebox Sheet

$$\frac{29{,}000{,}000 - 606\ ,}{29{,}000{,}000} \times 100 = 97.9\%$$

Percentage Reduction of Modulus of Elasticity Required To Obtain 1/8 in. (3 mm) Deflection of Firebox Sheet

$$\frac{29{,}000{,}000 - 303{,}030}{29{,}000{,}000} \times 100 = 98.95\%$$

Percentage Reduction of Modulus of Elasticity Required To Obtain ¼ in. (6 mm) Deflection of Firebox Sheet

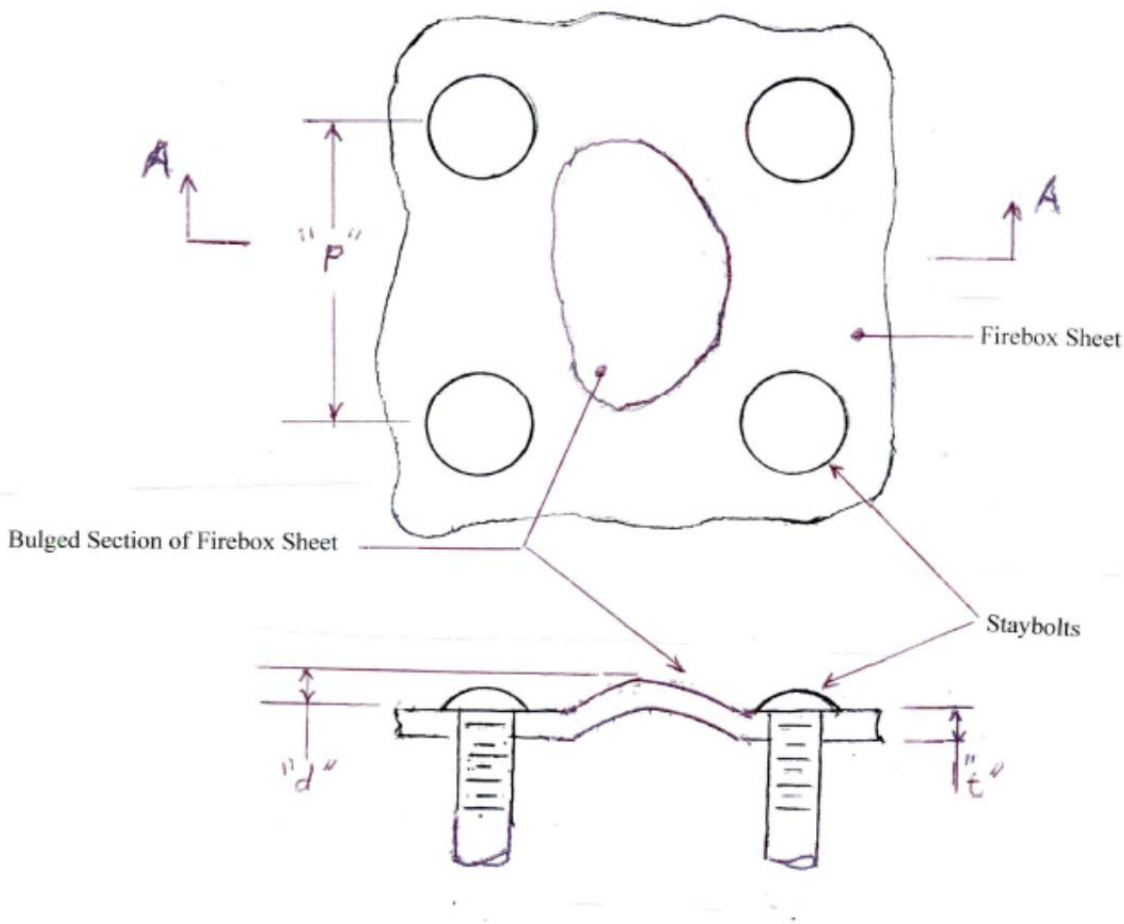
$$\frac{29{,}000{,}000 - 151{,}515}{29{,}000{,}000} \times 100 = 99.47\%$$

Percentage Reduction of Modulus of Elasticity Required To Obtain 3/8 in. (10 mm) Deflection of Firebox Sheet

$$\frac{29{,}000{,}000 - 101{,}010}{29{,}000{,}000} \times 100 = 99.7\%$$

Bulged Firebox Sheet
Analysis Method

Figure #1



Sec A - A

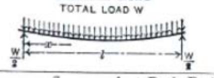
p = staybolt pitch

t = firebox sheet thickness

d = depth of bulge

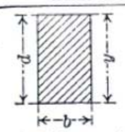
b = width of beam section = 1"

Stresses and Deflections in Beams

Type of Beam	Stresses		Deflections (*See footnote*)	
	General Formula for Stress at any Point	Stresses at Critical Points	General Formula for Deflection at any Point	Deflections at Critical Points
Case 1. — Supported at Both Ends, Uniform Load TOTAL LOAD W 	$s = -\frac{W}{2Zl}x(l-x)$	Stress at center, $-\frac{Wl}{8Z}$ If cross-section is constant, this is the maximum stress.	$y = \frac{Wx(l-x)}{24EIl}[l^2 + x(l-x)]$	Maximum deflection, at center, $\frac{5}{384}\frac{Wl^3}{EI}$

STRENGTH OF MATERIALS 379

Moments of Inertia, Section Moduli, etc., of Sections

A = area y = distance from axis to extreme fiber	Moment of Inertia I	Section Modulus $Z = \frac{I}{y}$	Radius of Gyration $k = \sqrt{\frac{I}{A}}$
 $A = bd;\ y = d$	$\frac{bd^3}{3}$	$\frac{bd^2}{3}$	$\frac{d}{\sqrt{3}} = 0.577\,d$

454 STRENGTH OF MATERIALS

Influence of Temperature on the Strength of Metals

Material	Degrees Fahrenheit							
	210	400	570	750	930	1100	1300	1475
	Strength in Per Cent of Strength at 70 Degrees F.							
Wrought iron	104	112	116	96	76	42	25	15
Cast iron	....	100	99	92	76	42	....	....
Steel castings	109	125	121	97	57	....	....	....
Structural steel	103	132	122	86	49	28	....	....
Copper	95	85	73	59	42	....	....	....
Bronze	101	94	57	26	18	....	....	....

Subgroup voted **Date:**

Note: Use ASME Section II Part D Table TM-1 to determine Moduli of Elasticity at temperature. Tables follow:

(10)

TABLE TM-1
MODULI OF ELASTICITY *E* OF FERROUS MATERIALS FOR GIVEN TEMPERATURES

Materials	Modulus of Elasticity E = Value Given × 10^6 psi, for Temperature, °F, of																	
	−325	−200	−100	70	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500
Carbon steels with C ≤ 0.30%	31.4	30.8	30.3	29.4	28.8	28.3	27.9	27.3	26.5	25.5	24.2	22.5	20.4	18.0	...	...	...	...
Carbon steels with C > 0.30%	31.2	30.6	30.1	29.2	28.6	28.1	27.7	27.1	26.4	25.3	24.0	22.3	20.2	17.9	15.4	...	...	...
Material Group A [Note (1)]	31.1	30.5	30.0	29.0	28.5	28.0	27.6	27.0	26.3	25.3	23.9	22.2	20.1	17.8	15.3	...	...	...
Material Group B [Note (2)]	29.6	29.0	28.6	27.8	27.1	26.7	26.2	25.7	25.1	24.6	23.9	23.2	22.4	21.5	20.4	19.2	17.7	...
Material Group C [Note (3)]	31.6	30.9	30.5	29.6	29.0	28.5	28.0	27.4	26.9	26.2	25.6	24.8	23.9	23.0	21.8	20.5	18.9	...
Material Group D [Note (4)]	32.6	31.9	31.4	30.6	29.9	29.4	28.8	28.3	27.7	27.0	26.3	25.6	24.7	23.7	22.5	21.1	19.4	...
Material Group E [Note (5)]	33.0	32.4	31.9	31.0	30.3	29.7	29.2	28.6	28.1	27.5	26.9	26.2	25.4	24.4	23.3	22.0	20.5	...
Material Group F [Note (6)]	31.2	30.7	30.2	29.2	28.4	27.9	27.3	26.8	26.2	25.5	24.5	23.2	21.5	19.2	16.5	...	...	...
Material Group G [Note (7)]	30.3	29.7	29.2	28.3	27.5	27.0	26.4	25.9	25.3	24.8	24.1	23.5	22.8	22.0	21.2	20.3	19.2	18.1
Material Group H [Note (14)]	...	...	30.2	29.0	28.2	27.5	27.0	26.4	26.0	25.5	25.1	...	...	...	...	...	...	...
Material Group I [Note (15)]	27.8	27.1	26.6	25.8	25.1	24.6	24.1	23.6	23.1	22.6	22.1	21.6	21.1	20.6	20.1	19.6	19.1	18.6
Material Group J [Note (16)]	31.1	30.3	29.7	28.6	27.8	27.2	26.6	26.0	25.4	24.7	24.1	23.5	22.9	...	...	...	...	...
S13800 [Note (8)]	31.5	30.9	30.3	29.4	28.7	28.1	27.5	26.9	26.3	25.7	25.0	24.4	...	...	...	...	...	...
S15500 [Note (9)]	30.5	29.9	29.4	28.5	27.8	27.2	26.7	26.1	25.5	24.9	24.3	23.7	...	...	...	...	...	...
S45000 [Note (10)]	31.6	31.0	30.4	29.5	28.8	28.2	27.6	27.0	26.4	25.8	25.1	24.5	...	...	...	...	...	...
S17400 [Note (11)]	30.5	29.9	29.4	28.5	27.8	27.2	26.7	26.1	25.5	24.9	24.3	23.7	...	...	...	...	...	...
S17700 [Note (12)]	31.6	31.0	30.4	29.5	28.8	28.2	27.6	27.0	26.4	25.8	25.1	24.5	...	...	...	...	...	...
S66286 [Note (13)]	31.0	30.6	30.2	29.2	28.5	27.9	27.3	26.7	26.1	25.5	24.9	24.2	...	...	...	...	...	...

Notes appear on following page.

(10)

TABLE TM-1
MODULI OF ELASTICITY E OF FERROUS MATERIALS FOR GIVEN TEMPERATURES

Materials	Modulus of Elasticity E = Value Given × 10^3 MPa, for Temperature, °C, of																
	−200	−125	−75	25	100	150	200	250	300	350	400	450	500	550	600	650	700
Carbon steels with C ≤ 0.30%	216	212	209	202	198	195	192	189	185	179	171	162	151	137	...	...	...
Carbon steels with C > 0.30%	215	211	207	201	197	194	191	188	183	178	170	161	149	136	121	...	...
Material Group A [Note (1)]	214	210	207	200	196	193	190	187	183	177	170	160	149	135	121	...	...
Material Group B [Note (2)]	204	200	197	191	187	184	181	178	174	171	167	163	158	153	147	141	133
Material Group C [Note (3)]	218	213	210	204	200	197	193	190	186	183	179	174	169	164	157	150	142
Material Group D [Note (4)]	225	220	217	210	206	202	199	196	192	188	184	180	175	169	162	155	146
Material Group E [Note (5)]	228	223	220	213	208	205	201	198	195	191	187	183	179	174	168	161	153
Material Group F [Note (6)]	215	212	208	201	195	192	189	186	182	178	173	166	157	145	131	...	...
Material Group G [Note (7)]	209	204	201	195	189	186	183	179	176	172	169	165	160	156	151	146	140
Material Group H [Note (14)]	...	...	209	200	194	190	186	183	180	177	174	172	...	...	...	...	...
Material Group I [Note (15)]	192	187	184	178	173	170	167	163	160	157	154	151	148	145	142	139	135
Material Group J [Note (16)]	214	209	205	197	191	187	184	180	176	172	168	164	161	157	...	...	...
S13800 [Note (8)]	217	213	209	202	197	194	190	186	183	179	175	171	...	...	...	...	...
S15500 [Note (9)]	210	206	203	196	191	188	184	181	177	173	169	166	...	...	...	...	...
S45000 [Note (10)]	218	213	210	203	198	194	191	187	183	179	175	171	...	...	...	...	...
S17400 [Note (11)]	210	206	203	196	191	188	184	181	177	173	169	166	...	...	...	...	...
S17700 [Note (12)]	218	213	210	203	198	194	191	187	183	179	175	171	...	...	...	...	...
S66286 [Note (13)]	214	211	208	201	196	192	189	185	181	178	174	169	...	...	...	...	...

Notes appear on following page.

Attachment Page 30

NB13-1701

2.3.6.6 INSPECTION OF WIRE WOUND PRESSURE VESSELS

(a) This section provides guidelines for inspection of wire wound pressure vessels typically designed for 10,000 psi or greater service. The scope of inspection of these vessels should include components affected by repeated opening and closing, such as the frame, yolk and cylinder inner diameter surface, or alignment of the yolk with the cylinder, lack of maintenance and a check for inoperable or bypassed safety and warning devices.

(b) These vessels consist of four parts, a wire wound cylinder, two end closures and a frame to retain the closures in the cylinder. The wire is one continuous piece and is wound in tension. On the cylinder, the wire can only carry circumferential or radial loading. The cylinder is typically not of sufficient thickness to carry axial load which requires the end closures have no threads or retaining grooves and requires a frame to retain the pressure vessel axial load imposed on the closures. The purpose for this design is to minimize weight of the containment cylinder using thinner wall materials and using external wound wire to induce a compressive preload. This design also provides increased resistance to damage from fatigue loading.

Note that some vessels may be monoblock cylinders (no winding) with wire wound frame and some vessels may be wire wound cylinder with a forged or welded plate frame (not wire wound). Use of a frame to retain the end closures removes the sharp transitions in shape (threads or grooves) associated with monoblock cylinder failures. The design of high pressure vessels is typically based on fatigue life criteria. The majority of operating wire wound vessels in North America today were fabricated under the rules of ASME BPVC Section VIII Division 3, Alternative Rules for Construction of High Pressure Vessels. Some inservice vessels may have been constructed the ASME BPVC Section VIII Division 1 or Division 2 rules, and others installed as “State Specials” that still require fatigue life analysis to determine a safe operating life. The primary failure mode is fatigue cracking. Early detection of any damage to the cylinder, closures or frame is essential to avoid catastrophic failure

High pressure design requires use of high strength materials, which have relatively low ductility. The material thickness required for reasonable fatigue life is greatly reduced by the pre-tensioned wire wound design. Typical winding design provides compression sufficient that at vessel design conditions there is no circumferential stress in the cylinder. These vessels have been used in various industrial applications, including foods and drinks processing, ceramic or refractory processing and powdered metal processing utilizing a liquid compressing fluid at ambient or slightly elevated temperature. The most frequent of these are isostatic pressing and hydrostatic extrusion. Isostatic pressing can be performed at either cold temperatures, at room temperature, with liquid as the pressure medium, or hot, at temperatures of 2000 to 3300°F with gas as the pressure medium. In hot isostatic presses, the vessel wall is separated from the hot space by insulation, which keeps the vessel wall operating at a low temperature of approximately 120 to 180°F.
Cold pressing is used for regular production at pressures up to 87,000 psi. Ceramic, refractory and metal processing is also performed at elevated temperature, up to 3632°F (2000°C). The “hot” processes utilize an inert gas fluid pressure up to 45,000 psi (310

MPa). Continuous cooling is necessary for the hot process and may contribute to corrosion damage of the cylinder of closures.
Hydrostatic extrusion is generally performed either cold, at room temperature, or warm, at temperatures up to 1110°F, in both cases with liquid as the pressure medium. Hydrostatic extrusion is used for regular production at pressures up to 200,000 psi. Both cold and hot processes are commonly found in research facilities and in universities.

(c) Record keeping

(1) Since these vessels have a finite fatigue life, it is essential a record be maintained of each operating cycle, recording both temperature and pressure. Deviation beyond design limits is cause for suspending operation and reevaluation of remaining fatigue life. Vessels having no operating record should be inspected and a fracture mechanics evaluation with a fatigue analysis test be performed to establish remaining life before resuming operation.

(2) Operating data should be recorded and include the following whenever the vessel is operating:

a. Number of cycles
b. Maximum pressure
c. Maximum temperature

(d) Any unusual conditions (d) Any damage to the cylinder or closures can lead to premature failure. Frequent visual inspection should be made of internal and external surfaces of the cylinder, frame and closures. A thorough examination should be completed if any visually apparent damage is identified or if any excursion beyond design temperature or pressure occurs.

In addition, surfaces of the cylinder and closures should be examined by dye penetrant or magnetic particle method at intervals based on vessel remaining life. Closures may require ultrasonic examination of passageways.

Following is an example of what the results of such a study might reveal as allowable cycles for a particular wire wound vessel:

Columns	> 10^6 Cycles	"Columns" are beams on either side of frame, between the yokes.
Yokes	> 10^6 Cycles	"Yokes" are the circular ends of the frame.
Wires of frames	> 10^6Cycles	"Wires" place frame in compression
Cylinder	100 X 10^3 cycles	
Wires of Cylinder	60 X 10^3 cycles	"Wires" place cylinder in compression.
Closures	30 X 10^3 cycles	All connections to the vessel are through the closures. These passageways create stress raisers, as do grooves for sealing system.

The vessel design life in this example is thus limited by the closure. The calculated design life is 30,000 cycles at design pressure and temperature.

An acceptable factor of safety for vessel fatigue inspection interval varies between 0.25 and 0.5 of the remaining design life. The inspection interval for the above example is therefore 10,000 to 20,000 cycles, but should not exceed five years.

In addition to scope of frequent inspection, the fatigue inspection should include measurement of the cylinder inside diameter and frame inside length to detect reduced tension in the wire windings. Note that monoblock cylinders and plate frames require additional inspection due to differing construction.

If a crack or flaw is detected during any inspection, an immediate evaluation, repair and study of impact on remaining fatigue life should be completed by a National Board authorized repair agency. Using the results of this study, and application of safety factor 0.25 (due to known damage), the number of cycles of operation to the next fatigue inspection is established.

As part of the frequent inspection, the following items should be reviewed:

(1) Verify no change in the process, such as the processing fluid, that might adversely impact vessel integrity.

(2) Review the vessel manufacturer’s inspection recommendations for vessel, closures and frame. If manufacturer’s recommendations are not available, obtain recommendations from a recognized wire wound vessel service provider.

(3) Verify any repair to pressure retaining items has been completed by National Board authorized service provider having wire wound vessel expertise.

(4) Verify overpressure protection with appropriate set pressure and capacity is provided. Rupture discs are commonly used for pressures exceeding 14,500 psi (100 MPa) to avoid valve seat leakage. Overpressure protection devices are frequently replaced to avoid premature operation.

(e) Additional Inspection Criteria

(1) If there are no manufacturer’s recommendations available for the vessel, the following are additional recommended inspections that should be conducted to ensure vessel integrity and safety

a. Conduct annual visual and dimensional vessel inspections with liquid penetrant examination of maximum stressed areas to ensure that the surfaces are free of defects. Conduct ultrasonic examination of the vessel after every 25% of the design cycle life or every five years, whichever comes first, to detect subsurface cracks. Special attention Should be given to the roots of threads and closures using threaded head retention construction. Other geometric discontinuities that are inherent in the design or irregularities resulting from localized corrosion, erosion, or mechanical damage should be carefully examined. This is particularly important for units of monoblock construction.

b. The closure mechanism of the vessel end-closure is opened and closed frequently during operation. It should be closely inspected for freedom of movement and proper contact with its locking elements. Wire wound vessels must have yoke-type closures so the yoke frame will need to be closely inspected on a regular basis

c. Should pitting, cracks, corrosion, or other defects are found during scheduled inspection; verify that an evaluation using fracture mechanics techniques is performed. This is to determine MAWP, cyclic life and extent of NDE frequency based on crack growth rate.

(2) Gages, Safety Devices, and Controls

a. Verify that the vessel is provided control and monitoring of the pressure, temperature, electrical system, fluid flow, liquid levels, and all variables that are essential for the safe operation of the system. If the vessel is automatically controlled, manual override should be available. Also, safety interlocks should be provided on the vessel closure to prevent vessel pressurization if the vessel closure is not complete and locked.

b. Verify that all safety device isolation valves are locked open if used.

c. Verify appropriate pressure relief device is installed with relief setpoint at low a pressure as possible, consistent with the normal operating pressure but in no case higher than the design operating pressure of the vessel. Rupture discs are normally considered more suitable for these types of applications since pressure relief devices operating at pressures above 14500 psi may tend to leak by their seat.

d. Verify that pressure and temperature of the vessel coolant and vessel wall is controlled and monitored. Interlock devices associated with these monitoring devices that will deenergize or depressurize the vessel are strongly recommended due to the potential significant damage that can be caused by release of energy in the event of overpressurization due to excess pressure or temperature in the vessel.

e. Verify audible and visual alarms are installed to indicate unsafe conditions.

I propose the following revisions to NBIC PART 2 paragraphs 5.2.1 (a) and 5.2.2 (a)

5.1 SCOPE

This Section provides guidelines and requirements for stamping and documentation (Forms) for inservice inspections of PRIs. This Section also describes evaluation of inspection results and assessment methodologies.

5.2 REPLACEMENT OF STAMPING OR NAMEPLATE

5.2.1 AUTHORIZATION

a) When the stamping on a pressure-retaining item becomes indistinct or the nameplate is lost, illegible, or detached, but traceability to the original pressure-retaining item is still possible, the Inspector shall instruct the Owner or user to have the nameplate or stamped data replaced. All re-stamping shall be done in accordance with the original code of construction, except as modified herein. Requests for permission to re-stamp or replace nameplates shall be made to the Jurisdiction in which the nameplate or stamping is reapplied. Application must be made on the Replacement of Stamped Data Form, NB-136 (see NBIC Part 2, ~~5.3.2~~ 5.4.2). Proof of traceability to the original nameplate or stamping and other such data, as is available, shall be furnished with the request. Permission from the Jurisdiction is not required for the reattachment of nameplates that are partially attached. When traceability cannot be established, the Jurisdiction shall be contacted. The completed Form NB- 136 (see ~~5.3.2~~ 5.4.2) shall be submitted to the National Board.

b) When there is no Jurisdiction, the traceability shall be accepted and the replacement of the nameplate or stamped data shall be authorized and witnessed by a National Board Commissioned Inspector. The completed Form NB-136 shall be submitted to the National Board.

5.2.2 REPLACEMENT OF NAMEPLATE OR STAMPED DATA

a) The re-stamping or replacement of data shall be witnessed by a National Board Commissioned Inspector.

b) The re-stamping or replacement of a code symbol stamp shall be performed only as permitted by the governing code of construction.

c) Replacement nameplates shall be clearly marked “replacement.”

5.2.3 REPORTING

Form NB-136 shall be filed with the Jurisdiction by the owner or user (if required) and The National Board by the “R” Stamp Holder bearing a facsimile of the replacement stamping or nameplate, as applied, and shall also bear the signature of the “R” Stamp holder that performed the replacement and the National Board Commissioned Inspector who authorized and witnessed the replacement.

5.3 REPLACEMENT OF DUPLICATE NAMEPLATES

a) Permission from the Jurisdiction is not required for the replacement of a manufacturer's duplicate nameplate.

b) When traceability to the original pressure-retaining item is still possible and a manufacturer's duplicate nameplate is replaced it shall be provided by the original manufacturer or the manufacturer's successor and may include the code symbol stamp, witnessing of the nameplate attachment by a Commissioned Inspector is not required.

5.4 NATIONAL BOARD INSPECTION FORMS

5.4.1 SCOPE

The following forms (~~5.3.2~~ 5.4.2 through ~~5.3.7.1~~ 5.4.7.1) may be used for documenting specific requirements as indicated on the top of each form.

Note: Jurisdictions may have adopted other forms and may not accept these forms.

Action Item Request Form

8.3 CODE REVISIONS OR ADDITIONS

Request for Code revisions or additions shall provide the following:

a) Proposed Revisions or Additions

For revisions, identify the rules of the Code that require revision and submit a copy of the appropriate rules as they appear in the Code, marked up with the proposed revision. For additions, provide the recommended wording referenced to the existing Code rules.

Existing Text:

None

Circulator and thermic syphon neck to diaphragm welds are typically fillet welds and no guidance has been provided on the inspection of locomotive boiler fillet welds.

c) Background Information

Provide background information to support the revision or addition, including any data or changes in technology that form the basis for the request that will allow the Committee to adequately evaluate the proposed revision or addition. Sketches, tables, figures, and graphs should be submitted as appropriate.

When applicable, identify any pertinent paragraph in the Code that would be affected by

S1.4.2.18.1 CIRCULATOR & THERMIC SYPHON FILLET WELDS

1. The firebox shall be entered every 31 service days, Annual, and 1472 service day inspection to inspect circulator and syphon fillet welds.
2. All circulator and syphon fillet welds shall be visually inspected.
3. Welds showing evidence of cracking shall have the indication removed and repaired.
4. Where Visual Inspection (VT) indicates evidence of erosion or corrosion which reduces the installed size of the attaching fillet weld, the complete weld will be examined with a gauge set to indicate a weld size equivalent to the original equal leg fillet weld.
5. Any weld where more than one quarter (1/4) of its circumference is less than a 1/4” equal leg dimension will be restored to its original installed dimension.

SYPHON AND CIRCULATOR FILLET WELDS – Dave Griner

Syphons and circulators used a flanged opening in the throat and side sheets to provide a point of attachment. The flanged piece was designed to deal with the geometry of the syphons and circulators regarding expansion, the "neck" was inserted into the flanged opening, then attached via fillet weld. In some instances the neck was flared on the water side, but drawings can be seen where the "neck" was not flared, relying on the strength of the fillet weld alone.

Our point of discussion is the strength of this fillet weld in this application.

There were many hundreds of these applied to locomotives and it should be noted that an historical review of these appliances does not document failures at this point of attachment. However, there is ample evidence of cracking at the upper corners where attached to the crown sheet with other joint design. Also there have been observations of cracking in the flared section of the attachment, beyond the fillet weld. All of this suggests that the fillet weld application in this area endures the stresses in excess of other aspects of installation.

To evaluate the fillet weld strength, we will again use the American Welding Society (AWS) data as noted in the volume "The Procedure Handbook of Arc Welding", 14th Edition, 2000, published by The James F. Lincoln Arc Welding Foundation. Specifically, Section 2.3-1, Allowables for Welds.

Using the AWS values more closely shows loads allowed at the time, in contrast to those developed later by the ASME, where additional penalties are introduced in excess of the 30% noted in the AWS equation. That equation is:

$f = 0.707 \times w \times t$,
where;
f = Allowable Unit Force on Fillet Weld kips / linear inch
0.707 = For equal leg fillet welds the effective throat equals 0.707 x leg size.
w = Leg Size
t = 0.30 times Electrode Minimum Tensile Strength (penalty)

Table 2-8 delineates allowable loads as calculated by this equation for various weld sizes and weld metal strength levels.

Using this information along with dimensions typically used in the construction of the syphons and circulators we will evaluate the applicable welds.

Using a neck outside diameter of 5.5" and a wall thickness of 0.437, we find the weld circumference to be 17.279". Assuming an equal leg weld of 0.437, using E6010 electrodes, Table 2-8 provides a value of 5,570 psi per linear inch of weld. In this instance the total allowable load is 96,242.691 lbs (48.121 tons).

If the design load is taken as a pressure of 200 psi, pushing on the area of 5.5" diameter, we develop 4,751.67 lbs. Taken to a factor of safety of 4 this load then becomes 19,006.68 lbs. In addition we must consider the loads imposed by expansion, which are beyond this writer's abilities. However, we can arbitrarily apply a loading of 30,000 lbs. Which develops a total loading of 49,006.68 lbs.

Using this value compared to the allowable limit of the weld we have an excess of strength of 1.96 to 1.

It appears that the fillet weld provides a more than adequate attachment method, and historically has proven as such.

It should be noted that the same weld designed under ASME criteria would not provide the same excess strength for the 0.437 leg size. If higher strength is required it will only come with the addition of weld metal, which in this instance would be considered detrimental.

Subgroup Locomotives

National Board Item Number: NB14-1801

Current Level: Subgroup discussion

NBIC Part 3 Paragraph(s): S1.2.9.7 Title: Ferrules (Figure S1.2.9.7)

Date: Opened: January 2014

Background:
Committee generated to correct errors in existing text, add additional information to the document and add a new figure to the document.

Original Text
S1.2.9.7 FERRULES

a) Ferrous or non-ferrous ferrules may be used on either or both ends of flues and arch tubes.

b) If ferrules are recessed the recessed depth shall not exceed 1/16" measured from the flue sheet fireside edge.

c) Protrusion of the ferrule beyond the edges of either flue sheet is permitted provided the ferrule does not interfere with any further attachment procedures.

d) For steel ferrules, if the flue is installed by expanding it straight and seal welding it to the flue sheet, the seal weld shall be arranged to contact the flue sheet and the flue. Seal welding the flue to the ferrule only is prohibited.

e) The application of ferrules where none were used before shall be considered a repair.

f) The application without ferrules, where none were used before shall be considered a repair. *(Note to group: This item reads incorrectly)*

Proposed Text & Changes
S1.2.9.7 FERRULES (SEE NBIC PART 3, FIGURE S1.2.9.7)

a) Ferrous or non-ferrous ferrules may be ~~used~~ installed into tube sheet or firebox sheet holes on either or both ends of flues and arch tubes. ~~by installing the ferrules into tube sheet or firebox sheet holes as required.~~

b) If the ferrule width is to be made wider than the tube sheet hole width in order to enable the ferrule to be flared outward (belled) on the sheet water side, the additional width of the ferrule shall should not exceed 1/4" (0.250" & 6.4 mm) unless the original design requires a different dimension. be used.

c) Each ferrule shall should be secured into position in the sheet hole by expanding the ferrule prior to insertion of the flue or arch tube unless the original design requires a different ferrule installation method. be used. When required by the original design the ferrule in addition to being expanded into the hole, may be flared outward (belled) on the tube sheet waterside to aid sealing and to aid guiding the flue and arch tube into the hole during installation. The ferrule expansion shall should be performed using a roller type expander or a prosser-type expander. If the prosser-type expander it shall should be either the combination roller-prosser design or the segmented pin design.

d) c) Protrusion of the installed ferrule beyond the either edges of either tube flue sheet is permitted provided the ferrule does not interfere with the further flue and arch tube installation, expansion and attachment procedures. These procedures include beading and seal welding the flues and arch tubes to the tube sheet.

e) b) If ferrules are to be recessed within the tube sheet holes, the recess depth shall should not exceed 1/16" (0.0625" & 1.59 mm) measured from the tube flue sheet fireside edge.

d) For steel ferrules, if the flue is installed by expanding it straight and seal welding it to the flue sheet, the seal weld shall be arranged to contact the flue sheet and the flue. Seal welding the flue to the ferrule only is prohibited. (*Note to Group: This topic has been moved to a separate document for Boiler Tube Installation.)*

f) f) The deletion of ferrules application without ferrules, where none where these were used before is considered to be a repair.

g) e) The application of ferrous ferrules where none were used before is considered to be a repair.

h) The application of non-ferrous ferrules where none were used before is considered to be an alteration unless provision is made to account for or control galvanic corrosion between the non-ferrous ferrule and the ferrous flue, arch tube and tube sheet. If this provision is made, the substitution is considered to be a repair.

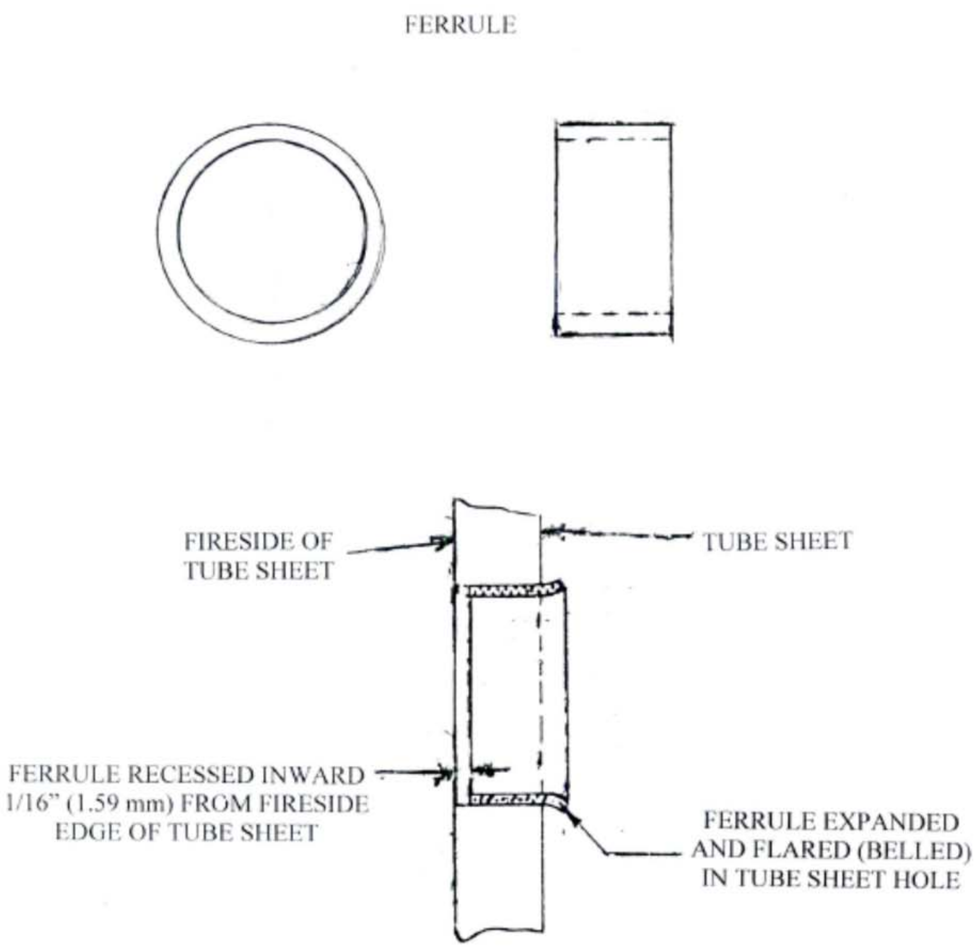
i) The substitution of non-ferrous ferrules for ferrous ferrules and the application of of non-ferrous ferrules where none were used before is considered to be an alteration unless provision is made to account for or control galvanic corrosion between the non-ferrous ferrule and the ferrous flue, arch tube and tube sheet. If this provision is made, the substitution is considered to be a repair.

~~j) The substitution of non-ferrous ferrules for ferrous ferrules is considered to be an alteration unless provision is made to account for or control galvanic corrosion between the non-ferrous ferrule and the ferrous flue, arch tube and tube sheet. If this provision is made, the substitution is considered to be a repair.~~

New Figure S1.2.9.7 is attached and is to be included as part of this action.

FERRULE FOR BOILER FLUES

Figure S1.2.9.7



Subgroup Locomotives

National Board Item Number: **14-1802**

Current Level: Subgroup discussion

NBIC Part 3 Figure S1.2.2-b Title: Riveted Staybolt Head Dimensions & Figure S1.2.2-c Title: Threaded Staybolt Inspection

Location: S1.2.2 Threaded Staybolts

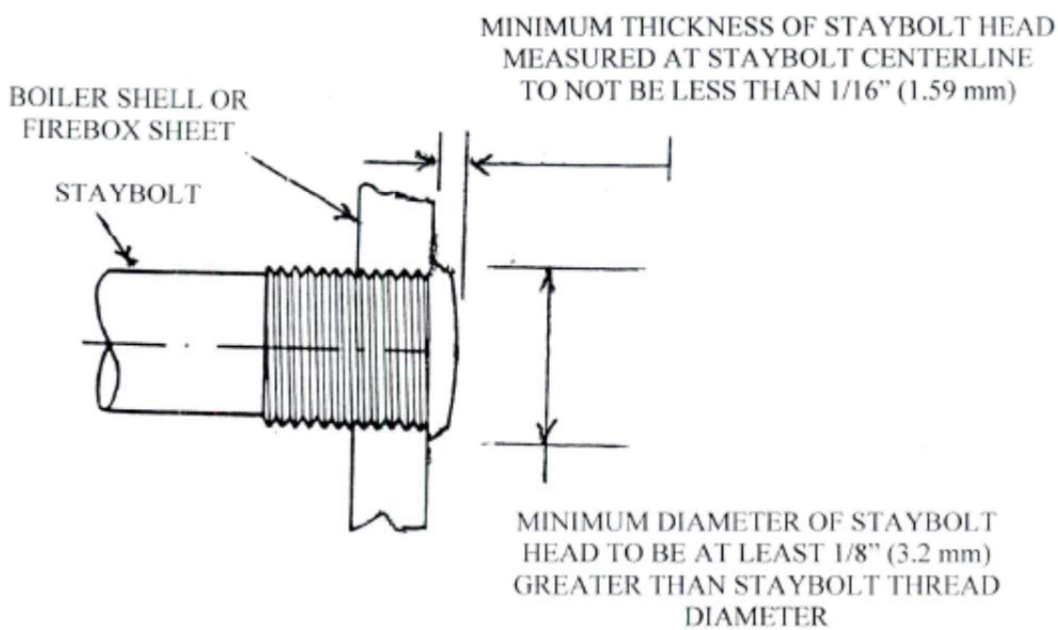
Date: Opened: February 2014

Background:
Committee generated to correct problems reported by NBIC users understanding Figure S1.2.2-b "Riveted Staybolt Head Dimensions" and to add new Figure S1.2.2-c "Threaded Staybolt Inspection" to section S1.2.2 Threaded Staybolts.

Attachment of Figures S1.2.2-b & S1.2.2-c

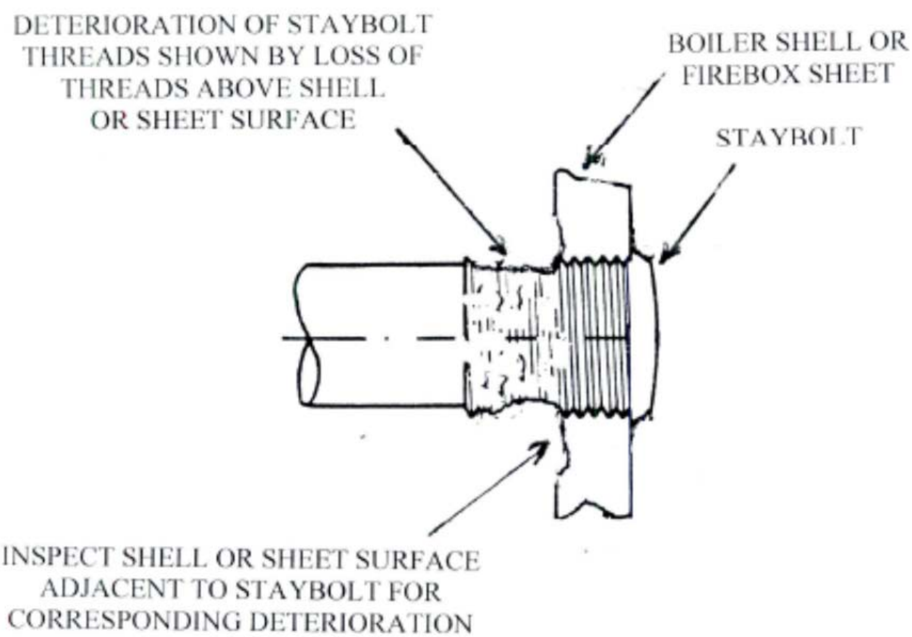
RIVETED STAYBOLT HEAD DIMENSIONS

Figure S1.2.2-b



THREADED STAYBOLT INSPECTION

Figure S1.2.2-c



NB15-0201 review wording in Part 2 on Pitting

3.3.1 MACROSCOPIC CORROSION ENVIRONMENTS

Macroscopic corrosion types are among the most prevalent conditions found in pressure-retaining items causing deterioration. The following corrosion types are found.

e) Pitting Corrosion

Pitting corrosion is the formation of holes in an otherwise relatively unattacked surface. Pitting is usually a slow process causing isolated, scattered pits over a small area that does not substantially weaken the vessel. It could, however, eventually cause leakage.

4.4.7.2 METHOD FOR ESTIMATING INSPECTION INTERVALS FOR EXPOSURE TO CORROSION

NB13-0701 4.4.4.7.2(J)(1)

Wording in 2015 NBIC

j) Local Metal Loss

Corrosion pitting shall be evaluated in accordance with NBIC Part 2, 4.4.8.7. Widely scattered corrosion pits may be left in the pressure-retaining item in accordance with the following requirements:

1) Their depth is not more than one-half the required thickness of the pressure-retaining item wall (exclusive of corrosion allowance).

of corrosion allowance);

2) the total area of the pits does not exceed 7 sq. in. (4500 sq mm) within any 50 sq. inches (32000 sq. mm); and

3) the sum of their dimensions (depth and width) along any straight line within this area does not exceed 2 in. (50 mm).

4.4.8.7 EVALUATING PRESSURE·RETAINING ITEMS CONTAINING LOCAL THIN AREAS

a) Local thin areas can resuit from corrosion/erosion, mechanical damage, or blend/grind techniques during fabrication or repair, and may occur internally or externally. Types of local thin areas are grooves, gouges, and pitting. When evaluating these types of flaws, the following should be considered:

d) Required measurements for evaluation of local thin areas shall include:
1) Thickness profiles within the local region;
2) Flaw dimensions;
3) Flaw to major structural discontinuity spacing;
4) Vessel geometry;
5) Material properties.
e) Required measurements for evaluation of pitting corrosion shall include:
1) Depth of the pit;
2) Diameter of the pit;
3) Shape of the pit;
4) Uniformity.
f) If metal loss is less than specified corrosion/erosion allowance and adequate thickness is available for future corrosion, then monitoring techniques should be established. If metal loss is greater than specified corrosion/erosion allowance and repairs are not performed, a detailed engineering evaluation shall be performed to ensure continued safe operation.
g) Techniques for evaluating local thin areas and pitting are referenced in applicable standards. See NBIC Part 2, 1.3.

?? NB13-0601 4.4.8 don't have this ballot item

SUPPLEMENT 7
INSPECTION OF PRESSURE VESSELS IN LIQUEFIED PETROLEUM GAS (LPG) SERVICE NBIC 2015 Edition

S7.8.5 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 25% the required thickness of the container wall;
2) The total area of the pits does not exceed 7 sq. in. (4500 sq. mm) within any 8 in. (200 mm) diameter circle; and
3) The sum of their dimensions along any straight line within this circle does not exceed 2 in. (50 mm).
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. (500 mm). 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 that 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 removed from service.
Copy`

NB15-0204

PROPOSED CHANGES – NBIC Part 2, SECTION 5 5.2 – 5.3.1

5.2 REPLACEMENT OF STAMPING OR NAMEPLATE ~~DURING INSERVICE INSPECTION~~

5.2.1 AUTHORIZATION

a) When the stamping on a pressure-retaining item becomes indistinct or the nameplate is lost, illegible, or detached, but traceability to the original pressure-retaining item is still possible, the Inspector shall instruct the owner or user to have the nameplate or stamped data replaced by an R Stamp Certificate Holder. All re-stamping shall be done in accordance with the original code of construction, except as modified herein. Requests for permission to re-stamp or replace nameplates shall be made to the Jurisdiction in which the ~~pressure retaining item is installed.~~ nameplate or stamping is re- applied. Application must be made on the Replacement of Stamped Data Form, NB-136 (see 5.3.2). Proof of traceability to the original nameplate or stamping, and other such data, as is available, shall be furnished with the request. Permission from the Jurisdiction is not required for the reattachment of nameplates that are partially attached, provided the nameplate belongs to that pressure-retaining item. When traceability cannot be established, the Jurisdiction shall be contacted for approval prior to replacing a nameplate or re-applying a stamping. The completed Form NB-136 (see 5.3.2) shall be submitted to the National Board. The owner or user shall retain all documentation of traceability and the completed NB-136 for as long as the pressure-retaining item is in their ownership or use. If the pressure-retaining item is sold, the NB-136 will be provided to the new owner. In order to avoid improper application of a nameplate or stamping, if the original manufacturer of the pressure-retaining item is available, they shall be included in the approval process prior to replacing a nameplate or re-applying a stamping.

b) When there is no Jurisdiction, and the proof of ~~the~~ traceability ~~shall be accepted~~ is acceptable, then ~~and~~ the replacement of the nameplate or stamped data shall be authorized and witnessed by a National Board Commissioned Inspector. ~~and t~~The completed Form NB-136 (see 5.3.2) shall be submitted to the National Board.

5.2.2 REPLACEMENT OF NAMEPLATE OR STAMPED DATA

a) The re-stamping or replacement of data shall be witnessed by a National Board Commissioned Inspector. ~~and shall be identical to the original stamping.~~

b) The Re-stamping or replacement of a code symbol stamp shall be performed only as permitted by the governing code of construction.

c) Replacement nameplates shall be clearly marked “replacement”.

5.2.3 REPORTING

Form NB-136 shall be filed with the Jurisdiction by the owner or user (if required) ~~or~~ and ~~t~~The National Board by the "R" Stamp Holder ~~owner or user together with~~ bearing a facsimile of the replacement stamping or nameplate, as applied, and shall also bear the signature of the "R" Stamp holder that performed the replacement and the National Board Commissioned Inspector who authorized and witnessed the replacement.

5.3 NATIONAL BOARD INSPECTION FORMS

5.3.1 SCOPE

The following forms (5.3.2 through 5.3.7.1) may be used for documenting specific requirements as indicated on the top of each form.

Note: Jurisdictions may have adopted other forms and may not accept these forms.

National Board of Boiler and Pressure Vessel Inspectors
National Board Inspection Code
Submission of Public Review Comment
2015 Draft Edition

Comments Must be Received No Later Than: October 13, 2014

Instructions: If unable to submit electronically, please print this form and fax or mail. Print or type clearly.

Date: October 7, 2014

Commenter Name: Nathan Carter

Commenter Address: HSB Global Standards, One State Street, PO Box 299
Hartford, CT 06141-0299

Commenter Phone: 860-722-5750

Commenter Fax:

Commenter Email: nathan_carter@hsbct.com

Section/Subsection Referenced: Part 2, S7.10 h)

Comment/Recommendation: *Proposed Solution:* ☐ New Text ☒ Revise Text ☐ Delete Text

Since a nameplate is required with a "R" stamp for the underground service change, was the requirement for an R-1/R-2 to be completed intentionally left off? Would it not be prudent for an Inspector to verify that the seal welding or flush patch welds comply at least visually comply with code? A "R" Certificate Holder is already required. Why not include an Inspector to verify the weld is acceptable and require a signed R-1/R-2 form, which is to be filed with the NB. There is a risk to life/property if a seal weld or flush patch on a LPG storage vessel is not completed in accordance with code requirements. Paragraph e) also introduces additional welding, which should be verified.

Also please consider a new item for Part 3, which would refer the reader to this Supplement for a Change of Service.

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

NB Use Only

Commenter No. Issued: PR15-01

Comment No. Issued: 42

Project Committee Referred To: SC Inspection

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Commenter Fax:

Commenter Email: nathan_carter@hsbct.com

Section/Subsection Referenced: Part 2, S7.10 k)

Comment/Recommendation: *Proposed Solution:* ☐ New Text ☒ Revise Text ☐ Delete Text

Part k) is silent concerning qualified welders. I don't believe the intent is for unqualified welders to be seal welding or welding flush patches to close off unused connections (d)) as well as welding the nameplate, especially since a qualified WPS is required. Consider requiring that the welder be qualified as specified in NBIC Part 3 2.2.3. Also, Consider providing more guidance to "stamp holder using a qualified welding procedure" by pointing the reader to Part 3. Consider changing this to "stamp holder using a qualified WPS or SWPS as specified in NBIC Part 3 2.2.1 and 2.2.2 respectfully."

Source: ☒ Own Experience/Idea ☐ Other Source/Article/Code/Standard

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Commenter No. Issued: PR15-01

Comment No. Issued: 43

Project Committee Referred To: SC Inspection

NB15-0503

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Commenter Phone: 860-722-5750

Commenter Fax:

Commenter Email: nathan_carter@hsbct.com

Section/Subsection Referenced: Part 2, S11.6, S11.7, S11.9

Comment/Recommendation: *Proposed Solution:* ☐ New Text ☒ Revise Text ☐ Delete Text

The Term "Examination" is used throughout S11.6, S11.7, and S11.9. Was this intended to read "Inspection" instead, which is a duty of the Inspector?

S11.7. Should there be a Visual Acuity requirement?

Source: ☒ Own Experience/Idea ☐ Other Source/Article/Code/Standard

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NB Use Only

Commenter No. Issued: PR15-07

Project Committee Referred To: SC Inspection

Comment No. Issued: 04

NB15-0504

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Commenter Address: HSB Global Standards, One State Street, PO Box 299
Hartford, CT 06141-0299

Commenter Phone: 860-722-5750

Commenter Fax: ______

Commenter Email: nathan_carter@hsbct.com

Section/Subsection Referenced: Part 2, S11.10.2 another

Comment/Recommendation: *Proposed Solution:* ☐ New Text ☒ Revise Text ☐ Delete Text

S11.10 specifies very complex, details throughout. Would it not be prudent for the Examiner to prepare a written procedure capturing all of the requirements in S11.10 as well as addressing all of the requirements in ASME Section V, Article 11? Would it also be prudent to require this procedure to be demonstrated to the Inspector also or at a minimum require that the procedure be available for review by the Inspector during his/her inspection cycle?

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

NB Use Only

Commenter No. Issued: PR15-07 | Project Committee Referred To:

Comment No. Issued: 01 | SC Inspection

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Commenter Address: HSB Global Standards, One State Street, PO Box 299
Hartford, CT 06141-0299

Commenter Phone: 860-722-5750

Commenter Fax:

Commenter Email: nathan_carter@hsbct.com

Section/Subsection Referenced: Part 2, S11.10.2 and S11.10.6

Comment/Recommendation: *Proposed Solution:* ☐ New Text ☒ Revise Text ☐ Delete Text

The Title "Test Procedure" is used in both Sections S11.10.2 and S11.10.6 under S11.10 Acoustic Emission Examination. Was it the intent to have "Test Procedure" listed twice for Acoustic Emission. If not, suggest that these two paragraphs be consolidated. The latter is more detailed than the former.

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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Commenter No. Issued: PR15-07

Comment No. Issued: 02

Project Committee Referred To: SC Inspection

NB15-0504

National Board of Boiler and Pressure Vessel Inspectors
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Hartford, CT 06141-0299

Commenter Phone: 860-722-5750

Commenter Fax: ______

Commenter Email: nathan_carter@hsbct.com

Section/Subsection Referenced: Part 2, S11.10.3

Comment/Recommendation: *Proposed Solution:* ☐ New Text ☒ Revise Text ☐ Delete Text

Which Edition of SNT-TC-1A and CP-189? Is any acceptable that addresses Acoustic Emission Examination?

Last Sentence. How is the training and experience quantified? To whose satisfaction? How is this training and experience documented? I assume that the intent is that considerable training and experience be performed and not a 5 minute training session and one examination interval be performed. Without quantifying this, what is there to prevent this from occurring?

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

NB Use Only

Commenter No. Issued: PR15-07

Comment No. Issued: 03

Project Committee Referred To: SC Inspection

2.3.6.8 INSPECTION OF PRESSURE VESSELS FOR HUMAN OCCUPANCY (PVHO's)

A pressure vessel for human occupancy (PVHO), as defined by ASME PVHO-1 is a pressure vessel that encloses a human being or animal within its pressure boundary while it is subject to internal or external pressure that exceeds a 2 psi (14 kPa) differential pressure. PVHOs include, but are not limited to submersibles, diving bells, personal transfer capsules, decompression chambers, recompression chambers, hyperbaric chambers, high altitude chambers and medical hyperbaric oxygenation facilities.

This section provides guidelines for inspection of PVHOs. Due to the many different designs and applications of PVHOs, potential failures of components or safety concerns that are not specifically covered, such as rapid decompression or fire/sparking issues should be considered.

a) General/operational

1) PVHOs ~~must~~ should be constructed in accordance with ASME PVHO-1 ~~and PVHO-2~~. This codes adopts Section VIII and therefore the vessels should bear a "U" or "U2" ASME designator. Inspections may be conducted using ASME PVHO-2 for reference.

2) Cast and ductile iron fittings are not allowed.

3) Due to the human occupancy element, a person should be in attendance to monitor the PVHO when in operation, in the event there is an accident.

4) The installation should be such that there is adequate clearance to inspect it properly. In some applications, such as underground tunneling, it may be impossible to perform a complete external inspection.

b) Internal Inspection

1) Where existing openings permit, perform a visual internal inspection of the vessel. Look for any cracks 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.

2) The vessel should be free of corrosion, damage, dents, gouges or other damage.

3) All openings leading to external fittings or controls should be free from obstruction.

4) All exhaust inlets should be checked to prevent a chamber occupant from inadvertently blocking the opening.

c) External Inspection

1) The Inspector should closely examine the external condition of the pressure vessel for corrosion, damage, dents, gouges or other damage.

2) The lower 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.

5) 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 vessel's insulated surfaces should be conducted once per year.

6) The most common and superior method to inspect for suspected corrosion under insulation (CUI) damage 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).

7) 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.

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

d) Inspection of Parts and Appurtenances (piping systems, pressure gage, bottom drain)

1) As stated above, cast iron is not allowed on PVHO's and shall be replaced with parts fabricated with other suitable materials, in accordance with ASME Code Section II.

2) If valves or fittings are in place, check to ensure that these are complete and functional.

3) The Inspector 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.

4) The Inspector shall verify that the vessel is provided with a drain opening.

5) The system should have a pressure gage designed for at least the most severe condition of coincident pressure in normal operation. This gage should be clearly visible to the person adjusting the setting of the pressure control valve. The graduation on the pressure gauge shall be graduated to not less than 1.5 times the MAWP of the vessel.
6) Provisions should be made to calibrate pressure gages or to have them checked against a standard test gage.
7) Any vents and exhausts should be piped at least 10 feet from any air intake.
8) Venting should be provided at all high points of the piping system.

e) Inspection of Viewports / Windows

1) Each window should be individually identified and be marked in accordance with PVHO-1
2) If there are any penetrations through windows, they must be circular.
3) Windows must be free of crazing, cracks and scratches.
4) Windows and viewports have a maximum interval for seat/seal inspection and refurbishment. Documentation should be checked to ensure compliance with PVHO-2, Table 7.1.3.

f) Inspection of Pressure Relief Devices

1) Pressure relief devices must have a quick opening manual shutoff valve installed between the chamber and the pressure relief device, with a frangible seal in place, within easy access to the operator.
2) The pressure relief device shall be constructed in accordance with ASME Code Section VIII.

3) The discharge from the pressure relief device must be piped outside to a safe point of discharge.
4) Rupture disks may be used only if they are in series with a pressure relief valve, or when there is less than 2 cubic feet of water volume.
5) Verify that the safety valve is periodically tested either manually by raising the disk from the seat or by removing and testing the valve on a test stand.

g) Acceptance Criteria
The following forms are required to be completed:
1) Form PVHO-1 Manufacturer's Data Report for Pressure Vessels for Human Occupancy
2) Form PVHO-2 Fabrication Certification for Acrylic Windows

h) All PVHO's under the jurisdiction of the U.S. Coast Guard must also comply with 46 CFR Part 197.

NB15-0801 & NB15-0901 – Part 2, S10
(PM) Mooney, Newton, Welch, Barker

Commenter Name: **Kenneth A. Stoller - American Insurance Association (AIA)**

Commenter Address: **2101 L Street NW, Suite 400**

Washington, DC 20037

Commenter Phone: **202-828-7167**

Commenter Fax: **202-495-7866**

Commenter Email: **kstoller@aiadc.org**

Section/Subsection Referenced: **Supplement 10, Inspection of Liquid Carbon Dioxide Storage Vessels**

Comment/Recommendation: *Proposed Solution:* ☐ New Text ☒ Revise Text ☒ Delete Text

AIA believes that several aspects of the proposed requirements are either undefined or otherwise beyond the normal scope and training of National Board Commissioned Inspectors. Imposing these requirements on Special Inspectors may also place them in the untenable position of assuming liability beyond the limits of the insurance policies under which they perform inspections. Items of concern include the failure to define the terms "sufficient clearance" (S10.2b), "safely supported" (S10.2d), "guarded (S10.2f); and "permanent" (S10.3a). We recommend either defining or deleting these terms. Furthermore, Commissioned Inspectors are not qualified to (i) determine whether a CO2 detector is set to alarm at any particular concentration (S10.5); (ii) verify the posting of warning signs and determine the setpoint of any alarms (S10.6); or (iii) determine the length of safety relief/vent lines or verify that the materials selected for valves, piping, tubing, hoses and fittings used in the LCDSV system meet certain requirements. We recommend deleting these sections.

SUPPLEMENT 10 INSPECTION OF LIQUID CARBON DIOXIDE STORAGE VESSELS

S10.1 SCOPE

This supplement provides ~~requirements~~ guidelines for the inspection of Liquid Carbon Dioxide Storage Vessels (LCDSVs),fill boxes, fill lines and pressure relief discharge/vent circuits used for carbonated beverage systems, swimming pool pH control systems and other fill in place systems storing liquid CO_2.

S10.2 GENERAL REQUIREMENTS (ENCLOSED AND UNENCLOSED AREAS)

The ~~Inspector~~ inspection ~~shall~~ should verify that LCDSVs are:

a) ~~are~~ not ~~be~~ located within 10 feet (3050 mm) of elevators, unprotected platform ledges or other areas where falling would result in dropping distances exceeding half the container height;

b) ~~are~~ installed with ~~sufficient~~ clearance for filling, operation, maintenance, inspection and replacement;

c) ~~are~~ not ~~installed~~ located on roofs;

d) ~~are safely~~ supported ~~as~~ to prevent the vessel from tipping or falling and meet seismic requirements as needed.;

e) ~~are~~ not located within 36 in. (915 mm) of electrical panels; and

f) located outdoors in areas in the vicinity of vehicular traffic are protected with barriers designed to ~~guarded to~~ prevent accidental impact by vehicles.

S10.3 ENCLOSED AREA LCDSV INSTALLATIONS

The ~~Inspector~~ inspection ~~shall~~ should verify that:

a) ~~Permanent~~ LCDSV installations that are not periodically removed with remote fill connections:

1) Are equipped with a gas detection system installed in accordance with NBIC Part 2, S10.5
2) Have signage posted in accordance with NBIC Part 2, S10.6
3) Are equipped with fill boxes; fill lines and safety relief/vent valve circuits installed in accordance with NBIC Part 2, S10.4.

b) Portable LCDSV installations with no permanent remote fill connection:

Warning: LCDSVs shall not be filled indoors or in enclosed areas under any circumstances. Tanks must always be moved to the outside to an unenclosed, free airflow area for filling.

1) Are equipped with a gas detection system installed in accordance with NBIC Part 2, S10.5**;**
2) Have signage posted in accordance with NBIC Part 2, S10.6.
3) Have a safety relief/vent valve circuit connected at all times except when the tank is being removed for filling. Connections may be fitted with quick disconnect fittings meeting the requirements of NBIC Part 2, S10.4.
4) Are provided with a pathway that provides a smooth rolling surface to the outdoor, unenclosed fill area. There shall not be any stairs or other than minimal inclines in the pathway.

S10.4 FILL BOX LOCATION /SAFETY RELIEF/VENT VALVE CIRCUIT TERMINATION

The ~~Inspector~~ inspection ~~shall~~ should verify that fill boxes and/or vent valve terminations are installed above grade, outdoors in an unenclosed, free airflow area, and that the fill connection is located so not to impede means of egress or the operation of sidewalk cellar entrance doors, including during the delivery process and that they are:

a) At least three (3) feet (915 mm) from any door or operable windows;*

b) At least three (3) feet (915 mm) above grade;*

c) Not located within ten (10) feet (3050 mm) from side to side at the same level or below, from any air intakes;*

d) Not located within ten (10) feet (3050 mm) from stair wells that go below grade.*

* Note: Many systems installed prior to 1/1/2014 do not meet the above requirements and the local Jurisdiction should be consulted for guidance.

S10.5 GAS DETECTION SYSTEMS

Rooms or areas where carbon dioxide storage vessel(s) are located indoors or in enclosed or below grade outdoor locations shall be provided with a gas detection and alarm system for general area monitoring that is capable of detecting and notifying building occupants of a CO_2 gas release. Alarms will be designed to activate a low level pre-alarm at 1.5% concentration of CO_2 and a full high alarm at 3% concentration of CO_2 which is the NIOSH & ACGIH 15 minute Short Term Exposure Limit for CO_2. These systems are not designed for employee personal exposure monitoring. Gas detection systems shall be installed and tested in accordance with manufactures installation instructions and the following requirements:

a) The ~~Inspector~~ inspection ~~shall~~ should verify that the gas detection system and audible alarm is operational and tested in accordance with manufacturer's guidelines.

b) The ~~Inspector~~ inspection ~~shall~~ should verify that audible alarms are placed at the entrance(s) to the room or area where the carbon dioxide storage vessel and/ or fill box is located to notify anyone who might try to enter the area of a potential problem.

S10.6 SIGNAGE

The ~~Inspector~~ inspection ~~shall~~ should verify that warning signs are posted at the entrance to the building, room, enclosure, or enclosed area where the container is located. The warning sign shall be at least 8 in (200mm) wide and 6 in. (150mm) high. The wording shall be concise and easy to read and the upper portion of the sign must be orange as shown in figure NBIC Part 2, Figure S10.6. The size of the lettering must be as large as possible for the intended viewing distance and in accordance with jurisdictional requirements. When no jurisdictional requirements exist, the minimum letter height shall be in accordance with NEMA American National Standard for Environmental and Facility Safety Signs (ANSI Z535.2). The warning signs shall be as shown in figure S10.6.

Figure S10.6

Additional instructional signage shall be posted outside of the area where the container is located and such signage shall contain at minimum the following information:

a) Carbon dioxide monitors for general area monitoring (not employee personal exposure monitoring) are provided in
this area. These monitors are set to alarm at 5,000 ppm(1.5% concentration) for the low level alarm and at 30,000 ppm (3% concentration) for high level alarm.

b) Low Level Alarm (5,000 ppm) – Provide appropriate cross ventilation to the area. Personnel may enter area for short periods of time (not to exceed 15 minutes at a time) in order to identify and repair potential leaks.

c) High Level Alarm (30,000 ppm) – Personnel should evacuate the area and nobody should enter the affected area without proper self-contained breathing apparatus until the area is adequately ventilated and the concentration of CO_2 is reduced below the high alarm limit.

S10.7 VALVES, PIPING, TUBING AND FITTINGS

a) Materials – The ~~Inspector~~ inspection should ~~shall~~ verify that the materials selected for valves, piping, tubing, hoses and fittings used in the LCDSV system meet following requirements:

1) Components shall be rated for the operational temperatures and pressures encountered in the applicable circuit of the system.

2) All valves and fittings used on the LCDSV shall be rated for the maximum allowable working pressure(MAWP) stamped on the tank.

3) All piping, hoses and tubing used in the LCDSV system shall be rated for the working pressure of the applicable circuit in the system and have a burst pressure rating of at least four times the MAWP of the piping, hose or tubing.

b) Relief Valves – The ~~Inspector shall~~inspection should verify that each LCDSV shall have at least one ASME/NB stamped & certified relief valve with a pressure setting at or below the MAWP of the tank. The relief valve shall be suitable for the temperatures and flows experienced during relief valve operation. The minimum relief valve capacity shall be designated by the manufacturer. Additional relief valves that do not require ASME stamps may be added per Compressed Gas Association pamphlet, CGA S-1.3 Pressure Relief Device Standards Part 3, Stationary Storage Containers for Compressed Gases, recommendations. Discharge lines from the relief valves shall be sized in accordance with NBIC Part 2, Tables S10-a and S10-b.

Note: Due to the design of the LCDSV the discharge line may be smaller in diameter than the relief valve outlet size.
Caution: Company's and or individuals filling or refilling LCDSV's shall be responsible for utilizing fill equipment that is acceptable to the manufacturer to prevent over pressurization of the vessel.

c) Isolation Valves – The ~~Inspector shall~~inspection should verify that each LCDSV shall have an isolation valve installed on the fill line and tank discharge, or gas supply line in accordance with the following requirements:

1) Isolation valves shall be located on the tank or at an accessible point as near to the storage tank a possible.
2) All valves shall be designed or marked to indicate clearly whether they are open or closed.
3) All valves shall be capable of being locked or tagged in the closed position for servicing.
4) Gas supply and liquid CO_2 fill valves shall be clearly marked for easy identification.

d) Safety Relief/Vent Lines – The ~~Inspector~~inspection, where possible, ~~shall~~ should verify the integrity of the pressure relief/vent line from the pressure relief valve to outside vent line discharge fitting. All connections shall be securely fastened to the LCDSV. The minimum size and length of the lines shall be in accordance with NBIC Part 2, Tables S2 10-a and S2 10-b. Fittings or other connections may result in a localized reduction in diameter have been factored into the lengths given by the NBIC Part 2, Tables S2 10-a and S2 10-b.

Table S10-a Minimum LCDSV System Pressure Relief/Vent Line Requirements (Metallic)

Tank Size
(Pounds)
Fire Flow Rate
Requirements
(Pounds per Minute)
Maximum Length of
3/8 inch ID Nominal
Metallic Tube Allowed
Maximum Length of 1/2
inch ID Nominal
Metallic Tube
Allowed
Less than 500 2.60 maximum 80 feet 100 feet
500-750 3.85 maximum 55 feet 100 feet
Over 750-1000 5.51 maximum 18 feet 100 feet

Table S10-b Minimum LCDSV System Pressure Relief/Vent Line Requirements (Plastic/Polymer)

Tank Size
(Pounds)
Fire Flow Rate
Requirements (Pounds
per Minute)
Maximum Length of
3/8 inch ID
Plastic/Polymer

Materials Tube Allowed
Maximum Length of ½
inch ID Plastic/Polymer
Materials
Tube Allowed
Less than 500 2.60 maximum 100 feet 100 feet
500-750 3.85 maximum 100 feet 100 feet
Over 750-1000 5.51 maximum N/A see ½ inch 100 feet

Table S10-a Metric Minimum LCDSV System Pressure Relief /Vent Line Requirements (Metallic)

Tank Size
(Kilograms)
Fire Flow Rate
Requirements
(Kilograms per Minute)
Maximum Length of
10mm ID Nominal
Metallic Tube Allowed
Maximum Length of
13mm ID Nominal
Metallic Tube Allowed
Less than 227 1.8 maximum 24 m 30.5 m
227-340 1.75 maximum 17 m 30.5 m
340-454 2.50 maximum 5.5 m 30.5 m

Table S10-b Metric Minimum LCDSV System Pressure Relief/Vent Line Requirements (Plastic/Polymer)

Tank size
(kg)
Fire Flow Rate (kg per
Minute)
Maximum Length of 10
mm ID Nominal Metallic
Tube Allowed
Maximum Length of 10
mm ID Plastic/Polymer
Materials Tube Allowed
Less than 227 1.18 maximum 30.5 m 30.5 m
227-340 1.75 maximum 30.5 m 30.5 m
Over 340-454 2.5 maximum N/A see 13 mm 30.5 m
Note: Due to the design of the LCDSV the discharge line may be smaller in diameter than the pressure relief valve outlet size but shall not be smaller than that shown in tables NBIC Part 2, S10-a and S10-b.

NB15-2302

FORM NB-6 BOILER-FIRED PRESSURE VESSEL
REPORT OF INSPECTION
Standard Form for Jurisdictions Operating Under the ASME Code

1	DATE INSPECTED MO | DAY | YEAR	CERT EXP DATE MO | YEAR	CERTIFICATE POSTED ☐ YES ☐ NO	OWNER NO.	JURISDICTION NUMBER	☐ NAT'L BD NO. ☐ OTHER NO.	
2	OWNER				NATURE OF BUSINESS	KIND OF INSPECTION ☐ INT ☐ EXT	CERTIFICATE INSPECTION ☐ YES ☐ NO
	OWNER'S STREET ADDRESS NUMBER				OWNER'S CITY	STATE	ZIP
3	USER'S NAME – OBJECT LOCATION				SPECIFIC LOCATION IN PLANT	OBJECT LOCATION - COUNTY	
	USER'S STREET ADDRESS NUMBER				OWNER'S CITY	STATE	ZIP
4	CERTIFICATE COMPANY NAME				CERTIFICATE COMPANY CONTACT NAME	EMAIL	
	CERTIFICATE COMPANY ADDRESS				CERTIFICATE COMPANY CITY	STATE	ZIP
5	TYPE ☐ FT ☐ WT ☐ CI ☐ OTHER ______			YEAR BUILT	MANUFACTURER		
6	USE ☐ POWER ☐ PROCESS ☐ STEAM HTG ☐ HWH ☐ HWS ☐ OTHER ______				FUEL	METHOD OF FIRING	PRESSURE GAGE TESTED ☐ YES ☐ NO
7	PRESSURE ALLOWED MAWP ______ THIS INSPECTION ______ PREV. INSPECTION ______			SAFETY-RELIEF VALVES SET AT ______ TOTAL CAPACITY ______		HEATING SURFACE OR BTU (INPUT/OUTPUT)	
8	IS CONDITION OF OBJECT SUCH THAT A CERTIFICATE MAY BE ISSUED? ☐ YES ☐ NO (IF NO, EXPLAIN FULLY UNDER CONDITIONS)					~~HYDRO TEST~~ Pressure Test ☐ YES ______ PSI DATE ______ ☐ NO	

9 CONDITIONS: With respect to the internal surface, describe and state location of any scale, oil or other deposits. Give location and extent of any corrosion and state whether active or inactive. State location and extent of any erosion, grooving, bulging, warping, cracking or similar condition. Report on any defective rivets, bowed, loose or broken stays. State condition of all tubes, tube ends, coils, nipples, etc. Describe any adverse conditions with respect to pressure gage, water column, gage glass, gage cocks, safety valves, etc. Report condition of setting, linings, baffles, supports, etc. Describe any major changes or repairs made since last inspection.

____

____

____

____

____

10 REQUIREMENTS: (LIST CODE VIOLATIONS)

____

____

____

____

11 NAME AND TITLE OF PERSON TO WHOM REQUIREMENTS WERE EXPLAINED:

I HEREBY CERTIFY THIS IS A TRUE REPORT OF MY INSPECTION	IDENT NO.	EMPLOYED BY	IDENT NO.
______ SIGNATURE OF INSPECTOR			

This form may be obtained from The National Board of Boiler and Pressure Vessel Inspectors, 1055 Crupper Ave., Columbus, OH 43229 NB-6 Rev. 6

FORM NB-7 PRESSURE VESSELS
REPORT OF INSPECTION
Standard Form for Jurisdictions Operating Under the ASME Code

1	DATE INSPECTED MO | DAY | YEAR	CERT EXP DATE MO | YEAR	CERTIFICATE POSTED ☐ YES ☐ NO	OWNER NO.	JURISDICTION NUMBER	☐ NAT'L BD NO. ☐ OTHER NO.
2	OWNER				NATURE OF BUSINESS	KIND OF INSPECTION ☐ INT ☐ EXT / CERTIFICATE INSPECTION ☐ YES ☐ NO
	OWNER'S STREET ADDRESS				OWNER'S CITY	STATE / ZIP
3	USER'S NAME - OBJECT LOCATION				SPECIFIC LOCATION IN PLANT	OBJECT LOCATION - COUNTY
	USER'S STREET ADDRESS				USER'S CITY	STATE / ZIP
4	CERTIFICATE COMPANY NAME				CERTIFICATE COMPANY CONTACT NAME	EMAIL
	CERTIFICATE COMPANY ADDRESS				CERTIFICATE COMPANY CITY	STATE / ZIP
5	TYPE ☐ AIR TANK ☐ WATER TANK ☐ OTHER ____			YEAR BUILT	MANUFACTURER	
6	USE ☐ STORAGE ☐ PROCESS ☐ HEAT EXCHANGE ☐ OTHER ____				SIZE	PRESSURE GAGE TESTED ☐ YES ☐ NO
7	PRESSURE ALLOWED THIS INSPECTION ____ PREVIOUS INSPECTION ____			SAFETY RELIEF VALVES SET AT ____ TOTAL CAPACITY ____		EXPLAIN IF PRESSURE CHANGED
8	IS CONDITION OF OBJECT SUCH THAT A CERTIFICATE MAY BE ISSUED? ☐ YES ☐ NO (IF NO EXPLAIN FULLY UNDER CONDITIONS)					~~HYDRO TEST~~ Pressure Test ☐ YES ____ PSI DATE ____ ☐ NO
9	CONDITIONS: With respect to the internal surface, describe and state location of any scale, oil or other deposits. Give location and extent of any corrosion and state whether active or inactive. State location and extent of any erosion, grooving, bulging, warping, cracking or similar condition. Report on any defective rivets, bowed, loose or broken stays. State condition of all tubes, tube ends, coils, nipples, etc. Describe any adverse conditions with respect to pressure gage, water column, gage glass, gage cocks, safety valves, etc. Report condition of setting, linings, baffles, supports, etc. Describe any major changes or repairs made since last inspection.					
10	REQUIREMENTS: (LIST CODE VIOLATIONS)					
11	NAME AND TITLE OF PERSON TO WHOM REQUIREMENTS WERE EXPLAINED:					
	I HEREBY CERTIFY THIS IS A TRUE REPORT OF MY INSPECTION ____ SIGNATURE OF INSPECTOR			IDENT NO.	EMPLOYED BY	IDENT NO.

This form may be obtained from The National Board of Boiler and Pressure Vessel Inspectors, 1055 Crupper Ave., Columbus, OH 43229

NB-7 Rev. 4

SECTION 5

parentheses. In Part 2, Supplement 6 and Part 3, Supplement 6 regarding DOT Transport Tanks, the metric units are shown first with the U.S. customary units shown in parentheses.

U.S. customary units or metric units may be used with this edition of the NBIC, but one system of units shall be used consistently throughout a repair or alteration of pressure-retaining items. It is the responsibility of National Board accredited repair organizations to ensure the appropriate units are used consistently throughout all phases of work. This includes materials, design, procedures, testing, documentation, and stamping. The NBIC policy for metrication is outlined in each part of the NBIC.

ACCREDITATION PROGRAMS

The National Board administers and accredits three specific repair programs[1] as shown below:

"**R**"……….Repairs and Alterations to Pressure-Retaining Items
"**VR**"……..Repairs to Pressure Relief Valves
"**NR**"……..Repair and Replacement Activities for Nuclear Items

Part 3, Repairs and Alterations, of the NBIC describes the administrative requirements for the accreditation of these repair organizations.

The National Board also administers and accredits four specific inspection agency programs as shown below:

New Construction
Criteria for Acceptance of Authorized Inspection Agencies for New Construction (NB-360)
Inservice
Qualifications and Duties for Authorized Inspection Agencies (AIAs) Performing Inservice Inspection Activities and Qualifications for Inspectors of Boilers and Pressure Vessels (NB-369)
Owner-User
Accreditation of Owner-User Inspection Organizations (OUIO) (NB-371) Owners or users may be accredited for both a repair and inspection program provided the requirements for each accreditation program are met.
Federal Government
Qualifications and Duties for Federal Inspection Agencies Performing Inservice Inspection Activities (FIAs) (NB-390)

These programs can be viewed on the National Board Website at www.nationalboard.org. For questions or further information regarding these programs contact the National Board by phone at (614) 888-8320 or by fax at (614) 847-1828

CERTIFICATES OF AUTHORIZATION FOR ACCREDITATION PROGRAMS

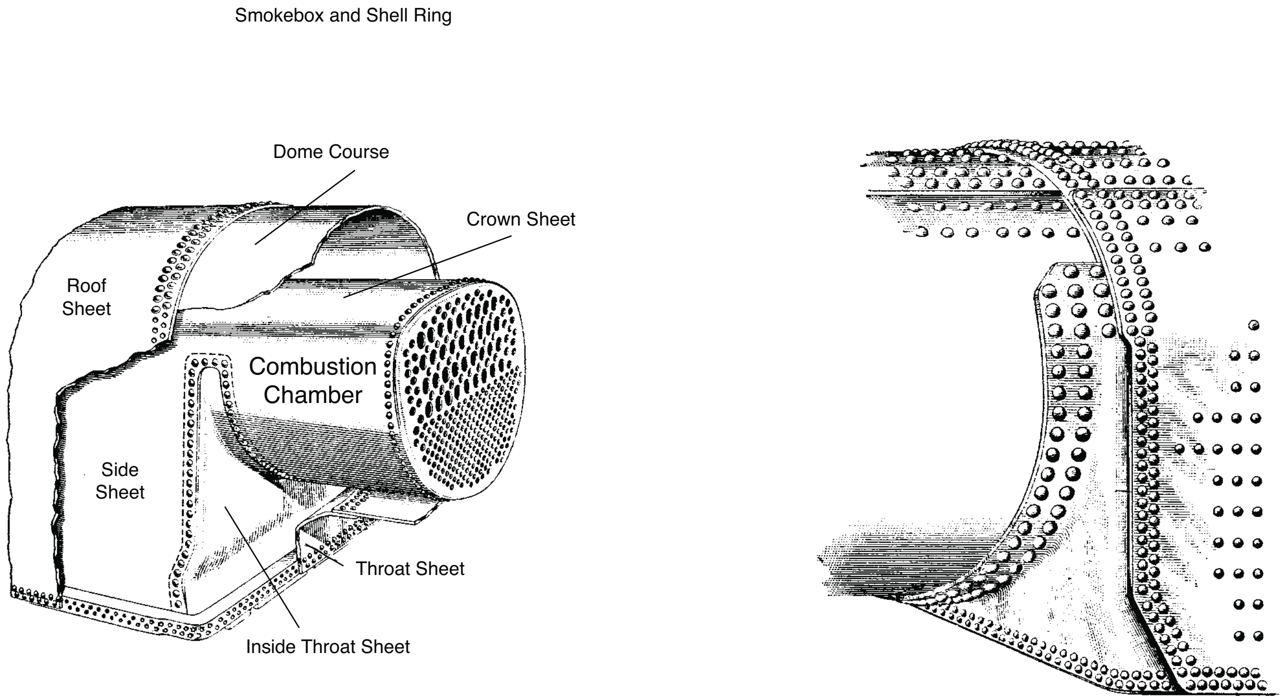
Any organization seeking an accredited program may apply to the National Board to obtain a Certificate of Authorization for the requested scope of activities. A confidential review shall be conducted to evaluate the organization's quality system. Upon completion of the evaluation, a recommendation will be made to the National Board regarding issuance of a Certificate of Authorization.

Certificate of Authorization scope, issuance, and revisions for National Board accreditation programs are specified in the applicable National Board procedures. When the quality system requirements of the appropriate accreditation program have been met, a Certificate of Authorization and appropriate National Board symbol stamp shall be issued.

1 Caution, some Jurisdictions may independently administer a program of authorization for organizations to perform repairs and alterations within that Jurisdiction.

FIGURE S1.1-b

ARRANGEMENT OF FIREBOX SHEETS (STAYBOLTS DELETED FOR CLARITY)



S1.2 SPECIAL JURISDICTIONAL REQUIREMENTS

Many Jurisdictions have special requirements for locomotive boilers. Such requirements shall be considered in addition to those in this supplement.

S1.3 FEDERAL RAILROAD ADMINISTRATION (FRA)

The FRA rules for steam locomotive boilers are published in the *Code of Federal Regulations* (CFR) 49CFR Part 230, dated November 17,1999.[2] All locomotives under FRA Jurisdiction are documented on FRA Form 4 as defined in 49CFR Part 230. This document is the formal documentation of the steam locomotive boiler and is required to be completed prior to the boiler being placed in service. This document shall be used as the data report for the boiler, applicable to all repairs and alterations performed. National Board "R" Certificate Holders shall document their repairs and/or alterations on National Board Forms R-1 or R-2. These reports shall be distributed to the owner or user of the boiler, who is required to incorporate them into the FRA Form 19, which becomes an attachment to the FRA Form 4. The design margin for all such repairs or alterations shall not be less than four, based on ultimate tensile strength of the material.

S1.4 LOCOMOTIVE FIRETUBE BOILER INSPECTION

S1.4.1 INSPECTION METHODS

a) Plate thickness and depth of corrosion may be determined by use of the ultrasonic thickness testing process.

2 Steam locomotive inspection and maintenance standards, which are now codified at 49CFR Part 230, may be obtained at the FRA Website.

acceptable for use. The use of malleable iron class 150 is not recommended. Forged threaded fittings per ASME B16.11 classes 2,000-6,000 are acceptable for use;

d) The blowdown line shall be piped to a safe point of discharge during the time the boiler is operating;

e) Piping shall be properly supported;

f) Valves shall be used in the manner for which they were designed, and shall be used within the specified pressure-temperature ratings. Valves shall be rated at or above the pressure setting of the boiler safety valve, denoted by the general or primary pressure class identification on the valve body and/or by the initials "WSP" or "S" to indicate working steam pressure or steam rating. Valves in cold-water service may be designated by the initials "WOG" to indicate water, oil, or gas rating and/or by the pressure class identification on the valve body; and

g) The boiler shall be equipped with two means of supplying feedwater while the boiler is under pressure.

S2.9.1 PIPING, FITTINGS, AND VALVE REPLACEMENTS

The installation date should be stamped or stenciled on the replaced boiler piping. Alternatively, the installation date may be documented in permanent boiler records, such as the operator log book.

S2.10 MAXIMUM ALLOWABLE WORKING PRESSURE (MAWP)

The MAWP of a boiler shall be determined by computing the strength of each boiler component. The computed strength of the weakest component using the factor of safety allowed by these rules shall determine the MAWP.

Note: The rules of ASME Section I 1971 Edition, Part "PR" and "PFT" may be used for determining specific requirements of design and construction of boilers and parts fabricated by riveting.[3]

S2.10.1 STRENGTH

a) In calculating the MAWP, when the tensile strength of the steel or wrought iron is known, that value shall be used. When the tensile strength of the steel or wrought iron is not known, the values to be used are 55,000 psi (379 MPa) for steel and 45,000 psi (310 MPa) for wrought iron. Original steel stamp marks, original material certifications, or current laboratory tests are acceptable sources for verification of tensile strength. Catalogs and advertising literature are not acceptable sources for tensile strength values.

b) In computing the ultimate strength of rivets in shear, the following values shall be used:

1) Iron rivets in single shear	38,000 psi (262 MPa)
2) Iron rivets in double shear	76,000 psi (524 MPa)
3) Steel rivets in single shear	44,000 psi (303 MPa)
4) Steel rivets in double shear	88,000 psi (607 MPa)

c) The resistance to crushing of mild steel shall be taken as 95,000 psi (655 MPa) unless otherwise known.

d) S = TS/FS. See definitions of nomenclature in NBIC Part 2,S2.10.6.

3 Copies of ASME Section I 1971 Edition Part "PR" and "PFT" referenced section may be obtained by contacting the National Board of Boiler and Pressure Vessel Inspectors, 1055 Crupper Ave., Columbus, OH 43229.

e) Remove gage glass and valves, and inspect these connections for lime deposits and clean if necessary. This should be done once a year; more often if conditions warrant it.

f) After inspection, replace glass (clean if necessary). Also inspect gage glass sealing washers and replace if necessary.

g) During cold weather, the historical boiler should be moved into a heated area and the boiler allowed to warm up in the air for several days until it is the same temperature as the air.

h) The initial fire-up should be done slowly to allow even heating of the boiler.

i) Before movement, the cylinder(s) should be warmed up by allowing a small quantity of steam to blow through them and out the cylinder cocks and exhaust passage(s). This is necessary to reduce the stress in the casting from thermal expansion of the metal.

j) Steam should be discharged through the cylinder cocks for several minutes to aid removal of any solvent, debris, or rust that may have formed in the steam pipes, cylinder, valve chest, and dry pipe.

k) All appliances should be tested under steam pressure before the historical boiler is moved or put under load.

S2.14 SAFETY PROCEDURES[4]

This chapter of text covers procedures in certain situations or emergencies that may occur.

S2.14.1 EXPERIENCE

a) Reading check lists and procedures can be of some value to get you thinking about what you are doing, but nothing can replace the experience gained by working beside conscientious and knowledgeable engineers. Ask questions, observe, read, listen, study, and think.

b) Safe operations depend upon thorough attention to detailed routines. Having procedures thought out, planned, and practiced before they are needed could minimize accidents and improve public safety. Know your abilities as well as the limitations of the machine that you are operating. In most cases knowing and keeping your machine in top operating condition can prevent most emergency situations from occurring. However, sometimes problems or situations beyond your control do occur. In any situation the first rule to remember is to keep a cool head. Haste and panic can never solve any emergency.

c) Don't be afraid to ask for help or advice. A lot of shows and public demonstrations have a designated individual in the area to ensure safe operation and assistance should a problem arise.

S2.14.2 STOPPING ENGINE IN AN EMERGENCY

a) Know how to stop the engine suddenly. For example, if someone or something runs out in front of the engine or some problem happens with whatever it is belted up to:

   1) Close throttle.

   2) Reverse valve quadrant position.

   3) Open throttle for a moment (this will quickly stop your engine).

   4) Close throttle.

SUPPLEMENT 5
INSPECTION OF YANKEE DRYERS (ROTATING CAST-IRON PRESSURE VESSELS) WITH FINISHED SHELL OUTER SURFACES

S5.1 SCOPE

a) This supplement describes guidelines for the inservice inspection of a Yankee dryer. A Yankee dryer is a rotating steam-pressurized cylindrical vessel commonly used in the paper industry, and is made of cast iron, finished to a high surface quality, and characterized by a center shaft connecting the heads.

b) Yankee dryers are primarily used in the production of tissue-type paper products. When used to produce machine-glazed (MG) paper, the dryer is termed an MG cylinder. A wet paper web is pressed onto the finished dryer surface using one or two pressure (pressing) rolls. Paper is dried through a combination of mechanical dewatering by the pressure roll(s); thermal drying by the pressurized Yankee dryer; and a steam-heated or fuel-fired hood. After drying, the paper web is removed from the dryer.

c) The dryer is typically manufactured in a range of outside diameters from 8 to 23 ft. (2.4 m to 7 m), widths from 8 to 28 ft. (2.4 m to 8.5 m), pressurized and heated with steam up to 160 psi (1,100 kPa), and rotated at speeds up to 7,000 ft./min (2,135 m/min). Typical pressure roll loads against the Yankee dryer are up to 600 pounds per linear inch (105 kN/m). A thermal load results from the drying process due to difference in temperature between internal and external shell surfaces. The dryer has an internal system to remove steam and condensate. These vessels can weigh up to 220 tons (200 tonnes).

d) The typical Yankee dryer is an assembly of several large castings. The shell is normally a gray iron casting, in accordance with ASME designation SA-278. Shells internally may be smooth bore or ribbed. Heads, center shafts, and journals may be gray cast iron, ductile cast iron, or steel.

S5.2 ASSESSMENT OF INSTALLATION

a) The Inspector verifies that the owner or user is properly controlling the operating conditions of the dryer. The Inspector does this by reviewing the owner's comprehensive assessments of the complete installation, operating environment, maintenance, and operating history.

b) The dryer is subjected to a variety of loads over its life. Some of the loads exist individually, while others are combined. Consideration of all the loads that can exist on a Yankee dryer is required to determine the maximum allowable operating parameters. There are four loads that combine during normal operation to create the maximum operating stresses, usually on the outside surface of the shell at the axial center line. These are:

1) Pressure load due to internal steam pressure;

2) Inertial load due to dryer rotation;

3) Thermal gradient load due to the drying of the web; and

4) Pressure roll load (line or nip load)[5] due to pressing the wet web onto the dryer.

c) Steam pressure, inertial, and thermal gradient loads impose steady-state stresses. These stresses typically change when the dryer shell thickness (effective thickness for ribbed dryers) is reduced to restore a paper-making surface, the grade of tissue is changed or speed of the dryer is changed.

5 Pressure roll load, line load, and nip load are terms that are used interchangeably to refer to the interaction between the pressure roll(s) and the Yankee dryer. It is called "nip" load because the pressure roll is rubber-covered and is pressed up against the Yankee with enough force to create a nip (or pinch) that forces the paper into line contact between the rolls and provides some mechanical dewatering. The paper then sticks onto the Yankee surface and follows the Yankee dryer for thermal dewatering by the steam-heated Yankee surface. This "nip load" is called a "line load" because the units are load (force) per length of line contact. The units are pounds per linear inch (PLI) and kilonewtons per meter (kN/m).

e) Permitted materials can be either an ASME, SA material, or an ASTM Material permitted by NBIC Part 2, Table S6.15.1-b;

f) DOT Specification 106A ton tanks shall only use forged-welded heads, convex to pressure. The forged-welded heads shall be torispherical with an inside radius not greater than the inside diameter of the shell. The heads shall be one piece, hot formed in one heat so as to provide a straight flange at least 100 mm (4 inches) long. The heads must have a snug fit into the shell;

g) DOT Specification 110A ton tanks shall only use fusion-welded heads formed concave to pressure. The fusion-welded heads shall be an ellipsoid of 2:1 ratio and shall be of one piece, hot formed in one heat so as to provide a straight flange at least 38 mm (1-1/2 inches) long;

h) All longitudinal welded joints on DOT Specification 106A and DOT Specification 110A ton tanks shall be a fusion weld. DOT Specification 106A ton tank head-to-shell attachments shall be a forged-welded joint.[6] DOT Specification 110A ton tank head-to-shell attachments shall be a fusion weld;

i) Postweld heat treatment is required after welding for all DOT Specification 106A and Specification 110A ton tanks;

j) DOT Specification 106A and DOT Specification 110A ton tanks shall be of such a design as to afford maximum protection to any fitting or attachment to the head, including loading and unloading valves. The protection housing[5] shall not project beyond the end of the ton tanks and shall be securely fastened to the tank head;

k) If applicable, siphon pipes and their couplings on the inside of the ton tank's head and lugs on the outside of the tank head for attaching valve protection housing shall be fusion welded prior to performing postweld heat treatment;

l) DOT Specification 106A and DOT Specification 110A ton tanks are required to be equipped with one or more approved types of pressure relief devices. The devices shall be made out of metal and the pressure relief devices shall not be subject to rapid deterioration by the lading. The device's inlet fitting to the tank shall be a screw-type fitting and installed or attached directly into the ton tank's head or attached to the head by other approved methods. For thread connections, the following shall apply:

   1) The threaded connections for all openings shall be in compliance with the National Gas Taper Threads (NGT);

   2) Pressure relief devices shall be set for start-to-discharge, and rupture discs shall burst at a pressure not exceeding the pressure identified in NBIC Part 2, Table S6.15.1-a; and

m) Fusible plugs, if used, shall be required to relieve the pressure from the tank at a temperature not exceeding 79°C (175°F) and shall be vapor tight at a temperature not exceeding 54°C (130°F).

6 The forged-welded joint shall be thoroughly hammered or rolled to ensure a sound weld.