Date Distributed:

The National Board of Boiler and Pressure Vessel Inspectors

NATIONAL BOARD SUBCOMMITTEE INSPECTION

AGENDA

Meeting of July 15th, 2020
Louisville, KY

The National Board of Boiler & Pressure Vessel Inspectors
1055 Crupper Avenue
Columbus, Ohio 43229-1183
Phone: (614)888-8320
FAX: (614)847-1828

1. **Call to Order**

8:00AM

2. **Introduction of Members and Visitors**

3. **Check for a Quorum**

4. **Awards/Special Recognition**

5. **Announcements**

The National Board will be hosting a reception for all committee members and visitors on Wednesday evening at 5:30pm at the SKY Grand Terrace on the 16th floor of The Brown Hotel.

6. **Adoption of the Agenda**

7. **Approval of the Minutes of the January 15th, 2020 Meeting**

The minutes are available for review on the National Board website, www.nationalboard.org.

8. **Review of Rosters (Attachment Page 1)**

a. Membership Nominations

i. Mr. Brent Ray (Users) is interested in becoming a member of SG Inspection.

b. Membership Reappointments

The following Subcommittee Inspection memberships are set to expire prior to the January 2021 meeting:

- Mr. Donnie LeSage
- Mr. James Roberts
- Mr. Jason Safarz

The following Subgroup Inspection memberships are set to expire prior to the January 2021 meeting:

- Mr. Donnie LeSage
- Mr. James Roberts
- Mr. Jason Safarz

c. Officer Appointments

9. **Open PRD Items Related to Inspection**

- NB14-0602B – Improve index in Part 2 relating to pressure relief devices – D. Marek (PM)
  - Update: Work is still being done for this item.
- NB15-0321 – Review testing requirements for inservice testing of pressure relief devices in Part 2, 2.5.7 a) – A. Renaldo (PM)
  - Update: Proposal was balloted to Main Committee and received a few negative votes. Further work is being done to address those comments.

10. **Interpretations**

There are no interpretations for Subcommittee Inspection.

11. Action Items

Item Number: NB16-1402	NBIC Location: Part 2, New Supplement	Attachment Pages 2-6
General Description: Life extension for high pressure FRP vessels above 20 years **Subgroup:** FRP **Task Group:** M. Gorman (PM) **January 2020 Meeting Action:** The SC reviewed the proposed and the background information provided by Mr. Jonathan Ellis. After review of the proposed changes a motion was made to **send the proposal to SC letter ballot** for further review. The motion was seconded and unanimously approved. **Update:** The proposal for this item was balloted to the SC and received several comments. At their April 2020 meeting, the FRP Task Group discussed the comments from the SC ballot. The project manager, Mr. Mike Gorman, and two other FRP members (Mr. Norm Newhouse and Mr. John Eihusen) are working to prepare responses to the comments and work on an updated proposal.		

Item Number: 18-6	NBIC Location: Part 2, S1.4.2.9	No Attachment
General Description: Riveted stay bolt dimensions **Subgroup:** Locomotive **Task Group:** M. Janssen (PM) **January 2020 Meeting Action:** Progress Report: Mr. Musser has stated they are hoping to have a proposal for the July 2020 meeting.		

Item Number: 18-43	NBIC Location: Part 2, Section 5	No Attachment
General Description: Permanent nameplate removal from pressure vessel being removed from service **Subgroup:** Inspection **Task Group:** J. Roberts (PM), J. Burgess, J. Calvert, J. Clark, M. Sansone **January 2020 Meeting Action:** The SC reviewed the 3 documents unanimously approved at the SG Inspection meeting. The subcommittee made a few editorial revisions, and a motion was made to accept the revised proposal. The motion was seconded and unanimously approved. **Update:** This item was balloted to Main Committee and received several comments to be addressed by the task group.		

Item Number: 18-62	NBIC Location: Part 2, 4.2.1	Attachment Pages 7-8
General Description: Remote Inspection of Confined Space Requirements **Subgroup:** Inspection **Task Group:** V. Newton (PM), M. Horbaczewski, B. Wilson, J. Calvert, J. Castle, D. Graf, T. Shernisky **January 2020 Meeting Action:** Progress Report: Mr. Newton stated they will be putting a proposal together & try to letter ballot it to SG Inspection and SC Inspection prior to the July 2020 meeting.		

Item Number: 18-63	NBIC Location: Part 2	No Attachment

General Description: Review inspection requirements for pressure vessels designed for high pressures

Subgroup: Inspection

Task Group: V. Scarcella (PM), J. Mangas, J. Peterson, and J. Castle

January 2020 Meeting Action:
Progress Report: Mr. Tim Bolden stated the task group is still working on a proposal.

Item Number: 19-6	NBIC Location: Part 2, 2.3.6.8	No Attachment

General Description: PVHO 2.3.6.8 Add other types of PVHO's

Subgroup: Inspection

Task Group: D. Buechel (PM), R. Smith, S. Reimers, J. Burgess, M. Mooney & D. LeSage

Explanation of Need: Currently part 2 only covers medical PVHO's.

January 2020 Meeting Action:
Progress Report: Mr. Buechel stated he has not been able to get in contact with any of the task group members so there has been no progress. A new task group was formed in the SG Inspection meeting.

Item Number: 19-7	NBIC Location: Part 2	Attachment Page 9

General Description: Pressure Gage Graduation

Subgroup: Inspection

Task Group: V. Newton (PM), D. Buechel, D. Rose, D. Graff, & J. Clark

Explanation of Need: This item was opened after discussion of the pressure gage for PVHO's. The SG Inspection decided they needed to look into the pressure gage graduation for other pressure retaining items beyond PVHO's.

January 2020 Meeting Action:
Progress Report: Mr. Buechel has stated to the SC that the task group worked together after the SG meeting to create a proposal. The proposal was then emailed to the NBIC Secretary, and they would like it to be letter balloted to SG Inspection.

Update: This item is currently out for letter ballot to the subgroup and subcommittee.

Item Number: 19-22	NBIC Location: Part 2, S2	Attachment Pages 10-15

General Description: Review of MAWP on Return Flue Boilers.

Subgroup: SG Historical

Task Group: M. Wahl (PM), J. Amato, R. Bryce & D. Rose

Explanation of Need: From the Presentation, by Robert Bryce, the subcommittee feels this needs to be reviewed more in-depth. Continue the research and documentation on the MAWP of Return Flue Boiler. This was started with the documentation presented by Robert Bryce which is located in the NBIC cloud under January 2019 Historical Subcommittee.

January 2020 Meeting Action:
Progress Report: Mr. Rose presented this item to the SC. The task group from historical wanted to give the SC some information on this item and let them know their plan. Mr. Rose let the SC know a proposal will be sent to TG Historical letter ballot prior to the July 2020 meeting. If the letter ballot passes, it will then be letter balloted to SC Inspection prior to the July 2020 meeting as well.

Update: This item is currently being balloted to the subcommittee.

Item Number: 19-46	NBIC Location: Part 2, S5	No Attachment

General Description: Revisions to Yankee dryer supplement in Part 2 (Scope)

Subgroup: Inspection
Task Group: V. Newton (PM), T. Barker, D. Lesage, J. Jessick

Explanation of Need: Ensure that wording in Part 2, S5.1, is identical to that found in Part 1, S1.1.

January 2020 Meeting Action:
Progress Report: Mr. Newton stated to the SC that the Task group will be getting together after the meeting to come up with a proposal and they are hoping to send it to SG Inspection letter ballot, and if it passes, have it sent to SC Inspection letter ballot, all prior to the July 2020 meeting.

Item Number: 19-63	NBIC Location: Part 2, S5.2	No Attachment

General Description: Changes to the Yankee Dryer Supplement (ASSESSMENT OF INSTALLATION)

Subgroup: Inspection
Task Group: V. Newton (PM), T. Barker, D. Lesage, J. Jessick

Explanation of Need: Ensure that wording in Part 2, S5.2, is identical to that found in Part 1, S1.2. Note that wording will be the same, but paragraph numberings will be different.

January 2020 Meeting Action:
Progress Report: Mr. Newton stated to the SC that the Task group will be getting together after the meeting to come up with a proposal and they are hoping to send it to SG Inspection letter ballot, and if it passes, have it sent to SC Inspection letter ballot, all prior to the July 2020 meeting.

Item Number: 19-64	NBIC Location: Part 2, S5.2.1	No Attachment

General Description: Changes to the Yankee Dryer Supplement (DETERMINATION OF ALLOWABLE OPERATING PARAMETERS)

Subgroup: Inspection

Task Group: None assigned

Explanation of Need: Ensure that wording in Part 2, S5.2.1, is identical to that found in Part 1, S1.3. Note that wording will be the same, but paragraph numberings will be different.

January 2020 Meeting Action:
Progress Report: Mr. Newton stated to the SC that the Task group will be getting together after the meeting to come up with a proposal and they are hoping to send it to SG Inspection letter ballot, and if it passes, have it sent to SC Inspection letter ballot, all prior to the July 2020 meeting.

Item Number: 19-84	NBIC Location: Part 2, S2.10.7	Attachment Pages 16-21

General Description: Inspecting riveted joints for failure

Subgroup: SG Historical

Task Group: F. Johnson (PM)

Explanation of Need:
Progress Report: Mr. Rose stated to the SC that the task group is still working on their proposal.

Item Number: 19-88	NBIC Location: Part 2, 2.2.12.7 c) 2)	Attachment Pages 22-24

General Description: At NBIC Part II propose the following be added to Thermal Fluid Heater

Subgroup: Inspection

Task Group: V. Scarcella (PM), M. Sansone, T. Bolden, M. Wadkinson

Explanation of Need: These items are essential to preventing catastrophic loss and are low cost items.

January 2020 Meeting Action:
Mr. Scarcella presented this item to the subgroup along with a proposal. The subgroup discussed the changes, and decided to create a task group to work on the proposal further.

Item Number: 19-89	NBIC Location: Part 2, S2.7.3.2	Attachment Page 25

General Description: Longer NDE cycle for historic boilers

Subgroup: SG Historical

Task Group: None assigned

Explanation of Need: The National Historic Boiler Association (NHBA) of Canada is the association of Canadian historical boiler associations.

The NHBA is submitting a request for change to the National Board Subgroup, Historical Boilers, to review and extend the current NDE cycle for historical boilers that is defined in Part 2, S2.7.3.2. The duration is currently shorter than other jurisdictions.

- TSSA of Ontario, Canada enforced a 10-year cycle on ultrasonic thickness testing on historical boilers after careful review of recurring NDE results and operating logs from various historical boilers in that province.
- England is reportedly also on a 10-year cycle.

Extending the NBIC NDE cycle to 10 years would reduce costs for owners in jurisdictions where NBIC is being strictly followed. If granted the opportunity, the NHBA has data to support this request.

January 2020 Meeting Action:
Mr. Rose and Mr. Getter presented the proposal that was passed (with 1 abstention) in the SG Historical meeting. The SC discussed the proposal and a **motion was made to send the proposal to letter ballot**. The motion was seconded and passed with one abstention.

Update: The proposal was balloted to SC Inspection and received several comments for review.

New Items:

Item Number: 20-5	NBIC Location: Part 2, 4.1 – 4.4	No Attachment

General Description: Add language in NBIC Pt2/Pt3 to minimize CSEs by allowing remote NDE.

Subgroup: Inspection

Task Group: None assigned

Explanation of Need: In order to minimize higher-risk work, specifically Confined Space Entries, remote NDE methodologies should be specifically allowed by the NBIC, at the discretion of the people performing the inspections.

Item Number: 20-9	NBIC Location: Part 2, 9.1	See attachment on the cloud

General Description: Define "Verify" in the NBIC Glossary

Subgroup: Repairs and Alterations

Task Group: N. Carter (PM)

Explanation of Need: Defining "Verify" in the NBIC Part 1, 2, 3, and 4 to align with the definition in NB-263, RCI-1, Rules for Commissioned Inspectors.

Item Number: 20-26	NBIC Location: Part 2, S2	No Attachment

General Description: Concern for Historical Boiler Inspections Nationwide

Subgroup: Inspection

Task Group: None assigned

Explanation of Need: Currently Jurisdictions are not uniform in adoption of how and when inspections are performed.

Item Number: 20-46	NBIC Location: Part 2, 5.3.2	No Attachment

General Description: Updates to Forms NB-5, NB-6, & NB-7

Subgroup: Inspection

Task Group: None assigned

Explanation of Need: On the current forms NB-5, NB-6, & NB-7 there are fields that are already on the ASME Manufactures Data Report making them repetitive. Other fields that ask for in- depth technical information would be hard if not impossible for an inspector to determine and are irrelevant to the inspection process.

12. Future Meetings

January 11th – 14th, 2021 – New Orleans, LA
July 12th – 15th, 2021 – Cincinnati, OH

13. Adjournment

Respectfully submitted,

Jonathan Ellis

Jonathan Ellis
NBIC Secretary

Contents

⊟ Subcommittee Inspection

Last Name	First Name	Interest Category	Role	Exp. Date	More
Getter	Jim	Manufacturers	Chair	08/30/2021	Details
Horbaczewski	Mark	Users	Vice Chair	08/30/2021	Details
Metzmaier	Jodi		Secretary	01/30/2099	Details
Barker	Timothy	Authorized Inspection Agencies	Member	01/30/2021	Details
Brantley	Ernest	Authorized Inspection Agencies	Member	01/30/2022	Details
Buechel	David	Authorized Inspection Agencies	Member	07/30/2022	Details
Calvert	James	National Board Certificate Holders	Member	08/30/2021	Details
Clark	James	Manufacturers	Member	10/30/2022	Details
Graf	Darrell	National Board Certificate Holders	Member	01/30/2023	Details
LeSage	Donnie	Jurisdictional Authorities	Member	07/30/2020	Details
Mangas	John	General Interest	Member	08/30/2021	Details
Newton	Venus	Authorized Inspection Agencies	Member	07/30/2022	Details
Petersen	Jeffrey	Users	Member	01/30/2023	Details
Roberts	James	Manufacturers	Member	08/30/2020	Details
Rose	David	Users	Member	10/30/2022	Details
Safarz	Jason	General Interest	Member	07/30/2020	Details
Sansone	Matthew	Jurisdictional Authorities	Member	01/30/2021	Details
Scarcella	Vincent	Authorized Inspection Agencies	Member	01/30/2023	Details
Vandini	Thomas	National Board Certificate Holders	Member	01/30/2023	Details
Welch	Paul	Authorized Inspection Agencies	Member	01/30/2022	Details

Supplement 14
Life Extension of High Pressure Fiber Reinforced Plastic Pressure Vessels

S14.1 Scope

This document may be used to evaluate whether the service life of high pressure fiber reinforced plastic pressure vessels (FRP) can be extended for an additional lifetime. High pressure means vessels with a working pressure from 3,000 psi (20 MPa) to 15,000 psi (103 MPa). For vessels intended for cyclic service, fatigue testing of new vessels is carried out by the vessel manufacturer to be certain that the vessel will not fail in service and such testing is typically required by regulatory authorities. Fatigue design and testing is the starting point for consideration of life extension.

S14.2 General

a) The procedure for in-service testing of high pressure composite pressure vessels, **Supplement 10** herein, is incorporated by reference into this procedure for life extension of high pressure composite pressure vessels. Supplement 10 is based on acoustic emission (AE) testing, specifically modal AE (MAE) testing. The MAE inspection procedure employs detection and analysis techniques similar to those found in seismology and SONAR. Much as with earthquakes, transient acoustical impulses arise in a composite material due to the motion of sources such as the rupture of fibers. These transients propagate as waves through the material and, if properly measured and analyzed by the methods in Supplement 10, the captured waves reveal, for example, how many fibers have ruptured. Similar information about other sources is also determinable, such as the presence and size of delaminations. Delaminations can play a significant role in vessel fatigue life, particularly delaminations near the transition regions and in the heads. The rupture behavior can be used to determine the integrity of the vessel. However, the development of criteria for life extension (LE) requires an understanding of the vessel design and fatigue life.

b) Fatigue testing of out of life vessels is a crucial part of the life extension process. It is used to validate the mechanical behavior of the vessels and to develop the numerical values for the allowables in the MAE pass/fail criteria for the particular design, material and construction.

S 14.3 Life Extension Procedure

a) New vessel fatigue life testing data shall be obtained from the Manufacturer's Design Report (MDR) and the number of cycles in a lifetime shall be determined from the MDR. The type of vessel under consideration for life extension shall have been shown through testing to be capable of sustaining at least three lifetimes of cycles to developed fill pressure followed by a subsequent burst test at a pressure greater than minimum design burst pressure.

b) An evaluation of the service the vessel has seen should take into account any operational conditions that may have differed from those used in the design testing and analysis. Such conditions include for example exposure to more severe weather than expected, more cycles per year, constant high temperature and humidity, chemical attack or any other of a number of conditions under which operations take place that were not specifically included in testing at manufacture. Any such conditions shall be listed on the attached form. If no such conditions exist, it shall be so noted on the form. The test program delineated herein shall be revised to reflect the modified conditions as documented by the user and submitted for approval to the proper authorities.

c) Data and records for all vessels considered for life extension shall be kept and made readily available to inspectors or examination personnel. This includes an operating log, number of operating cycles since the previous examination, total number of operating cycles, examinations, examination techniques and results, maximum operating pressure and any unexpected pressures, temperatures, temperature cycles, damage events or other significant events that were outside the intended operating parameters or conditions.

d) A life extension test program shall be carried out for each type of vessel under consideration. Type of vessel means the particular manufacturer, materials (fiber and resin), water volume and design. If the type of vessel passes all requirements, then that type shall be eligible for life extension testing. If such a vessel passes the life extension MAE test its lifetime can be extended for one additional lifetime in five-year increments. In order to maintain life extension a vessel must be requalified every five years using the MAE test.

S14.4 Life Extension Test Program

a) The type of vessel under consideration for LE shall be noted. Manufacturer, place of manufacture and manufacturing date shall be recorded. The vessel dimensions shall be recorded. The specific fiber, matrix and winding pattern shall be recorded. If the fiber, matrix and winding pattern are not available from the manufacturer, then a vessel of the type under consideration shall be used to verify the winding pattern (hoop and helical angles and number of plies) through destructive testing.

b) Ten out-of-life vessels of the particular type shall be tested in the manner described herein. MAE techniques shall be applied to every vessel tested. Analysis of the MAE data is described herein. Two strain gages, one in the 0-degree and one in the 90-degree direction, shall be applied to every vessel pressure tested under this program. The purpose of strain gage data is to compute the 0 and 90 modulus values and to confirm that the modulus values of the material do not vary during the fatigue cycling required herein. Strain data shall be recorded and analyzed as described later on.

c) The LE test program proceeds by Steps. If the Step 1 is not successful, then there is no need to proceed to Step 2, and so forth.

S14.5 Life Extension Test Program Steps

S14.5.1 Step 1

Three vessels shall be selected from the ten and pressurized to burst. The vessels shall be inspected for visible damage, i.e., cuts, scrapes, discolored areas, and the vessel appearance shall be documented with photographs. MAE testing shall be done in conjunction with this testing as specified in Supplement 10, except for transducer spacing, pressurization plan and accept/reject criteria values. The values in Supplement 10 are for requalification testing. The transducer spacing shall be determined by the distance at which the 400 kHz component of a suitable pulser source is detectable along the axis of the vessel (essentially across the hoop fibers) and in the perpendicular direction (essentially parallel to the hoop fibers). Detectable means that the resulting signal component has an amplitude with at least a signal to noise ratio of 1.4. Transducer frequency response calibration and energy scale shall be carried out as specified in SUPPLEMENT 10. The pressurization plan shall follow that in ASME Section X Mandatory Appendix 8, i.e., there shall be two pressure cycles to test pressure with holds at test pressure as prescribed therein, however, the time interval between the two cycles may be reduced to one minute. For the purposes of life extension, the fiber fracture energy and BEO (background energy oscillation) values shall be as specified below.

a) No BEO greater than 2 times the quiescent energy (see Supplement 10) shall be observed up to test pressure or during pressure holds.
b) No fiber break event energy shall be greater than $24 \times 10^3 \times U_{FB}$ (see Supplement 10) during the second pressurization cycle.
c) No single event shall have an energy greater than $24 \times 10^5 \times U_{FB}$ during the second pressurization cycle.

Note: The numerical values specified in b) and c) can be adjusted through documented testing and stress analysis methods in order to account for the particular design, material and construction.

d) At least two sensors shall remain on each vessel all the way to burst in order to establish the BEO pressure for this type of vessel.
e) Plots of stress versus strain shall show linear behavior up to 90% of burst pressure.
f) The burst pressures of all three vessels shall be greater than the minimum design burst pressure.
g) If the burst pressure of any one of the three vessels is not greater than the minimum design burst pressure, then these vessels shall not be eligible for life extension and there is no need to proceed with Step 2 below.

Note: It is possible that one or more of the vessels selected had damage not obvious to visual inspection. If during this burst testing phase the MAE test identifies a vessel as damaged, the substitution of three other randomly selected vessels is allowed.

S14.5.2 Step 2

If the vessels pass Step 1, fatigue testing shall be carried out on a minimum of three vessels of the same type being considered for life extension.

a) Prior to testing, the vessels shall be inspected for visible damage, i.e., cuts, scrapes, discolored areas, and the vessel appearance shall be documented with photographs.
b) Prior to fatigue testing, MAE testing as specified in Step 1 shall be done in conjunction with the fatigue testing, hereinafter called the MAE test or MAE testing, in order to determine the suitability of the vessels for fatigue testing, i.e., that they pass the MAE test.
c) Next, the vessels shall be subjected to fatigue cycles. Pressure shall be 100 psi +0, -50% to at least 1.05 x working pressure. Vessels shall survive one and one-half (1.5) additional lifetimes. If they survive then they shall be tested by an MAE test as was done prior to fatigue cycling.

d) Provided they pass the MAE test, they shall be burst tested. At least two sensors shall remain on each vessel all the way to burst in order to establish that the BEO (background energy oscillation) pressure for the fatigued vessels is consistent, i.e., is the same percentage of ultimate, with that of the vessels tested in Step 1.

e) Plots of stress versus strain shall show linear behavior up to 90% of burst pressure.

f) The burst pressures at the end of the fatigue testing shall be greater than or equal to the minimum design burst. If the burst pressure of any one of the three vessels is not greater than the minimum design burst pressure, then these vessels shall not be eligible for life extension.

S14.5.3 Step 3

If the vessels pass Step 2, impact testing shall be carried out on a minimum of three vessels of the same type being considered for life extension.

a) Prior to testing, the vessels shall be inspected for visible damage, i.e., cuts, scrapes, discolored areas, and the vessel appearance shall be documented with photographs. Prior to impact testing, MAE testing shall be done in order to determine the suitability of the vessels for impact testing, i.e., that they pass the MAE test.

b) Two vessels shall be subjected to an ISO 11119.2 drop test and then subjected to the MAE test.

If they pass the MAE test, then one vessel shall be burst tested. At least two sensors shall remain on the vessel all the way to burst in order to establish that the BEO (background energy oscillation) pressure for the fatigued vessels is consistent, i.e., is the same percentage of ultimate, with that of the vessels tested in Step 1.

c) Plots of stress versus strain shall show linear behavior up to 90% of burst pressure.

d) If the burst pressure is not greater than the minimum design burst pressure, then these vessels shall not be eligible for life extension.

e) If the first vessel passes the burst test, the other dropped vessel shall be fatigue cycled and subsequently subjected to the MAE test and, if it passes, shall be burst tested under the same conditions as before. If the vessel fails during fatigue cycling, i.e., bursts or leaks, then these vessels shall not be eligible for life extension.

f) If the modulus changes by more than 10%, then these vessels shall not be eligible for life extension. The strain gages should be mounted in a location that is away from the impact zone.

g) The burst pressure at the end of the fatigue testing of the dropped vessel shall be greater than or equal to the minimum design burst. The vessels shall have MAE testing applied during burst testing as before and the BEO shall be consistent with the previously established percent of burst ±10%.

S14.5.4 Step 4

If the vessels pass Step 3, cut testing shall be carried out on a minimum of two vessels of the same type being considered for life extension.

a) Prior to testing, the vessels shall be inspected for visible damage, i.e., cuts, scrapes, discolored areas, and the vessel appearance shall be documented with photographs. Prior to cut testing, MAE testing shall be done in order to determine the suitability of the vessels for cut testing, i.e., that they pass the MAE test.

b) Two vessels shall be subjected to an ISO 11119.2 cut test and then subjected to the MAE test. If they pass, then one shall be burst tested under all the conditions and procedures delineated in Step 2. If the burst pressure is not greater than the minimum design burst pressure, then these vessels shall not be eligible for life extension.

c) If the cut vessel passes, then the other cut vessel shall be fatigue cycled as described in Step 2 and subsequently subjected to the MAE test and then burst tested with at least two MAE sensors remaining on and monitoring the vessel as before. If it does not survive fatigue cycling, then these vessels shall not be eligible for life extension.

d) The burst pressure at the end of the fatigue testing of the cut vessel shall be greater than or equal to the minimum burst pressure specified by ISO 11119.2.

If the vessel type passes Steps 1 to 4, then that type is eligible for life extension. An out of life vessel of the type subjected to the program above may have its life extended for one additional lifetime if it passes the MAE test. The vessel shall pass the MAE test at subsequent five-year intervals or at one-third of the lifetime, whichever is less, in order to continue in service. The vessel shall be labeled as having passed the NBIC life extension test.

1.6 CHANGE OF SERVICE

Supplement 9 of this part provides requirements and guidelines to be followed when a change of service or service type is made to a pressure-retaining item.

Whenever there is a change of service, the Jurisdiction where the pressure-retaining item is to be operated, shall be notified for acceptance, when applicable. Any specific jurisdictional requirements shall be met.

1.7 SCRAPPING PRESSURE RETAINING ITEMS

The owner or user shall deface the code nameplate(s) of any pressure retaining item that is scrapped. The removal or defacement of the Code nameplate(s) should be verified by the Inspector, and the National Board form NB-XXX shall be completed and submitted to the National Board and Jurisdiction, if required.

ADD DEFINITION:

SCRAPPED – Permanent removal from service by owner's or user's procedures.

Scrapping of Pressure Retaining Items

In accordance with provisions of the National Board Inspection Code

1.Submitted to:

____
Name of Jurisdiction

____
Address

____
Phone Number

2. Submitted by:

____
(Name of Owner/User)

____
Address

____
Phone Number

3. Manufactured by: ______________________________
(name and address)
____
____

4. Location of Installation: ______________________________
(address)
____

5. Manufacturer's Data Report: ☐ YES ☐ NO

6. Item Registered with National Board: ☐ YES ☐ NO NB Number: ____________

7. Item Identification:

Year Built: ____________________ Mfr. Serial No.: ____________________

Type: ____________________ Jurisdiction no.: ____________________

Dimensions: ____________________ MAWP: ____________________

8. Date of removal or defacement of the Code nameplate(s) ____________

9. I certify that to the best of my knowledge and belief the statements in this report are correct, and with provisions of the National Board Inspection Code.

Name of Owner or User: ______________________________

Signature: ______________________________ Date: ____________________

Instructions for Completing the Form NB-XXX, *Scrapping of Pressure Retaining Items Form*

Items 1-9 shall be completed by the owner, user, or "R" Stamp Holder making the request.

1) The name, address, and phone number of the Jurisdiction, Authorized Inspection Agency (when there is no Jurisdiction) the form is being submitted to for approval.
2) Enter the name and address of your company or organization.
3) Enter the name and address of the manufacturer shown on the name plate.
4) Enter the name and address of the location where the pressure-retaining item is installed. If this is the same as number 2, check the box "same as # 4."
5) Manufacturer's Data Report Attached-check the appropriate box.
6) Is the pressure-retaining item registered with the National Board? Check the appropriate box. If yes, provide the National Board Registration Number.
7) Provide as much information as known to help identify the pressure-retaining item.
8) Enter date the removal or defacement of the Code nameplate.
9) Enter the name and signature of the owner, user, or "R" Stamp Holder (and "R" Stamp number if applicable).

Note: Once completed the requester shall file a copy with the Jurisdiction where the pressure retaining item is installed, the National Board (if registered with the National Board), and the owner or user of the vessel if the request was made by an "R" Stamp Holder, and upon request to the Authorized Inspection Agency who witnessed the removal or defacement of the nameplate.

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1.4.1 PERSONAL SAFETY REQUIREMENTS FOR ENTERING CONFINED SPACES

a) No pressure-retaining item shall be entered until it has been properly prepared for inspection. The owner or user and Inspector shall jointly determine that pressure-retaining items may be entered safely. This shall include:

1) Recognized hazards associated with entry into the object have been identified by the owner or user and are brought to the attention of the Inspector, along with acceptable means or methods for eliminating or minimizing each of the hazards;

2) Coordination of entry into the object by the Inspector and owner or user representative(s) working in or near the object;

3) Personal protective equipment required to enter an object shall be used. This may include, among other items, protective outer clothing, gloves, respiratory protection, eye protection, foot protection, and safety harnesses. The Inspector shall have the proper training governing the selection and use of any personal protective clothing and equipment necessary to safely perform each inspection. Particular attention shall be afforded respiratory protection if the testing of the atmosphere of the object reveals any hazards

4) Completing and posting of confined space entry permits, as applicable; and

5) An effective energy isolation program (lock out and/or tag out) is in place and in effect that will prevent the unexpected energizing, start-up, or release of stored energy.

b) The Inspector shall determine that a safe atmosphere exists before entering the pressure-retaining item. The atmosphere shall be verified by the owner or user as directed by the Inspector.

1) The oxygen content of the breathable atmosphere shall be between 19.5% and 23.5%.
2) If any flammable or combustible materials are present in the atmosphere they shall not exceed 10% of their Lower Explosive Limit (LEL) or Lower Flammable Limit (LFL).
3) The Inspector shall not enter an area if toxic, flammable or inert gases, vapors or dusts are present and above acceptable limits

.

c) Remote visual inspection is an acceptable alternative to confined space entry provided the requirements of 4.2.1 c) are met and where allowed by the jurisdiction.

1.4.2 EQUIPMENT OPERATION

The Inspector shall not operate owner or user equipment. Operation shall be conducted only by competent owner or user employees familiar with the equipment and qualified to perform such tasks.

PART 2, SECTION 4 INSPECTION — EXAMINATIONS, TEST METHODS, AND EVALUATIONS

4.1 SCOPE

This section describes acceptable examination and test methods that are available to the Inspector during inspection of pressure-retaining items. This section also describes evaluation of test results and assessment methodologies.

4.2 NONDESTRUCTIVE EXAMINATION METHODS (NDE)

a) Listed below is a variety of nondestructive examination methods that may be employed to assess the condition of pressure-retaining items. The skill, experience, and integrity of the personnel performing these examinations are essential to obtain meaningful results. The Inspector should review the methods and procedures to be employed to ensure compliance with jurisdictional requirements.

b) Generally, some form of surface preparation will be required prior to use of these examination methods. When there is doubt as to the extent of a defect or detrimental condition found in a pressure-retaining item, the Inspector is cautioned to seek competent technical advice and supplemental NDE.

c) Personnel performing examination and test methods shall have proper training and certification, as required by the owner and acceptable to the Inspector and Jurisdiction, if required.

4.2.1 VISUAL

a) Visual examination is the basic method used when conducting an inservice inspection of pressure-retaining items. Additional examination and test methods may be required at the discretion of the Inspector to provide additional information to assess the condition of the pressure-retaining item.

b) Visual examination is an inspection method to ascertain the surface condition of the pressure-retaining item. The Inspector should be aware of recognizing various surface features and comparing these features with damage mechanisms listed in NBIC Part 2, Section 3 that could indicate exposure of the pressure-retaining item to harmful corrosion or elevated temperature service.

c) ~~In some cases the Inspector may have limited or no access while performing an inspection of the pressure-retaining item. Subject to approval of the Jurisdiction, remote camera or fiber optic devices may be considered acceptable methods to view and record the surface condition of the pressure-retaining item.~~

c) Remote Visual Inspection is an acceptable method of visual examination if the process is agreed upon by the owner and acceptable to the Inspector and Jurisdiction.

i) For Remote Visual Inspection, plans are reviewed and approved by the Inspector.

ii) The Inspector shall be present at time of data collection.

iii) The Inspector will be provided a dedicated monitor that has a resolution at least equal to that obtainable by direct observation, care should be taken to minimize glare on the viewing screen.

iv) The Inspector shall have direct communication with the operator of the remote visual camera.

v) For Remote Visual Inspections, the final report is acceptable to the Inspector / Jurisdiction and all raw data is available to the Inspector / Jurisdiction as needed.

vi) For Remote Visual Inspections, the inspection procedure shall reference a validated qualification of the equipment, including verification that the equipment is safe for use in the environment it will be operating in. Equipment validation will refer to ASME BPVC Section V. As a minimum the equipment shall meet:
a. 1/32" simulated defect identification
b. Minimum light intensity of 100 fc
c. Not less than 30deg offset to the surface to be examined
d. Resolution at least equal to that obtainable by direct observation

2.3.6.5 INSPECTION OF PRESSURE VESSELS FOR HUMAN OCCUPANCY (PVHO'S)

d) Inspection of parts and appurtenances (e.g., piping systems, pressure gage, bottom drain)

1) As stated above, cast iron is not allowed on PVHOs 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. Lines leading to chamber primary depth gages should connect only to the depth gage.

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 gage shall be graduated to not less than 1.5 times the pressure at which the lowest safety/relief valve is set.~~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 ft. (3.0 m) from any air intake.

8) Low points should be fitted with drains.

Action Item Request Form

CODE REVISIONS OR ADDITIONS

Request for Code revisions or additions shall provide the following:

a) Proposed Revisions or Additions

Item Number: 19-22.

b) Existing Text:

None

Provide a brief explanation of the need for the revision or addition.

No existing text to instruct inspectors on rating return-flue (Scotch Marine) historical boilers. Add section S2.10.3.1 and table for constant values. Update S2.10.6 Nomenclature

c) Background Information

An extensive review of all code and pre-code equations has been made:

1.) ASME equations from 1914-1971 editions are simple but the steps to determine the choice of equations is complex in nature, and examples exist where engineers did not correctly interpret the steps or equations. Design criteria may not match construction on pre-code boilers, and construction may hide details needed for a field inspector to choose the appropriate equation. These equations typically grant the highest calculated MAWP which may or not be appropriate for pre-code boilers with unknown material or non-compliant designs.

2.) The Canadian Interprovincial Regulations define a set of simple equations, but do not consider tensile strength. These equations were first enforced in 1910, then deprecated in favour of ASME wording in the 1920's, presumably in efforts to harmonize aspects of the two standards.

49.—Internally Fired Furnaces or Parts of Boilers (other than Ordinary Fire Tubes) Subjected to Compression.

The furnace plates in plain circular internally fired furnaces, not exceeding 42 inches in diameter if not found sufficiently strong, must be stayed as flat surfaces, allowing in the calculations for such seventy-five per cent. (75%) of the value of the resistance to collapse, as found by the following formula, the pitch of the stays being computed by the rule for flat surfaces, but the pitch shall in no case exceed eight inches on the furnace plate. For furnaces over forty-two inches in diameter, no allowance for value of resistance to collapse shall be made. Care must be taken not to reduce the efficiency of the riveted joint when applying these stays.

$$B=\frac{C\times T^2}{(L_1+1)\,Dr}$$

Where—

Dr= Outside diameter of furnace in inches.

T= Thickness of plate in inches.

L_1= Length of furnace in feet, or length between rings.

C= Constant according to the following circumstances:

B= Working pressure per square inch, which must not exceed that found by the limiting formula, as follows:

$$B=\frac{10000\times T}{Dr}$$

Furnaces with butt joints and rivet holes punched small and reamed out in place.

112500 where the longitudinal seams are double riveted, and fitted with single butt straps.

100000 where the longitudinal seam is single riveted, and fitted with single butt strap.

112500 where the longitudinal seam is single riveted, and fitted with double butt straps, or where seam is welded.

Furnaces with lap joints and rivet holes punched small and reamed out in place.

96000 where the longitudinal seams are double riveted.

87500 where the longitudinal seams are single riveted.

3.) The British Board of Trade rule (circa 1880) is a precursor to the Canadian regulations. The equation is of the same form, but assumed different materials. It is only appropriate for wrought iron boilerplate. It is clear that this equation was heavily researched and heavily enforced because other formulas were "dangerously weak".

"Circular furnaces with the longitudinal joints welded or made with a butt strap:

$$\frac{90{,}000 \times \text{the square of the thickness of the plate in inches}}{(\text{Length in feet} + 1) \times \text{diameter in inches}} = \text{the working}$$

pressure per square inch, provided it does not exceed that found by the following formula:

$$\frac{8{,}000 \times \text{thickness in inches}}{\text{diameter in inches.}} = \text{Working pressure per square inch.}$$

The second formula limits the crushing stress to 4000 lbs. per sectional square inch.

The length is to be measured between the rings if the furnace is made with rings.

If the longitudinal joints instead of being butted are lap jointed in the ordinary way then 70,000 is to be used instead of 90,000, excepting only where the lap is bevelled and so made as to give the flues the form of a true circle, when 80,000 may be used.

When the material or the workmanship is not of the best quality, the constants given above must be reduced, that is to say, the 90,000 will become 80,000; the 80,000 will become 70,000; the 70,000 will become 60,000; when tke material and the workmanship are not of the best quality, such constants will require to be further reduced, according to circumstances and the judgment of the surveyor, as in the case of old boilers. One of the conditions of best workmanship is that the joints are either

double rivetted with single butt straps, or single rivetted with double butt straps, and the holes drilled after the bending is done and when in place, and the plates afterwards taken apart, the burr on the holes taken off, and the holes slightly countersunk from the outside *

*** The following examples will serve to show the application of the constants for the different cases that may arise:**

Furnaces with butt joints and drilled rivet holes.	**90,000 where the longitudinal seams are welded.** **90,000 where the longitudinal seams are double rivetted and fitted with single butt straps.** **80,000 where the longitudinal seams are single rivetted and fitted with single butt straps.** **90,000 where the longitudinal seams are single rivetted and fitted with double butt straps.**
Furnaces with butt joints and punched rivet holes.	**85,000 where the longitudinal seams are double rivetted and fitted with single butt straps.** **75,000 where the longitudinal seams are single rivetted and fitted with single butt straps.** **85,000 where the longitudinal seams are single rivetted and fitted with double butt straps.**
Furnaces with lapped joints and drilled rivet holes.	**80,000 where the longitudinal seams are double rivetted and bevelled.** **75,000 “ “ “ “ “ “ “ and not bevelled.** **70,000 “ “ “ “ “ single “ and bevelled.** **65,000 “ “ “ “ “ “ and not bevelled.**
Furnaces with lapped joints and punched rivet holes.	**75,000 where the longitudinal seams are double rivetted and bevelled.** **70,000 “ “ “ “ “ “ “ and not bevelled.** **65,000 “ “ “ “ “ single “ and bevelled.** **60,000 “ “ “ “ “ “ “ and not bevelled.**

In the case of upright fire-boxes of donkey or similar boilers, 10 per cent. should be deducted from the constants given above, applicable to the respective classes of work.

4.) Lloyds Rule (circa 1870) is a precursor to the British Board of Trade rules, derived from research by Sir William Fairbairn. It was deemed incorrect by the British Board of Trade for determining collapsing pressure of large cylinders. For the firetube dimensions it was intended for, this equation applied a 4.5:1 factor of safety. Thus, this equation is not a suitable candidate.

5.) Modern ASME equations assume modern materials and welded construction. Compensation for the length of the tube is inappropriate for riveted construction.

6.) Other research and equations, generally from the mid 1800’s through early 1900’s, were investigated and documented but not evaluated because it is clear that the equations predate any current knowledge or definition of safety factors. Note that in the USA there was no known accepted standard equation for external pressures on cylindrical surfaces. In fact, one extensive study in 1896 did not provide any equation for USA boilers.

This proposal derives an equation based on the Canadian and British Board of Trade regulations. With both forms of the equation, it is possible to derive a new equation that requires material tensile strength. The calculated MAWP results are generally more conservative than ASME equations, which may be acceptable when ASME design criteria may not be met, and when thickness readings are based from sampling of deteriorated plate, not new construction with uncorroded, new, material.

S2.10.3.1 Cylindrical Components Under External Pressure

The MAWP of unstayed plain circular cylindrical components not exceeding 42 inches in diameter and under external pressure shall be determined by the strength of the weakest course computed from the minimum thickness of the plate, the tensile strength of the plate, the type of longitudinal joint, outside diameter of the weakest course, and the length of the firetube, using the following formulas:

$$P_1 = \frac{C_1 \times t^2 \times TS}{\left(\frac{f}{12} + 1\right) \times d_o}$$

$$P_2 = \frac{t \times TS}{C_2 \times d_o}$$

$$P = min(P_1, P_2)$$

C_1, C_2 = constants, see table

Constant Values		
C_1	**Longitudinal Joint**	
	1-row lap seam	1.85
	2-row lap seam	1.95
	1-row butt strap, single butt strap	2.1
	1-row butt strap, double butt strap	2.2
	2-row butt strap, single butt strap	2.2
	2-row butt strap, double butt strap	2.3
	Forge welded	2.3
C_2		5.0

Example 1: vertical boiler with an unstayed steel firebox with an outside diameter of 34 inches, height of 24 inches, thickness of 0.4 inches calculates as follows, 1-row lap seam is calculated as follows:

$$P_1 = \frac{1.85 \times 0.4^2 \times 55000}{\left(\frac{24}{12} + 1\right) \times 34} = 160\ PSI$$

$$P_2 = \frac{0.4 \times 55000}{5.0 \times 34} = 129\ PSI$$

$$P = min(160, 129) = 129\text{psi}$$

S2.10.6 NOMENCLATURE

p = maximum pitch measured (inches or mm) between straight lines, (horizontal, vertical, or inclined) passing through the centers of staybolts in different rows.

l = the pitch of stays in one row, passing through the center of staybolts, these lines may be horizontal, vertical, or inclined and measured in inches or mm.

w = the distance between two rows of staybolts, inches or mm.

h = the hypotenuse of a square or rectangle, defined as either $\sqrt{2p^2}$ or, $\sqrt{l^2 + w^2}$ inches or mm.

d = minimum diameter of corroded staybolt, inches or mm

R = inside radius of the weakest course of shell or drum, in inches or mm. TS= ultimate tensile strength of shell plates, psi (MPa)

t = minimum thickness of shell plate in the weakest course, inches or mm. P = calculated MAWP psi (MPa).

S = maximum allowable stress value, psi (MPa).

d_0 = outside diameter of firetube; if tapered use the largest outside diameter
f = length of firetube, inches, measured between circumferential joints

C = 2.1 for welded stays or stays screwed through plates not over 7/16 in. (11 mm) in thickness with ends riveted over.

C = 2.2 for welded stays or stays screwed through plates over 7/16 in. (11 mm) in thickness with ends riveted over.

C = 2.5 for stays screwed through plates and fitted with single nuts outside of plate, or with inside and outside nuts, omitting washers.

C = 2.8 for stays with heads not less than 1.3 times the diameter of the stays screwed through plates, or made a taper fit and having the heads formed on the stays before installing them and not riveted over, said heads being made to have true bearing on the plate.

C = 3.2 for stays fitted with inside and outside nuts and outside washers where the diameter of washers is not less than 0.4p and thickness not less than t.

Note: The ends of stays fitted with nuts shall not be exposed to the direct radiant heat of the fire.

E = the efficiency of the longitudinal riveted joint.

See Table S2.10.6 for efficiencies (E), which are the average for the different types of riveted joints.

Action Item Request Form

CODE REVISIONS OR ADDITIONS

Request for Code revisions or additions shall provide the following:

a) Proposed Revisions or Additions

Current text is incomplete with respect to inspecting riveted joints for failure. This proposal suggests adding more text, found in historic inspection documents, to further assist and direct the field inspector for assessing the condition of a riveted joint.

Existing Text:

S2.10.7 LIMITATIONS

a) The maximum allowable working pressure shall be the lesser of that calculated in accordance with NBIC Part 2, S2.10, or the MAWP established by the original manufacturer.

b) The shell or drum of a boiler in which a "lap seam crack" extending parallel to the longitudinal joint and located either between or adjacent to rivet holes, when discovered along a longitudinal riveted joint for either butt or lap joint, shall be permanently discontinued for use under steam pressure, unless it is repaired with jurisdictional approval.

Provide a brief explanation of the need for the revision or addition.

The text covers cracks parallel to a longitudinal joint, but there is no text covering inspection of plate material around a rivet.

c) Background Information

Review of the NBIC shows that failure indicators of riveted seams have not been identified or itemized. This proposal addresses this oversite.

Referenced standards, related discussion follow proposed wording.

Proposed wording

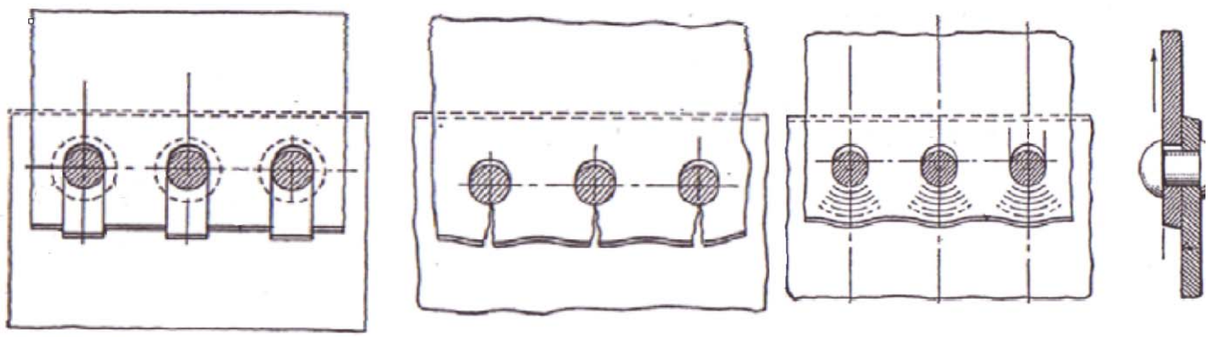
S2.10.2.3 INSPECTION OF RIVETED SEAMS

A riveted joint in a vessel subjected to pressure may fail in a number of different ways, depending on the type and relative proportions of the joint. Methods of failure may be classified as follows:

a.) Rivets may shear off.
b.) The plate may tear along the centerline of the row of rivets.
c.) The plate may shear in front of the rivets.
d.) The plate may tear from the outer edge of the rivet hole to the caulking edge.
e.) The plate may crush in front of the rivets.

Figure S2.10.2.3 illustrates visual indicators of (c), (d), (e). Inspection shall visually inspect for cracked or stressed plate material along a riveted joint. Indications of failure shall be monitored or repaired, at the discretion of the jurisdiction.

FIGURE S2.10.2.3



Note: Good engineering practice requires that the lap of plate outside rivet holes, measured from the outer edge of the rivet holes to the edge of the plate must be at least equal to the diameter of the rivet hole.

Referenced text:

Steam Boiler Design, Part 2, Great Britain, 1922:

20. Methods of Failure of Riveted Joint.—A riveted joint in a vessel subjected to pressure may fail in a number of different ways, depending on the type and relative proportions of the joint; but the simplest methods of failure may be illustrated by taking a single-riveted lap joint as an example. With such a joint, the methods of failure may be classified as follows:

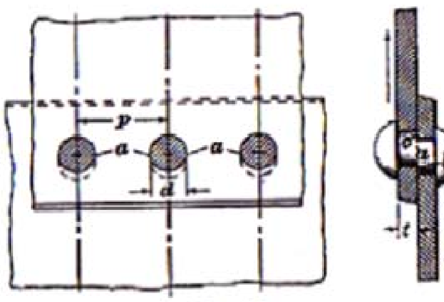


Fig. 19

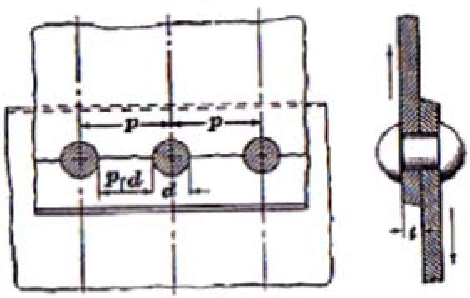


Fig. 20

1. The rivets may shear off, as shown in Fig. 19.
2. The plate may tear along the center line of the row of rivets, as shown in Fig. 20.
3. The plate may crush in front of the rivets, as shown in Fig. 21.
4. The plate may shear in front of the rivets, as shown in Fig. 22 (*a*).
5. The plate may tear from the outer edge of the rivet hole to the calking edge, as shown in Fig. 22 (*b*).

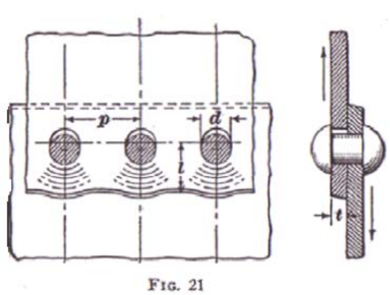
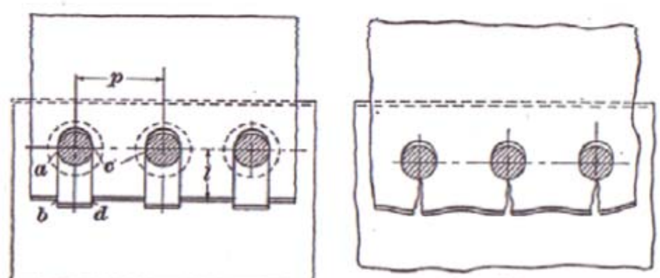


Fig. 21



(*a*) (*b*)

Fig. 22

The provided Note is also important, because a design that does not adhere to this rule may need a different joint efficiency value than what is provided in TABLE S2.10.6. This rule has existed but is not necessarily followed in pre-code boilers.

ASME, 1914:

183 On longitudinal joints, the distance from the centers of rivet holes to the edges of the plates, except rivet holes in the ends of butt straps, shall be not less than one and one-half times the diameter of the rivet holes.

Canadian Interprovincial Standard, 1931:

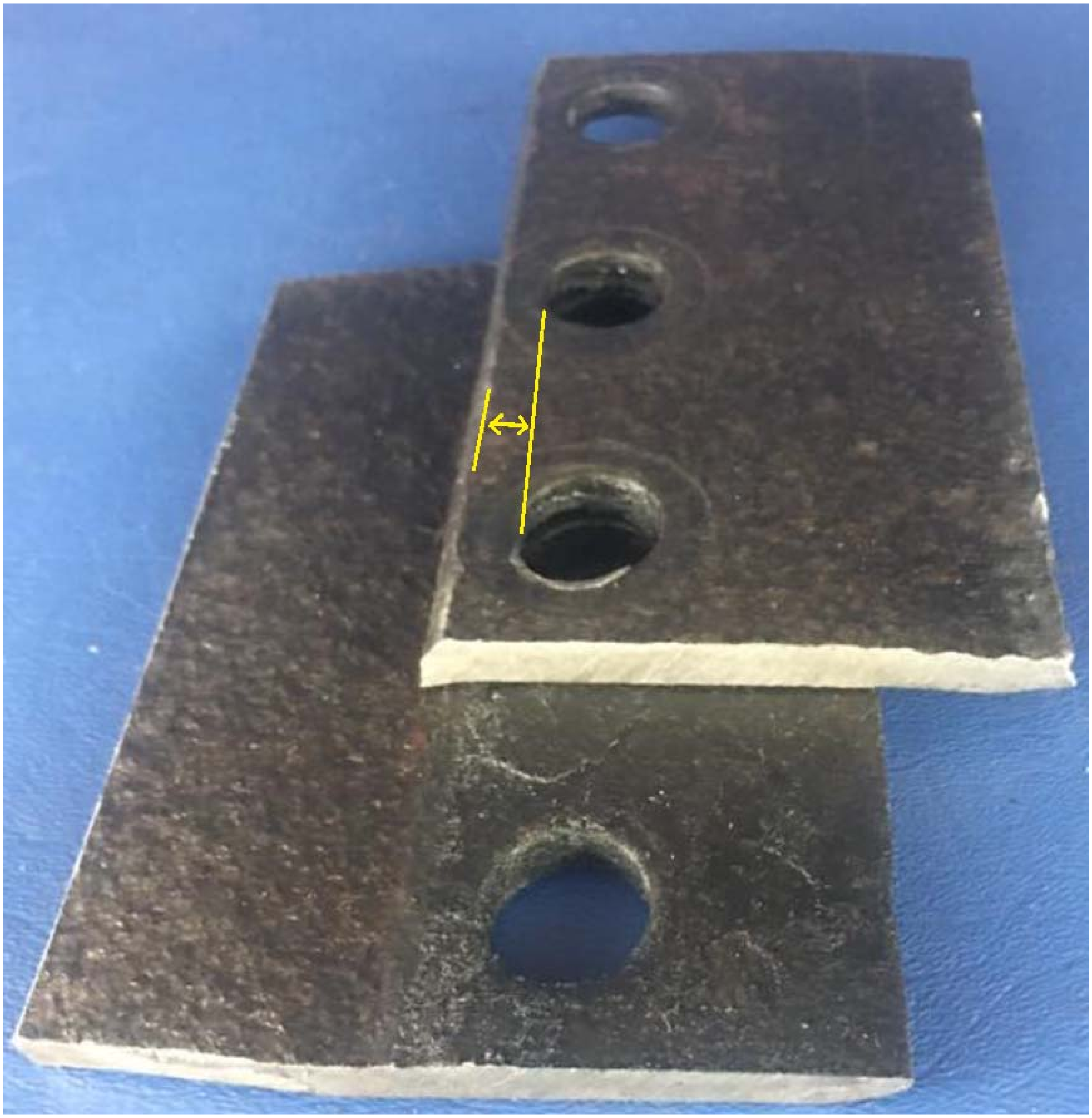
Lap Outside Rivet Holes

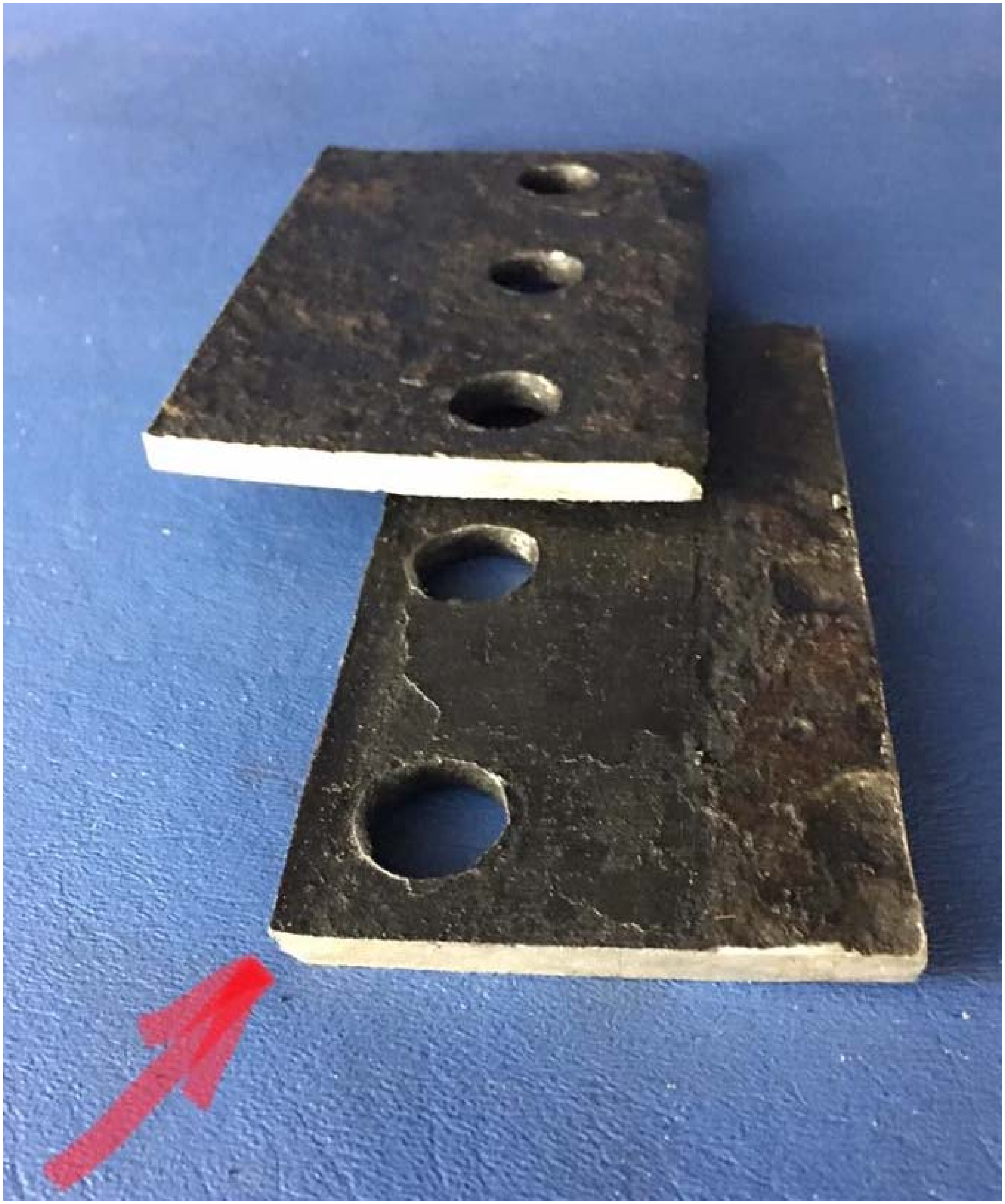
199. The lap of plate outside rivet holes measured from the outer edge of the rivet holes to edge of plate must be at least equal to diameter of rivet hole, and must not be more than 1/8 inch in excess of the diameter of the rivet hole.

Thurston, 1888:

tion. The joint is so proportioned that the fracture will occur by shearing the rivets rather than by breaking out the edge of the sheet or tearing away the lap bodily. The lap usually extends beyond the rivet-hole about 1.5 times the diameter of the rivet.

Single-row lap seam from an 1881 6hp Russell traction engine:





2.2.12.7 THERMAL FLUID HEATERS

a) Design and Operating Features

1) Many thermal fluid heaters are pressure vessels in which a synthetic or organic fluid is heated or vaporized. Some thermal fluid heaters operate at atmospheric pressure. The fluids are typically flammable, are heated above the liquid flash point, and may be heated above the liquid boiling point. The heaters are commonly direct-fired by combustion of a fuel or by electric resistance elements. Heater design may be similar to an electric resistance heated boiler, to a firetube boiler or, more commonly, to a watertube boiler. Depending on process heating requirements, the fluid may be vaporized with a natural circulation, but more often, the fluid is heated and circulated by pumping the liquid. Use of thermal fluid heating permits heating at a high temperature with a low system pressure (600°F to 700°F [316°C to 371°C] at pressures just above atmospheric). To heat water to those temperatures would require pressures of at least 1,530 psig (10.6 MPa).

2) Nearly all thermal heating fluids are flammable. Leaks within a fired heater can result in destruction of the heater. Leaks in external piping can result in fire and may result in an explosion. Water accumulation in a thermal heating system may cause upsets and possible fluid release from the system if the water contacts heated fluid (remember, flashing water expands approximately 1,600 times). It is essential for safe system operation to have installed and to maintain appropriate fluid level, temperature and flow controls for liquid systems, and level, temperature, and pressure controls for vapor systems. Expansion tanks used in thermal heater systems, including vented systems, should be designed and constructed to a recognized standard such as ASME Section VIII, Div. 1, to withstand pressure surges that may occur during process upsets. This is due to the rapid expansion of water exceeding the venting capability.

3) ~~3)~~ Because heat transfer fluids contract and become more viscous when cooled, proper controls and expansion tank venting are required to prevent low fluid level and collapse of the tank. Some commonly used fluids will solidify at temperatures as high as 54°F (12°C). Others do not become solid until -40°F (-40°C) or even lower. The fluids that become viscous will also become difficult to pump when cooled. Increased viscosity could cause low flow rates through the heater. The heater manufacturer recommendations and the fluid manufacturer's Material Safety Data Sheets (MSDS) should be reviewed for heat tracing requirements.

4) It is recommended that thermal fluid heaters have stack gas temperature indicators, alarms and safety shut down devices. Stack gas temerpatures must be monitored daily while in operation.

b) Industrial Applications

Thermal fluid heaters, often called boilers, are used in a variety of industrial applications such as solid wood products manufacturing, resins, turpentines, and various types of chemicals, drugs, plastics, corrugating plants, and wherever high temperatures are required. They are also frequently found in asphalt plants for heating of oils, tars, asphalt pitches, and other viscous materials. Many chemical plants use this type of heater in jacketed reactors or other types of heat exchangers.

c) ~~Inspection~~

~~1) Inspection of thermal fluid heaters typically is done in either the operating mode or the shutdown mode. Internal inspections, however, are rarely possible due to the characteristics of the fluids and the need to drain and store the fluid. Reliable and safe operation of a heater requires frequent analysis of the fluid to determine that its condition is satisfactory for continued operation. If the fluid begins to break down, carbon will form and collect on heat transfer surfaces within the heater. Over- heating and pressure boundary failure may result. Review of fluid test results and control and safety device maintenance records are essential in determining satisfactory conditions for continued safe heater operation.~~

~~2)~~1) Due to the unique design and material considerations of thermal fluid heaters and vaporizers, common areas of inspection are:

a. Design — Specific requirements outlined in construction codes must be met. Some jurisdictions may require ASME Section I or Section VIII construction. Code requirements for the particular Jurisdiction should be reviewed for specific design criteria;

b. Materials — For some thermal fluids, the use of aluminum or zinc anywhere in the system is not advisable. Aluminum acts as a catalyst that will hasten decomposition of the fluid. In addition, some fluids when hot will cause aluminum to corrode rapidly or will dissolve zinc. The zinc will then form a precipitate that can cause localized corrosion or plug instrumentation, valves, or even piping in extreme cases. These fluids should not be used in systems containing aluminum or galvanized pipe. The fluid specifications will list such restrictions;

Note: Some manufacturers of these fluids recommend not using aluminum paint on valves or fittings in the heat transfer system.

c. Corrosion — When used in applications and installations recommended by fluid manufacturer, heat transfer fluids are typically noncorrosive. However, some fluids, if used at temperatures above 150°F (65°C) in systems containing aluminum or zinc, can cause rapid corrosion;

d. Leakage — Any sign of leakage could signify problems since the fluid or its vapors can be hazardous as well as flammable. Areas for potential leaks include cracks at weld attachment points and tube thinning in areas where tubes are near soot blowers. The thermal fluid manufacturer specifications will list the potential hazards;

e. Solidification of the fluid — Determine that no conditions exist that would allow solidification of the thermal fluid. When heat tracing or insulation on piping is recommended by the heater manufacturer, the heat tracing and insulation should be checked for proper operation and installation;

f. Pressure relief devices — Pressure relief valves shall be a closed bonnet design with no manual lift lever. Pressure relief valves must be tested by a qualified repair concern every 36 months unless otherwise directed by the jurisdiction. The pressure relief discharge should be connected to a closed, vented stor- age tank or blowdown tank with solid piping (no drip pan elbow or other air gap). When outdoor discharge is used, the following should be considered for discharge piping at the point of discharge:

1. Both thermal and chemical reactions (personnel hazard);
2. Combustible materials (fire hazard);
3. Surface drains (pollution and fire hazard);
4. Loop seal or rain cap on the discharge (keep both air and water out of the system);
5. Drip leg near device (prevent liquid collection); and
6. Heat tracing for systems using

g. Inspections

In addition to the requirements set down in this part for the type of construction, inspections of thermal fluid heaters shall include verifying that fluid testing is conducted annually and that results are compared to the fluid manufacturer's standard. The inspector shall also verify the documentation of annual testing of controls and safety devices. For those types of construction where the boiler internal cannot be completed on the fluid side a borescope or other suitable device should be used to ascertain conditions to the extent possible.

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January 13, 2020
NBIC Part 2

S2.7.3.2 SUBSEQUENT INSPECTIONS

a) Boilers that have completed the initial inspection requirements begin the subsequent inspection intervals. The following inspection intervals should be used unless other requirements are mandated by the Jurisdiction.

1) Interval #1 — One year following initial inspection. Inservice inspection per NBIC Part 2, S2.7.1.
2) Interval #2 — Two years following initial inspection. Visual inspection per NBIC Part 2, S2.5.2.2.
3) Interval #3 — Three years following initial inspection. A pressure test per NBIC Part 2, S2.6.1.
~~4) Interval #4 — Same as interval #1.~~
~~5) Interval #5 — Visual inspection per NBIC Part 2, S2.5.2.2 and UT thickness testing per NBIC Part 2, S2.6.2.~~
~~6) Interval #6 — Same as interval #3.~~

b) After interval #~~6~~ 3 is completed, the subsequent inspection cycle continues with interval #1.

c) Ultrasonic thickness testing per NBIC Part 2, S2.6.2 shall be performed twenty years from the original boiler manufacturing date and every ten years thereafter, or more frequently at the discretion of the Jurisdiction when applicable.