Date Distributed:

THE
NATIONAL
BOARD
OF BOILER AND
PRESSURE VESSEL
INSPECTORS

NATIONAL BOARD
TASK GROUP
HISTORICAL BOILERS

AGENDA

Meeting of July 13th, 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**
   8:00 AM

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 13th, 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 Reappointments**
      i. Mr. Jon wolf's membership to the group expires on July 30th, 2020.

   b. **Membership Nominations**
      i. Mr. Trevor Seime would like to become a member of the Historical Task Group. He would represent Jurisdictional Authorities.

   c. **Officer Nominations**

9. Action Items

Item Number: 19-22	NBIC Location: Part 2, S2	Attachment Page 3

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. Wahl presented this item to the task group, and wanted the groups thoughts/opinions on how they should move forward. After much discussion, the task group is planning to get more information from past ASME codes before a proposal is presented. During a breakout session the task group worked together and created a PowerPoint to present to the group with further information/research on this item. Mr. Wahl and Mr. Bryce presented the slideshow to the group for further discussion. After much discussion regarding the calculation for external pressure the group decided Mr. Wahl will put together a proposal, and have the proposal sent out for letter ballot to the Historical task group prior to the July 2020 meeting. If the letter ballot passes, they are hoping to have it letter balloted to SC Inspection prior to the July 2020 meeting so they can get their comments and make any necessary revisions.

Update: This item was approved by TG Historical and is currently out for ballot to SC Inspection. The ballot is scheduled to close on July 7th, 2020.

Item Number: 19-84	NBIC Location: Part 2, S2.10.7	Attachment Page 9

General Description: Inspecting riveted joints for failure

Subgroup: SG Historical

Task Group: F. Johnson (PM), M. Wahl & Robert Underwood

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

January 2020 Meeting Action:
Progress Report: R. Bryce presented this item to the group along with a proposal. The proposal showed wording changes and a new figure. There were many concerns with both the wording and the figure. After discussion, the historical task group decided to create a task group for further work on the proposal.

Item Number: 19-89	NBIC Location: Part 2, S2.7.3.2	Attachment Page 15

General Description: Longer NDE cycle for historic boilers

Subgroup: SG Historical

Task Group: D. Rose

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:
R. Bryce presented this item to the group. He presented a PowerPoint showing his research. He then presented a proposal. D. Rose also presented a power point with further information on the subject. A motion was made to accept the proposal as presented. The motion was seconded and passed with 9 approval votes and one abstention.

Update: This item was balloted to SC Inspection and received multiple comments and negative votes.

Item Number: 20-25	NBIC Location: Part 3, S2.13	No Attachment

General Description: Repair Procedure for Fire Boxes

Subgroup: SG Historical

Task Group: M. Wahl (PM), Robin Forbes, T. Dillon, & F. Johnson

Explanation of Need: In NBIC Part 3, S2.13.10.3, S2.13.11 do not define what to do at a riveted joint. On the tubesheet, or firedoor sheet, where it is flanged to rivet to the firebox, the repairs are silent on what to do at the riveted joint.

January 2020 Meeting Action:
Progress Report: Robert Bryce presented this item to the group. He explained the need for new wording to address repair procedures for fire boxes. L. Moedinger noted that this has been addressed in TG Locomotive (Part 3, S1.2.11.5 & Figure S1.2.11.5-c1). After discussion, the group decided to create a task group to create a proposal for the July 2020 meeting.

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

General Description: Concern for Historical Boiler Inspections Nationwide

Subgroup: SG Historical

Task Group: T. Dillon (PM), R. Underwood, L. Moedinger, M. Wahl, D. Rupert, & J. Wolf

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

January 2020 Meeting Action:
Progress Report: Tom Dillon presented the letter submitted by Kevin Anderson to the group, and talked about why Mr. Anderson felt the need for more information on the subject. There was much discussion about the possibility of the National Board coming up with a Historical Boiler Inspectors training course. A task group was assigned to look further into the subject to decide if something needs to be added to the NBIC.

10. Future Meetings

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

11. Adjournment

Respectfully submitted,

Jonathan Ellis

Jonathan Ellis
NBIC Secretary

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TREVOR S. SEIME
825 Crescent Lane, Bismarck, ND 58501
(701) 220-4723

Summary of Qualifications

- Obtained **National Board Joint Review Team Leader** commission.
- Obtained **Asbestos Inspector** certification.
- Over 5 years experience as **Chief Boiler Inspector** for the **State of North Dakota.**
- Over 8 years experience as **Deputy Boiler Inspector** for the **State of North Dakota**.
- Over 7 years experience in **production management** including inventory management and procurement, quality assurance program management, and direct personnel supervision.
- Commissioned as an **Authorized Inspector** by the National Board of Boiler and Pressure Vessel Inspectors.
- Over 8 years experience in all aspects of **quality assurance** and machinery maintenance; **technical supervision**, **training**, and team problem solving associated with nuclear power reactors, steam plants, and all related auxiliary equipment.
- Proficient with IBM compatible computers including the use of Microsoft Office and related software.

Work Experience

State of North Dakota	Chief Boiler Inspector	2015-Present
State of North Dakota	Deputy Boiler Inspector	2006-2015
Creative Industries Inc.	Production Manager	1999-2006
Hartford Steam Boiler I & I Co. of CT	Authorized Inspector	1996-1999
Unites States Navy	Senior Machinery Inspector/Instructor/ Repair Technician/Supervisor	1988-1996

Chief Boiler Inspector

- Responsible for the administration and supervision of the program for the inspection of boilers and equipment for **safe operation and installation** in the State of North Dakota.
- Jurisdictional member of the **National Board of Boilers and Pressure Vessel Inspectors**.
- Maintained **National Board** commission with “A” & “IS” endorsements through continuing education courses.
- Have performed multiple joint reviews for repair shops to help insure compliance to the **National Board Inspection Code** and their quality control programs.

Deputy Boiler Inspector

- Responsible for inspection of boilers and equipment for **safe operation and installation** in the State of North Dakota.
- Witnessed and accepted **repairs** to all types of boilers within the state.

Production Management

- Directly responsible for **overall supervision** of production personnel/assembly line.
- Responsible for **procurement, receipt inspection, and management** of all inventory items.
- Developed time schedule for **timely completion** of production to meet required deadlines.

Authorized Inspector

- Possess a **National Board of Boilers and Pressure Vessel Inspectors** commission.
- Responsible for inspections in accordance with the **American Society of Mechanical Engineers Boiler**

and Pressure Vessel Code.
- Actively performed inspections within the regulations of the **National Board Inspection Code**.
- Directly involved in administering/upgrading the Quality Control systems for multiple shops/repair facilities.

Quality Assurance Inspector/Supervisor

- Administered the Navy's **Quality Assurance** program utilizing **ISO 9000** requirements.
- Responsible for the **procurement, receipt in-check inspection, in-process control, and final acceptance** of repair parts for plant components.
- Knowledgeable in quality assurance; offering solutions to complex maintenance issues combining an in-depth knowledge of quality assurance with an overall understanding of all mechanical systems.

Supervisor/Operator

- **Expertly managed division** while direct supervisor was absent and provided forceful backup when supervisor was present.
- Excellent **steam plant operator** with a rapid qualification policy which provided for enhanced flexibility of man-hours and work schedule.
- Proven **flexibility** of hours that ensured **completion** of work and team goals.
- **Technical** proficiency and a sound **understanding** of power plant operation, making for an excellent team supervisor/member.
- **Created** work teams and **devised** creative plans to coordinate work to efficiently complete maintenance items despite a very restrictive schedule.

Instructor

- Responsible for the **training and certification** of officer and enlisted nuclear power plant operators in the areas of: Theoretical Concepts, Physics, Heat Transfer and Fluid Dynamics, Thermodynamics, and hands-on operation and emergency control.
- Provided **guidance** to newly reported personnel, treating them fairly and with dignity, instructing them on plant operation, and helping to ease their transition to submarine life and realize their importance to the division and to the entire team.

Maintenance Technician

- Obtained qualification as an **EPA** air conditioning and refrigeration universal technician.
- Displayed **superior** technical expertise and projected knowledge of plant maintenance to trainees.
- Provided an endless resource of **technical ability/knowledge** to division.

Training

National Board Joint Review Team Leader	32 Hours
Asbestos Inspector Course	24 Hours
Hartford Steam Boiler National Board Preparatory Course	120 Hours
Hartford Steam Boiler "A" Endorsement Course	40 Hours
Quality Assurance Inspector	40 Hours
Administration and Operation of Maintenance Systems	40 Hours
EPA Refrigeration and Air Conditioning Technician	40 Hours
Machine Tool Operator	120 Hours
Naval Nuclear Power Plant Operator	26 Weeks
Naval Nuclear Power School	24 Weeks
Naval Machinist's Mate "A" School	13 Weeks

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

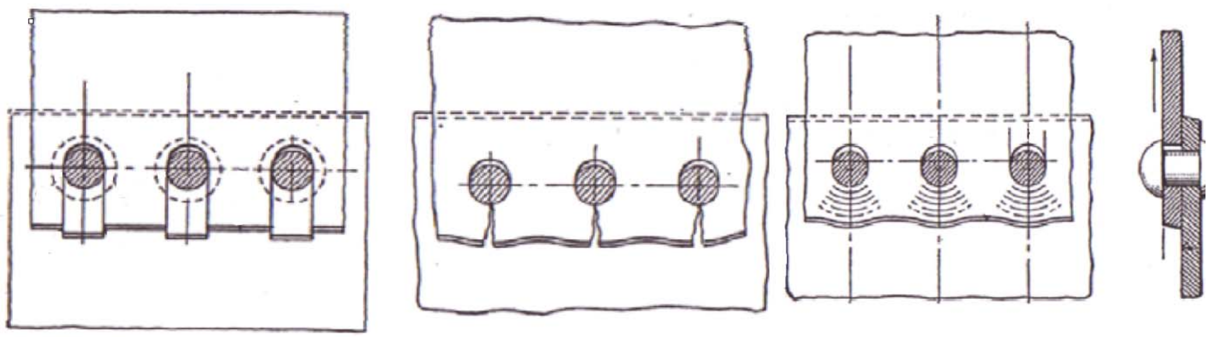
S2.10.2.3 INSPECTION OF RIVETED SEAMS

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:

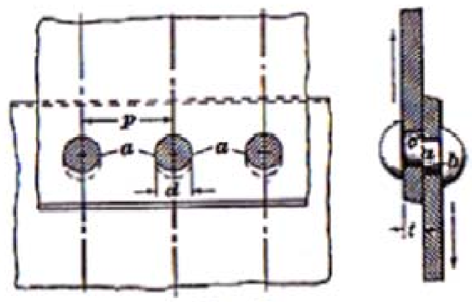


Fig. 19

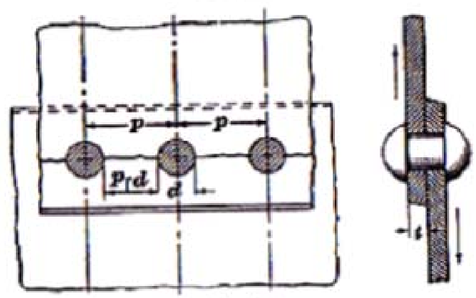


Fig. 20

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*).

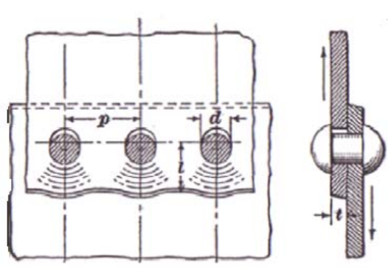
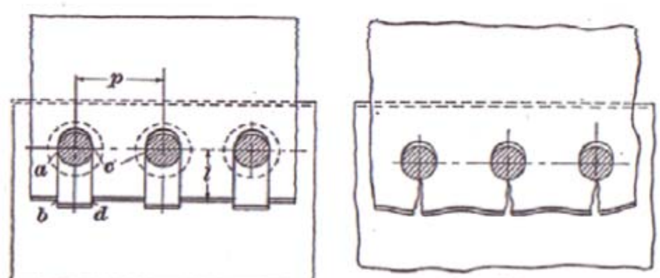


Fig. 21



(*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:

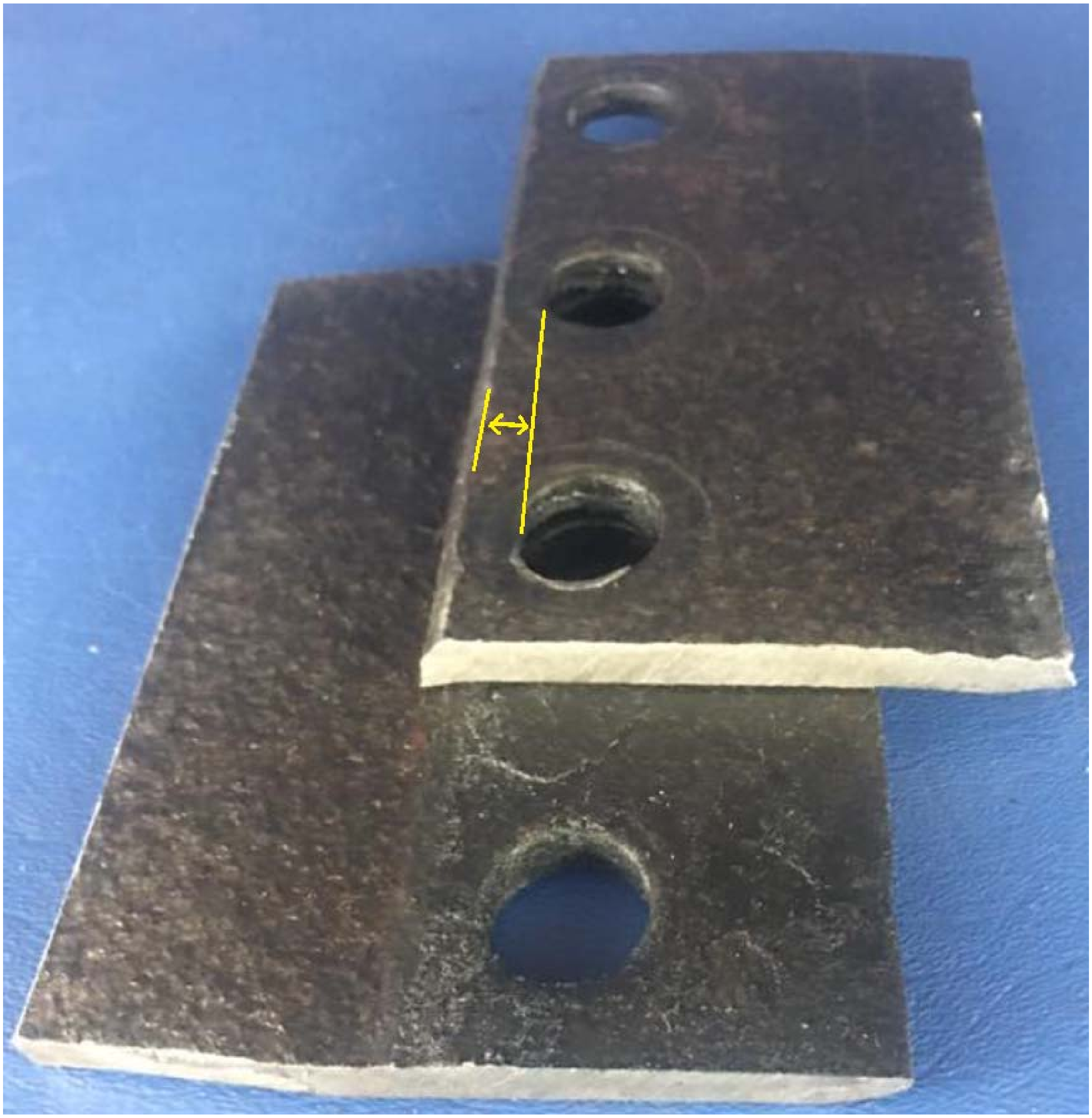
Lap Outside Rivet Holes

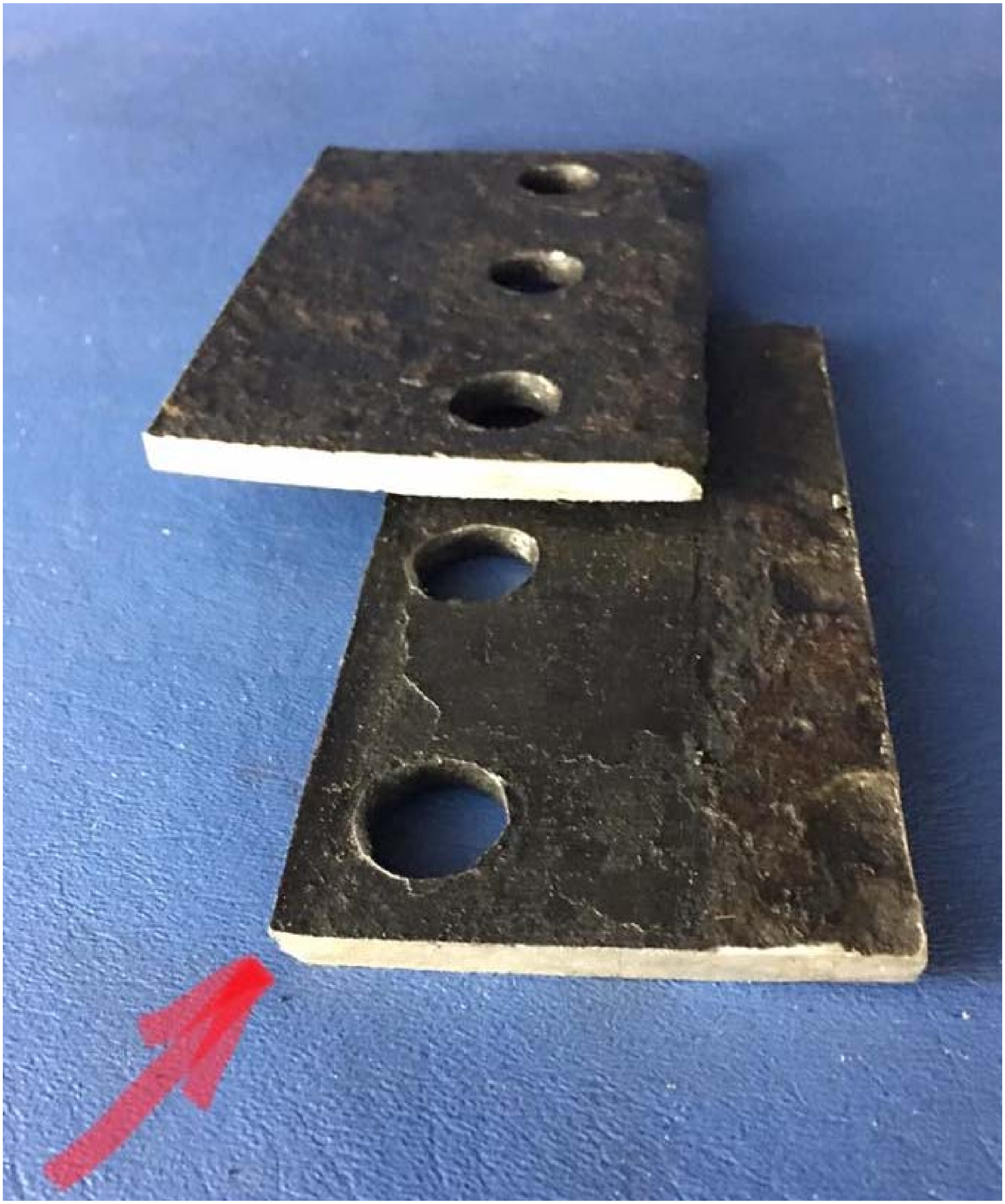
199. The lap of plate outside rivet holes measured from the outer edge of the rivet holes to edge of plate must be at least equal to diameter of rivet hole, and must not be more than 1/8 inch in excess of the diameter of the rivet hole.

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:





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.