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THE NATIONAL BOARD OF BOILER AND PRESSURE VESSEL INSPECTORS

NATIONAL BOARD TASK GROUP HISTORICAL BOILERS

MINUTES

Meeting of July 13, 2020
Louisville, KY

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The National Board of Boiler & Pressure Vessel Inspectors
1055 Crupper Avenue
Columbus, Ohio 43229-1183
Phone: (614)888-8320
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1. **Call to Order**
   Chairman, Tom Dillon, called the meeting to order at 8:14 am.

2. **Introduction of Members and Visitors (Attendance Sheet – Attachment Page 1)**
   The members & visitors that were physically present at the meeting went around the room to introduce themselves. The members and visitors that were present via WebEx, were called upon one at a time to introduce themselves.

3. **Check for a Quorum**
   With the members present both physically and through WebEx, a quorum was established.

4. **Awards/Special Recognition**
   Mike Whal was to be presented with a 10 year pin in July 2019; however, he has not been in attendance to receive his pin.

5. **Announcements**
   Secretary, Jodi Metzmaier gave the announcements to the Subgroup **(Attachment Page 2).**

   It was announced that voice voting was going to be for negatives, abstentions, and not voting only. All other votes would be assumed as approved.

6. **Adoption of the Agenda**
   A motion was made to accept the agenda. The motion was seconded. There below changes were made to the agenda:

   - Add Chris Jowett as a nominee for Task Group Historical. His interest category will be (National Board Certificate Holder)

   Agenda was unanimously adopted as revised.

7. **Approval of the Minutes of the January 13th, 2020 Meeting**
   A motion was made to approve the minutes from the January 13, 2020 Historical Task Group meeting. The motion was seconded and **unanimously approved**.

8. **Review of Rosters**
   a. **Membership Reappointments**
      Mr. Jon Wolf's membership to the group expires on July 30th, 2020.

      Mr. Jon Wolf voiced that he would like to continue being a member of the Historical Task Group. A motion was made to approve his reappointment. The motion was seconded and unanimously approved.

   b. **Membership Nominations**
      Mr. Trevor Seime **(Resume - Attachment Pages 3-4)** would like to become a member of the Historical Task Group. He would represent Jurisdictional Authorities.

      Mr. Chris Jowett **(Resume - Attachment Pages 5-6)** would like to become a member of the Historical Task Group. His interest category will be National Board Certificate Holder.

      Both nominees spoke on their behalf stating why they want to become a member of the Historical Task Group and noted how they would be a good asset to the group. Both nominees have attended at least 2 previous meetings. A motion was made for each nominee to become a member. The motions were both seconded and unanimously approved.

   c. **Officer Nominations -** There were no officer nominations at this meeting.

9. Action Items

Item Number: 19-22	NBIC Location: Part 2, S2	Attachment Page 7-12

General Description: Review of MAWP on Return Flue Boilers.

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

July 2020 Meeting Action:
This item was presented to the task group by Tom Dillon. The group reviewed the negative vote from the SC Inspection Letter Ballot. During discussion of the proposal there were many changes made to the document. A motion was made to approve the document as revised. The motion was seconded and **unanimously approved**.

During discussion of this item it was also noted that the General Description be changed to read "Review of MAWP on Cylindrical Components Under External Pressure".

Item Number: 19-84	NBIC Location: Part 2, S2.10.7	No Attachment

General Description: Inspecting riveted joints for failure

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

July 2020 Meeting Action:
Progress Report: Frank Johnson presented this item to the Historical Task Group. There were concerns and questions that Mr. Bryce was able to respond to and answer. The group has a lot of discussion and made a few changes to the presented document. After more discussion it was decided that the Task Group needs to do more work on the proposal before it can be moved forward.

Item Number: 19-89	NBIC Location: Part 2, S2.7.3.2	Attachment Page 13

General Description: Longer NDE cycle for historic boilers

Subgroup: SG Historical
Task Group: D. Rose

July 2020 Meeting Action:
The disapproval comments from the letter ballot to SC Inspection were reviewed and discussed. There were many concerns, which lead to a break out session by the task group. After the breakout session, the revised proposal was presented. The task group revised the wording in S2.7.3.2 on their proposal. There were more changes made during discussion of the revised proposal. The group then made sure all letter ballot comments were addressed. A motion was made to accept the revised proposal. The motion was seconded and **unanimously approved**.

After approval another question came up and the group made more changes to the proposal. Another motion was made to accept the revised proposal again. The motion was seconded and **unanimously approved**.

Kathy Moore had to leave the meeting and nominated Don Kinney as her alternate.

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

July 2020 Meeting Action:
Progress Report: Mr. Bryce discussed this item with the Task Group along with a diagram from the ASME Code. Mr. Moedinger explained the similar diagram used in the Locomotive section of NBIC Part 3, Figure S1.2.11.5-c1, New Patch Alignment with Original Material. Mr. Dillon suggested adding new figured for other angles (side view) to better explain the transition. Locomotive will be opening a new item to update and revise their diagrams, and possible add new diagrams. Locomotive and Historical will work together on these figures. After a breakout session Mr. Moedinger showed a new figure that he worked on to show the direction he is going and to get the Task Groups comments.

TASK GROUP UPDATE: Add L. Moedinger to the task group

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

July 2020 Meeting Action:
Progress Report: K. Anderson presented this item to the task group. He read the letter he submitted to the task group, and the group had a discussion. Mr. Amato noted there are Historical Boiler Courses popping up all over the US, but the National Board is still looking into the option of creating their own course. The task group will do more work and research on this item before presenting a proposal.

The discussion of this item also led to a discussion regarding making sections of the NBIC available for purchase. The National Board will discuss this internally.

TASK GROUP UPDATE: Add K. Anderson to the task group.

10. Future Meetings

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

Chairman, Tom Dillon, discussed the future meetings with the Task Group.

11. Adjournment

A motion was made to adjourn the meeting at 3:56 PM. The motion was seconded and **unanimously approved**.

Respectfully submitted,

Jodi Metzmaier
Task Group Historical Secretary

Historical Attendance

MEMBERS:	In Person	WebEx	Not In Attendance
Tom Dillon	X		
Jim Getter	X		
Frank Johnson	X		
Kathy Moore		X	
David Rose		X	
Dennis Rupert			X
Matt Sansone	X		
Rob Troutt		X	
Rob Underwood	X		
Mike Wahl			X
Jon Wolf		X	

VISITORS:	In Person	WebEx
Joe Morgan	X	
Chris Jowett	X	
Trevor Seime	X	
Don Kinney		X
George Galanes		X
Kevin Anderson		X
Linn Moedinger		X
Michael Carlson		X
Robin Forbes		X
Robert Bryce		X
M.A. Shah		X
Mark Jordan	X	

Announcements

- The National Board will be hosting a reception for all committee members and visitors on Wednesday evening at 5:30pm in the Bluegrass Room
    - Seated dinner
    - Who is coming to the reception?

- Breakfast (7-8 am) and Lunch (11:30 -12:30) will be provided to NBIC Committee members and visitors on Thursday.

- We will take a short break around 9:30-10:00 for task groups to work on items.

- Meetings schedule and meeting rooms layout are on the website under National Board Inspection Code tab → NBIC Committee Information → NBIC Meeting Information

- If the meeting ends early use the extra time to work with your task groups.
    - This can be done through Zoom/WebEx if needed.

- Always submit attachments in word format showing "strike through/underline"
    - Does anyone need to know how to do this?

- Naming format reminder:
    - *Item number - person who made the revision - date update*

- **We will do a voice voting for the negatives, not voting, and abstentions only.**

- As a reminder, anyone who would like to become a member of a group or committee, must submit their resume to Jonathan PRIOR TO the meeting.
    - *nbicsecretary@nationalboard.org*

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

CHRIS JOWETT

Construction Equipment Services, Inc
157 Mckendree Rd
Odessa, Mo 64076
816-230-1514

I am an active owner/operator in the steam traction engine hobby. I am also a co-owner of an R Stamp holding company that specializes in historical boiler repair and the restoration of steam traction engines, since 2011.

EXPERIENCE

CONSTRUCTION EQUIPMENT SERVICES, INC
2014 – PRESENT

VICE PRESIDENT

Quality Control Manager for the company's R Stamp. I am responsible for all of the design and calculations for the repairs and alterations performed by the company. I also head up all the restoration projects that my company performs including machine shop services, painting, and fabrication.

GRAIN VALLEY TOOL & MFG
2012 – 2014

QUALITY CONTROL INSPECTOR

Head Quality Control Manager. Performed duties such as in process inspection, final inspection, non-conforming reports, government sanctioned inspections, and CMM Operator and Programmer.

2006 – 2012

MACHINEST

Performed many job duties such as. Tool and Die Machinist, fixture design and fabrication, part assembly, CNC Programmer, CNC Operator, machine maintenance and repair

EDUCATION

2006-2008
METROPOLITAN COMMUNITY COLLEGE
Studied in Machining, Tool and Die Making, Geometric Dimension and Tolerancing, Non-Destructive Examination, Destructive Examination and general studies

2004-2006
LEX-LA RAY TECHNICAL SCHOOL
Studied in Machining, CNC Operation and Programing, and CAD Design

2002-2006
ODESSA HIGH SCHOOL
General studies with emphasis in Math and Agriculture studies

QUALIFICATIONS FOR POSITION

- Proficient with Solidworks Design Software
- Owner/Operator of historical boilers
- Co-owner of an R Stamp holding company
- Works with the NBIC code every day in my profession

ACTIVITIES

I grew up in a family dedicated to the steam traction engine hobby since 1974. In our family we personally own 11 steam traction engines. In 2011, my father David Jowett owner of Construction Equipment Services, Inc received his R Stamp. Shortly after I joined the family business and we work everyday on historical boilers and steam traction engines. We exhibit our engines at shows across Kansas and Missouri every year.

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:

50

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

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:

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

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

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

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.

S2.6.2 ULTRASONIC THICKNESS TESTING

Ultrasonic thickness (UT) testing shall be performed to determine boiler plate thickness. UT testing shall be performed by personnel acceptable to the Jurisdiction and the Inspector. The following requirements shall be met, to the extent possible. Performance and results shall be acceptable to the Inspector and, if required, the Jurisdiction.

a) Equipment, operator, and calibration standards used shall be documented.
b) On initial UT of stayed sections, the plate thickness readings should be taken on a grid not exceeding the maximum staybolt pitch. Additional readings may be taken close to each staybolt to determine if localized thinning has occurred. Particular attention should be given to the joint between the staybolt and the plate.
c) On initial UT of unstayed sections, the plate thickness readings should be taken on a grid not exceeding 12 inch (300mm) centers. Additional readings should be taken if conditions warrant.
d) UT test results shall be documented so location of test results can be checked at subsequent UT tests to determine if material loss has occurred.
e) Recurring UT testing shall be performed by randomly checking 10% of original UT checks. Areas of thinning identified during previous inspections shall be given particular attention. If material loss is determined, additional testing may be requested by the Inspector.
f) Particular attention should be placed upon areas that typically exhibit thinning. These areas include the ogee curve, the mudlegs, the fusible plug, around feedwater inlets, and around the firebox door ring.
g) The owner/operator shall maintain the initial and recurring grid mapped UT readings in conjunction with the calculations in permanent boiler records. Documentation shall be available to the Inspector for review and acceptance.
h) Unstayed plain circular cylindrical components under external pressure shall require readings performed on a grid not exceeding 9 inch centers. Additional readings should be taken if conditions warrant.

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:

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

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

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

TABLE S2.10.3.1

CONSTANTS FOR CALCULATED MAWP FOR CYLINDRICAL COMPONENTS UNDER EXTERNAL PRESSURE

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, and a 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.

C_1 & C_2 = constants, see Table S2.10.3.1

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.

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

c) UT thickness testing per NBIC Part 2 S2.6.2 shall be performed at 5 year intervals, or at a shorter interval if deemed necessary by the Jurisdiction.

1) Recurring UT thickness testing may be extended by up to 1 cycle (5 years) where the owner can demonstrate the following:

a. Two prior consecutive NDE reports following this cycle, spanning a minimum of 5 years, showing that current practice permits a longer NDE cycle;

b. Storage and care of the boiler in adherence with the applicable sections of S2.13.1 STORAGE METHODS; and

c. Continued records (ie; visual images and log book records showing correct water treatment) shall be reviewed annually during the extension period indicating no change to boiler condition.

2) New construction ASME Section I boilers are not subject to UT thickness testing for 20 years from the date of manufacture.