THE NATIONAL BOARD OF BOILER AND PRESSURE VESSEL INSPECTORS

NATIONAL BOARD INSPECTION CODE SUBCOMMITTEE ON INSPECTION

MINUTES

Meeting of January16, 2013
Mobile, Alabama

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The National Board of Boiler & Pressure Vessel Inspectors
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MINUTES OF SUBCOMMITTEE ON INSPECTION
JANUARY 16, 2013 MOBILE, ALABAMA

1. Call to Order

The Vice-Chairman Stan Staniszewski called the meeting to order at 8:00 AM on January 16, 2013. Mr. Cook resigned as Chairman of the Subcommittee to assume responsibilities as Chairman of the NBIC Main Committee.

2. Announcements

a) The National Board would host an outing to the USS Alabama on January 16, 2013 from 6 – 9:00 PM
b) The National Board would host a breakfast on January 16, 2013 from 7 – 8:00 AM
c) The National Board would host a breakfast on January 17, 2013 from 6:30 – 8:00 AM
d) The National Board would provide a luncheon on January 17, 2013 from 11:30 - 12:30 PM

3. Adoption of the Agenda

A motion was made to adopt the Agenda as modified. The motion was unanimously approved.

4. Approval of the Minutes of July, 2012

A motion was made to approve the minutes of the July, 2012 meeting. The motion was unanimously approved.

5. Review of the Roster

The attendees, members, alternates and guests are identified on **Attachment 1.** With the attached attendance listing, a quorum was established. Mr. McRae was excused.

A vote was taken to elect a new chairman for the Subcommittee on Inspection to replace Mr. Don Cook. Mr. Mark Mooney was elected by majority vote.

Dr. Marshall Clark was reappointed to SG on Inspection-Specific.
Dr. Domenic Canonico was elected to SG on Inspection-Specific.

Mr. Paul Welch was elected to SG on Inspection-General and SG on Inspection-Specific.

6. Public Review Comments

The responses to all the following public review comments are tabulated on **Attachment 2:**

PR13-0209 ***Part 2, 2.2.10.6 SC on Inspection*** **-**The NBIC is supposed to be a safety code so why is a good practice only a good practice if required by a jurisdiction. For example, 2.2.10.6 a) is or is not that paragraph a good practice? A Jurisdiction only makes a good practice mandatory but without the jurisdictional requirement a good practice is optional with the owner/user. This section should be revised to indicate "good practices" should be complied with but are mandatory when required by the jurisdiction.

PR13-0210 ***Part 2, 2.2.10.6 h) SC on Inspection*****-**Revise h) On forced circulation boilers the flow sensing device shall be tested to verify the boiler shuts down on loss of flow.

PR13-0211 ***Part 2, 2.3.6.5 b) 1) SC on Inspection*** **-** How is intended service of a tank determined when the service is not marked on the nameplate, and most likely is not listed on the Manufacturer's Data Report. Further, what does welding have to do with a missing or illegible nameplate? Also, the paragraph states welding is prohibited, but the next sentence indicates post construction welding is permitted. The paragraph is confusing and contradictory. Please revise.

PR13-0212 ***Part 2, 2.3.6.5 b) 4) SC on Inspection*** - Z87 rated goggles: List the rating organization and the full identification of the specification.

PR13-0213 ***Part 2, 2.3.6.7 a) SC on Inspection*****-** Change "must" and "should" to "shall".

PR13-0214 ***Part 2, 2.3.6.7 a) 3) SC on Inspection*** - Change "should" to "shall". The vessel will not be in operation during an inspection so I don't understand how this requirement can be verified. This is an operational requirement and should not be in Part 2 of the NBIC.

Public Review Comments (continued)

PR13-0215 ***Part 2, 2.3.6.7 a) 4) SC on Inspection*** **-** Change "should" to "shall".

PR13-0216 ***Part 2, 2.3.6.7 b)2) & 3) SC on Inspection*** **-** Change "should" to "shall". In many cases, these are lifesaving vessels. The owner/operator should be told in strong terms the vessel needs to be in excellent condition. Should indicates "when you get around to it, minor inconvenience."

PR13-0217 ***Part 2, 2.3.6.7(b)(4) SC on Inspection*** **-**Change "should" to "shall" Also, if the opening is for exhaust, then it is an outlet for the vessel. How is this inspection to be accomplished? Are there grates over the outlets?

7. Inquiries

IN12-0201 ***SC on Inspection Part 2, 5.2*** *Q: If a National Board Commissioned Inspector has verified the replacement of stamped data or nameplate by an "R" Certificate Holder on Corrugated Rolls that are not stationary and subject to operation in multiple Jurisdictions, possibly by multiple owners, is the application of an NB-36 "Replacement of Stamped Data" form required? A: No, if performed by an "R" Certificate Holder and verified by an National Board Commissioned Inspector the responsibility of traceability and nameplate accuracy is on the Certificate Holder similar to nameplate replacement in the NBIC Part 3, 5.5.9.5.*

The reply to this inquiry was answered by Action Item NB12-1801

IN12-0202 ***SC on Inspection Part 2, 5.2*** *Q: Can an NB-36 "Replacement of Stamped Data" form which is required to be signed by an National Board Commissioned Inspector, for Corrugated Rolls that are not stationary and subject to operation in multiple Jurisdictions, possibly by multiple owners, be filed with the National Board and copied to the applicable Jurisdiction in lieu of obtaining an approval signature from the Jurisdiction? A: Yes, the approval from one Jurisdiction should not be incumbent on any other Jurisdiction due to transient nature of Corrugated Roll Presure Wquipment. Similarly, if there is no Jurisdiction in the location of installation another Jurisdiction would be compelled to accept National Board filing if the equipment is moved.*

The reply to this inquiry was answered by Action Item NB12-1801

8. Action Items

NB07-0910 ***Part 2 S-6 SG Inspection Specific*** *Review DOT supplement. A Task Group comprised of S. Staniszewski (Lead), G. McRae, and J. Riley is assigned*
A progress report was given by Mr. Staniszewski.

NB08-0321 ***Part 2 1.5 SG on Insp. Spec.*** *Add in paragraph 1.5 Inspection Activities wording to address change of service for a pressure vessel. These requirements should caution inspectors, owners, and jurisdictional authorities of the inherent dangers involved when changing service. A new supplement or new Subject under 2.3.6, Description and Concern of Specific Types of Pressure Vessels, should be added to address the specific requirements for inspection of pressure vessels that have been converted from one service to another. A Task Group has been formed from all three parts of the NBIC under the leadership of R. Wielgoszinski. Task group members from Part 2 are G. McRae (Lead), R. Reetz, R. Wacker, D. Cook, and J. Getter.* A progress report was given by Mr. Staniszewski.

NB08-0701 ***Part 2 S7 SG on Insp. Spec.*** *Add a requirement for change of service from above ground to below ground installations of LPG tanks. Also needed are requirements for how to inspect these tanks. A Task Group comprised of G. McRae(Lead), G. Galanes, J. Getter, M. Huffman, V. Mullins, J. Reed, D. Cook, J. Richardson, and V. Newton is assigned.* A report was given by Mr. Staniszewski. The Task Group was reorganized, V. Mullins(Lead)

NB10-0601 Part 2 S9, SG on Fiber Reinforced Plastic - *Inspection of high pressure composite vessels.*
A report was given by Mr. Staniszewski.

Action Items (Continued)

NB11-0201 ***Part 2 Supplement 2 SG on Historical Boilers*** *Limits for Bulged Stayed Firebox Sheets A Task Group consisting of R. Bryce (Chair), D. Cook and F. Johnson was assigned.* A presentation was given by Mr. Reetz. A motion was made to accept the proposal. Motion carried. 11 votes in favor, 2 not voting. **(Attachment 3)**

NB11-0204 ***Part 2 &3 Supplement 2 SG on Historical Boilers*** *Review NDE requirements of stayed areas. A Task Group consisting of M. Wahl (Chair), J. Larson and F. Johnson was assigned.* A progress report was given by Mr. Reetz.

NB11-1101 ***Part 2 S2.6.2 b) SG on Historical Boilers*** *This section should be revised to provide more guidance for evaluating local pitting corrosion versus general corrosion. A Task Group consisting of M. Wahl and Don Cook was assigned.* A progress report was given by Mr. Reetz.

NB12-1201 ***Part 2 S2.10.2 SG on Historical Boilers*** *Review requirements for stayed areas. A task group of D. Cook, T. Dillon, and R. Bryce was assigned.* A presentation was given by Mr. Reetz. A motion was made to accept the proposal. The motion passed unanimously. **(Attachment 4)**

NB12-1501 ***Part 2 SG Inspection General -*** *Review inspection requirements so as to align with installation requirements in Part 1. A Task Group of V. Newton, M. Horbaczewski, J. Daiber and J. Safarz was assigned.*
A progress report was given by Mr. Newton.

NB12-1801 ***Part 2 5.5.2 – 5.5.3 SG Inspection General -*** *This item is a result of IN12-0201 & IN12-0202. Replacement of stamping during inservice inspection*. A Task Group consisting of M. Mooney (Lead), R. Dobbins, T. Barker, D. Canonico, and Daren Daily was assigned. A report was given by Mr. Mooney. After much discussion, the response language to IN12-0201 & IN12-0202 was completed. **(Attachment 5)**

NB13-0601 ***Part 2 4.4.7 & 4.4.8, SG Inspection General*** *List item "j" in part be relocated to 4.4.8.7 Evaluating Pressure Retaining Items containing local thin arrears, with the relocated text placed between current list item "e" and "f" of section 4.4.8.7 with the existing list items following this insert then designated as items "g" and "h" respectively.* A discussion was led by Mr. Mooney. After discussion, a motion was made to accept the proposal. The motion was unanimously approved. **(Attachment 6)**

NB13-0701 ***Part 2 4.4.7 (j), SG Inspection General*** *Revise wording to clarify the rule in this section.*
A Task Group will be assigned. No progress.

9. New Business

NB13-0901 ***SG on Historical Boilers*** *Review requirements for safety valve discharge piping.* A Task Group consisting of F. Johnson and T. Dillon was assigned.

NB13-0902 ***SG on Historical Boilers*** *Review alternate methods of Tube Sheet repair.* A Task Group consisting of F. Johnson, T. Dillon and M. Wahl was assigned.

NB13-1301 ***Part 2 SG Inspection General*** *Review methods of Finite Element Analysis as they pertain to inspection.* A Task Group consisting of J. Riley(Chair), Stan Staniszewski, M. Schwartzwalder, M. Mooney and R. Pate was assigned.

NB13-1302 ***Part 2 SG Inspection General*** *Review Cryogenic vessel inspection requirements.* A Task Group consisting of J. Riley(Chair), A. Renaldo, R. Dobbins, R. Bartley and R. Pate was assigned.

NB13-1303 ***Part 2 SG Inspection General*** *Review Inspection requirements for Biomass Fueled Boilers.* A Task Group consisting of M. Mooney(Chair), M. Horbaczewski, D. Canonico, and J. Safarz was assigned

NB13-1001 ***Part 2 2.3.6.6 SG on Insp. Spec. –*** *Consider adding new paragraph concerning DOT Traansport Tanks.* Mr. Staniszewski presented a proposed new paragraph.

New Business (continued)

NB13-0801 ***Part 2 SG on Insp. Spec. –*** *Review inspection requirements for CO2 Tanks.* A Task Group will be assigned.

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

10. Future Meetings

July 2013 Columbus, Ohio
January 2014 San Antonio, Texas

11. Adjournment

The meeting was adjourned at 12:30 PM on January 16, 2013.

Respectfully Submitted,

Bill Smith
Secretary, Subcommittee on Inspections

Attachment 1- Attendance Roster
Attachment 2- PR13-0208 thru PR13-0217
Attachment 3- NB11-0201
Attachment 4- NB12-1201
Attachment 5- NB12-1801
Attachment 6- NB13-0601

Attendance List SC on Inspection

Meeting Date: January 16, 2013

Ralph Pate Chief Elevator/Boiler Inspector Alabama Department of Labor 100 North Union St., Suite 630 PO Box 303500 Montgomery AL 36130-3500 Ph: 334-242-3066 Fax: 334-240-3417 Email: ralph.pate@labor.alabama.gov see Next Page Below	Attended: Yes ☐ No ☐ *Initial*	**Domenic A. Canonico** Canonico & Assoc. 1423 East Brown Road Signal Mountain, TN 37377 Ph: 423-886-1008 Fax: E-mail: canonicod@epbfi.com.	Attended: Yes ☒ No ☐ DCC *Initial*
Stanley Staniszewski, Jr. US Dept. of Transportation, Pipelines & Administration Hazardous Materials Safety East Building PHH -20 1200 New Jersey Ave. SE Washington, DC 20590 Ph: 202-366-4545 x 0453 Fax: 202-366-3753 E-mail: stanley.staniszewski@ dot.gov	Attended: Yes ☑ No ☐ *Initial*	**Robert Reetz** Chief Boiler Inspector North Dakota Insurance Department Boiler Inspection Program 1701 S. 12th Street Bismarck, ND 58504-6644 Ph: 701/328-9607 Fax: 701/328-9610 E-mail:**breetz@nd.gov**	Attended: Yes ☒ No ☐ *Initial*
Tim Barker → OPERATIONAL CHIEF INSPECTOR FM Global 601 108th NE Suite 1400 Bellevue, WA 98004 Ph: 360-801-3790 Fax: E-mail: **Timothy.Barker@FMGlobal.com**	Attended: Yes ☑ No ☐ *Initial*	**Jason Safarz** SALES & MARKETING DIRECTOR ~~Senior Account Engineer~~ CEC Combustion Services Group 11699 Brookpark Road Cleveland, OH 44130 Ph: 216-749-2992 Fax: 216-398-8403 Email: jsafarz@cumbustionsafety.com	Attended: Yes ☒ No ☐ JMS *Initial*
Mark Mooney Liberty Mutual Insurance ~~Engineering Manager-Eastern Region~~ Chief Engineer 20 Riverside Road MS:03BN Weston, MA Ph: 781-891-890 x 27329 Fax: 781-642-6512 E-mail: Mark.Mooney@Libertulmual.com	Attended: Yes ☑ No ☐ *Initial*	**Jim Getter** Worthington Cylinders 200 Old Wilson Bridge Road Columbus, OH 43085 P: 614-840-3087 F: 614-438-3083 E-mail: jmgetter@worthingtonindustries.com	Attended: Yes ☒ No ☐ *Initial*
Mike Schwartzwalder Stress Engineer Services, Inc. ~~5380 Courseview Drive~~ 7030 STRESS ENGINEERING WAY Mason, OH 45045 Ph: 513-336-6701 Fax-614-716-1744 E-mail: ~~meschwartzwr~~@stress.com MSchwartzwalder@ Stress.com	Attended: Yes ☐ No ☐ *Initial*	**Bill Smith** National Board 1055 Crupper Ave. Columbus, OH 43229 P: 614-888-8320 F: 614-847-1828 E: bsmith@nationalboard.org	Attended: Yes ☒ No ☐ WKS *Initial*

Attendance List SC on Inspection

Meeting Date: **January 16, 2013**

Jim Riley ~~Conoco~~Phillips 66 1380 San Pablo Ave. Rodeo, CA 94572-1354 P: 510-245-5895 F: E-mail: jim.riley@conocophillips.com jim.riley@P66.com	Attended: Yes ☒ No ☐ JMR *Initial*	**Greg McRae** Engineering and Technical Director Trinity Containers, LLC 2525 Stemmons Freeway Dallas, TX 75207 Ph: 214-589-8559 Fax: 214-589-8553 E-mail: greg.mcrae@trin.net	Attended: Yes ☐ No ☐ *Initial*
Venus Newton Manager of Jurisdictional Inspection Services One CIS Insurance Company 3380 Chastain Meadows Pkwy Kennesaw, GA 30144 Ph: 770-590-6726 Cell: 678-457-1310 Fax: E-mail: venus.newton@us.bureauveritas.com	Attended: Yes ☒ No ☐ VN *Initial*	**Mark Horbaczewski** Midwest Generation ~~1111 W Cermak~~ Joliet Generating Station ~~Chicago, IL 60608~~ 1601 S Patterson Rd Joliet IL 60436 Ph: ~~773-447-5667~~ 815 207 4946 Fax: E-mail: MHorbaczewski@MWGen.com	Attended: Yes ☑ No ☐ MH *Initial*
John Richardson GE Oil & Gas Consultant - ~~Dresser, Inc.~~ 980 Richardson Road Colfax, LA 71417 Ph: 318-627-5504 Fax: 318-627-2969 E-mail: jwrichar@aol.com	Attended: Yes ☑ No ☐ JWR *Initial*		Attended: Yes ☐ No ☐ *Initial*
	Attended: Yes ☐ No ☐ *Initial*		Attended: Yes ☐ No ☐ *Initial*

Ralph P. Pate
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649 Monroe Street
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P 334 242 3066
F 334 353-4528

Attendance List SC on Inspection

Meeting Date: **January 16, 2013**

Bob Brantley Product Manager - Chart Industries Beverage CO2 Systems 1300 Airport Dr, Ball Ground, Ga 30107 770 704 8615 robert.brantley@chartindustries.com	CHARLES Withers NXB
DON COOK STATE OF CT	MARK ANDERSON MARQUIP LLC 1300 NORTH AIRPORT Rd. PHILLIPS WI. 54555 715 339 2191 EXT. 2407 MARK.ANDERSON@MARQUIPWARDUNITED.COM
PAUL WELCH ARISE VISITOR	DAREN DAILY MARQUIP, LLC 1300 N. AIRPORT RD. PHILLIPS, WI 54555 715-339-2188 EXT. 8772303 DAREN.DAILY@MARQUIPWARD UNITED.COM
VICTOR KENNEY, PRAXAIR MICROBULK SUPPLY SYSTEMS MANAGER. VISITOR VICTOR_KENNEY@PRAXAIR.COM	

Members Attendance:
SC _Inspection
Main Committee

NBIC Committee Public Review Comments

PRC #	**Reference Paragraph**	**Response**	**Vote** A-D-AB-N	**Action**
PR13-0209	Part 2, 2.2.10.6	5	13-0-0-0	
PR13-0210	Part 2, 2.2.10.6 h)	5	9-0-2-2	
PR13-0211	Part 2, 2.3.6.5	7	12-0-1-0	
PR13-0212	Part 2, 2.3.6.5 b) 4)	3	13-0-0-0	
PR13-0213	Part 2, 2.3.6.7 a)	7	13-0-0-0	
PR13-0214	Part 2, 2.3.6.7 a) 3)	7	13-0-0-0	
PR13-0215	Part 2, 2.3.6.7 a) 4)	7	12-0-0-1	
PR13-0216	Part 2, 2.3.6.7 b) 2)&(3	7	13-0-0-0	
PR13-0217	Part 2, 2.3.6.7 b) 4)	7	13-0-0-0	

1. Accepted comment, will incorporate into next draft
2. Accepted comment, no revision required
3. Accepted in principle
4. Accepted, changes are incorporated
5. Accepted for new business action
6. Rejected, except as noted
7. Rejected
8. More information is needed

Subject: **Part 2, Supplement 2, S2.10.4 – Stayed Surfaces**

File Number: **NB11-0201**

Proposal:

Introduce a new section to provide guidance for bulged stayed surfaces to address requests for guidance from various jurisdictions. Proposed wording is as follows:

S2.10.4.2 BULGING

Stayed surfaces shall be examined, and any deformations shall be measured and recorded. Deformations may be caused from freezing, localized overheating, broken staybolts, or extended use (cyclic activity). Deformations may be described as bulging, bagging, or pillow/mattress-effects. The bulged section depth is defined as the protrusion of the sheet beyond its original position.

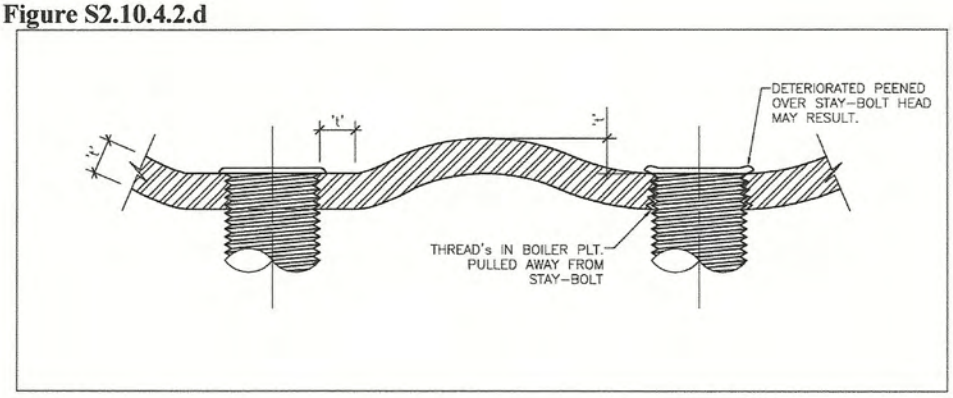
a) Changes in deformations between inspections shall be noted and shall require additional evaluation to determine fitness for service.

b) The probable cause of the deformation shall be determined and, where possible, resolved. For example, overheating due to scale build-up requires removal of scale.

c) The amount of the bulging shall be measured:
   i. If the depth of the bulge does not exceed 50% of plate thickness, then no further activity is required.
   ii. If the depth of the bulge is between 50% and 100% plate thickness, and thread engagement is not affected, then additional NDE is required.
      - Note: If ultrasonic thickness testing (S2.6.2.c) is performed, then it is performed on a tight (1-inch) grid to determine any thinning throughout the deformation. Any generalized thinning (S2.6.2.b) shall be used in the calculation of MAWP.
   iii. If the depth of the bulge exceeds the thickness of the plate, then repair is required.

d) The location of the deformations shall be examined. If the point of tangency of the curve in a bulge is within '*t*' of the edge of the staybolt head , then determination of thread engagement shall be made. ('*t*' is defined in S2.10.6, and is the thickness of the plate.) Removal of one or more staybolts may be required to make this determination. Refer to Figure S2.10.4.2.d.
   i. Cracks, deformations, and/or missing portions of the threaded staybolt head may indicate a deformation of the plate at the staybolt.

Figure S2.10.4.2.d



e) The following guidelines apply where repair is required.
   i. Plate may only be repaired using a flush patch, in accordance with Supplement 2 of Part 3.
   ii. Where a deformation is to be repaired, all portions of that deformity shall be repaired. For example, for contiguous bulging where only some bulges exceed allowable deformation, the entire bulged area shall be repaired. Unrelated bulges separated by non-deformed plate shall be independently evaluated.

FIGURE OF BULGED STAYED AREA

Subject: Part 2, Supplement 2, S2.10.4 – Average Staybolt Pitch

File Number: NB12-1201

Proposal: Update text in S2.10.4, S2.10.6 to include provisions and mathematics for rectangular staybolt patterns found on many historical boilers.

Current text:

S2.10.4 STAYED SURFACES

The maximum allowable working pressure for stayed flat plates and those parts which, by these rules, require staying as flat plates with stays or staybolts of uniform diameter symmetrically spaced, shall be calculated using the following formula or Tables S2.10.4 and S2.10.4.1:

A07 $P = \frac{T^2 \times S \times C}{p^2}$

See definitions of nomenclature in S2.10.6

A08 **S2.10.4.1 STAYBOLTS**

Table S2.10.4.1 may be used to determine the MAWP for corroded staybolts. The table
A09 is based on a stress value of 7,500 psi (51.7 MPa) for staybolts that was the value used in the ASME Section I, 1971 Edition. The table identifies a calculated MAWP based on measuring the staybolt spacing on the crownsheet and the minimum diameter of the corroded staybolt. See Table S2.10.4.1.

Reword as follows:

S2.10.4 STAYED SURFACES

The maximum allowable working pressure for stayed flat plates and those parts which, by these rules, require staying as flat plates with stays or staybolts of uniform diameter, uniformly spaced, shall be calculated using the following formula or Table S2.10.4.

$$P = \frac{t^2 \times S \times C}{p^2}$$

When pitches of stays or staybolts of uniform diameter are symmetrical and form a rectangle, the equation may be replaced with the following equation:

$$P = \frac{2 \times t^2 \times S \times C}{l^2 + w^2}$$

See definitions of nomenclature in S2.10.6.

Example: Representative boiler dimensions and thicknesses: dimensions retrieved from a historical boiler blueprints, stated thickness deteriorated to 0.300 inches, staybolt pitch of 4.375x4.07.

$l = 4.375$
$w = 4.07$
$t = 0.300$

Currently:

$$P = \frac{t^2 \times S \times C}{p^2} \qquad P = \frac{0.300^2 \times 13750x2.1}{4.375^2} \qquad P = 135.8psi$$

Rectangular equations:

$$P = \frac{2 \times t^2 \times S \times C}{l^2 + w^2} \qquad P = \frac{2 \times 0.300^2 \times 13750x2.1}{4.375^2 + 4.07^2} \qquad P = 145.6psi$$

In this real-world example, the historical boiler MAWP has increased approximately 10psi, or about 7%.

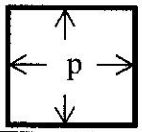
[…]

S2.10.6 NOMENCLATURE

[…]

- p = maximum pitch measured between straight lines passing through the centers of the staybolts in the different rows, which lines may be horizontal, vertical, or inclined, inches or mm
- l = the pitch of stays in one row, passing through the centers of the staybolts, which line may be horizontal, vertical, or inclined, 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

[…]



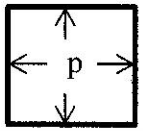
Thickness of Stayed Surface, in.	Staybolt Spacing (Square Pitch), in. (p)																				
	3.500	3.625	3.750	3.875	4.000	4.125	4.250	4.375	4.500	4.625	4.750	4.875	5.000	5.125	5.250	5.375	5.500	5.625	5.750	5.875	6.000
0.19	85	80	74	70	65	61	58	55	52	49	46	44	42	40	38	36	35	33	32	30	29
0.2	95	88	82	77	72	68	64	61	57	54	51	49	46	44	42	40	38	37	35	34	32
0.21	104	97	91	85	80	75	71	67	63	60	57	54	51	49	46	44	42	40	39	37	36
0.22	115	107	100	93	88	82	78	73	69	66	62	59	56	53	51	49	46	44	42	41	39
0.23	125	117	109	102	96	90	85	80	76	72	68	65	61	58	56	53	51	48	46	44	43
0.24	136	127	119	111	104	98	92	87	82	78	74	70	67	64	61	58	55	53	50	48	46
0.25	148	138	129	121	113	106	100	95	89	85	80	76	72	69	66	63	60	57	55	52	50
0.26	160	149	139	130	122	115	108	102	97	92	87	82	78	75	71	68	65	62	59	57	54
0.27	172	161	150	141	132	124	117	110	104	99	94	89	85	80	77	73	70	67	64	61	59
0.28	185	173	162	151	142	134	126	119	112	106	101	96	91	87	82	79	75	72	69	66	63
0.29	199	185	173	162	152	143	135	127	120	114	108	103	97	93	88	84	81	77	74	71	68
0.3	213	198	185	174	163	153	144	136	129	122	116	110	104	99	95	90	86	82	79	76	72
0.31	227	212	198	185	174	164	154	146	138	130	123	117	111	106	101	96	92	88	84	81	77
0.32	242	226	211	198	185	174	164	155	147	139	132	125	119	113	108	103	98	94	90	86	82
0.33	258	240	224	210	197	185	175	165	156	148	140	133	126	120	115	109	104	100	95	91	88
0.34	273	255	238	223	209	197	185	175	165	157	148	141	134	128	122	116	111	106	101	97	93
0.35	290	270	252	236	222	209	197	185	175	166	157	149	142	135	129	123	117	112	107	103	99
0.36	307	286	267	250	235	221	208	196	185	176	166	158	150	143	136	130	124	119	114	109	104
0.37	324	302	282	264	248	233	220	207	196	185	176	167	159	151	144	137	131	125	120	115	110
0.38	342	318	298	279	262	246	232	219	207	196	185	176	167	159	152	145	138	132	127	121	116
0.39	360	335	313	294	275	259	244	230	218	206	195	185	176	168	160	153	146	139	133	128	122
0.4	379	353	330	309	290	273	257	242	229	217	206	195	185	177	168	160	153	147	140	134	129
0.41	398	371	346	324	304	286	270	255	241	228	216	205	195	185	177	169	161	154	147	141	135
0.42	417	389	364	340	320	300	283	267	252	239	227	215	204	195	185	177	169	162	155	148	142
0.43	437	408	381	357	335	315	297	280	265	251	237	225	214	204	194	185	177	169	162	155	149
0.44	480	447	418	391	367	345	325	307	290	275	261	247	235	224	213	203	194	186	178	170	163
0.45	502	468	437	409	384	361	340	321	304	287	272	259	246	234	223	213	203	194	186	178	171
0.46	524	489	457	428	402	378	356	336	317	300	285	270	257	245	233	222	212	203	194	186	178
0.47	547	510	477	447	419	394	371	350	331	314	297	282	268	255	243	232	222	212	203	194	186
0.48	571	532	497	466	437	411	387	365	345	327	310	294	280	266	254	242	231	221	212	203	194

TS **= Tensile Strength, 55,000 psi**
S **= 13,800 psi**
t **= Thickness of Stayed Surface, in.**
p **= staybolt spacing, in.**

$$P = \frac{t^2 \times S \times C}{p^2}$$

For thicknesses 0.4375" and less, C = 2.1
For thicknesses larger than 0.4375", C = 2.2
P **= MAWP, psi**

Table S2.10.4 [US Customary Units]
Maximum Allowable Working Pressure for Square Stayed Surfaces, Formula per ASME Section 1, PG-46.1



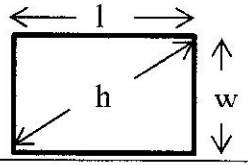
Thickness of Stayed Surface, mm	Staybolt Spacing (Square Pitch), mm (p)																					
	89	92	95	98	101	104	107	110	113	116	119	122	125	128	131	134	137	140	143	146	149	152
5	630	589	553	519	489	461	436	412	391	371	352	335	319	304	291	278	266	254	244	234	225	216
5.25	694	650	609	573	539	508	480	454	431	409	388	369	352	336	320	306	293	281	269	258	248	238
5.5	762	713	669	628	592	558	527	499	473	448	426	405	386	368	352	336	322	308	295	283	272	261
5.75	833	779	731	687	647	610	576	545	517	490	466	443	422	403	384	367	351	337	323	309	297	285
6	907	849	796	748	704	664	627	594	562	534	507	483	460	438	419	400	383	366	351	337	323	311
6.25	984	921	863	811	764	721	681	644	610	579	550	524	499	476	454	434	415	398	381	366	351	337
6.5	1064	996	934	878	826	779	736	697	660	626	595	566	539	514	491	469	449	430	412	395	380	365
6.75	1148	1074	1007	946	891	840	794	751	712	676	642	611	582	555	530	506	484	464	445	426	409	393
7	1234	1155	1083	1018	958	904	854	808	766	726	690	657	626	597	570	544	521	499	478	459	440	423
7.25	1324	1239	1162	1092	1028	970	916	867	821	779	740	705	671	640	611	584	559	535	513	492	472	454
7.5	1417	1326	1243	1168	1100	1038	980	927	879	834	792	754	718	685	654	625	598	573	549	526	505	486
7.75	1513	1416	1328	1248	1175	1108	1047	990	938	890	846	805	767	731	698	667	638	611	586	562	540	519
8	1612	1509	1415	1329	1252	1180	1115	1055	1000	949	902	858	817	779	744	711	680	651	624	599	575	553
8.25	1714	1604	1505	1414	1331	1255	1186	1122	1063	1009	959	912	869	829	791	756	723	693	664	637	612	588
8.5	1820	1703	1597	1501	1413	1333	1259	1191	1129	1071	1018	968	922	880	840	803	768	735	705	676	649	624
8.75	1928	1805	1692	1590	1497	1412	1334	1262	1196	1135	1079	1026	978	932	890	851	814	779	747	717	688	661
9	2040	1909	1791	1683	1584	1494	1411	1335	1266	1201	1141	1086	1034	986	942	900	861	824	790	758	728	699
9.25	2155	2017	1891	1777	1673	1578	1491	1411	1337	1269	1205	1147	1092	1042	995	951	909	871	835	801	769	739
9.5	2273	2127	1995	1875	1765	1665	1573	1488	1410	1338	1271	1210	1152	1099	1049	1003	959	919	880	845	811	779
9.75	2394	2241	2101	1975	1859	1753	1656	1567	1485	1409	1339	1274	1214	1158	1105	1056	1010	968	927	890	854	821
10	2519	2357	2211	2077	1956	1844	1743	1649	1562	1483	1409	1340	1277	1218	1163	1111	1063	1018	976	936	899	863
10.25	2646	2476	2322	2182	2055	1938	1831	1732	1641	1558	1480	1408	1341	1279	1221	1167	1117	1069	1025	983	944	907
10.5	2777	2599	2437	2290	2156	2034	1921	1818	1723	1635	1553	1478	1408	1342	1282	1225	1172	1122	1076	1032	991	952
10.75	2911	2724	2555	2401	2260	2132	2014	1905	1806	1713	1628	1549	1476	1407	1343	1284	1228	1176	1127	1082	1038	998
11	3048	2852	2675	2513	2366	2232	2108	1995	1890	1794	1705	1622	1545	1473	1407	1344	1286	1232	1180	1132	1087	1045
11.25	3339	3125	2931	2754	2593	2446	2310	2186	2072	1966	1868	1777	1693	1614	1541	1473	1409	1350	1294	1241	1191	1145
11.5	3489	3266	3063	2878	2710	2555	2414	2284	2165	2054	1952	1857	1769	1687	1611	1539	1473	1410	1352	1297	1245	1196
11.75	3643	3409	3197	3004	2829	2668	2520	2385	2260	2144	2038	1939	1847	1761	1681	1607	1537	1472	1411	1354	1300	1249
12	3800	3556	3335	3134	2950	2783	2629	2487	2357	2237	2125	2022	1926	1837	1754	1676	1603	1536	1472	1412	1356	1303
12.25	3959	3705	3475	3266	3075	2900	2739	2592	2456	2331	2215	2107	2007	1914	1828	1747	1671	1600	1534	1471	1413	1357

TS = Tensile Strength, 380,000 kPa
S = 95,000 kPa
t = Thickness of Stayed Surface, mm
p = staybolt spacing, mm

$$P = \frac{t^2 \times S \times C}{p^2}$$

For thicknesses 11mm and less, C = 2.1
For thicknesses larger than 11mm, C = 2.2
P = MAWP, kPa

Table S2.10.4 [Metric Units]
Maximum Allowable Working Pressure for Square Stayed Surfaces, Formula per ASME Section 1, PG-46.1



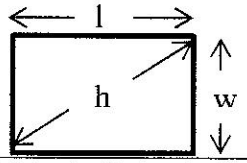
Thickness of Stayed Surface, in.	Staybolt Spacing (Rectangular Pitch), in. (h)																				
	5.000	5.125	5.250	5.375	5.500	5.625	5.750	5.875	6.000	6.125	6.250	6.375	6.500	6.625	6.750	6.875	7.000	7.125	7.250	7.375	7.500
0.19	84	80	76	72	69	66	63	61	58	56	54	51	50	48	46	44	43	41	40	38	37
0.2	93	88	84	80	77	73	70	67	64	62	59	57	55	53	51	49	47	46	44	43	41
0.21	102	97	93	88	84	81	77	74	71	68	65	63	60	58	56	54	52	50	49	47	45
0.22	112	107	102	97	93	89	85	81	78	75	72	69	66	64	62	59	57	55	53	52	50
0.23	123	117	111	106	101	97	93	89	85	82	78	75	73	70	67	65	63	60	58	56	55
0.24	134	127	121	116	110	106	101	97	93	89	85	82	79	76	73	71	68	66	64	61	59
0.25	145	138	131	125	120	114	110	105	101	97	93	89	86	83	80	77	74	71	69	67	64
0.26	157	149	142	136	130	124	119	114	109	104	100	96	93	89	86	83	80	77	75	72	70
0.27	169	161	153	146	140	134	128	122	117	113	108	104	100	96	93	89	86	83	80	78	75
0.28	182	173	165	157	150	144	137	132	126	121	116	112	108	104	100	96	93	90	86	84	81
0.29	195	186	177	169	161	154	147	141	135	130	125	120	115	111	107	103	99	96	93	90	87
0.3	209	199	189	181	172	165	158	151	145	139	134	128	123	119	114	110	106	103	99	96	93
0.31	223	212	202	193	184	176	168	161	155	148	143	137	132	127	122	118	114	110	106	102	99
0.32	237	226	215	205	196	188	180	172	165	158	152	146	140	135	130	126	121	117	113	109	106
0.33	252	240	229	218	209	199	191	183	175	168	162	155	149	144	139	134	129	124	120	116	112
0.34	268	255	243	232	221	212	203	194	186	179	172	165	159	153	147	142	137	132	127	123	119
0.35	284	270	258	246	235	224	215	206	197	189	182	175	168	162	156	150	145	140	135	131	126
0.36	300	286	273	260	248	237	227	218	209	200	192	185	178	171	165	159	153	148	143	138	134
0.37	317	302	288	275	262	251	240	230	220	212	203	195	188	181	174	168	162	156	151	146	141
0.38	335	319	304	290	277	265	253	242	232	223	214	206	198	191	184	177	171	165	159	154	149
0.39	353	336	320	305	291	279	267	255	245	235	226	217	209	201	193	187	180	174	168	162	157
0.4	371	353	336	321	307	293	280	269	258	247	237	228	219	211	204	196	189	183	176	170	165
0.41	390	371	353	337	322	308	295	282	271	260	249	240	231	222	214	206	199	192	185	179	173
0.42	409	389	371	354	338	323	309	296	284	273	262	252	242	233	224	216	209	201	195	188	182
0.43	429	408	389	371	354	339	324	310	298	286	274	264	254	244	235	227	219	211	204	197	191
0.44	470	448	426	407	389	372	356	341	327	313	301	289	278	268	258	249	240	232	224	216	209
0.45	492	468	446	426	406	389	372	356	342	328	315	303	291	280	270	260	251	242	234	226	219
0.46	514	489	466	445	425	406	389	372	357	342	329	316	304	293	282	272	262	253	244	236	228
0.47	537	511	487	464	443	424	406	389	373	358	343	330	317	306	294	284	274	264	255	247	238
0.48	560	533	508	484	462	442	423	405	389	373	358	344	331	319	307	296	286	276	266	257	249

TS **= Tensile Strength, 55,000 psi**
S **= 13,800 psi**
t **= Thickness of Stayed Surface, in.**
h **= Hypothenusal staybolt spacing, in.**

$$P = \frac{2 \times t^2 \times S \times C}{h^2}$$

For thicknesses 0.4375" and less, C = 2.1
For thicknesses larger than 0.4375", C = 2.2
P **= MAWP, psi**

Table S2.10.4.a [US Customary Units]
Maximum Allowable Working Pressure for Rectangular Stayed Surfaces



Thickness of Stayed Surface, mm	Staybolt Spacing (Rectangular Pitch), mm (h)																					
	125	130	135	140	145	150	155	160	165	170	175	180	185	190	195	200	205	210	215	220	225	230
5	638	590	547	509	474	443	415	390	366	345	326	308	291	276	262	249	237	226	216	206	197	189
5.25	704	651	603	561	523	489	458	430	404	381	359	339	321	305	289	275	262	249	238	227	217	208
5.5	772	714	662	616	574	536	502	471	443	418	394	373	353	334	317	302	287	274	261	249	238	228
5.75	844	781	724	673	627	586	549	515	485	456	431	407	385	365	347	330	314	299	285	273	261	249
6	919	850	788	733	683	638	598	561	528	497	469	443	420	398	378	359	342	326	311	297	284	272
6.25	998	922	855	795	741	693	649	609	572	539	509	481	455	432	410	390	371	353	337	322	308	295
6.5	1079	998	925	860	802	749	702	659	619	583	550	520	493	467	443	421	401	382	365	348	333	319
6.75	1163	1076	998	928	865	808	757	710	668	629	594	561	531	504	478	454	433	412	393	376	359	344
7	1251	1157	1073	998	930	869	814	764	718	677	638	603	571	542	514	489	465	443	423	404	386	370
7.25	1342	1241	1151	1070	998	932	873	819	770	726	685	647	613	581	552	524	499	476	454	433	414	396
7.5	1436	1328	1231	1145	1067	998	934	877	824	777	733	693	656	622	590	561	534	509	486	464	443	424
7.75	1534	1418	1315	1223	1140	1065	998	936	880	829	783	740	700	664	630	599	570	543	518	495	473	453
8	1634	1511	1401	1303	1215	1135	1063	998	938	884	834	788	746	707	672	638	608	579	552	528	504	483
8.25	1738	1607	1490	1386	1292	1207	1130	1061	998	940	887	838	793	752	714	679	646	616	587	561	536	513
8.5	1845	1706	1582	1471	1371	1281	1200	1126	1059	998	941	890	842	799	758	721	686	654	624	596	569	545
8.75	1955	1808	1676	1559	1453	1358	1272	1193	1122	1057	998	943	893	846	803	764	727	693	661	631	603	577
9	2068	1912	1773	1649	1537	1436	1345	1262	1187	1118	1055	998	944	895	850	808	769	733	699	668	638	611
9.25	2185	2020	1873	1742	1624	1517	1421	1334	1254	1181	1115	1054	998	946	898	853	812	774	739	705	674	645
9.5	2305	2131	1976	1837	1713	1600	1499	1407	1323	1246	1176	1111	1052	998	947	900	857	817	779	744	711	681
9.75	2428	2244	2081	1935	1804	1686	1579	1482	1393	1312	1239	1171	1108	1051	998	948	903	860	821	784	749	717
10	2554	2361	2189	2036	1898	1773	1661	1559	1466	1381	1303	1231	1166	1105	1049	998	949	905	863	824	788	754
10.25	2683	2480	2300	2139	1994	1863	1745	1637	1540	1451	1369	1294	1225	1161	1102	1048	998	951	907	866	828	792
10.5	2815	2603	2414	2244	2092	1955	1831	1718	1616	1522	1436	1358	1285	1219	1157	1100	1047	998	952	909	869	832
10.75	2951	2728	2530	2353	2193	2049	1919	1801	1694	1595	1506	1423	1347	1277	1213	1153	1097	1046	998	953	911	872
11	3090	2857	2649	2463	2296	2146	2010	1886	1773	1671	1576	1490	1411	1337	1270	1207	1149	1095	1044	998	954	913
11.25	3386	3130	2903	2699	2516	2351	2202	2067	1943	1831	1727	1633	1546	1465	1391	1323	1259	1200	1144	1093	1045	1000
11.5	3538	3271	3033	2820	2629	2457	2301	2159	2031	1913	1805	1706	1615	1531	1454	1382	1315	1254	1196	1142	1092	1045
11.75	3693	3415	3167	2944	2745	2565	2402	2254	2120	1997	1884	1781	1686	1599	1518	1443	1373	1309	1248	1192	1140	1091
12	3852	3562	3303	3071	2863	2675	2505	2351	2211	2083	1965	1858	1759	1667	1583	1505	1432	1365	1302	1244	1189	1138
12.25	4014	3712	3442	3200	2983	2788	2611	2450	2304	2170	2048	1936	1833	1738	1650	1568	1493	1422	1357	1296	1239	1186

TS = Tensile Strength, 380,000 kPa
S = 95,000 kPa
t = Thickness of Stayed Surface, mm
h = Hypothenusal staybolt spacing, mm

$$P = \frac{2 \times t^2 \times S \times C}{h^2}$$

For thicknesses 11mm and less, C = 2.1
For thicknesses larger than 11mm, C = 2.2
P = MAWP, kPa

Table S2.10.4.a [Metric Units]
Maximum Allowable Working Pressure for Rectangular Stayed Surfaces

Explanation: All known course materials and interpretations of all editions of ASME interpret PG-46.1 (STAYED SURFACES) to require application of the largest dimension of the rectangular pattern as the dimension of 'p' in the familiar equation:

$$P = \frac{t^2 \times S \times C}{p^2}$$

(also used in S2.10.4). This wording and interpretation is duplicated in ASME Section VIII UG-47. However, ASME 1971 PFT-27.1 and ASME 2002 PFT-26.1 both use similar wording stating "*The full pitch dimensions of the stays shall be employed in determining the area to be supported by a stay...*". We interpret this wording to mean true dimensions of a rectangle.

All editions of the Canadian Interprovincial Standard (1910-1938) provide a variation for the same equation for flat stayed surfaces. Specifically, the dimensions of a theoretical square with the same hypotenuse as that of the rectangle, is used. It is believed that, in this respect, the ASME code and the historic Canadian code share underlying theories. Additionally, traction engine blueprints and registration documents have shown that many historical boilers were built to this Canadian standard. For these reasons, this proposal is based on this precedent.

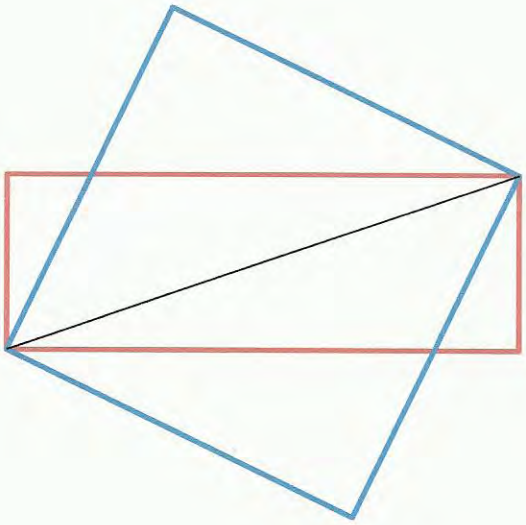
Unequal Stay Pitches

216. When the pitches of stays are unequal $\frac{l^2+w^2}{2}$ is to be taken instead of P^2 in the formulae given in Section 213 to 215.

l = the pitch of stays in inches in one row.

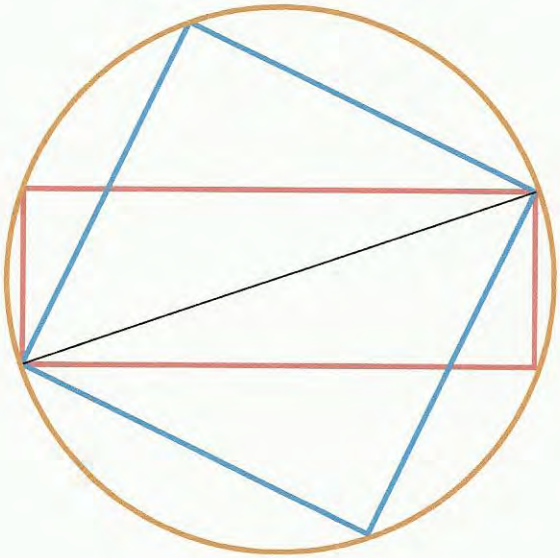
w = distance in inches between two rows of stays.

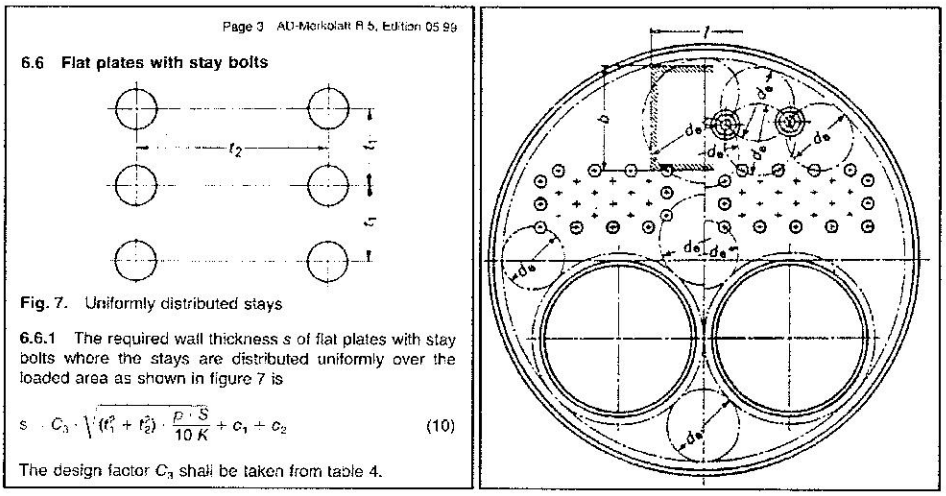
As shown in the following diagram, the red rectangle and the blue square share the same hypotenuse (black), although the blue square actually covers more surface area. The origins of this theory appear to be based in consideration for *unsupported* area *and* distance between stays, not *supported* area of each stay.



When the staybolt pattern is square, both equations yield the same results. Most staybolt patterns are very close to being square.

Furthermore, the current Swedish, Dutch (*"AD-Merkblatt" by Verband der Technischen Uberwachuns-Vereine e.V.*) and German ("*Drutscher DampfkesselausschuB (DDA)" by Vereinigung der Technischen Uberwachungsvereine e.V. Essen)* boiler codes provide equations that replace a rectangle with a circle. Here, the (brown) circle's diameter is equivalent to the hypotenuse of both the original rectangle and of the theoretical square.





Page 3 AD-Merkblatt B 5, Edition 05 99

6.6 Flat plates with stay bolts

Fig. 7. Uniformly distributed stays

6.6.1 The required wall thickness s of flat plates with stay bolts where the stays are distributed uniformly over the loaded area as shown in figure 7 is

$$s = C_3 \cdot \sqrt{(t_1^2 + t_2^2) \cdot \frac{p \cdot S}{10\,K}} + c_1 + c_2 \qquad (10)$$

The design factor C_3 shall be taken from table 4.

Dutch code

German Code

Of note, that the approach to using a theoretical square or a theoretical circle is equal. The same results can be obtained by applying a *linear* scale from the square's area to the circle's area. Hence, we believe that *all* of these boiler codes apply the same underlying geometric theories, but apply different criteria and limitations to these theories. Since the European equations would require an additional scale factor and the historic Canadian equations do not, the proposal uses the Canadian equations only for clarity of presentation.

ATTACHMENT 5
1 OF 1

DRAFT RESPONSE LANGUAGE

IN12-0201
IN12-0202
RE: Code Interpretation – NBIC Part 2, Section 5.2.2 through 5.2.3 Replacement of Stamping

Inquiry #1
If a National Board Commissioned Inspector has verified the replacement of stamped data or nameplate by an "R" Certificate holder on Corrugated rolls that are not stationary and subject to operation in multiple Jurisdictions, possibly by multiple owners, is the application of NB-136 "Replacement of Stamped Data Form" required?

Reply #1:
Yes, Section 5.2.1 clearly states that that requests for permission to re-stamp or replace nameplates shall be made to the Jurisdiction in which the pressure retaining item is installed, and that such application must be made on the NB-136 form. If the vessel is not stationary, application should be made in the jurisdiction where the nameplate is re-applied.

Inquiry #2
Can an NB-136 "Replacement of Stamped Data Form", which is required to be signed by a National Board Commissioned Inspector, for Corrugated Rolls that are not stationary and subject to operation in multiple Jurisdictions, possibly by multiple owners, be filed with the National Board and copied to the applicable Jurisdiction in lieu of obtaining an approval signature from the Jurisdiction?

Reply #2:
No, Section 5.2.1 ~~only~~ allows the ~~use~~ of the National Board in this manner only when there is no jurisdiction

Background Information

Although corrugated rolls are not stationary and are routinely transported to an "R" Certificate holder's facility for refurbishment, frequently requiring the replacement of lost or illegible nameplates, there is no exemption or distinction between vessels that are stationary or not with regard to the requirement to request permission of the jurisdiction and the application of the NB-136 form.

Task Group for NB12-1801 will work on potential draft language that would seek to address the concerns of the party requesting the interpretation.

Proposed revision NBIC Part 2, sections 4.4.7 and 4.4.8

30 August 2012

This page for reference only.

c) Damage may also be caused by mechanical forces such as thermal shock, cyclic temperature changes, vibration, pressure surges, excessive temperature, external loading, and material and fabrication defects.

4.4.7 DETERMINING INSPECTION INTERVALS

a) The maximum period between internal inspections or a complete inservice evaluation of pressure-retaining items shall not exceed one-half of the estimated remaining service life of the vessel or ten years, whichever is less. The method for estimating inspection intervals of pressure-retaining items subject to internal erosion or corrosion is discussed in NBIC Part 2, 4.4.7.1 and 4.4.7.2.

b) Inspection intervals can be revised beyond the maximum period stated above, provided the owner-user has submitted technical justification for revising the inspection interval, subject to review and acceptance by the Jurisdiction, where required.

c) Data used in engineering assessment methods to develop revised inspection intervals for pressure-retaining items shall be re-evaluated every five years, when a change in operation occurs, or after discovery of new and/or altered damage mechanisms.

4.4.7.1 METHOD FOR ESTIMATING INSPECTION INTERVALS FOR PRESSURE-RETAINING ITEMS SUBJECT TO EROSION OR CORROSION

Assessment guidelines for pressure-retaining items subject to corrosion or erosion are provided in this section. These guidelines are based on actual thickness measurements within the area of concern. Minimum required wall thickness shall be based on allowable stress of the material. Applicability and limitations of this guideline are as follows:

a) Original design criteria are known;

b) Item is not operating in the creep range;

c) Item does not contain crack-like indications;

d) Service stresses are known; and

e) Maintenance and operating history are known.

4.4.7.2 METHOD FOR ESTIMATING INSPECTION INTERVALS FOR EXPOSURE TO CORROSION

a) When the pressure-retaining item is exposed to service temperatures below the creep range, and the corrosion rate controls the remaining wall thickness of the pressure-retaining item, the inspection interval shall be calculated by the formula below or by other industry methods as accepted by the Jurisdiction.

$$\text{remaining life (years)} = \frac{t_{(actual)} - t_{(required)}}{\text{corrosion rate}}$$

$t_{(actual)}$ = thickness in inches (mm) measured at the time of inspection for the limiting section used in the determination of $t_{(required)}$

$t_{(required)}$ = minimum allowable thickness in inches (mm) for the limiting section of the pressure-retaining item or zone. It shall be the greater of the following:

Proposed revision NBIC Part 2, sections 4.4.7 and 4.4.8

30 August 2012

1) The calculated thickness, exclusive of the corrosion allowance, required for the pressure relieving device set pressure, static head, or other loading and design temperature, or

2) The minimum thickness permitted by the provision of the applicable Section of the original code of construction.

Corrosion Rate = inches (mm) per year of metal removal as a result of corrosion.

b) Any suitable nondestructive examination method may be used to obtain thickness measurements provided the instruments employed are calibrated in accordance with the manufacturer's specification or an acceptable national standard.

1) If suitably located existing openings are available measurements may be taken through the openings.

2) When it is impossible to determine thickness by nondestructive means, a hole may be drilled through the metal wall and thickness gage measurements taken.

c) For new pressure-retaining items or PRI's for which service conditions are being changed, one of the following methods shall be employed to determine the probable rate of corrosion from which the remaining wall thickness, at the time of the next inspection, can be estimated:

1) The corrosion rate as established by data for pressure-retaining items in the same or similar service;

2) If the probable corrosion rate cannot be determined by the above method, on-stream thickness determinations shall be made after approximately 1,000 hours of service. Subsequent sets of thickness measurements shall be taken after additional similar intervals until the corrosion rate is established.

d) Corrosion Resistant Lining
When part or all of the pressure-retaining items have a corrosion resistant lining, the interval between inspections of those sections so protected may be based on recorded experience with the same type of lining in similar service, but shall not exceed ten years, unless sufficient data has been provided to establish an alternative inspection interval. If there is no experience on which to base the interval between inspections, performance of the liner shall be monitored by a suitable means, such as the use of removable corrosion probes of the same material as the lining, ultrasonic examination, or radiography. To check the effectiveness of an internal insulation liner, metal temperatures may be obtained by surveying the pressure-retaining item with temperature measuring or indicating devices.

e) Two or More Zones
When a pressure-retaining item has two or more zones of pressure or temperature and the required thickness, corrosion allowance, or corrosion rate differ so much that the foregoing provisions give significant differences in maximum periods between inspections for the respective zones (e.g., the upper and lower portions of some fractionating towers), the period between inspections may be established individually for each zone on the basis of the condition applicable thereto, instead of being established for the entire vessel on the basis of the zone requiring the more frequent inspection.

f) Above-Ground Pressure Vessels
All pressure vessels above ground shall be given an external examination after operating the lesser of five years, or one quarter of remaining life, preferably while in operation. Alternative intervals resulting in longer periods may be assigned provided the requirements of this section have been followed. Inspection shall include determining the condition of the exterior insulation, the supports, and the general alignment of the vessel on its supports. Pressure vessels that are known to have a remaining life of over ten years or that are prevented from being exposed to external corrosion (such as being installed in a cold box in which the atmosphere is purged with an inert gas, or by the temperature being maintained sufficiently

Proposed revision NBIC Part 2, sections 4.4.7 and 4.4.8

30 August 2012

low or sufficiently high to preclude the presence of water), need not have the insulation removed for the external inspection. However, the condition of the insulating system and/or the outer jacketing, such as the cold box shell, shall be observed periodically and repaired if necessary.

g) Interrupted Service

1) The periods for inspection referred to above assume that the pressure-retaining item is in continuous operation, interrupted only by normal shutdown intervals. If a pressure-retaining item is out of service for an extended interval, the effect of the environmental conditions during such an interval shall be considered.

2) If the pressure-retaining item was improperly stored, exposed to a detrimental environment or the condition is suspect, it shall be given an inspection before being placed into service.

3) The date of next inspection, which was established at the previous inspection, shall be revised if damage occurred during the period of interrupted service.

h) Circumferential Stresses
For an area affected by a general corrosion in which the circumferential stresses govern the MAWP, the least thicknesses along the most critical plane of such area may be averaged over a length not exceeding:

1) The lesser of one-half the pressure vessel diameter, or 20 in. (500 mm) for vessels with inside diameters of 60 in. (1.5 m) or less, or

2) The lesser of one-third the pressure vessel diameter, or 40 in. (1 m), for vessels with inside diameters greater than 60 in. (1.5 m), except that if the area contains an opening, the distance within which thicknesses may be averaged on either side of such opening shall not extend beyond the limits of reinforcement as defined in the applicable Section of the ASME Code for ASME Stamped vessels and for other vessels in their applicable codes of construction.

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i) Longitudinal Stresses
If because of wind loads or other factors the longitudinal stresses would be of importance, the least thicknesses in a length of arc in the most critical plane perpendicular to the axis of the pressure vessel may be averaged for computation of the longitudinal stresses. The thicknesses used for determining corrosion rates at the respective locations shall be the most critical value of average thickness. The potential for buckling shall also be considered.

Revise Text to "Local Metal Loss"

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

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

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

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

k) Weld Joint Efficiency Factor
When the surface at a weld having a joint efficiency factor of other than one is corroded as well as surfaces remote from the weld, an independent calculation using the appropriate weld joint efficiency factor

Proposed revision NBIC Part 2, sections 4.4.7 and 4.4.8

30 August 2012

This page for reference only.

7) Dimensional verification checks;

d) If visual distortion or changes in the microstructure or mechanical properties are noted, consider replacing the component or a detailed engineering analysis shall be performed to verify continued safe operation.

e) Techniques for evaluating fire damage are referenced in applicable standards. See NBIC Part 2, 1.3. A1

4.4.8.6 EVALUATING EXPOSURE OF PRESSURE-RETAINING ITEMS TO CYCLIC FATIGUE

a) A fatigue evaluation should be performed if a component is subject to cyclic operation. The allowable number of cycles (mechanical or thermal) at a given level of stress should be adequate for the specified duration of service to determine suitability for continued operation.

b) Data requirements and history information should be obtained as identified in NBIC Part 2, 4.4.5.

c) Techniques for evaluating fatigue are referenced in applicable standards. See NBIC Part 2, 1.3.

4.4.8.7 EVALUATING PRESSURE-RETAINING ITEMS CONTAINING LOCAL THIN AREAS

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

1) Original design and current operating conditions;

2) Component is not operating in the creep range;

3) Material has sufficient toughness;

4) Not operating in cyclic service;

5) Does not contain crack-like indications;

6) Flaws are not located in knuckle regions of heads or conical transitions;

7) Applied loads;

8) The range of temperature or pressure fluctuation.

b) Where appropriate, crack-like indications should be removed by blend/grinding, and evaluated as a local thin area.

c) Data requirements and history information should be obtained as identified in NBIC Part 2, 4.4.5.

d) Required measurements for evaluation of local thin areas shall include:

1) Thickness profiles within the local region;

Proposed revision NBIC Part 2, sections 4.4.7 and 4.4.8

30 August 2012

2) Flaw dimensions;

3) Flaw to major structural discontinuity spacing;

4) Vessel geometry;

5) Material properties.

e) Required measurements for evaluation of pitting corrosion shall include:

1) Depth of the pit;

2) Diameter of the pit;

3) Shape of the pit;

4) Uniformity.

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f) Widely scattered corrosion pits may be left in the pressure-retaining item in accordance with the following requirements:
1) Their depth is not more than one-half the required thickness of the pressure-retaining item wall (exclusive of corrosion allowance);
2) the total area of the pits does not exceed 7 sq. in. (4500 sq mm) within any 50 sq. inches (32000 sq. mm); and
3) the sum of their dimensions (depth and width) along any straight line within this area does not exceed 2 in. (50 mm).

f) If metal loss is less than specified corrosion/erosion allowance and adequate thickness is available for future corrosion, then monitoring techniques should be established. If metal loss is greater than specified corrosion/erosion allowance and repairs are not performed, a detailed engineering evaluation shall be performed to ensure continued safe operation.

g) Techniques for evaluating local thin areas and pitting are referenced in applicable standards. See NBIC Part 2, 1.3.

4.5 RISK-BASED INSPECTION ASSESSMENT PROGRAMS

4.5.1 SCOPE

a) This Section describes the basic elements, principles, and guidelines of a risk-based inspection (RBI) program. This Section does not address any one method but is intended to clarify the elements associated with a RBI program. Risk assessment is a process to evaluate continued safe operation of a pressure-containing component. This process is based on sound engineering practices, proven risk assessment experience, and management principles. There are numerous risk-based assessment methods being applied throughout many industries. Details for developing and implementing risk-based inspection programs are defined in other referenced standards.

Implementation of a risk-based inspection (RBI) assessment program allows an owner-user to plan inspection frequencies based on assessing probability of failure (POF) and consequence of failure (COF) (risk = POF x COF). Risk assessment programs involve a team concept based on knowledge, training and experience between engineers, inspectors, operators, analysts, financial, maintenance, and management personnel. Appropriate and responsible decisions must be made from input by all team members to ensure safe operation of systems and their components. Organizational commitment and cooperation is required to successfully implement and maintain a RBI program.

4.5.2 DEFINITIONS

COF — Consequence of Failure. Outcome from a failure. There may be one or more outcomes from a single failure.