

**NATIONAL BOARD
INSPECTION CODE
COMMITTEE**

Minutes

*Meeting of NBIC Sub-Group on Inspection and Repair of Locomotive Boilers
14 November 2011
Meeting at Chattanooga, TN*

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Meeting convened at: 11:21 am, 11/14/2011

Members present: G. Mark Ray, Steve Jackson, Linn Moedinger, Matt Janssen, Bob Schueler, Steven Butler, Bob Reetz, Bob Yuill

Agenda

- 1. Adoption of Agenda**
- 2. Announcements**
- 3. Minutes of previous meeting**
- 4. Errata –**
- 5. NBIC negative votes**
- 7. Old Business**
- 8. New Business**
- 9. Guest questions**
- 10. Next meeting**
- 11. Adjournment**
- 12. Roster - attachment**

Minutes

Adoption of Agenda

Motion to adopt agenda – Janssen, 2nd Butler

Voted – 7 affirmative, 0 negative, 0 abstaining, 0 not voting

Announcements – Bob Schueler

Minutes of previous meeting

Motion to approve minutes – Janssen, 2nd Jackson

Voted - 9 affirmative, 0 negative, 0 abstaining, 0 not voting

Errata – none

NBIC negative votes – Made changes to Item NB11-1804;

Motion to submit changes – Janssen, 2nd Butler

Voted - 7 affirmative, 0 negative, 0 abstaining, 0 not voting

Old Business

Discussion and Progress Report: a general discussion ensued in the ESC meeting regarding staybolt and flue tools; It was generally agreed that emphasis should be on the application and not the tools; Staybolt material and application was discussed and it was decided that this may be a subject that can be included in the NBIC; Secretary will put it in the NBIC agenda; This item was not officially opened so the secretary is removing it from the ESC agenda; nothing new as of 11/08; Dick Stone will make an initial draft for 11/09 meeting, as of 3/09; no discussion 11/09; no discussion 4/10; no discussion 11/10; no discussion 3/11; no discussion 11/11

Discussion and Progress Report: Boiler tube seal welding; NB philosophy has changed to allow more explanatory items in the NBIC; to that end it was agreed to include the text from the current ASME Section I on flue application; a submission will be prepared for the 11/07 meeting; nothing new as of 11/08; Dick Stone will draft an initial document for 11/09 meeting, as of 3/09; no discussion 11/09; No discussion 4/10; Stone will

have a complete submission in two column form reflecting the following items discussed at the 11/10 meeting for next meeting as of 11/10; Same as of 3/11; no discussion 11/11

1. Each Flue shall be expanded either partially or completely into the flue sheet hole prior to seal welding. Upon completion of seal welding the flue shall be expanded to the final setting or re-expanded lightly to confirm the seal welding has not loosened it.
2. Changing the method by which flues are installed from prossering and beading to expanding straight and seal welding shall be considered a repair.
3. Changing the method by which flues are expanded from the prosser method to the roller expander method shall be considered a repair.
4. When flues are installed by expanding straight and seal welding, the outer tube edge shall be even with the outer seal weld edge. All sharp edges of the flue and seal weld shall be smoothed and rounded by filing, sanding, or grinding. Care shall be used to prevent tearing or overheating the tube.
5. Flues that show cracks upon completion of the installation process shall be replaced. Repair is prohibited.
6. When flues are beaded, the bead edge shall contact the flue sheet around the entire flue circumference. Repair of a defective or incorrectly formed bead by welding is prohibited.

Discussion and Progress Report: FRA inspector class. None scheduled for 2005. Nothing new as of 11/05; Rob Castiglione indicated the interest of FRA for recurring training for its inspectors as of 3/06; no report as of 11/06; discussion and recommendations for future training as of 3/07; class set for week of 4 May 2008 as of 11/07; nothing new as of 3/08; Nothing new as of 11/08; Nothing new as of 3/09; none scheduled for 2010 as of 11/09; no classes for 2010; no classes until 2012 as of 11/10; No report as of 3/11;

Motion to close this item – Moedinger, 2nd Jackson

Voted - 7 affirmative, 0 negative, 0 abstaining, 0 not voting

NB10-0502 Discussion and Progress Report: Operating procedures for NBIC Steam Locomotive subgroup adopted as presented at 3/09 meeting; no discussion at 11/09 meeting; Submitted Action Item NB10 – 0502 under “General Requirements”, Part 3, Supplement 1, S1.1 at 4/10 meeting; Handled under NBIC negatives at 11/10 meeting;

Motion to close this item – Reetz, 2nd Butler

Voted - 7 affirmative, 0 negative, 0 abstaining, 0 not voting

NB11-1801 Discussion and Progress Report: Part 2, Section 6, S1.1 – additional wording to define the scope.

Motion to close this item – Jackson, 2nd Butler

Voted - 7 affirmative, 0 negative, 0 abstaining, 0 not voting

Discussion and Progress Report: Rivets **NB11-1802**

Motion to close this item – Janssen, 2nd Jackson

Voted - 7 affirmative, 0 negative, 0 abstaining, 0 not voting

Discussion and Progress Report: Ferrules **NB11-1803**

Motion to close this item – Janssen, 2nd Butler

Voted - 7 affirmative, 0 negative, 0 abstaining, 0 not voting

Discussion and Progress Report: Threaded Staybolts, Part 3, S1.2.2 **NB11-1804** negative vote addressed and resubmitted at 11/11 meeting

Discussion and Progress Report: Threaded Staybolts, Part 3, S1.2.2, h) Installation of different diameter staybolts shall be considered a repair.

Motion to close this item – Janssen, 2nd Butler

Voted - 6 affirmative, 0 negative, 0 abstaining, 1 not voting

Discussion and Progress Report: Staybolts, Part 2, S1.4.2.9 **NB11-1805**

See attachment. No discussion at 3/11 meeting; no discussion at 11/11 meeting

Discussion and Progress Report: This task group has been requested by ASME to write a locomotive construction code for ASME Section I; ASME 08-1760; NB10-1501; No discussion at 3/11 meeting; Item will be closed

Discussion and Progress Report: New member - Robert J. Castiglione

FRA - Staff Director, Safety Improvement & Development Team (Technical Training)

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Motion to recommend adding Mr. Castiglione to the sub-group on Locomotive Boilers – Moedinger, 2nd Butler

Voted - 9 affirmative, 0 negative, 0 abstaining, 0 not voting

New Business

Discussion and Progress Report: Add ferrule material to material list and change wording in material list paragraph to reflect other than steel materials.

Discussion and Progress Report: Revise S1.2.9.7 Ferrules – attachment A – Bob Yuill will bring the item for reconsideration under the D&P above.

Discussion and Progress Report: Proposed Limit for Bulged Stayed Firebox Sheets - NBIC Inspection

Section - Stone No discussion at 3/11 meeting;

I recommend we adopt the following rules and limits for the inspection of bulges in stayed firebox sheets. These would be placed in the Inspection Section (Part 2) of our NBIC Locomotive Code within the Stayed Firebox Sheet section.

1) The maximum depth of the bulged section of the firebox sheet shall not exceed the firebox sheet thickness. The bulged section depth is defined as the protrusion of the firebox sheet beyond its original

position. Sheets bulged more than ¼” within one staybolt pitch, the thickness of the plate shall be verified. If the thickness is less than required the sheet shall be replaced. If the thickness of the sheet is adequate for the pressure, at least one staybolt per square foot of bulged area up to a maximum of three staybolts shall be removed and the condition of the threaded hole shall be evaluated. If any bolt hole is found to be deficient, at least three additional staybolts shall be removed as above and the holes evaluated and three more staybolts removed if one additional hole is found to be deficient and so on until three staybolts holes are found to be deficient, at which time the sheet shall be replaced.

2) If the maximum depth of the bulge exceeds the firebox sheet thickness, the bulged section of the firebox sheet shall be replaced. All staybolts within and/or contacting the bulged firebox sheet section shall be replaced. The adjacent sections of the firebox sheet shall be inspected to determine the cause of the bulge such as scale or mud accumulation prior to completing the repair.

3) If the bulged firebox sheet will remain in service, the conditions that caused the bulge shall be identified and corrected prior to placing the boiler back into operation.

4) If the bulged firebox sheet will remain in service the bulged sheet section and the sheet sections adjacent to the bulge shall be inspected for cracking and thinning (wastage) by use of NDE in order to confirm their suitability for service prior to placing the boiler back into operation.

Comments To Committee

The purpose of these rules/limits are to provide guidance to the locomotive owners/operators and the National Board inspectors. I advocate using a ratio of the bulge depth to the firebox sheet thickness in order to provide a simple reference for the inspectors to use during their work. My initial method is to limit the bulge depth to the firebox sheet thickness as 1 :1 ratio. For a 3/8" thick side sheet this would allow a maximum allowable bulge depth of 3/8".

We can increase the ratio to a higher value, such as 1.25 :1 or 1.5 :1 if our committee considers this necessary. For the 3/8" thick side sheet and the 1.25 :1 ratio the maximum allowable bulge depth would be $3/8" \times 1.25 = 15/32"$ (.46875").

I developed these rules/limits by equating the bulged section of the stayed firebox sheet as a uniformly loaded simply supported beam. The loading of which is created by the boiler pressure acting on the firebox sheet cross-section and the beam length is the pitch (distance) between the staybolts.

The bulge occurs when the firebox sheet, as it becomes over-heated, exceeds its allowable temperature and suffers a reduction of tensile strength as a result. This tensile strength reduction allows the boiler pressure to form the bulge by forcing the overheated section of the firebox sheet into the firebox interior.

As the bulge forms on the overheated firebox sheet, the physical deformation, strain, and deflection of the bulge first causes the firebox sheet to become thinner, then to work harden as a result. This work hardening process often allows the firebox sheet to recover its strength sufficiently to prevent the bulge from rupturing, but the bulge remains in position and becomes a permanent part of the firebox sheet.

For reference bulges and overheating of our stayed fire locomotive boilers can be caused by poor heat transfer through the sheet as a result of mud and scale; poor water chemistry; over-firing (more of a problem with oil burners than coal burners); oil burner misalignment that causes the flame to impinge directly on the firebox sheet; defective fire pan brick work; and poor operating practice such as firing with low water or firing up the boiler when the water level is too low to cover all of the sheet surfaces.

A mechanical cause of firebox sheet bulges occurs when multiple broken staybolts cause the now insufficiently supported section of the firebox sheet to be forced by the boiler pressure into the firebox interior. The same process by which the physical deformation, strain, and deflection of the bulge cause the firebox sheet to become thinner, then to work harden occurs. This work hardening process often allows the firebox sheet to recover its strength sufficiently to prevent the bulge from rupturing, but the bulge remains in position and becomes a permanent part of the firebox sheet.

Task group with Stone and Reetz will work on this issue as of 11/10;

Discussion and Progress Report: Revision to NBIC Materials List for Locomotive Boiler Tubes (Flues), Superheater Units & Arch Tubes – Stone No discussion at 3/11 meeting;

A) I recommend we update our NBIC locomotive boiler material list of allowable materials for boiler tubes (flues), superheater units, and arch tubes.

Note that in my text I've had to interchange use of the terms "flues" and "tubes" in certain sections in order to accommodate the ASME terminology. We can perform the final text edit during our meeting.

I've also listed the answers I received from our Alstom boiler shop regarding the use of these materials and a copy of the referenced ASME B&PVC Table PW-39 (this was supplied by Linn).

The changes I recommend for our NBIC material list for boiler tubes (flues), superheater units, and arch tubes are to:

1. Allow use of SA-178 Grade C Carbon Steel boiler tubes.
2. Allow use of SA-209 Carbon Molybdenum Alloy Steel boiler tubes, Grades T1, T1a & T1b. (this material often is generically referred to as "T1").

In addition, I recommend the two following comments be added to the Comments Section at the bottom of our NBIC locomotive boiler flue section:

1. "When SA-178 Grade C Carbon Steel boiler flues will be seal welded during the installation process, the maximum allowable carbon content of the boiler flues may be limited to a lower value, such as 0.30%, instead of the present specification maximum of 0.35%."

2. The use of preheating when performing seal welding of boiler flues is not required provided the thickness of the flues and flue sheet meet the thickness requirements of ASME B&PVC Table PW-39 General Notes (a) & 6. (*Comment to committee: should we include these two sections from the ASME PW-39 Table in this section?*)

B) The advantage to locomotive operators of adding these two ASME boiler tube specifications are:

1) It provides locomotive users a larger inventory supply (better availability) of boiler tube sizes. The reason for the better availability is the SA-179 Grade C Carbon Steel and SA-209 Carbon Molybdenum Alloy Steel boiler tubes are kept in inventory by many boiler tube suppliers and tube manufacturers because these grades are used in many industrial and utility power boilers.

2) The SA-209 Carbon Molybdenum Alloy Steel boiler tubes can provide better corrosion resistance than the carbon steel boiler tubes. This will be an advantage to locomotives that have variable or corrosive water supplies.

C) My Reference Comments Regarding Use of SA-178 Grade C Boiler Tubes

The ASME B&PVC specification for SA-178 Grades A & C boiler tubes requires all boiler tubes to be expanded and beaded without splitting or cracking. In addition, the tube must pass the flaring and flattening tests as part of the material certification procedure

In the event one or more of the boiler tubes does crack or split during the installation (this includes rolling, beading and seal welding), the tube is defective and should be replaced by the supplier.

The higher maximum allowable carbon content of SA-178 Grade C does not lead to cracking problems of the boiler tube. However, we can recommend to users that they limit the carbon content if seal welding will be used.

The use of preheating when performing seal welding of boiler tubes is not required provided the thickness of the tubes and flue sheet meet the thickness requirements of ASME B&PVC Table PW-39 General Notes (a) & 6.

D) My Reference Comments Regarding Use of SA-209 Carbon Molybdenum Alloy Steel Boiler Tubes

The ASME B&PVC specification for SA-209 Carbon Molybdenum Alloy Steel boiler tubes requires all boiler tubes to be expanded and beaded without splitting or cracking. In addition, the tube must pass the flaring and flattening tests as part of the material certification procedure

In the event one or more of the boiler tubes does crack or split during the installation (this includes rolling, beading and seal welding), the tube is defective and should be replaced by the supplier.

The SA-209 Carbon Molybdenum Alloy Steel can be seal welded readily.

The use of preheating when performing seal welding of boiler tubes is not required provided the thickness of the tubes and flue sheet meet the thickness requirements of ASME B&PVC Table PW-39 General Notes (a) & 6.

E) The Answers Received From The Alstom Shop

My questions to our shop are listed in black. The shop's answers are listed in red.

1) Do we (Alstom) have any restrictions for seal welding either SA-178 Grade C or SA-209 for firetube boilers?
No, as long as the procedure agrees with Table PW-39 General Note (a) (6),

The copy of the referenced ASME B&PVC Table PW-39 is in the attached PDF file.

(See attached file: DOC060410.pdf)

2) Would the seal welding of SA-178 Grade C boiler tubes be improved if we restricted its maximum allowable carbon content of the boiler tubes to a lower value, such as 0.30%, instead of the present specification maximum of 0.35%? **Yes, the lower value of carbon is better,**

3) Do we have a preferred electrode for this type of boiler tube seal welding, especially for SA-209? **The E-7018 is the standard while E-7015 is good for out of position welding,**

Discussed and continued to next meeting as of 11/10;

Discussion and Progress Report: Installation of Boiler Tubes & Arch Tubes Stone No discussion at 3/11 meeting;

I recommend we prepare rules regarding the length and fit up of boiler tubes and arch tubes into locomotive boilers. I consider that these rules are necessary to prevent shops and repair firms from installing boiler tubes and arch tubes that are cut too short or are formed (bent) to the wrong shape.

The present lack of rules regarding the necessity for boiler tubes and arch tubes to have the correct fit up, length, and shape upon assembly, along with the lack of a known prohibition preventing altering the tubes that were cut too short or were formed to the wrong shape by heating or mechanical stretching, allows shops and repair firms to use these "force fit" assembly methods since the inspectors are not aware of the problems that are created.

For simplicity in the text I will be using the term "boiler tube" to represent boiler tubes, arch tubes, and boiler flues.

The specific problem we need to address is the installation of boiler tubes that have been cut too short and then are lengthened to obtain the installation. The lengthening process is accomplished either by heating the boiler tube with a heating torch to temporarily obtain the required additional length from thermal expansion or by stretching the boiler tube using a mechanical pulling device.

The problem with heating boiler tubes that are too short is that after the boiler tube has been rolled and secured to both tube sheets, the contraction of the tube length as it cools back to ambient temperature places an enormous axial tension/compression load on both tube sheets, the tube sheet braces, the front section of the firebox plates and the stays that contact the firebox plates. The axial tension/compression loads created either alter or exceed the original boiler design stresses for these components because it was not included in the original boiler design. As a result, it qualifies as an alteration.

The problem with the use of mechanical stretching to lengthen boiler tubes that are too short is the stretching process reduces the original design boiler tube wall thickness and can work harden the boiler tubes. The tube wall thickness reduction changes the original design stresses calculated for the boiler tubes. It too qualifies as an alteration of the original boiler design.

1. Boiler tubes and arch tubes shall be cut to or made to the correct length required for installation with all parts at ambient temperature. The use of heating or stretching the tube at installation to obtain the required length is prohibited. Tubes that are cut too short shall be rejected.

2. The ends of boiler tubes and arch tubes may be swedged to the diameter required to fit the tube sheet holes. The swedging shall create smooth surfaces, smooth curves, and a uniform diameter reduction across the entire swedged length. The creation of sharp corners, sharp edges or a partial collapse of tube interior within the swedged section is prohibited. Tubes that are swedged incorrectly shall be rejected.

Swedging shall be performed using dies whenever possible.

Machining the tube end to obtain the required swedge diameter is prohibited.

3. Bends in boiler tubes and arch tubes shall be formed to correct shape and curvature required for installation with all parts at ambient temperature. The bending work shall be performed to create smooth surfaces over the entire bend. The creation of sharp corners, sharp edges, or a partial collapse of tube interior within the bend is prohibited.

The use of heating or stretching the tube at installation to obtain the correct bend shape is prohibited. Tubes that are formed to the wrong shape or curvature shall be rejected.

COMMENTS

1. This subject is based on the experiences of Mike Tillger with a boiler repair firm that cut the boiler tubes too short for installation into a locomotive. The boiler repair firm personnel tried to heat the boiler tubes during the installation process in order to lengthen them sufficiently to engage the tube sheet. When Mike questioned them about it they replied, "we do this all the time". Mike forbid it and sent them back to their shop to obtain the correct length tubes.

This same problem also occurs in the power boiler industry for firetube and water tube boilers on which the boiler tubes and/or tube panels have been formed incorrectly (wrong the shape) or are cut too short.

2. I encountered a locomotive boiler on which the firebox tube ends were machined to a smaller diameter in order to obtain the required swedge size. The wall thickness reduction of the boiler tube this created was considerable and made the tubes unfit for use.

NBIC Procedures for addenda

No discussion at 11/10 meeting; will close this item;

Guest questions –

Next meeting – 6 February 2012, Houston, TX, Westin Galleria/Westin Oaks

Adjournment – 12:26 pm, 11/14/2012

Attachment A

Our Existing NBIC Locomotive Boiler Rules for Ferrules: S1.2.9.7 Ferrules.

- a) Ferrous or non-ferrous ferrules may be used on either of both ends of flues and arch tubes.
- b) If ferrules are recessed, the recess depth shall not exceed 1/16" measured from the flue sheet fireside edge.
- c) Protrusion of the ferrule beyond the edges of either flue sheet is permitted provided the ferrule does not interfere with any further attachment procedures.
- d) For steel ferrules, if the flue is installed by expanding in straight and seal welding it to the flue sheet, the seal weld shall be so arranged to contact the flue sheet and the flue. Seal welding the flue to the ferrule is prohibited.
- e) The application of ferrules were none were used before shall be considered a repair.
- f) The application without ferrules, where none were used before shall be considered a repair.

Our Proposed NBIC Locomotive Boiler Section Rules for Ferrules: S1.2.9.7. Ferrules.

1. Steel ferrules may be made of material conforming to the chemical requirements of SA-178 gr. A, SA-192, or SA-210 boiler tube.
2. Copper ferrules may be made of material conforming to SB-111, SB-75, SB-41, SB-133. *These specifications cover copper products produced from material conforming to C10100, C10200, C10300, C10400, and others. These copper alloys are available in tube, strip, and sheet form, thus offering a readily available selection.*
3. When steel or copper ferrules are made or formed from strip (or sheet), the overlap of the ends of the strip shall not exceed 1/2". The overlapped portion of the strip ends shall be tapered to prevent extra thickness.
4. The installation of ferrules having a wall thickness not exceeding 1/8" to all regular flue holes and arch tube holes is a repair.
5. The ferrule shall be located and positioned within the flue sheet hole as required but shall not exceed beyond the flue sheet fireside edge upon completion of installation. When the ferrule installation requires the ferrule to be recessed in the flue sheet hole, the recess depth shall not exceed 1/16" measured from the flue sheet fireside edge.
6. On the waterside of the firebox flue sheet and the waterside of the front tube sheet the protrusion of the ferrule beyond the sheet edge shall be minimized .

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(M) = Member (MN) = Member non-voting

14 November 2011

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