



**THE  
NATIONAL  
BOARD**  
OF BOILER AND  
PRESSURE VESSEL  
INSPECTORS

# **NATIONAL BOARD SUBGROUP GRAPHITE**

## **MINUTES**

---

Meeting of July 17th, 2018  
Columbus, Ohio

These minutes are subject to approval and are for committee use only. They are not to be duplicated or quoted for other than committee use.

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

### **1. Call to Order**

As the Chair Mr. Ed Soltow was not present, and the group had no Vice Chair, the secretary Mr. Jonathan Ellis called the meeting to order at 9:05 am local time.

### **2. Introduction of Members and Visitors**

Mr. Ellis asked those present at the meeting to introduce themselves to the group. Enough members were present to establish a quorum.

### **3. Announcements**

The National Board will be hosting a reception for all committee members and visitors on Wednesday evening at 5:30pm at the pavilion.

Mr. Ellis made an announcement about the National Board's new award policy for Subgroup and Subcommittee members who do not serve on Main Committee. These members will now be receiving awards for every 5, 10, 15, etc. years of service on a subgroup/subcommittee. Mr. Ellis then awarded Mr. Aaron Viet with a 5 Year Pin and Mr. Andrew Stupica with a 10 Year Pin.

Mr. Viet announced that Mr. Bryan Jones has resigned from Subgroup Graphite.

### **4. Adoption of the Agenda**

A motion was made, seconded, and unanimously approved to adopt the agenda with no additions.

### **5. Approval of the Minutes of March 27<sup>th</sup>, 2018 Meeting**

The minutes from the March 2018 meeting can be found on the National Board website - <http://www.nationalboard.org/Index.aspx?pageID=13&ID=18>

A motion was made, seconded, and unanimously approved to adopt the March 2018 minutes with no changes.

### **6. Review of Rosters (Attachment Page 1)**

Mr. Viet will be reaching out to Mr. Ed Soltow and Mr. Keith Cummins to inquire about their intentions on remaining involved in the subgroup. Discussion was held on the importance of participation from current and potential new members.

#### **a. Membership Nominations**

- i. No new nominations. Mr. Nolan Lee will be submitting his resume and letter of support to Mr. Ellis before the next meeting to be reviewed by the group at their fall meeting.

**b. Membership Reappointments**

- i. Mr. Andrew Stupica's membership to SG Graphite ends on 8/30/2018. A vote was taken by the group to reappoint him to the subgroup. The subgroup voted unanimously to reappoint him. His reappointment is subject to Board of Trustees' approval.

**c. Officer Nominations**

- i. Mr. Aaron Viet was nominated and approved by the group to be the new Chair of Subgroup Graphite. This appointment is subject to the approval of the Board of Trustees

At this point in the meeting, Mr. Ellis asked for nominations for an acting chair for this meeting. Mr. Chris Cary nominated Mr. Viet to be acting Chair. This motion was seconded and unanimously approved. Mr. Ellis then turned the meeting over to Mr. Viet.

**7. NBIC Business**

<b>Item Number: NB15-2208</b>	<b>NBIC Location: Part 3, S3</b>	<b>No Attachment</b>
<b>General Description:</b> Investigate repair options for graphite block heat exchangers		
<b>Subgroup:</b> Graphite		
<b>Task Group:</b> G. Becherer (PM)		
<b>Meeting Action:</b> Mr. Greg Becherer had nothing to report for this meeting. Discussion was held on how to proceed with creating a proposal for this item. Mr. Becherer will work on a draft proposal for the next meeting.		

<b>Item Number: NB15-2210</b>	<b>NBIC Location: Part 3</b>	<b>Attachment Page 2</b>
<b>General Description:</b> Reduce cementing requirements for plugging of tubes		
<b>Subgroup:</b> Graphite		
<b>Task Group:</b> C. Cary (PM)		
<b>Meeting Action:</b> Mr. Viet gave an overview of where the item is at and an update on what will happen for this item this week was provided. The group will send two members to SC R&A meeting to answer their questions as well as Main Committee, as both groups will potentially vote on this item. Further discussion was held on the item to help clarify things for members who were not present at the last meeting.		

<b>Item Number: 17-166</b>	<b>NBIC Location: Part 3, S3</b>	<b>No Attachment</b>
<b>General Description:</b> Remove nozzle replacement and tube replacement from graphite routine repair list		
<b>Subgroup:</b> Graphite		
<b>Task Group:</b> F. Brown (PM)		
<b>Meeting Action:</b> Mr. Brown presented his proposal to the group. Mr. Viet asked how the changes affect field repair. Discussion was then held on whether or not tube replacement and nozzle replacement should remain on the list of routine repairs. Mr. Brown felt that leaving them off of the routine repairs list was the best option, but others disagreed. After discussing the merits of both options, the group took		

a straw poll vote to determine how to proceed with the item. The group agreed that leaving tube replacement on the list was the best option, and nozzle replacement would also remain as long as the maximum nozzle diameter was reduced from 18 inches to 6 inches. Mr. Brown will update the proposal accordingly, and requested that it be sent to letter ballot once completed. The group agreed to this plan unanimously.

At this point in the meeting, the group adjourned for lunch (12:07pm local time). Mr. Brown also left the meeting at this time.

Item Number: 17-167	NBIC Location: Part 3, S3.2 d)	No Attachment
<b>General Description:</b> Clarify repair inspection requirements for machined only graphite parts		
<b>Subgroup:</b> Graphite		
<b>Task Group:</b> A. Viet, M. Bost		
<b>Meeting Action:</b> No progress to report. Further discussion was held on how to proceed with the proposal. Work will be done between now and the next meeting to create a proposal.		

## 8. Future Meetings

- Late October 2018 – Columbus, OH or Tampa, FL
  - Mr. Viet requested Mr. Ellis check the availability of a meeting room at the National Board for a SG Graphite meeting on October 23<sup>rd</sup> and 24<sup>th</sup>.
- March 2019 – Columbus, OH

## 9. Adjournment

Mr. Viet motioned to adjourn the meeting. The motion was seconded and approved, and the meeting was adjourned at 2:09pm local time.

Respectfully submitted,

*Jonathan Ellis*

Jonathan Ellis  
NBIC Secretary

[illegible]

NOLAN LEE	MERSEN	590-389-7535
6-eg		350-998
BECHER, CG Jr		(-5786

## SUPPLEMENT 3

### REPAIR AND ALTERATION OF GRAPHITE PRESSURE EQUIPMENT

#### S3.1 SCOPE

(17)

- a) This supplement provides requirements and guidelines for repairs to graphite pressure equipment **requiring** the use of certified impregnated graphite and cement. The determining factor in establishing the desired material properties is the resin impregnation cycle. If the resin impregnation cycle is not controlled, it is not possible to meet the minimum design values.
- b) The letter “G” shall be included on the “R” *Certificate of Authorization* for those organizations authorized to perform repairs/alterations of graphite pressure equipment **except as permitted by Part 3, S3.5.4 f).**

#### S3.2 REPAIRS

(17)

The requirements provided in this supplement shall apply, insofar as they are applicable to graphite pressure equipment. Graphite specific requirements include:

- a) When the original code of construction is other than ASME, replacement parts subject to internal or external pressure shall be manufactured by an organization certified as required by the original code of construction. The item shall be inspected and stamped as required by the original code of construction. Certification to the original code of construction as required by the original code of construction or equivalent shall be supplied with the item. When this is not possible or practicable, the organization fabricating the part shall have a National Board *Certificate of Authorization*; replacement parts shall be documented on Form R-3 and the “R” Symbol Stamp applied as described in NBIC Part 3, Section 5
- b) When the standard governing the original construction is not the ASME Code, repairs or alterations shall conform to the edition of the original construction standard or specification most applicable to the work. Where the original code of construction is unknown, the edition and addenda of the ASME Code most appropriate for the work shall be used, provided the “R” Certificate Holder has the concurrence of the Inspector and the Jurisdiction where the pressure-retaining item is installed.
- c) The materials used in making repairs or alterations shall conform to the requirements of the original code of construction except as provided in NBIC Part 3, S3.2 j). The “R” Certificate Holder is responsible for verifying identification of existing materials from original data, drawings, or unit records and identification of the materials to be installed.
- d) When ASME is the original code of construction, replacement parts subject to internal or external pressure, which require shop inspection by an Authorized Inspector, shall be fabricated by an organization having an appropriate ASME *Certificate of Authorization*. The item shall be inspected and stamped as required by the applicable section of the ASME Code. A completed ASME *Manufacturer’s Partial Data Report* shall be supplied by the manufacturer. Further, all impregnated graphite material subject to internal or external pressure shall be fabricated by an organization having the appropriate ASME *Certificate of Authorization*. The impregnated graphite material shall be inspected and stamped as required by the applicable section of the ASME Code. A completed ASME *Manufacturer’s Partial Data Report* with supplementary U1B shall be supplied by the impregnated graphite material manufacturer.
- e) When the original code of construction is other than ASME, replacement parts subject to internal or external pressure shall be manufactured by an organization certified as required by the original code of construction. The item shall be inspected and stamped as required by the original code of construction. Certification to the original code of construction as required by the original code of construction or equivalent shall be supplied with the item. When this is not possible or practicable, the organization fabricating the part may have a National Board *Certificate of Authorization*; replacement parts shall be documented on Form R-3 and the “R” Symbol Stamp applied as described in NBIC Part 3, Section 5.

- e) Redrill a 7/8 in. (22 mm) hole at every other pilot hole. Holes must be drilled the full depth of the crack. The depth and direction of the crack can be checked with hydrophilic solvent.
- f) A 7/8 in. (22 mm) diameter reamer may be used to true the drilled holes.
- g) Dry fit a plug into the holes. There should be 0.005 in. to 0.010 in. (0.13 mm to 0.25 mm) clearance for the cement joint. At no time should there be a force fit of plugs into any drilled hole. Provisions shall be provided for venting trapped air.
- h) Sand the outside surface of the plugs. Thoroughly clean all the surfaces of the repair, plugs, and drilled holes with hydrophilic solvent.
- i) Apply graphite cement to both plugs and holes. All surfaces of plugs and holes to be joined are to be wetted with cement.
- j) Insert the cemented plugs into the holes allowing 1/16 in. (1.5 mm) of the plug to extend beyond the surface of the graphite part.
- k) Cure the graphite cement according to the cement manufacturer's instruction.
- l) At this point, half of the plug stitch repair is completed. A row of plugs has been installed with 1/4 in. (6 mm) pilot holes between them.
- m) Redrill the remaining pilot holes to 7/8 in. (22 mm) diameter. The drill will remove part of the plugs that were installed. It is important to have the plugs replace all of the fracture. If the new holes do not cut into the installed plugs, it will be necessary to repeat the procedure between these holes and plug locations to ensure that all of the crack has been repaired. The line of fracture is completely removed by the overlapping effect of the graphite plugs.
- n) After the second set of holes have been drilled, repeat the plug cementing procedures.
- o) Contour the plugs to provide a smooth transition into the adjoining surface area. The finished repair may be coated with a wash coat for appearance.

### S3.5.3.2 FIGURES — TYPICAL PLUG STITCHING PROCEDURE

- a) Step one: Layout hole centers.
- b) Step two: Drilling pilot holes.
- c) Step three: Drilling the first set of holes.
- d) Step four: Cementing and curing the first set of plugs.
- e) Step five: Drilling the second set of holes.
- f) Step six: Plug stitching repair completed.

### ~~S3.5.4 REIMPREGNATION OF GRAPHITE PARTS (TUBESHEETS, HEADS, AND BLOCKS)~~

- ~~a) As a function of time, temperature, and chemical exposure, the resin used to impregnate graphite may shrink and/or degrade. As such, it is possible for voids to develop in impregnated graphite that has been in chemical service for a period of time. The resin loss can vary from slight to almost complete loss of impregnation. There is no practical way to determine the amount of resin remaining in the pores. However, a pressure test will determine if the graphite has continuous porosity.~~

- b) ~~Reimpregnation of a graphite component may be used to reduce porosity in an existing graphite component, which in turn will improve the performance and expected life of the existing graphite components. A written re-impregnation procedure acceptable to the Inspector is required. The reimpregnation procedure shall include as a minimum:~~
- ~~1) Decontamination and drying of the graphite component~~
  - ~~2) Subjecting the component to a vacuum~~
  - ~~3) Introducing resin under pressure~~
  - ~~4) Curing the resin at a specified temperature and time~~
  - ~~5) Leak test~~

#### ~~S3.5.4.1 CONTROL OF IMPREGNATION MATERIAL~~

- a) ~~Impregnation material shall be the same as that specified in the Reimpregnation Procedure. Each impregnation material shall be traceable by the name of its manufacturer and the trade name or number of that manufacturer.~~
- b) ~~The impregnation material manufacturer shall supply the Certificate Holder a *Certificate of Analysis* for each material. It shall include the following:~~
- ~~1) Impregnation material identification~~
  - ~~2) Batch number(s)~~
  - ~~3) Date of manufacture~~
  - ~~4) Shelf life~~
  - ~~5) Viscosity per ASTM D 2393~~
  - ~~6) Specific gravity~~
- c) ~~Prior to reimpregnation, and at subsequent intervals not to exceed 14 days, the Certificate Holder shall test each batch of impregnation material to assure that the characteristics of the material have not changed from values specified in the Reimpregnation Procedure. The values obtained for viscosity and specific gravity for the impregnation material shall be within the limits specified by the manufacturer and as listed in the Reimpregnation Procedure. The test values shall be made available to the Inspector.~~

#### ~~S3.5.4.2 FINISHING THE REPAIR~~

- a) ~~The parts should be held in place to prevent movement while curing the cemented joint to achieve a proper repair. The repair firm should take care to ensure that the cement joint thickness is within the range recommended by the cement manufacturer. Care spent in precisely aligning the parts while clamping will avoid many finishing and machining operations later. Particular attention should be given to gasket and other bearing surfaces.~~
- b) ~~Gasket and bearing surfaces may have to be machined, filed, or sanded before the job is completed. Gasket serrations must be clean and continuous. Serrations can be easily re-cut into graphite and any repair plugs that cross the gasket surface.~~



S3.5.4

(17) ~~S3.5.5~~ **PLUGGING OF LEAKING OR DAMAGED TUBES**

- a) The material used for plugging tubes shall comply with the requirements of the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, Part UIG.
- b) The point(s) of leakage shall be verified, and the corresponding leak site(s) shall be marked/labeled on the tubesheet, and recorded.
- c) A plug shall be used to plug each end of the tube(s) in question and each plug shall have a minimum length of 1 in. (25 mm). Multiple plugs may be used.
- d) The tube(s) shall be prepared for plugging by enlarging the inside of the tube(s) with a suitable drill bit or reamer.
  - 1) To ensure a sound cement joint between the tube sidewall and the plug, a slightly smaller diameter plug shall be selected. The maximum clearance between the tube inside diameter and the outside diameter of the plug shall not exceed 3/32 in. (2.4 mm).
  - 2) As an alternative to d)1) a mandrel with an abrasive, such as sandpaper, may be used, as long as the maximum tube I.D. to plug O.D. clearance of 3/32 in. (2.4 mm) is not exceeded.
  - 3) The minimum plug insertion depth of the prepared hole(s) shall meet the minimum combined plug length requirements of "c". When the minimum plug length of "c" is exceeded, the total insertion depth of the plugs may exceed the combined length of the plugs; however, the longer plugs shall not project outside the face of the tube(s) being plugged.
- e) Plugging of leaking or damaged tubes shall be performed by certified cementing technicians, using qualified cementing procedures, in accordance with the requirements of the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, Part UIG.  
See below for new S3.5.4 f)
- g) f) The cement shall be prepared per the cement manufacturer's instructions.
- h) g) When cementing the plugs, 100% of individual plugs, as well as the inside diameter of the tube opening(s), shall be coated with cement. The plugs shall then be inserted one by one, against each other, into each end of the tube(s) being plugged.
- i) h) Once the plugging is completed, and before the cement cures, the endplugs may need to be held in place, as newly cemented plugs may exhibit a tendency to dislodge from the plugged tube(s) prior to final curing of the cement.
- j) i) Curing time is dependent upon the cement manufacturer's instructions, and is considered complete when the cement is hardened to the point that it cannot be indented with pressure from a flat screwdriver or other similar instrument.
- k) j) After the cement is completely cured, the plugged, cemented area(s) on the tubesheet face may be dressed with sandpaper or other suitable abrasive.
- l) k) Repaired tubes shall be tested in accordance with this code, using a method acceptable to the Inspector, with a written procedure as approved by the manufacturer's internal quality system, to ensure leaks have been repaired.
- m) l) The scope of the work completed shall be described and reported on a Form R-1.  
See below for new Figure S3.5.4

S3.5.5

~~S3.5.6~~ **TUBE REPLACEMENT**

Tube replacement should be performed with the unit preferably in the horizontal position. Avoid replacing adjacent tubes simultaneously because the replacement areas may overlap or reduce the ligament between

holes and possibly damage the tubesheet. The general steps used in horizontal tube replacement follow below.

- a) The material used for tube replacement shall comply with the requirements of the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, Part UIG.
- b) Tube replacement shall be performed by qualified cementing technicians, using qualified cementing procedures, in accordance with the requirements of the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, Part UIG-79 and UIG-80.
- c) Determine the thickness of each tubesheet and inside distance between the tubesheets to obtain tube and sleeve length.
- d) Access each tubesheet face, clearly identify and mark each tube hole on each tubesheet of the tubes to be replaced.
- e) Prepare/clean the existing tube hole in preparation for extracting the damaged tube. Some holes may contain plugs which require removal. A boring tool slightly larger than the outside diameter of the tube being replaced is required.
- f) Drill/bore out the tube hole in each tubesheet to release the tube from the tubesheet. Exercise caution when centering and align cutting to the common axis of the tube.
- g) The damaged tube should disengage and become loose. Using guides, remove the damaged tube. Ensure that no debris is trapped in the space where the tube was removed (Fig. ~~S3.5.6-a~~). S3.5.5-a
- h) Replacement tube shall have sleeves at the ends cemented in the bored holes to replace the material in the tubesheet that was bored out to access the damaged tube (Fig. ~~S3.5.6-b~~ and ~~S3.5.6-c~~).
  - 1) Dry-fit a new tube and sleeve. S3.5.5-b and S3.5.5-c
  - 2) The sleeve length may vary.
  - 3) Prior to applying cement, prepare and clean all surfaces to be cemented.
- i) Cement the ID of the prepared bore in the floating tubesheet and the tube end OD at the fixed tubesheet. (Fig. ~~S3.5.6-b~~). S3.5.5-b
- j) Insert the tube through the fixed tubesheet and through the floating tubesheet cemented bore so that it protrudes. Cement the ID of the fixed tubesheet bore as shown in (Fig. ~~S3.5.6-c~~). The use of alignment dowels can assist/guide in tube handling. S3.5.5-c
- k) Cement the OD of the tube end protruding from the floating tubesheet. Cement the ID of the mating sleeve end, fit it to the cemented tube end and push the assembly part-way into the floating tubesheet. Cement the remainder of the OD of the floating tube end sleeve. Push this cemented assembly the rest of the way into the floating tubesheet (Fig. ~~S3.5.6-c~~). S3.5.5-c
- l) Cement the ID and OD of the sleeve for the fixed tubesheet and insert it until it mates with the tube end inside. Push together cemented tube/sleeve assemblies. (Fig. ~~S3.5.6-d~~). Clean/wipe away any excess cement. S3.5.5-d
- m) Apply slight pressure on the sleeves to seat the joints. Remove excess cement.
- n) Maintain pressure and cure both ends of the cemented assembly according to the cement manufacturer's instructions.
- o) Sleeves may be trimmed after curing.

- p) Replaced tubes shall be tested in accordance with this code per a written procedure acceptable to the Inspector.
- q) The scope of work completed shall be described and reported on a Form R-1.

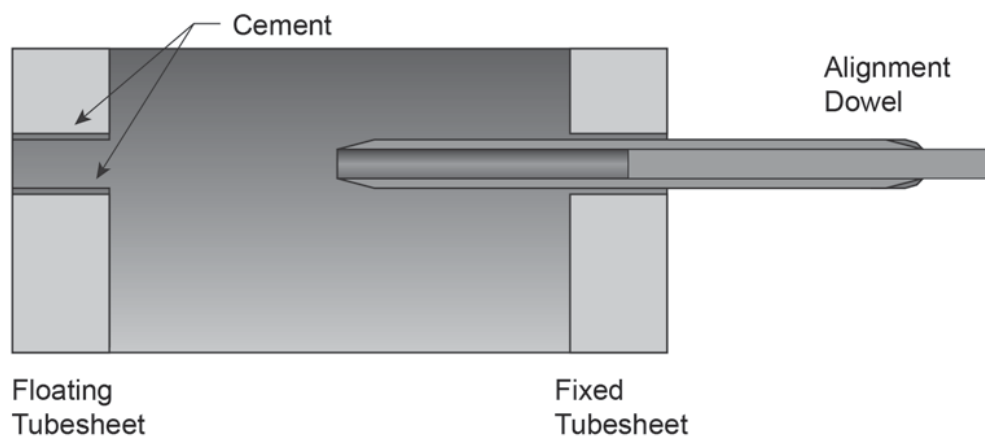
**FIGURE S3.5.6-a** S3.5.5-a

CLEANED AND PREPARED TUBESHEETS

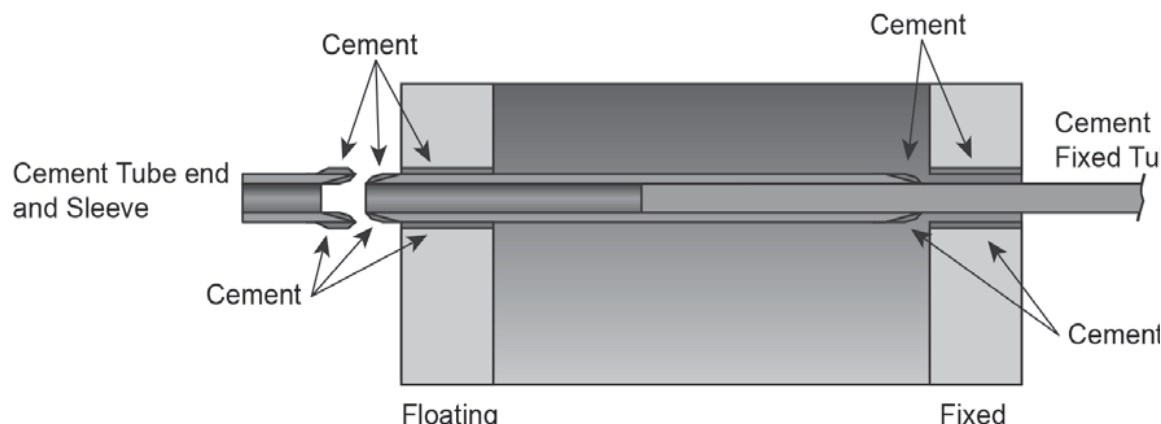


**FIGURE S3.5.6-b** S3.5.5-b

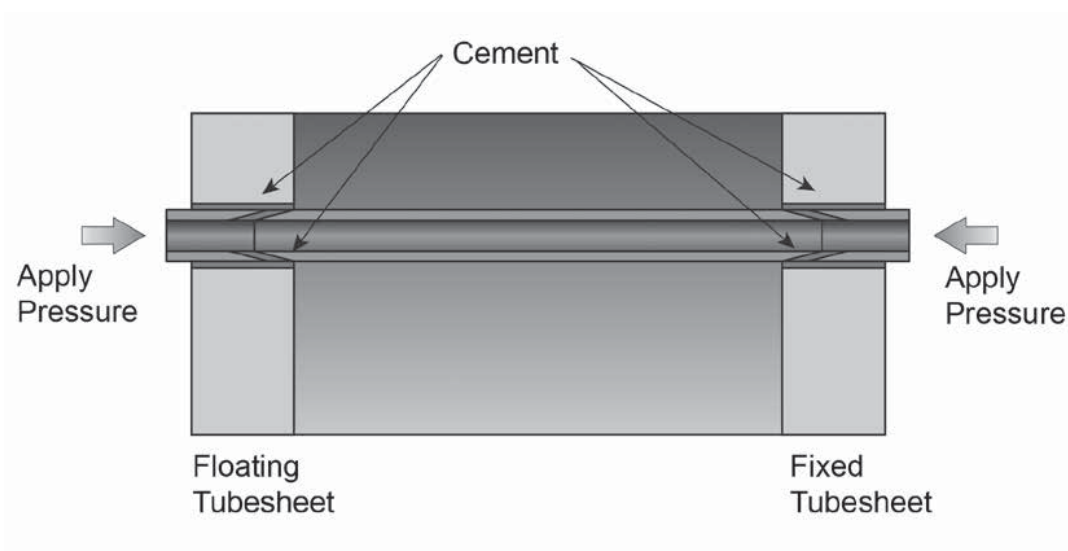
STARTING TUBE REPLACEMENT



**FIGURE S3.5.6-c** S3.5.5-c  
SLEEVE CEMENTING



**FIGURE S3.5.6-d** S3.5.5-d  
COMPLETED TUBE REPLACEMENT



S3.5.6 **S3.5.7 REIMPREGNATION OF GRAPHITE PARTS (TUBESHEETS, HEADS, AND BLOCKS)**

(17)

- a) As a function of time, temperature, and chemical exposure, the resin used to impregnate graphite may shrink and/or degrade. As such, it is possible for voids to develop in impregnated graphite that has been in chemical service for a period of time. The resin loss can vary from slight to almost complete loss of impregnation. There is no practical way to determine the amount of resin remaining in the pores. However a pressure test will determine if the graphite has continuous porosity.
- b) Reimpregnation of a graphite component may be used to reduce porosity in an existing graphite component, which in turn will improve the performance and expected life of the existing graphite components. A written re-impregnation procedure acceptable to the Inspector is required. The reimpregnation procedure shall include as a minimum:

- 1) Decontamination and drying of the graphite component
- 2) Subjecting the component to a vacuum
- 3) Introducing resin under pressure
- 4) Curing the resin at a specified temperature and time
- 5) Leak test

S3.5.6.1

**(17) ~~S3.5.7.1~~ CONTROL OF IMPREGNATION MATERIAL**

- a) Impregnation material shall be the same as that specified in the Reimpregnation Procedure. Each impregnation material shall be traceable by the name of its manufacturer and the trade name or number of that manufacturer.
- b) The impregnation material manufacturer shall supply the Certificate Holder with a Certificate of Analysis for each material. It shall include the following:
  - 1) Impregnation material identification
  - 2) Batch number(s)
  - 3) Date of manufacture
  - 4) Shelf life
  - 5) Viscosity per ASTM D 2393
  - 6) Specific gravity
- c) Prior to reimpregnation, and at subsequent intervals not to exceed 14 days, the Certificate Holder shall test each batch of impregnation material to assure that the characteristics of the material have not changed from values specified in the Reimpregnation Procedure. The values obtained for viscosity and specific gravity for the impregnation material shall be within the limits specified by the manufacturer and as listed in the Reimpregnation Procedure. The test values shall be made available to the Inspector.

New S3.5.4 f)

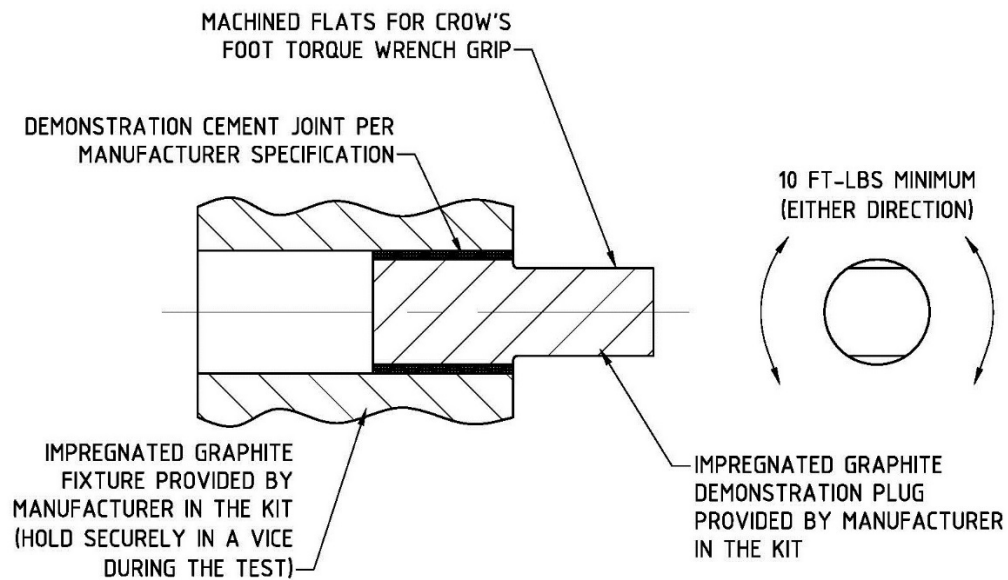
f) As an alternative to e) any R Certificate Holder, with or without the letter “G” included on the “R” Certificate of Authorization, may install graphite tube plugs provided the following conditions are met. The R Certificate Holder shall gain the concurrence of the Inspector, and shall utilize a tube plugging kit provided by an ASME Certificate Holder authorized to use the G designator. The kit shall include the following items:

1. Certified graphite plugs and certified cement ingredients, both accompanied by the appropriate documentation (Partial Data Report).
2. The qualified cementing procedure of the ASME Certificate Holder authorized to use the G designator, and a step-by-step procedural checklist that shall be followed explicitly. The procedure shall address the entire tube plugging process including plug configuration, tube hole cleaning and preparation, mixing and applying of the cement, application of the plugs, securing the plugs during the curing process, controlling the curing process, and leak testing, thereby meeting S3.3.
3. Additional materials and procedure shall be provided and used to prepare a demonstration plug joint prior to performing the repair. This demonstration plug joint shall be tested by a twist (torsional) test designed to demonstrate acceptable application and curing of the cement (Fig. S3.5.4). The test procedure shall include acceptance criteria, which may be based on a principle of breakage of part of the test piece. A successful twist test, in conjunction with the completed procedural checklist, shall serve as a valid cement technician certification for a single repair operation. **The twist test shall be witnessed by the Inspector.**

The R Certificate Holder shall review the material certifications including verification that the shelf life of the cement has not been exceeded, and assure that the certified cement technician has completed the qualification demonstration, and has access to the procedure and checklist. The Inspector shall review and verify that the procedure and the other elements of the certified kit, as provided by the authorized G-designated ASME Certificate Holder, have been administered and completed prior to his acceptance. The R-certificate Holder shall note on Line 8 of the R-1 Form the installation of cemented graphite tube plugs in accordance with this section. The letter “G” shall not be applied to the vessel when performing this alternative repair. The R Certificate Holder shall identify and document the location of the plugged tubes on the R Form.

FIGURE S3.5.4

DEMONSTRATION PLUG JOINT TWIST TEST



**NOTE: THIS DEMONSTRATION APPLIES TO PLUGS OF ALL DIAMETERS AND LENGTHS.**