**Date Distributed: October 27th, 2016**

THE NATIONAL BOARD OF BOILER AND PRESSURE VESSEL INSPECTORS

# NATIONAL BOARD SUBGROUP GRAPHITE

# MINUTES

Meeting of October 26th, 2016
Columbus, OH

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The National Board of Boiler & Pressure Vessel Inspectors
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1. **Call to Order**

Chair Mr. Ed Soltow called the meeting to order at 8:42am local time.

2. **Introduction of Members and Visitors**

All in attendance introduced themselves and their company affiliation. The following people were present at the meeting:

Ed Soltow – Chair
Brad Besserman - Secretary
Francis Brown – Member
Justin Clemens – Member
Luke Cummins – Alternate for Keith Cummins
Andrew Stupica – Member
Aaron Viet – Member
Chris Cary – Visitor
Bob Dickerson – Visitor
Bryan Jones – Visitor

It was pointed out that Shawn Malone is no longer a member of the committee. Additionally, Drew Sholar's interest category should be changed from Manufacturer to National Board Certificate Holder.

3. **Announcements**

It was announced that the National Board would provide lunch for the subgroup.

4. **Adoption of the Agenda**

The agenda was approved by a unanimous vote of the subgroup.

5. **Approval of the Minutes of July 19th, 2016 Meeting**

The minutes from the July 2016 meeting were reviewed by the committee. The minutes were approved by a unanimous vote of the subgroup.

6. **Action Items**

| **Item Number: NB15-2204** | **NBIC Location: Part 2, S3** | **No Attachment** |
|---|---|---|
| **General Description:** Describe post construction inspection methods specific to graphite pressure equipment<br><br>**Subgroup:** Graphite<br><br>**Task Group:** T. Rudy (PM)<br><br>**Meeting Action:** It was discussed whether additional inspection information was needed for post-construction inspection or post-repair inspection. It was decided no additional information was needed | | |

for this topic. The item was closed by a unanimous vote of the subgroup.

| Item Number: NB15-2208 | NBIC Location: Part 3, S3 | No Attachment |
|---|---|---|

**General Description:** Investigate repair options for graphite block heat exchangers

**Subgroup:** Graphite

**Task Group:** Greg Becherer (PM)

**Meeting Action:** Mr. Becherer was not present for the meeting. Mr. Viet said no progress has been made on the item.

| Item Number: NB15-2209 | NBIC Location: Part 1 | Attachment Page 1-7 |
|---|---|---|

**General Description:** Develop guidance and requirements for installation of graphite pressure equipment

**Subgroup:** Graphite

**Task Group:** A. Stupica (PM)

**Meeting Action**: Mr. Andy Stupica presented a proposed supplement for installation of graphite pressure equipment. He explained the changes to the proposal since it was last presented to the committee. The subgroup suggested extensive revisions to the proposal during the review. The committee requested the revised document be distributed to the subgroup for review and comment, and then opened for a letter ballot.

| Item Number: NB15-2210 | NBIC Location: Part 3 | Attachment Pages 8-11 |
|---|---|---|

**General Description:** Reduce cementing requirements for plugging of tubes

**Subgroup:** Graphite

**Task Group:** C. Cary (PM)

**Meeting Action:** The committee reviewed comments submitted by members of the SC Repairs and Alterations during a previous letter ballot. The subgroup will respond to the comments and revise the document based on the comments. After the comments have been addressed, the ballot will be opened for reaffirmation.

| Item Number: NB16-1302 | NBIC Location: Part 3, S3.2 | Attachment Page 12 |
|---|---|---|

**General Description:** Pressure test requirements rewrite for graphite vessels

**Subgroup:** Graphite

**Task Group:** None assigned

**Meeting Action:** A ballot was previously approved by the subgroup at the July 2016 meeting. The text of the proposal was shown. The proposal will be forwarded to SC Repairs and Alterations at their January 2017 meeting.

| Item Number: NB16-1303 | NBIC Location: Part 3, S3.5.1 f) | Attachment Page 13 |
|---|---|---|

**General Description:** Revise wording mandating examination and evaluation for graphite vessels

**Subgroup:** Graphite

**Task Group:** None assigned

**Meeting Action:** A ballot was previously approved by the subgroup at the July 2016 meeting. The text of the proposal was shown. The proposal will be forwarded to SC Repairs and Alterations at their January 2017 meeting.

**7. Future Meetings**

March 28-29 – National Board Headquarters – Columbus, Ohio
July 17-18 – National Board Headquarters – Columbus, Ohio

**8. Adjournment**

The meeting was adjourned by Chair Ed Soltow at 1:42pm local time.

Respectfully submitted,

Brad Besserman
NBIC Secretary

**Installation, Impervious graphite Equip.:** **NB 15-2209**
**as submitted by Andrew Stupica to Graphite SG Graphite for discussion**

**Rev's: July 2015 & (Nov 2015 Rev2) & (Dec2015 rev3)…(July-21-2016 rev4) Aug-19-2016 rev5 – Oct-26-2016 rev6**

## SX.1 SCOPE

This supplement provides ~~requirements and~~ guidelines for the installation and related consideration of impervious/impregnated graphite pressure vessels.

SX.2 Definitions: SX.2 Glossary of terms/definitions: "see last page of this document…"

## Sx3 General requirements

Sx3.1 Transportation of Units to Installation Site

Receiving and Initial Inspection of Graphite equipment

~~For users protection, it is suggested~~ Ggraphite equipment should be thoroughly inspected and tested as it is received in order to identify any in-transit damage. Whenever possible, this inspection ~~is best~~should be made before the exchanger is removed from the carrier. ~~Some pressure, not to exceed design pressure, such as operating pressure, can be applied on the service/process side to~~ To verify the unit has arrived in an undamaged condition, a pressure test may be performed. This pressure test shall not exceed the MAWP of the vessel. ~~DO NOT EXCEED THE NAME PLATE PRESSURE LIMIT or SEVERE DAMAGE MAY RESULT~~. Graphite equipment may arrive from the manufacturer under ~~slight~~ low pressure and/or with shock ~~indicators~~ detectors as an indication of un-damaged arrival. ~~Cylindrical graphite heat exchangers should not have strapping and transport hold~~ Transport straps should only be mounted on the main shell body because end components are less sturdy. ~~downs on end heads/channels and graphite dome ends which are less sturdy than the main shell body.~~ Discussion between users and ~~suppliers~~ manufacturers ~~on~~ regarding transport details, such as use of air-ride trucks, is worthwhile. Any crating should be inspected both for direct damage and/or evidence of improper handling. ~~(such as chains/cables secured to critical~~

~~graphite heads/chambers or components).~~ If there is any evidence of damage, notify the manufacturer.

Some ~~large type heat exchangers/units~~graphite pressure equipment may be shipped unassembled for later assembly ~~by authorized personnel~~. Review any packing or check list. All parts should be carefully inspected. ~~Often only a service side hydrostatic test (not to exceed design pressures) may be administered to verify transit damage but an added careful inspection of all parts is also suggested for a thorough assessment. Review any packing or check list and~~ P~~p~~ay special attention to graphite parts surfaces. Avoid pry bars, chisels, wedges or excessive force to separate any protective covers from graphite nozzles or openings. Activity around graphite surfaces should progress gently and with caution.

~~Impervious graphite exchangers/equipment may have multiple pass designs on both service and process sides in the end chambers. For extended storage where a chance of~~Where freezing could occur, open all vents and drains ~~in chambers on service side and all vents and drains in on the process side~~ after a pressure test to drain out all water from all passes and pockets to prevent freeze damage. ~~Impervious graphite exchangers/equipment may have multiple pass designs on both service and process sides in the end chambers.~~ Follow other good practices such as to prime the unit with an antifreeze solution and/or drain and dry it completely.

Sx3.2 Equipment parameters/ Clearances /Movement

~~These impregnated~~Impregnated graphite ~~heat exchangers and vessels~~equipment ~~are units which~~ utilize the properties of graphite to primarily transfer heat in corrosive application and with those properties usually contain corrosive media. Proper handling, installation, operation and maintenance of ~~these units~~this equipment will ensure many years of trouble-free service. The construction details can be obtained by consulting the bill of materials and the assembly drawing provided by the manufacturer.

In many cases, ~~the units~~ graphite pressure equipment is~~are~~ of a modular construction & design and ~~are possible to~~may be assembled in the field. Installation and surrounding space for this assembly should consider that impregnated graphite ~~heat exchangers are~~pressure equipment may be readily disassembled ~~from their internal graphite components if cylindrical or unstacked if it is a square or rectangular graphite block~~. ~~This is done preferably in a vertical position based on the orientation of the vessels and disassembly technique.~~Consideration should be given to the orientation of the equipment for potential disassembly.

~~For safety, keep~~Keep the following points in mind when handling impervious graphite ~~heat exchangers~~pressure equipment as impervious graphite is easier to damage than metal components.

- Use only soft slings when handling
- ~~.~~ ~~If steel cables are employed there should be some provision of protection/barrier for the graphite parts~~Graphite parts should be protected with a barrier if steel cables or chains are employed
- ~~.~~Lifting and transportation ~~of impervious graphite heat exchangers~~ should be done at designated lifting points or per manufacturer's recommendations
- ~~.~~Avoid~~-~~ lifting ~~impervious graphite equipment~~ by placing slings directly around the graphite.

Sx3.x Supports/Foundations

See NBIC Part 1, 1.6.1 for requirements on supports, foundations, and settings.~~Supporting the unit considerations for graphite pressure equipment is similar to pressure vessel installation NBIC Part 1, Section 4.~~

~~Foundations and supports shall be adequate to prevent settling or the transmission of stresses, vibrations or shock loads to the graphite pressure vessel. Any base structure shall be designed to support the exchanger and also to eliminate movements or moments caused by but not limited to possible hydraulic thrusts of process and service fluids.~~

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Additionally, ~~Heat exchangers~~graphite pressure equipment should be set level and square so that all piping connections may be made without excessive force. ~~Equipment may be in various orientations such as vertical, horizontal or other but with all installations~~Regardless of equipment orientation, ~~it is usually recommended that consideration are mad~~ consideration should be given to minimize~~s~~ air entrapment ~~at the highest point.~~.

Graphite pressure equipment may be built with bolted on lined vessel ~~parts~~components ~~that contain the same corrosive materials that is handled by the graphite pressure equipment~~. These lined ~~parts~~ components may or may not be insulated. Any design of side bracing should avoid direct contact with outer vessel wall that could create cold wall effect~~promote hot/cold reactions~~.

Sx3.x Piping Connections

Impregnated graphite components are strongest in compression, weakest in tension and thus most all connections are ~~bolted~~ by design in compression. Before ~~reassembling the heat exchanger~~connecting piping, ~~grooves and surfaces on the impregnated graphite blocks and headers for~~ gasket~~s~~ surfaces including serrations ~~and baffles~~ should be ~~cleaned~~ thoroughly cleaned to prevent any leakage of fluids. Use a suitable solvent if possible to completely remove ~~completely~~ all dirt or contaminants from connections~~, if any~~. Be careful not to scratch or gouge the graphite surface as it is ~~not as immune~~more susceptible to damage ~~as~~ than metallic ~~components~~surfaces. Gaskets ~~are recommended to~~should be very soft/low-stress ~~&~~ and flat thus avoiding any high spots and stress concentrations. ~~(r~~Refer to graphite equipment manufacturer for any spring settings, gasket ~~&~~ and bolt torque recommendations.~~)~~

~~Carefully connect to units and prevent undue stress from being transmitted to the exchanger's graphite parts.~~ Flexible connections such as expansion joints and bellows are recommended for the impregnated graphite connections. ~~to considerably reduce the connecting stress from pipe loads.~~ These are typically made from a suitable corrosion resistant material ~~&~~ and installed as close to the

~~exchanger graphite~~ nozzles as possible. These are recommended to isolate the ~~unit~~ equipment from but not limited to vibration, misalignment and thermal expansion of the piping or other loads which can impose stress on the impregnated graphite components or other nozzles that would transmit loads to the graphite.

After positioning and initial tightening of connections to graphite parts, the bolts/ nuts shall be tightened ~~by means of a torque wrench set~~ to the torque value provided by the manufacturer. Bolt torque charts or assembly drawings, which can be obtained from the equipment manufacturer, may be utilized ~~for~~ to determine these values. Equipment supplier/manufacturers data should be used ~~first and as a primary resource~~if available. Bolts are tightened in multiple stages (such as 3 or 4 stages) and in a diametrically staggered pattern starting with a torque value that is a small percentage of the final torque value until design values are achieved. ~~OEM Graphite equipment suppliers should have drawing details for owners of equipment or basic torque values charts if none are provided for old units that lack this information. Equipment supplier/manufacturers data should be used first and as a primary resource.~~

**Sx3.x Instruments and controls.**

Pressure: ~~Need for pressure indicating devices/controllers shall be considered in the installation of graphite pressure equipment and shall not allow the vessel to exceed MAWP. Additionally, the installation of pressure relief devices on both process and service sides of the exchanger are recommended or may be required by rules or laws~~. See NBIC Part 1, 4.4.2 and 4.5 for requirements related to pressure indicating devices and pressure relief devices.

Temperature control: Automatically controlled systems, such as for heating of impregnated graphite equipment, may be considered. ~~It~~ The temperature control~~would~~ should ~~allow~~ provide for over temperature protection such that inlet temperature ~~heat~~ is regulated to maintain a specified operating limit which shall be less than the maximum allowable temperature.

Sensors ~~control~~: ~~Automatic~~ Continuous monitoring ~~of the service~~ is suggested since process streams used in ~~Graphite~~ graphite heat exchangers~~equipment~~ are usually corrosive and a failure path or crossover to the service side ~~would need to~~should be identified ~~as soon as possible~~ with immediate correction and action.

Flow control ~~is critical~~: In operation of Graphite heat exchangers~~equipment~~ cold fluid flow is usually started first and the hotter product follows in small incremental steps. Shutting down a unit allows for the hotter fluid to be stopped and colder fluid to ~~slowly be~~be slowly reduced. Any unexpected or unregulated in-process rapid loss of cooling that allows heat buildup is a hazard to the equipment as a sudden ~~cold~~ surge of cold fluid could flash and damage equipment internals or have more severe consequences.

**Sx3.1 ~~Nondestructive exam~~Post-Installation Activities**

- Due to the nature of impregnated graphite, the surface is subject to light scratches (much more than a metallic material) and it is often difficult to distinguish scratches from cracks without further investigation. Consult the manufacturer as required.
- Graphite pressure equipment may be damaged by concentrated hydroblasting or pressure washing.
- Careful consideration should be given to painting graphite pressure equipment because improper painting can damage the equipment.
- ~~Nondestructive examinations (NDE) of impregnated graphite and related pressure retaining items shall be performed by those certified in the visual exam methods as specified in the governing code of construction.~~

- ~~Additional NDE exams may be employed by or under the guidance of the OEM. Due to the nature of impregnated graphite, the surface is subject to light scratches (much more than a metallic material) and difficult sometimes to distinguish them from cracks without further investigation.~~

SX.2 Glossary of terms/definitions:

**Impervious graphite** is a composite manufactured by impregnating porous graphite with chemically resistant synthetic resins used in the construction of graphite pressure equipment. With special processing the graphite becomes impervious, even to gases & under pressure. The final product partakes of the properties of both graphite and resin, but the predominate characteristics are similar to graphite which gives the most useful properties with its natural corrosion resistance and conductivity as a heat exchange material. Unlike corrosion resistant metals, graphite does not depend on the formation of a surface film or oxide for corrosion resistance, nor does it exhibit a measurable corrosion rate. Once rendered impervious, however, the chemical inertness of graphite may be limited by the characteristics of the resin such as a phenolic resin which is resistant to most acids, salt solutions and organic compounds but not suitable to alkalis and strong oxidizing chemicals that may degrade & weaken the material with no visible/measurable sign of material loss.

End components – Components attached to the main shell of graphite pressure equipment including heads, channels, domes, and tubesheets

Cold wall effect – a detrimental condition that promotes corrosion due to a temperature gradient between a vessel and its supports

NB15-2210 Ballot comments as of 10-27-16

| Comments for Ballot: NB15-22-10 | |
|---|---|
| **Soltow,Ed**<br>voted: Not Voting 10/27/2016 12:32:48 PM<br>*Reply To: Edwards,Paul* | Mr. Edwards, Thank you for your comments. Please be advised that a revised proposal is forthcoming. |
| **Soltow,Ed**<br>voted: Not Voting 10/27/2016 12:32:11 PM<br>*Reply To: Schaefer,Benjamin* | Mr. Schaefer, Thank you for your comments. Please be advised that a revised proposal is forthcoming. |
| **Soltow,Ed**<br>voted: Not Voting 10/27/2016 12:31:14 PM<br>*Reply To: Webb,Michael* | Mr. Webb, Thank you for your comments. Please be advised that a revised proposal is forthcoming. |
| **Edwards,Paul**<br>voted: Disapprove 10/7/2016 11:23:48 AM | Ballot resubmitted to correct my email address. Disapproval comments previously posted on 10/4/16. |
| **Schaefer,Benjamin**<br>voted: Approve 10/6/2016 12:07:04 PM | A couple suggestions, I tend to think this paragraph would be better located as a new 3.5.5 e) 1) rather then 3.5.5 m) since it is a direct alterative to (e) exclusively. Also, it might make it easier to read it the specific requirements for this alternative be as in a), b), c) rather than paragraph form. |
| **Webb,Michael**<br>voted: Disapprove 10/5/2016 11:58:19 AM | For the time, I will vote to "disapprove". While I support the proposition to introduce item "m" into Supplement 3, at 3.5.5, the controls and presented background seemingly sound, I am however curious how any "R"-Certificate Holder could present a repair of this nature on a Form R-1 when their "R"-Certificate may be otherwise limited. I am not aware of rules that would allow the "R" Certificate Holder to work outside of their scope of authorization and as initially presented, is in direct conflict with S3.2-a)of this Graphite Supplement. This would need to be reconciled. To add, I would like to propose the manner the information is introduced and some changes be considered as presented in the attachment. -M. Webb, 10-5-16<br>Reference Document: NB15-2210, Part 3, S3.5.5-m, rev.proposed.pdf |
| **Soltow,Ed**<br>voted: Not Voting 10/4/2016 7:13:53 PM<br>*Reply To: Edwards,Paul* | Mr. Edwards, Thank you for your comment and good suggestion. This request seems reasonable and I will bring it up to the subgroup when we meet later this month for consideration. |
| **Edwards,Paul**<br>voted: Disapprove 10/4/2016 3:12:16 PM | I support this action, however the use of this alternative needs to be documented in the Description of Work section on the R-1 form. As written, there is no traceability permitting an R Certificate holder without graphite in their scope to sign an R-1 form with Graphite Pressure Equipment identified as the Repair Type on line 7. |

To be added to S3.5.5 Plugging of leaking or damaged tubes

m) As an alternative to e) any R Certificate Holder may install graphite tube plugs utilizing a tube plugging kit provided by an ASME Certificate Holder authorized to use the G designator. The kit shall include certified graphite plugs and certified cement ingredients, both accompanied by the appropriate documentation. The kit shall also include 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. Finally, the kit shall include additional materials that would allow the individual performing the installation to demonstrate the ability to follow the procedure. This demonstration repair, in conjunction with the procedural checklist, shall serve as a cement technician certification valid for a single repair operation. 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. The R Certificate Holder shall review the material certifications including verification that the shelf life of the cement has not been exceeded. The Inspector shall review and accept the procedure as well as the completed checklist.

See background information document for additional info.

Background information on impregnated graphite tube plugging:

Cementing tube plugs is a proven field reliable and simple operation that has been effectively used by graphite equipment users for over half a century. With the introduction of the G mark and part UIG in the Code in 2010, and the subsequent inclusion of graphite pressure equipment repair procedures to the NBIC books, the option for end users to use the procedure was obsoleted for vessels marked with the 'G' mark indicator.

It is the opinion of this group that cementing plugs for tube plugging should be given some special consideration in regards to required certifications as detailed in part UIG.

Some key points:

- Cementing tube plugs is a very simple and effective operation.
- All tube plugging will be performed by an "R" Certificate Holder
- A cemented tube plugging operation can be performed successfully in as little as a day or two.
- While there are alternative tube plugging options, cementing is far and away the most effective and longest lasting option.
- There is little to no chance of doing further damage to the part as a result of a failed tube plugging operation. If the plug doesn't hold, or isn't properly installed, the resulting action is simply back to remove the plug and install a new one in its place
- In some jurisdictions, outside contractors are not allowed to perform code repairs on pressure vessels without obtaining a state license. In actual cases like these, a user would be forced to pull a vessel out and ship it to a repair organization certified for graphite to get the repair completed. This can result in weeks of downtime, rather than days, for such a simple operation.
- There are very few repair organizations that have graphite repair included in their scope nationwide.
- While commonly viewed as the graphite version of welding, cementing is a much less complex operation. There is no "fusing" of material as there is in welding, where the weld filler and base materials mix in the welded zone. A poorly cemented plug can be removed and the surrounding material is not affected. Proper combination of ingredients to produce adequate cement, applying enough cement to cover the joining surface, and properly curing the joint are the key factors in a good joint. All of which will be covered in the procedure specification.
- The nature of tube plugging is to simply seal a hole. This sets tube plugging apart from most other cementing operations which can be critical to vessel fit, form, and function.
- All of the design work is included in the kit. The proper bore diameter, and surface preparation steps are detailed, the plug is pre-made and ready to use, the cement mixing recipe is included, and the curing procedure is also part of the given procedure.

It is our belief that tube plugging operations do need to be controlled, but think limiting them to only repair organizations certified for graphite is unnecessary. We think that this proposal covers all the important bases by maintaining that an ASME certificate holder authorized to use the G designator provides the kit, a certified repair organization does the work, providing certified graphite materials with all the proper documentation, providing a qualified cementing procedure, and by requiring that the Inspector representing the repair organization get involved, similar to any other routine repair. All the

material is as required by the Code, and the joining methodology remains controlled by the use of the qualified procedure.

**Item Number: NB16-1302 NBIC Location: Part 3, S3.2 p)**

p) Completed repairs shall be subjected to a pressure test. The test pressure shall not be less than ~~the maximum allowable working pressure or twice the operating pressure, whichever is lower~~operating pressure or more than maximum allowable working pressure. The test pressure shall be maintained for 30 minutes minimum.

Justification:

Present pressure range requirements are excessive and cause unnecessary hardship. This action brings them more in line with the general requirements in Part 3.

Page A-6

**Item Number: NB16-1303 NBIC Location: Part 3, S3.5.1f)**

f) All damage ~~should~~ shall be examined and should be evaluated to determine the cause. Identification and elimination of the cause is essential in helping to prevent a recurrence

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