Date Distributed:

THE
NATIONAL
BOARD
OF BOILER AND
PRESSURE VESSEL
INSPECTORS

NATIONAL BOARD
TASK GROUP FRP

MINUTES

Meeting of April 19th, 2021
Zoom Meeting

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**
Mr. Bernie Shelley called the meeting to order at 1:04 PM Eastern Time.

2. **Introduction of Members and Visitors**
The following Task Group Members were present for the meeting:
   - Mr. Bernie Shelley, Chair
   - Mr. Jonathan Ellis, Secretary
   - Mr. Mike Gorman
   - Mr. Jess Richter
   - Ms. Debra McCauley
   - Mr. Norm Newhouse
   - Mr. Francis Brown
   - Mr. Doug Eisberg
   - Mr. Allen Beckwith
   - Mr. Juan Bustillos
   - Mr. Brian Linnemann

   Mr. Rex Smith was present at the meeting as a visitor.

   Enough members were present to establish a quorum for the meeting.

3. **Announcements**

   There were no major announcements for the meeting.

4. **Adoption of the Agenda**

   A motion was made, seconded, and unanimously approved to adopt the agenda as presented.

5. **Approval of the Minutes of October 2020 Meeting**

   The minutes of the October 2020 virtual meeting can be found on the National Board website:
   https://www.nationalboard.org/Index.aspx?pageID=13&ID=18

   A motion was made, seconded, and unanimously approved to approve the minutes from the October 2020 meeting.

6. **Review of Rosters**
   a. Membership Nominations
      i. None
   b. Membership Reappointments
      i. None
   c. Officer nominations
      i. None

7. Action Items

Item Number: NB11-1901	**NBIC Location: Part 1**	**Attachment Page 1**

General Description: Add guidance for the safe installation of high pressure composite pressure vessels operating in close proximity to the public

Subgroup: FRP

Task Group: R. Smith (PM), J. Eihusen, N. Newhouse

April Meeting Action: Mr. Shelley asked Mr. Newhouse about his review of the previous proposal for this item. Mr. Newhouse determined that there were two courses of action to take for the proposal to address comments from Subcommittee Installation and Main Committee. The first was to leave the reference to NFPA-2 as is since it fits with the current language. The other option is to differentiate between NFPA-2 for hydrogen and NFPA-52 for CNG. Mr. Newhouse provided revised language adding the reference to NFPA-52. Mr. Shelley asked that the revised proposal be sent to the Task Group as a letter ballot. He also asked that he and Mr. Newhouse should be invited to the SC Installation meeting in July.

Item Number: NB16-1402	**NBIC Location: Part 2**	**Attachment Page 13**

General Description: Life extension for high pressure vessels above 20 years

Subgroup: FRP

Task Group: M. Gorman (PM), N. Newhouse, J. Eihusen

April Meeting Action: Mr. Gorman provided an update on the item, discussing responses to Subcommittee Inspection questions/comments. He also discussed a new Life Extension Test form that would be used to track testing. A new proposal will be put together to address subcommittee comments, and responses will be provided to SC Inspection to ensure that the FRP responses are adequate.

New Items:

Item Number: 20-79	**NBIC Location: Part 2, S10.10.4 c)**	**Attachment Page 20**

General Description: Add nomenclature to the formula shown in NBIC Part 2, S10.10.4 c)

Subgroup: FRP

Task Group: M. Gorman (PM).

Background Information: This change request came about from a Public Review Comment submitted to the National Board for the 2021 NBIC. This comment related to action item NB16-1401, which made several changes to Supplement 10. The Main Committee responded to this comment stating that a new action item would be opened to add nomenclature for this formula.

Mr. Gorman, the Project Manager for item NB16-1401, provided the following definitions for the variables in the formula:

> U is the measured signal energy in joules. The signal is the captured waveform from, say, a fiber break source. V is the signal amplitude in volts point by point in the signal. Voltage must be corrected for gain (G). Z is in ohms. The (differential) time is dt in seconds.

April Meeting Action: Mr. Shelley asked Mr. Ellis to submit the proposal for this item as a letter ballot to the Task Group.

8. Additional Business

9. Future Meetings

October 18th, 2021 - Virtual

10. Adjournment

Mr. Shelley adjourned the meeting at 2:36 PM Eastern Time

Respectfully submitted,
Jonathan Ellis
Secretary

NB11-1901

SUPPLEMENT X

INSTALLATION OF HIGH PRESSURE COMPOSITE PRESSURE VESSELS

SX.1 SCOPE

This supplement provides requirements for the installation of high-pressure composite pressure vessels. This supplement is applicable to pressure vessels with an MAWP not exceeding 15,000 psi, and is applicable to the following classes of vessels:

a) Metallic vessel with a Fiber Reinforced Plastic FRP) hoop wrap over the shell part of the vessel both load sharing)

b) Metallic vessel with a full FRP wrap (both load sharing)

c) FRP vessel with a non-load sharing metallic liner

d) FRP vessel with a non-load sharing non-metallic liner

SX.2 SUPPORTS

Design of supports, foundations, and settings shall consider the dead loads, live loads, wind, and seismic loads. Vibration and thermal expansion shall also be considered. The design of supports, foundations, and settings shall be in accordance with ASCE/SEI 7, *Minimum Design Loads for Buildings and Other Structures*. The importance factors used in calculating the seismic and wind loads shall be the highest value specified for any category in ASCE/SEI 7.

SX.3 CLEARANCES

The pressure vessel installation shall allow sufficient clearance for normal operation, maintenance, and inspection. Stacking of pressure vessels is permitted. The minimum clear space between pressure vessels shall be 1 ft. vertical and 2 ft. horizontal. Vessel nameplates shall be visible after installation for inspection. The location of vessels containing flammable compressed natural gas fluids shall comply with NFPA 52. The location of vessels containing hydrogen or other flammable fluids shall comply with NFPA 2. The vessel owner shall document the vessel pressure and pipe diameters used as a basis for compliance with NFPA 2 location requirements.

SX.4 PIPING LOADS

Piping loads on vessel nozzles shall be determined by a formal flexibility analysis per ASME B31.12: paragraph IP-6.1.5(b). The piping loads shall not exceed the maximum nozzle loads defined by the vessel manufacturer.

SX.5 MECHANICAL CONNECTIONS

Mechanical connections shall comply with pressure vessel manufacturer's instructions, and with requirements of the Jurisdiction. Connections to threaded nozzles shall have primary and secondary seals. The seal design shall include a method for detecting a leak in the primary seal. Seal functionality shall be demonstrated at the initial pressurization of the vessel.

SX.6 PRESSURE INDICATING DEVICES

Each pressure vessel shall be equipped with a pressure gage mounted on the vessel. The dial range shall be from 0 psi to not less than 1.25 times the vessel MAWP. The pressure gage shall have an opening not to exceed 0.0550in (1.4mm) (No. 54 drill size) at the inlet connection. In addition, vessel pressure shall be monitored by a suitable remote pressure indicating device with alarm having an indicating range of 0 psi to not less than 1.25 times the vessel MAWP.

SX.7 PRESSURE RELIEF DEVICES

Each pressure vessel shall be protected by pressure relief devices per the following requirements:

a) Pressure relief devices shall be suitable for the intended service.

b) Pressure relief devices shall be manufactured in accordance with a national or international standard and certified for capacity (or resistance to flow for rupture disk devices) by the National Board.

c) Dead weight or weighted lever pressure relief valves are prohibited.

d) Pressure relief valves shall not be fitted with lifting devices.

e) The pressure relief device shall be installed directly on the pressure vessel with no isolation valves between the vessel and the pressure relief device except:

1) When these isolation valves are so constructed or positively controlled below the minimum required capacity, that closing the maximum number of valves at one time will not reduce the pressure relieving capacity, or

2) Upon specific acceptance of the Jurisdiction, an isolation valve between vessel and its pressure relief device may be provided for vessel inspection and repair only. The isolation valve shall be arranged so it can be locked or sealed open.

f) The discharge from pressure relief device(s) shall be directed upward to prevent any impingement of escaping fluid upon the vessel, adjacent vessels, adjacent structures, or personnel. The discharge must be to outdoors, not under any structure or roof that might permit formation of a "cloud". The pressure relief device(s) discharge piping shall be designed so that it cannot become plugged by animals, insects, rainwater, or other materials.

g) When a single pressure relieving device is used, it shall be set to operate at a pressure not exceeding the MAWP of the vessel. When the required capacity is provided in more than one pressure relieving device, only one device need be set at or below the MAWP, and the additional device(s) may be set to open at higher pressures but in no case at a pressure higher than 105% of the MAWP. The requirements of RR-130 of ASME Section X shall also apply.

h) The pressure relief device(s) shall have sufficient capacity to ensure the pressure vessel does not exceed the MAWP of that specified in the original code of construction.

i) The owner shall document the basis for selection of the pressure relief device(s) used, including capacity.

j) The owner shall have such analysis available for review by the Jurisdiction.

k) Pressure relief devices and discharge piping shall be supported so that reaction forces are not transmitted to the vessel.

l) Heat detection system: a heat activated system shall be provided so that vessel contents will be vented per f) (above), if any part of the vessel is exposed to a temperature greater than 220°F.

m) Positive methods shall be incorporated to prevent overfilling of the vessel.

SX.8 ASSESSMENT OF INSTALLATION

a) Isolation valve(s) shall be installed directly on each vessel, but not between the vessel and the pressure relief device except as noted in 3.7, e), above.

b) Vessels shall not be buried.

c) Vessels may be installed in a vault subject to a hazard analysis, verified by the manufacturer, owner, user, qualified engineer, or the Jurisdiction, to include as a minimum the following:

1) Ventilation

2) Inlet and outlet openings

3) Access to vessels

4) Clearances

5) Intrusion of ground water

6) Designed for cover loads

7) Explosion control

8) Ignition sources

9) Noncombustible construction

10) Remote monitoring for leaks, smoke, and fire

11) Remote controlled isolation valves

d) Fire and heat detection/suppression provisions shall comply with the requirements of the Jurisdiction and, as a minimum, include relief scenarios in the event of a fire or impending overpressure from heat sources.

e) Installation locations shall provide the following:

1) Guard posts shall be provided to protect the vessels from vehicular damage per NFPA 2 or NFPA 52, as appropriate. Protection from wind, seismic events shall be provided.

2) Supports and barriers shall be constructed of non-combustible materials.

3) Vessels shall be protected from degradation due to direct sunlight.

4) Access to vessels shall be limited to authorized personnel.

5) Any fence surrounding the vessels shall be provided with a minimum of two gates. The gates shall open outward, and shall be capable of being opened from the inside without a key.

6) Access for initial and periodic visual inspection and NDE of vessels, supports, piping, pressure gages or devices, relief devices and related piping, and other associated equipment.

7) Completed installations shall be validated as required by the Jurisdiction as addressing all of the above, and any requirements of the Jurisdiction, prior to first use. This verification shall be posted in a conspicuous location near the vessel and, when required, on file with the

Jurisdiction. Certificates shall be updated as required by mandated subsequent inspections.

8) Piping installation shall comply with ASME B31.12, NFPA 52, or NFPA 2.

9) The vessels shall be electrically bonded and grounded per NFPA 55.

SX.9 LADDERS AND RUNWAYS

See NBIC Part 1, Section 1.6.4 *Ladders and Runways*

Item NB16-1402 (NBIC Part 3, Section 6)

SC Inspection Letter Ballot Comments:

David Buechel: Step 1 - I'm confused about the three vessels to be selected for burst test. Are these the same type of vessels that have also reached the end of their life cycle? Where do they come from?

Jim Clark:

1. S14.3(d) states that the vessel type is dependent solely on manufacturer, materials, water volume, and design. Should environmental and installation conditions be included as well? If an inspector/user in Ohio performs LE testing on a given type of vessel, would that type then be certified for life extension in all other states and for all applications? It's unclear who is intended to be doing this testing. Owner/users, inspection agencies, manufacturers?

2. I don't agree with the MAE test interval (every 5 years) being the same as for in-life vessels despite the proof testing required for life extension. In addition, the language in S14.3(d) concerning ongoing MAE testing doesn't match that in the final paragraph of S14.5.4. The former specifies an MAE test every five years while the latter specifies five years or one-third of a lifetime, whichever is less.

3. I'm concerned about the notes associated with Step 1 (S14.5.1). The note for S14.5.1(c) could allow for the lowering of MAE acceptance criteria. With MAE being the backbone of the life extension program, I feel that there should be hard numbers for pass/fail criteria.

4. The note for S14.5.1(g) could allow for testing vessels until you get one that passes.

5. S14.3(b) references a form that is supposed to go along with this testing. Is there a form that should be attached as well?

Jim Getter: I sent this inquiry to our FRP Composite group, following is the discus supporting my Disapproved vote. We have great concerns with the use of acoustic emissions for those purposes and I would advise to vote NO for the following reasons.

1. There is significant variation in crack propagation rates within composite laminates, and certainly compared to monolithic materials such as steel alloys.

There is also variation in crack propagation rates among composite pressure vessels (COPV's) of the same design. Most critically, catastrophic failure can occur immediately or nearly immediately after crack initiation. As such, acoustic emissions may be a good tool for determining whether COPV should be taken out of service, but it is a very poor tool for predicting future structural performance.

2. With composite laminates, there is greater complexity and less accuracy when developing a baseline acoustic signature for each COPV design. Voids are inherently created when filament winding COPV's and the size, number, and distribution of such voids varies from vessel to vessel. This variation can be overcome by measuring the acoustic signature from a statistically representative population of newly manufactured COPV's. However, the baseline signature that is ultimately developed should be the lowest observed noise level and there will be statistical uncertainty as to whether the lowest possible noise level was established.

3. There will no doubt be discussion that DOT has allowed acoustic emission testing as a re-qualification method in various special permits for COPV's. This is true. However, DOT was seeking an alternative to hydrostatic testing. Neither of these technologies are accurate for predicting future structural performance and so in general safety interests are not compromised by allowing acoustic emissions in place of hydrostatic testing.

Vincent Scarcella: Trend analysis needs to be part of the process. For instance, if you have a history of NDE with no or low levels of degradation than I could support using the C factor.

Supplement 14

Life Extension of High Pressure Fiber Reinforced Plastic Pressure Vessels

S14.1 Scope

This document may be used to evaluate whether the service life of high pressure fiber reinforced plastic pressure vessels (FRP) can be extended for an additional lifetime. High pressure means vessels with a working pressure from 3,000 psi (20 MPa) to 15,000 psi (103 MPa). For vessels intended for cyclic service, fatigue testing of new vessels is carried out by the vessel manufacturer to be certain that the vessel will not fail in service and such testing is typically required by regulatory authorities. Fatigue design and testing is the starting point for consideration of life extension.

S14.2 General

a) The procedure for in-service testing of high pressure composite pressure vessels, **Supplement 10** herein, is incorporated by reference into this procedure for life extension of high pressure composite pressure vessels. Supplement 10 is based on acoustic emission (AE) testing, specifically modal AE (MAE) testing. The MAE inspection procedure employs detection and analysis techniques similar to those found in seismology and SONAR. Much as with earthquakes, transient acoustical impulses arise in a composite material due to the motion of sources such as the rupture of fibers. These transients propagate as waves through the material and, if properly measured and analyzed by the methods in Supplement 10, the captured waves reveal, for example, how many fibers have ruptured. Similar information about other sources is also determinable, such as the presence and size of delaminations. Delaminations can play a significant role in vessel fatigue life, particularly delaminations near the transition regions and in the heads. The rupture behavior can be used to determine the integrity of the vessel. However, the development of criteria for life extension (LE) requires an understanding of the vessel design and fatigue life.

b) Fatigue testing of out of life vessels is a crucial part of the life extension process. It is used to validate the mechanical behavior of the vessels and to develop the numerical values for the allowables in the MAE pass/fail criteria for the particular design, material and construction.

S 14.3 Life Extension Procedure

a) New vessel fatigue life testing data shall be obtained from the Manufacturer's Design Report (MDR) and the number of cycles in a lifetime shall be determined from the MDR. The type of vessel under consideration for life extension shall have been shown through testing to be capable of sustaining at least three lifetimes of cycles to developed fill pressure followed by a subsequent burst test at a pressure greater than minimum design burst pressure.

b) An evaluation of the service the vessel has seen should take into account any operational conditions that may have differed from those used in the design testing and analysis. Such conditions include for example exposure to more severe weather than expected, more cycles per year, constant high temperature and humidity, chemical attack or any other of a number of conditions under which operations take place that were not specifically included in testing at manufacture. Any such conditions shall be listed on the attached form. If no such conditions exist, it shall be so noted on the form. The test program delineated herein shall be revised to reflect the modified conditions as documented by the user and submitted for approval to the proper authorities.

c) Data and records for all vessels considered for life extension shall be kept and made readily available to inspectors or examination personnel. This includes an operating log, number of operating cycles since the previous examination, total number of operating cycles, examinations, examination techniques and results, maximum operating pressure and any unexpected pressures, temperatures, temperature cycles, damage events or other significant events that were outside the intended operating parameters or conditions.

d) A life extension test program shall be carried out for each type of vessel under consideration. Type of vessel means the particular manufacturer, materials (fiber and resin), water volume and design. If the type of vessel passes all requirements, then that type shall be eligible for life extension testing. If such a vessel passes the life extension MAE test its lifetime can be extended for one additional lifetime in five-year increments. In order to maintain life extension a vessel must be requalified every five years using the MAE test.

S14.4 Life Extension Test Program

a) The type of vessel under consideration for LE shall be noted. Manufacturer, place of manufacture and manufacturing date shall be recorded. The vessel dimensions shall be recorded. The specific fiber, matrix and winding pattern shall be recorded. If the fiber, matrix and winding pattern are not available from the manufacturer, then a vessel of the type under consideration shall be used to verify the winding pattern (hoop and helical angles and number of plies) through destructive testing.

b) Ten out-of-life vessels of the particular type shall be tested in the manner described herein. MAE techniques shall be applied to every vessel tested. Analysis of the MAE data is described herein. Two strain gages, one in the 0-degree and one in the 90-degree direction, shall be applied to every vessel pressure tested under this program. The purpose of strain gage data is to compute the 0 and 90 modulus values and to confirm that the modulus values of the material do not vary during the fatigue cycling required herein. Strain data shall be recorded and analyzed as described later on.

c) The LE test program proceeds by Steps. If the Step 1 is not successful, then there is no need to proceed to Step 2, and so forth.

S14.5 Life Extension Test Program Steps

S14.5.1 Step 1

Three vessels shall be selected from the ten and pressurized to burst. The vessels shall be inspected for visible damage, i.e., cuts, scrapes, discolored areas, and the vessel appearance shall be documented with photographs. MAE testing shall be done in conjunction with this testing as specified in Supplement 10, except for transducer spacing, pressurization plan and accept/reject criteria values. The values in Supplement 10 are for requalification testing. The transducer spacing shall be determined by the distance at which the 400 kHz component of a suitable pulser source is detectable along the axis of the vessel (essentially across the hoop fibers) and in the perpendicular direction (essentially parallel to the hoop fibers). Detectable means that the resulting signal component has an amplitude with at least a signal to noise ratio of 1.4. Transducer frequency response calibration and energy scale shall be carried out as specified in SUPPLEMENT 10. The pressurization plan shall follow that in ASME Section X Mandatory Appendix 8, i.e., there shall be two pressure cycles to test pressure with holds at test pressure as prescribed therein, however, the time interval between the two cycles may be reduced to one minute. For the purposes of life extension, the fiber fracture energy and BEO (background energy oscillation) values shall be as specified below.

a) No BEO greater than 2 times the quiescent energy (see Supplement 10) shall be observed up to test pressure or during pressure holds.

b) No fiber break event energy shall be greater than $24 \times 10^3 \times U_{FB}$ (see Supplement 10) during the second pressurization cycle.

c) No single event shall have an energy greater than $24 \times 10^5 \times U_{FB}$ during the second pressurization cycle.

Note: The numerical values specified in b) and c) can be adjusted through documented testing and stress analysis methods in order to account for the particular design, material and construction.

d) At least two sensors shall remain on each vessel all the way to burst in order to establish the BEO pressure for this type of vessel.

e) Plots of stress versus strain shall show linear behavior up to 90% of burst pressure.

f) The burst pressures of all three vessels shall be greater than the minimum design burst pressure.

g) If the burst pressure of any one of the three vessels is not greater than the minimum design burst pressure, then these vessels shall not be eligible for life extension and there is no need to proceed with Step 2 below.

Note: It is possible that one or more of the vessels selected had damage not obvious to visual inspection. If during this burst testing phase the MAE test identifies a vessel as damaged, the substitution of three other randomly selected vessels is allowed.

S14.5.2 Step 2

If the vessels pass Step 1, fatigue testing shall be carried out on a minimum of three vessels of the same type being considered for life extension.

a) Prior to testing, the vessels shall be inspected for visible damage, i.e., cuts, scrapes, discolored areas, and the vessel appearance shall be documented with photographs.

b) Prior to fatigue testing, MAE testing as specified in Step 1 shall be done in conjunction with the fatigue testing, hereinafter called the MAE test or MAE testing, in order to determine the suitability of the vessels for fatigue testing, i.e., that they pass the MAE test.

c) Next, the vessels shall be subjected to fatigue cycles. Pressure shall be 100 psi +0, -50% to at least 1.05 x working pressure. Vessels shall survive one and one-half (1.5) additional lifetimes. If they survive then they shall be tested by an MAE test as was done prior to fatigue cycling.

d) Provided they pass the MAE test, they shall be burst tested. At least two sensors shall remain on each vessel all the way to burst in order to establish that the BEO (background energy oscillation) pressure for the fatigued vessels is consistent, i.e., is the same percentage of ultimate, with that of the vessels tested in Step 1.

e) Plots of stress versus strain shall show linear behavior up to 90% of burst pressure.

f) The burst pressures at the end of the fatigue testing shall be greater than or equal to the minimum design burst. If the burst pressure of any one of the three vessels is not greater than the minimum design burst pressure, then these vessels shall not be eligible for life extension.

S14.5.3 Step 3

If the vessels pass Step 2, impact testing shall be carried out on a minimum of three vessels of the same type being considered for life extension.

a) Prior to testing, the vessels shall be inspected for visible damage, i.e., cuts, scrapes, discolored areas, and the vessel appearance shall be documented with photographs. Prior to impact testing, MAE testing shall be done in order to determine the suitability of the vessels for impact testing, i.e., that they pass the MAE test.

b) Two vessels shall be subjected to an ISO 11119.2 drop test and then subjected to the MAE test.

If they pass the MAE test, then one vessel shall be burst tested. At least two sensors shall remain on the vessel all the way to burst in order to establish that the BEO (background energy oscillation) pressure for the fatigued vessels is consistent, i.e., is the same percentage of ultimate, with that of the vessels tested in Step 1.

c) Plots of stress versus strain shall show linear behavior up to 90% of burst pressure.

d) If the burst pressure is not greater than the minimum design burst pressure, then these vessels shall not be eligible for life extension.

e) If the first vessel passes the burst test, the other dropped vessel shall be fatigue cycled and subsequently subjected to the MAE test and, if it passes, shall be burst tested under the same conditions as before. If the vessel fails during fatigue cycling, i.e., bursts or leaks, then these vessels shall not be eligible for life extension.

f) If the modulus changes by more than 10%, then these vessels shall not be eligible for life extension. The strain gages should be mounted in a location that is away from the impact zone.

g) The burst pressure at the end of the fatigue testing of the dropped vessel shall be greater than or equal to the minimum design burst. The vessels shall have MAE testing applied during burst testing as before and the BEO shall be consistent with the previously established percent of burst ±10%.

S14.5.4 Step 4

If the vessels pass Step 3, cut testing shall be carried out on a minimum of two vessels of the same type being considered for life extension.

a) Prior to testing, the vessels shall be inspected for visible damage, i.e., cuts, scrapes, discolored areas, and the vessel appearance shall be documented with photographs. Prior to cut testing, MAE testing shall be done in order to determine the suitability of the vessels for cut testing, i.e., that they pass the MAE test.

b) Two vessels shall be subjected to an ISO 11119.2 cut test and then subjected to the MAE test. If they pass, then one shall be burst tested under all the conditions and procedures delineated in Step 2. If the burst pressure is not greater than the minimum design burst pressure, then these vessels shall not be eligible for life extension.
c) If the cut vessel passes, then the other cut vessel shall be fatigue cycled as described in Step 2 and subsequently subjected to the MAE test and then burst tested with at least two MAE sensors remaining on and monitoring the vessel as before. If it does not survive fatigue cycling, then these vessels shall not be eligible for life extension.
d) The burst pressure at the end of the fatigue testing of the cut vessel shall be greater than or equal to the minimum burst pressure specified by ISO 11119.2.

If the vessel type passes Steps 1 to 4, then that type is eligible for life extension. An out of life vessel of the type subjected to the program above may have its life extended for one additional lifetime if it passes the MAE test. The vessel shall pass the MAE test at subsequent five-year intervals or at one-third of the lifetime, whichever is less, in order to continue in service. The vessel shall be labeled as having passed the NBIC life extension test.

PROPOSED ACTION ITEM

Item Number:	**20-79**
Submitted by:	Jonathan Ellis via PR20-0201 jellis@nationalboard.org
Subject:	Add nomenclature to formula in Part 2, S10.10.4 c) **Explanation of Need:** The current formula has no nomenclature to define the variables. **Background Information:** The change request came about from Public Review Comment PR20-0201, which relates to the approved item NB16-1401. The Main Committee voted in October of 2020 to open a new action item to add nomenclature for this formula. Mike Gorman, Project Manager for item NB16-1401, provided the following definitions for the variables in the equation: "U is the measured signal energy in joules. The signal is the captured waveform from, say, a fiber break source. V is the signal amplitude in volts point by point in the signal. Voltage must be corrected for gain (G). Z is in ohms. The (differential) time is dt in seconds."
NBIC Location:	2021 NBIC Part 2, S10.10.4 c)

Current Text:	**Proposed Text:**
S10.10.4 EQUIPMENT c) Scaling Fiber Break Energy The wave energy shall be computed by the formula: $u = \int v^2 \, dt/z$	**S10.10.4 EQUIPMENT** d) Scaling Fiber Break Energy The wave energy shall be computed by the formula: $u = \int v^2 \, dt/z$ Where: u = signal energy (joules) v = signal amplitude (volts) t = time (seconds) z = resistance (ohms)