THE
NATIONAL
BOARD
OF BOILER AND
PRESSURE VESSEL
INSPECTORS

Date Distributed: February 18, 2020

NATIONAL BOARD SUBCOMMITTEE INSPECTION

MINUTES

Meeting of January 15th, 2020
San Diego, CA

These minutes are subject to approval and are for the 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**
The meeting was called to order at 8:01 am by Chairman, Mr. Jim Getter.

2. **Introduction of Members and Visitors**
The Members and Visitors introduced themselves. All attendees are identified on the attendance sign in sheet (**Attachment pages 1-2**). As shown on the attached attendance sheet, there were 14 of 18 voting members present, which includes one alternate (listed below), a quorum was established.

William Hackworth sat on the Subcommittee as an alternate for Paul Welch.

3. **Awards/Special Recognition**
There were no awards/special recognitions given at this meeting.

4. **Announcements**
Announcements were made by the Secretary, Ms. Jodi Metzmaier (**Attachment page 3**)

5. **Adoption of the Agenda**
A motion was made to adopt the agenda. The items listed below were added to the agenda, and the motion was revised to adopt the revised agenda. The motion was seconded and unanimously approved.

- Add Interpretation Item 20-3 (SG Inspection)
- Add new item 19-93 (SG Inspection)
- Add new item 20-25 (TG Historical)
- Add item 20-26 (TG Historical)

6. **Approval of the Minutes of the July 17th, 2019 Meeting**
A motion was made to approve the minutes from the July 17, 2019 SC Inspection meeting. The motion was seconded and unanimously approved.

7. **Review of Rosters**
   a. **Membership Nominations**
   Mr. Jeff Petersen and Mr. Vincent Scarcella are interested in becoming members of Subgroup and Subcommittee Inspection. (See **Attachment pages 4-12** for their resumes)

   Both nominees spoke on their behalf, explaining why they wanted to become a member of SG & SC Inspection and how their experience and knowledge of the industry would benefit the SG & SC. Mr. Petersen's Interest category is "User". Mr. Scarcella's interest category is "Authorized Inspection Agency". The two nominees left the room while the SC had a discussion. A motion was made to approve both nominees for both SG & SC Inspection. The motion was seconded and unanimously approved.

   b. **Membership Reappointments**
   Mr. Darrell Graf and Mr. Thomas Vandini are up for reappointment to the Subcommittee. Mr. Vandini is also up for reappointment to Subgroup Inspection.

   Mr. Graf and Mr. Vandini both stated they would like to remain members of the SC Inspection. Mr. Vandini also stated he would like to remain a member of the SG Inspection. The SG Inspection approved his reappointment to the SG unanimously. A motion was made to reappoint both members to the SC and to reappoint Mr. Vandini to SG. The motion was seconded and unanimously approved.

   c. **Officer Appointments**
   There were not officer nominations.

8. **Open PRD Items Related to Inspection**
   - NB14-0602B – Improve index in Part 2 relating to pressure relief devices – D. Marek (PM)
     - Update: A proposal will be made following the publication of the 2019 NBIC.
   - NB15-0321 – Review testing requirements for inservice testing of pressure relief devices in Part 2, 2.5.7 a) – A. Renaldo (PM)
     - Update: Proposal has been approved by SC PRD and is awaiting Main Committee review.
   - NB15-0324 – guidelines for storage/shelf life in regard to inspection and testing frequencies – A. Renaldo (PM)
     - Update: Item has been approved by SG PRD and is awaiting approval from SC PRD
   - 17-132 – Paragraph 3.2.6 in Part 4 can be put into tabular format (Part 2, 2.5.8) – B. Nutter (PM), M. Brodeur, D. Marek, D. DeMichael, A. Cox, P. Dhobi, R. McCaffrey, T. Beirne
   - 19-9 – Inspect shipping plug removal for PRDs

9. **Interpretations**

Item Number: 20-3	**NBIC Location: Part 2, 4.4**	**Attachment pages 13-14**
General Description: Inspector involvement in Fitness-for-Service Assessments **Subgroup:** Inspection & Repairs and Alterations **Task Group:** None Assigned **January 2020 Meeting Action:** Mr. Getter present this item to the SC explaining during the SG inspection meeting the group decided to close this item from their agenda and allow Part 3 to respond. A motion was made to close this item with no action from part 2. The motion was seconded and unanimously approved.		

10. **Action Items**

Item Number: NB16-1401	**NBIC Location: Part 2, S10**	**Attachment pages 15-34**
General Description: Revise and update Supplement 10 on Inspection of CRPVs **Subgroup:** FRP **Task Group:** N. Newhouse (PM) **January 2020 Meeting Action:** The SC reviewed the proposed document approved at the SG FRP meeting in April 2019 and the background information provided by Mr. Jonathan Ellis. After review of the proposed changes a motion was made to accept the changes as presented and recommend sending to Main Committee letter ballot. The motion was seconded and unanimously approved.		

Item Number: NB16-1402	**NBIC Location: Part 2, New Supplement**	**Attachment pages 35-39**
General Description: Life extension for high pressure FRP vessels above 20 years **Subgroup:** FRP **Task Group:** M. Gorman (PM) **January 2020 Meeting Action:** The SC reviewed the proposed and the background information provided by Mr. Jonathan Ellis. After review of the proposed changes a motion was made to **send the proposal to SC letter ballot** for further review. The motion was seconded and unanimously approved.		

Item Number: 18-6	**NBIC Location: Part 2, S1.4.2.9**	**No Attachment**
General Description: Riveted stay bolt dimensions **Subgroup:** Locomotive **Task Group:** M. Janssen (PM) **January 2020 Meeting Action** Progress Report: Mr. Musser has stated they are hoping to have a proposal for the July 2020 meeting.		

Item Number: 18-43	NBIC Location: Part 2, Section 5	Attachment pages 40-42

General Description: Permanent nameplate removal from pressure vessel being removed from service

Subgroup: Inspection
Task Group: J. Roberts (PM), J. Burgess, J. Calvert, T. Shernisky, J. Clark, M. Sansone

January 2020 Meeting Action:
The SC reviewed the 3 documents unanimously approved at the SG Inspection meeting. The subcommittee made a few editorial revisions, and a motion was made to accept the revised proposal. The motion was seconded and unanimously approved.

Task Group Update: Remove T. Shernisky

Item Number: 18-62	NBIC Location: Part 2, S12.5	No Attachment

General Description: Remote Visual Inspection Requirements

Subgroup: Inspection
Task Group: V. Newton (PM), M. Horbaczewski, B. Wilson, J. Calvert, J. Castle, D. Graf, T. Shernisky

January 2020 Meeting Action:
Progress Report: Mr Newton stated they will be putting a proposal together & try to letter ballot it to SG Inspection and SC Inspection prior to the July 2020 meeting.

Task Group Update: Add Brent Ray, remove T. Shernisky

Item Number: 18-63	NBIC Location: Part 2	No Attachment

General Description: Review inspection requirements for pressure vessels designed for high pressures

Subgroup: Inspection
Task Group: T. Shernisky (PM), J. Mangas, J. Peterson, and J. Castle

January 2020 Meeting Action:
Progress Report: Mr. Tim Bolden stated the task group is still working on a proposal.

Task Group Update: Remove T. Shernisky. Change the PM to V. Scarcella

Item Number: 19-6	NBIC Location: Part 2, 2.3.6.8	No Attachment

General Description: PVHO 2.3.6.8 Add other types of PVHO's

Subgroup: Inspection
Task Group: D. Buechel (PM), R. Smith, S. Reimers, J. Burgess, M. Mooney & D. LeSage

January 2020 Meeting Action:
Progress Report: Mr. Buechel stated he has not been able to get in contact with any of the task group members so there has been no progress. A new task group was formed in the SG Inspection meeting.

Item Number: 19-7	NBIC Location: Part 2	No Attachment

General Description: Pressure Gage Graduation

Subgroup: Inspection
Task Group: V. Newton (PM), D. Buechel, D. Rose, D. Graff, & J. Clark

January 2020 Meeting Action:
Progress Report: Mr. Buechel has stated to the SC that the task group worked together after the SG meeting to create a proposal. The proposal was then emailed to the NBIC Secretary, and they would like it to be letter balloted to SG Inspection.

Item Number: 19-8	NBIC Location: Part 2, 2.3.6.8	No Attachment

General Description: Clarification of gage requirements for PVHO

Subgroup: Inspection
Task Group: D. Buechel (PM), R. Smith & V. Newton

January 2020 Meeting Action:
Mr. Buechel explained to the SC that at the SG Inspection meeting the group decided to close this item with no action, as it will be covered in action item 19-7. A motion was made to **close this item with no action**. The motion was seconded and unanimously approved.

Item Number: 19-9	NBIC Location: Part 2	No Attachment

General Description: Inspect shipping plug removal for PRDs

Subgroup: Inspection
Task Group: V. Scarcella (PM), J. Peterson, T. Bolden, E. Brantley

January 2020 Meeting Action:
MR. Scarcella reported to the SC that the SG closed this item with no action and they have decided to let Part 4 take care of it. A motion was made to **close this item with no action**. The motion was seconded and unanimously approved.

Item Number: 19-22	NBIC Location: Part 2, S2	No Attachment

General Description: Review of MAWP on Return Flue Boilers.

Subgroup: SG Historical
Task Group: M. Wahl (PM), J. Amato, R. Bryce & D. Rose

January 2020 Meeting Action:
Progress Report: Mr. Rose presented this item to the SC. The task group from historical wanted to give the SC some information on this item and let them know their plan. Mr. Rose let the SC know a proposal will be sent to TG Historical letter ballot prior to the July 2020 meeting. If the letter ballot passes, it will then be letter balloted to SC Inspection prior to the July 2020 meeting as well.

Item Number: 19-46	NBIC Location: Part 2, S5	No Attachment

General Description: Revisions to Yankee dryer supplement in Part 2 (Scope)

Subgroup: Inspection
Task Group: V. Newton (PM), T. Barker, D. Lesage, J. Jessick

January 2020 Meeting Action:
Progress Report: Mr. Newton stated to the SC that the Task group will be getting together after the meeting to come up with a proposal and they are hoping to send it to SG Inspection letter ballot, and if it passes, have it sent to SC Inspection letter ballot, all prior to the July 2020 meeting.

Item Number: 19-63	NBIC Location: Part 2, S5.2	No Attachment

General Description: Changes to the Yankee Dryer Supplement (ASSESSMENT OF INSTALLATION)

Subgroup: Inspection
Task Group: V. Newton (PM), T. Barker, D. Lesage, J. Jessick

January 2020 Meeting Action:
Progress Report: Mr. Newton stated to the SC that the Task group will be getting together after the meeting to come up with a proposal and they are hoping to send it to SG Inspection letter ballot, and if it passes, have it sent to SC Inspection letter ballot, all prior to the July 2020 meeting.

Item Number: 19-64	NBIC Location: Part 2, S5.2.1	No Attachment

General Description: Changes to the Yankee Dryer Supplement (DETERMINATION OF ALLOWABLE OPERATING PARAMETERS)

Subgroup: Inspection
Task Group: None assigned

January 2020 Meeting Action:
Progress Report: Mr. Newton stated to the SC that the Task group will be getting together after the meeting to come up with a proposal and they are hoping to send it to SG Inspection letter ballot, and if it passes, have it sent to SC Inspection letter ballot, all prior to the July 2020 meeting.

Task Group should be: V. Newton (PM), T. Barker, D. Lesage, J. Jessick

New Items:

Item Number: 19-78	NBIC Location: Part 2, 2.2.12.1 a)	Attachment page 43

General Description: Detailed Requirements for Inservice Inspection of Cast Iron Boilers.

Subgroup: Inspection
Task Group: None assigned

January 2020 Meeting Action:
Mr. Getter presented the proposal which was unanimously approved at the SG Inspection meeting. After review a motion as made to accept the proposal as presented. The motion was seconded and unanimously approved.

Item Number: 19-80	NBIC Location: Part 2, 2.2.10.6 l) 1)	Attachment page 44

General Description: Conflicting statements in Part 1 and Part 2 about boiler controls

Subgroup: Inspection
Task Group: None assigned

January 2020 Meeting Action:
Mr. Graf has stated that during the SG Inspection meeting they decided the change did not need to be made and they unanimously voted to close this item with no action. A motion was made to close this item with no action. The motion was seconded and unanimously approved. (attachment is attached for reference)

Item Number: 19-84	NBIC Location: Part 2, S2.10.7	No Attachment

General Description: Inspecting riveted joints for failure

Subgroup: SG Historical
Task Group: None assigned

January 2020 Meeting Action:
Progress Report: Mr. Rose stated to the SC that the task group is still working on their proposal.

Item Number: 19-88	NBIC Location: Part 2, 2.2.12.7 c) 2)	No Attachment

General Description: At NBIC Part 2 propose the following be added to Thermal Fluid Heater

Subgroup: Inspection
Task Group: None assigned

January 2020 Meeting Action:
Progress Report: Mr. Scarcella stated a task group was created in the SG Inspection meeting and no further progress has been made.

Item Number: 19-89	NBIC Location: Part 2, S2.7.3.2	Attachment page 45

General Description: Longer NDE cycle for historic boilers

Subgroup: SG Historical
Task Group: None assigned

January 2020 Meeting Action:
Mr. Rose and Mr. Getter presented the proposal that was passed (with 1 abstention) in the SG Historical meeting. The SC discussed the proposal and a **motion was made to send the proposal to letter ballot**. The motion was seconded and passed with one abstention.

Item Number: 19-90	NBIC Location: Part 2	No Attachment

General Description: Request NBIC Part II add guidance for inspection for high pressure vessels

Subgroup: Inspection

Task Group: None assigned

January 2020 Meeting Action:
It was explained that this item was closed with no action at the SG Inspection meeting because it will be covered under action item 18-63. A motion was made to **close this item with no action**. The motion was seconded and unanimously approved.

Item Number: 19-93	NBIC Location: Part 2, 5.3.2	Attachment page 46

General Description: NBIC Forms have the wrong pages identified for reference

Subgroup: Inspection
Task Group: None assigned

January 2020 Meeting Action:
Mr. Graf presented this item to the SC. A motion was made to accept the proposal as presented. The motion was seconded and unanimously approved.

Item Number: 20-25	**NBIC Location: Part 2**	**No Attachment**

General Description: Repair procedure for fireboxes

Subgroup: SG Historical
Task Group: None assigned

January 2020 Meeting Action:
Mr. Getter presented this item to the SC. After reviewing the item, they decided **this item should be moved to Part 3**. A motion was made to move this item to Part 3. The motion was seconded and unanimously approved.

Item Number: 20-26	**NBIC Location: Part 2**	**No Attachment**

General Description: Concerns for Historical Boiler Inspections Nationwide

Subgroup: SG Historical
Task Group: None assigned

January 2020 Meeting Action:
Progress Report: Mr. Getter stated a task group was assigned at the TG Historical meeting. No further progress has been made.

11. Future Meetings

- July 13th-16th, 2020 – Louisville, KY
- January 11th -14th, 2021 – TBD

The Chairman discussed the future meetings with the subcommittee.

12. Adjournment

A motion was made to adjourn the meeting at 10:36 a.m. The motion was seconded and unanimously approved.

Respectfully submitted,

Jodi Metzmaier
SC Inspection Secretary

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NBIC Subcommittee Inspection Attendance - 1/15/2020

First Last	Email	Company	Phone #	Signature	Attending Reception?
Paul Welch	paul.welch@tuvsud.com	ARISE	470 606-4707	William Seffing III FOR PAUL	
Venus Newton	venus_newton@yahoo.com	XL Insurance America	404 710-8626	[signature]	✓
Timothy Barker	Timothy.Barker@fmglobal.com	FM Global	360 801-3790	[signature]	✓
Mark Horbaczewski	MHorbaczewski@diamondtechnicalservices.com	Diamond Technical Services	815 634-2727	[signature]	✓
James Clark	James.Clark@worthingtonindustries.com	Worthington Industries	614 840-3661	[signature]	✓
Jason Safarz	jsafarz@selas.com	Selas	330 653-4076		
Jim Getter	jim.getter@worthingtonindustries.com	Worthington Industries	614 840-3087	[signature]	✓
Thomas Vandini	tvandini@propanetank.com	Quality Steel	419 333-5205	[signature]	✓
Jodi Metzmaier	jmetzmaier@nationalboard.org	The National Board	614 888-8320	Jodi Metzmaier	
Ernest Brantley	ernest.brantley@bpcllcga.com	XL Insurance America	337 842-7044		
David Buechel	david_buechel@hsb.com	Hartford Steam Boiler	412 310 7740	David M Buechel	✓
Darrell Graf	grafdr@airproducts.com	Air Products & Chemicals	601 799-2889	[signature]	✓
Donnie LeSage	Donnie.LeSage@LA.gov	State of Louisiana	225 925-4572	Donnie LeSage	✓
James Roberts	james.roberts@arcosa.com	ARCOSA TANK ~~Trinity Containers~~	~~214 589-8344~~ 469 818 6101	[signature]	✓
Matthew Sansone	matthew.sansone@labor.ny.gov	NYS Department of Labor	518 457-2722		
James Calvert	jlcalvert@lilly.com	Eli Lilly and Company	317 679-4900	[signature]	✓ +1
Thomas Shernisky	thomas.shernisky@tuvsud.com	ARISE	304 559-5358		
John Mangas	mangasjc@airproducts.com	Air Products & Chemicals	925 997-5633	John Mangas	✓
David Rose	dr3747@telus.net	T&T Inspections	1 780 217-8175	[signature]	✓
Brent David Ray	bdray@marathonpetroleum.com	Marathon Petroleum Corporation	(606) 471-9446	[signature]	✓
Rick Musso	armusso683@gmail.com	Strasburg Rail Road	717 682-7587	[signature]	—
Diana Davry	diana_davry@hsb.com	Hartford Steam Boiler	860 794-7093	[signature]	✓

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NBIC Subcommittee Inspection Attendance - 1/15/2020					
First Last	**Email**	**Company**	**Phone #**	**Signature**	**Attending Reception?**
Melissa Headland	mjheadland@dow.com	Dow	989-636 6065	[signature]	✓
JERRY JESSICK	jerry.jessick@gapac.com	GEORGIA PACIFIC	920-819 8570	[signature]	✓
William Hackworth	william.Hackworth@TOUSA...	ARISC	732-221 3461	[signature]	✓
Jeff Petersen	Pete JC @ INL.GOV	INL	208 526-1568	[signature]	✓
Timothy Bolden	Timothy.Bolden@CNA.Com	CNA	407-636 1060	[signature]	✓
JEFF CASTLE	jeffrey.castle@zurichna.com	ZURICH	716-753-0928	[signature]	✓
Vin Scarcella	Vincent.Scarcella@CNA.com	CNA	845-986 6357	[signature]	✓+1

Announcements

- The National Board will be hosting a reception for all committee members and visitors on Wednesday evening at 5:30pm at The Smoking Gun
  - Information for the venue can be found on the website
  - Who is coming to the reception?

- Breakfast (7-8 am) and Lunch (11:30 -12:30) will be provided to NBIC Committee members and visitors on Thursday in Le Fontainebleau on the 2nd floor.

- We will take a short break around 9:30-10:00 for task groups to work on items.

- Meetings schedule and meeting rooms layout are on the website under National Board Inspection Code tab → NBIC Committee Information → NBIC Meeting Information

- If the meeting ends early use the extra time to work with your task groups.

- Always submit attachments in word format showing "strike through/underline"
  - Does anyone need to know how to do this?

- Naming format reminder:
  - *Item number - person who made the revision - date update*

- As a reminder, anyone who would like to become a member of a group or committee, must submit their resume to Jonathan PRIOR TO the meeting.
  - *nbicsecretary@nationalboard.org*

JEFF C. PETERSEN

EDUCATION:
College of Eastern Idaho, Idaho Falls, Idaho. Graduated July 1987.
Received Associate of Applied Science in Quality Assurance and Nondestructive Examination. Course included: PT, MT, UT, RT, Visual Inspection, Leak Testing, Mechanical Inspection, Metrology, and Radiation Safety.

American Society of Mechanical Engineers (ASME) Continuing Education Training: ASME B31.3, ASME B31.1, ASME Section VIII, Division I, II and III. ASME Section I and IV. ASME Section IX. ASME Practical Welding Technology. ASME Section XI In-service Inspection of Nuclear Power Plant Components. API 579-1/ASME FFS-1 Fitness for Service. National Board Repair of Pressure Relief Valves. Davis NDE Advanced IGSCC Ultrasonic Weld Inspection and Sizing.
Hartford Steam Boiler Technical Training Preparation Course for the National Board Examination, November 1995.

CERTIFICATIONS:
--National Board In-Service Commission, OU-697 (R) Endorsement: 05/1996 to Present. Certificate of Competency Industrial Commission of Utah 2/96.
--Certified Level II, SNT-TC-1A, in the following disciplines: UT, VT, ASME Section XI, VT-1, 2 and 3.

--Past Certifications Level II, SNT-TC-1A, in the following disciplines: PT, MT, RT, and Leak testing.

--AWS Certified Welding Inspector # 92090071: Expires 09/2022.

JOB EXPERIENCE:
July 1996 – Present. Battelle Energy Alliance, LLC: Idaho National Laboratory (INL).
--Applied Engineering / In-service Commissioned Inspector/Quality Engineer. Responsible for managing and performing in-service inspections of boilers and pressure vessels located at the INL per the requirements of the National Board Inspection Code (NBIC).
--Responsibilities include: Implementing the (BEA) Owner-User pressure vessel inspection program, in accordance with established company procedures, required safety codes, DOE orders and national codes and bylaws.
--Verify all repairs to boilers and pressure vessels meet the requirements of the NBIC and ASME codes as applicable. Interface with the Department of Energy pertaining to the NBIC.
--Perform reviews of engineering designs for new construction, repairs, and alterations.
--Provide and approve inspection instructions for work control documents which perform maintenance, repair, and alterations of unfired pressure vessels and boilers for

compliance with established quality assurance requirements.
--Provide ASME Section XI in-service inspections for the Advanced Test Reactor. Duties included review and approval of technical documents such as design packages, work orders, drawings, new purchase order requisitions, In-Service inspection plans and procedures for appropriate quality and technical requirements for the Advanced Test Reactor.
-- Perform independent assessments verifying implementation and effectiveness of the ASME NQA-1, INL Quality Assurance Program. Assessments include: Quality Improvement, Inspection and Acceptance Testing, Software Quality Assurance, Design Control, Material Control, M&TE, Nonconformance, NDE.

August 1990 - July 1996. Lockheed Martin Idaho: Idaho National Laboratory (INL).
--Master Support Technician, Nuclear Operations QA, (INL) Test Reactor Area. Performed quality inspections, testing, and surveillance services to ensure adherence to quality standards. Performed routine, complex and unusual mechanical inspections of supplier/furnished material. Initiated reports and complied data as required for inspection planning and record keeping. Coordinated with buyers, vendors, quality engineers, and requesters to resolve any noncompliance issues.

July 1987-August 1990. General Dynamics Electric Boat Division:
--Performed NDE/Mechanical inspections in support of the refueling of the AIW, MARF and S8G Naval Reactors prototypes located at the West Milton, New York and Naval Reactors Facility, Idaho Falls Idaho.

Career Profile

Current Position

Risk Control Director

Prior (CNA) Positions

Resume

Employer: CNA
Job Title: Director
Start Date: June, 2002 , **End Date:**
Description:
As Director of Risk Control of the Northeast Region I am responsible for risk control services for over 10,000 clients that very from large government entities to power generating facilities. The zone staff routinely complete 15,000 inspections a year. My responsibilities include the following:

- Working with various government agencies to assist clients with compliance

- Working with staff counsel on contracts, compliance and litigation

-Coordination of claims services for CAT response

-Review of large claims

-Management of large accounts

-Presentations to industry organizations, large client leadership teams and future leaders

-Manage broker relationships

-Lead auditor of countrywide quality control

City: New York , **State:** New York
Country: United States

Employer: Enron Energy Services
Job Title: Senior Field Service Engineer
Start Date: September, 1999 , **End Date:** September, 2002
Description:
Managed field services for contracts exceeding $1B in combined service and energy contracts. Piloted Field Service reporting and procedures for the Quality Control of contractor services at client locations. Conduct Due Diligence Surveys, Energy Managment Surveys, Safety Surveys and Incident Investigations for energy assets at client locations. Participated in the Planned Maintenance Committee and Communication Committee

City: , **State:** New York
Country: United States

Employer: HSB/IRI
Job Title: Industrial Group Consultant
Start Date: September, 1991 , **End Date:** September, 2000
Description:
Risk control activities at a wide range of accounts, including fully integrated pulp and paper facilities, fully integrated steel, chemical, co-generation, technologies, and pharmaceuticals. Extensive use and evaluation of non-destructive testing including mag flux particle testing, ultrasonic testing and infrared testing. Evaluated construction of non-code pressure vessels. Consult with Account Teams on renewals and new business. Conducted training on ASME Section I and Confined Space Entry. Authorized Inspector with supervisor endorsement for quality control programs for ASME and NBIC code repairs.

City: , **State:** New York
Country: United States

Employer: CU
Job Title: Underwriter/Loss Control Engineer
Start Date: September, 1989 , **End Date:** September, 1991
Description:
Marketed, quoted and underwrote middle market and small business accounts. Conducted broker visitis and training. Responsable for all NYS & NJ claims. Conducted jurisdictional inspections on boilers and risk evaluations of small to medium size retail, institutional, commercial, co-generation and industrial facilities. Extensive use of New York Building Code Sections that pertain to boilers and New York State Boiler Codes.

City: , **State:** New York
Country: United States

Employer: HSB
Job Title: Loss Investigator
Start Date: March, 1987 , **End Date:** March, 1989
Description:
Conducted claims investigations in the New York City Metropolitan area. Piloted electronic claims system. Interfaced with claims and contractors to subjugate losses. Trained new field inspectors.

City: , **State:** New York
Country: United States

Employer: USN
Job Title: First Class Petty Officer
Start Date: September, 1980 , **End Date:** January, 1987
Description:
Work center supervisor in boiler engineering spaces, fuel/water testing lab, fire department and automatic control repair shop. Conducted training on propulsion system basics. Responsible for Quality Control of system and component repairs and replacements while assigned to the Philadelphia Shipyard. Extensive experience in the operation, maintenance and repair of steam propulsion equipment.

City: , **State:** Pennsylvania
Country: United States

Education

Degree: Bachelor of Science
Major: Business
School: SUNY Empire State College
School (if not in the above list):
Has this degree been completed?: Yes
Date Acquired: May, 2012

Languages

Licenses, Designations and Certifications

License /Designation/Certification: Nat Brd Boiler Press Vess Inst
Issue Date: June, 1987
Expiration Date: December, 2017
License Number: 8965
Issued by: NBB&PVI
Active: Yes
State: New York , **Country:** United States

Professional Memberships

Organization: Nat Board Boilr/Press Vess Ins
Position / Role: Committee Member NB 269
Start Date: June, 2015 , **End Date:**
Current Role:

Organization: Amer Soc Mechanical Engineers
Position / Role: MEMBER
Start Date: February, 2011 , **End Date:**
Current Role:

Other Activities

Other Activity Type: Board
Organization: NBBPVI
Internal/External: External
From Date: May, 2017 , **To Date:** May, 2017
Other Activity: Presented to the general assembly on changes to RCI-1
Comments:

Other Activity Type: Classes Taught
Organization: National Board of BPV Inspectors
Internal/External: External
From Date: May, 2017 , **To Date:** May, 2017
Other Activity: Adressed the General Assembly on cahnges to Rules for Commisioned Inspectors
Comments:

On going series:

4/2104: Most critical leadership functions

9/2014: Situational leadership

4/2015: Rumsfeld's Rules Chapter 1-7

9/2015: Rumsfeld's Rules Chapter 7-14

4/2016 Strength Based Leadership Review survey results

1/2017 "Bringing Out the Best in People"

Other Activity Type: Classes Taught
Organization: Tyson Foods
Internal/External: External
From Date: October, 2016 , **To Date:** October, 2016
Other Activity: Protection for Thermal Fluid Heaters
Comments:
Presented to operators, risk management and managers on NFPA 87 and ASME CSD-1 protection devices for thermal fluid heaters, their function, maintenance calibration and testing. Included an overview of construction codes and risk control activities for leakage prevention and CO prevention.

Other Activity Type: Committee
Organization: National Board Qualifications Committee
Internal/External: External
From Date: May, 2015 , **To Date:** December, 2016
Other Activity: Member
Comments:
Appointed member to the committee in May 2015. The committee sets the qualifications for certification internationally.

Other Activity Type: Task Force
Organization: NBBPV
Internal/External: External
From Date: June, 2013 , **To Date:** January, 2014
Other Activity: Task Group memeber for NBIC Part II
Comments:
Wire wound pressure vessels

Other Activity Type: Committee
Organization: NYC Department of Buildings
Internal/External: External
From Date: November, 2011 , **To Date:** June, 2013
Other Activity: NYC Code Com. MCC
Comments:
Panel and Com memeber

Other Activity Type: Committee
Organization: NJ State DOL
Internal/External: External
From Date: May, 2010 , **To Date:** September, 2011
Other Activity: NJ DOL Contractor License Com

Comments:
Com participation to develop Rules and Regs for contractors

Other Activity Type: Classes Taught
Organization: SORCE School Risk Control for Electrical Exposures
Internal/External: External
From Date: July, 2007 , **To Date:** July, 2014
Other Activity: NFPA 70B, NFPA 70, IEEE 242
Comments:
Internal and external classes for all lines risk control for electrical exposures.

Other Activity Type: Classes Taught
Organization: CNA
Internal/External: Internal
From Date: July, 2006 , **To Date:** August, 2007
Other Activity: Electrical Exposures Basic Risk Control
Comments:
Taught electrical safety and exposure classes to trainees

Other Activity Type: Major Project work
Organization: WWP
Internal/External: External
From Date: June, 2005 , **To Date:** September, 2008
Other Activity: Wounded Warrior Project
Comments:

Other Activity Type: Major Project work
Organization: Enron
Internal/External: External
From Date: April, 2000 , **To Date:** June, 2002
Other Activity: Fire Safety Audit Project
Comments:
Conducted safety audits at cleint locations

Other Activity Type: Classes Taught
Organization: Various
Internal/External: External
From Date: June, 1991 , **To Date:** June, 2014
Other Activity: ASME & NBIC Classes
Comments:
Certified trainer for various ASME, NFPA and jurisdictional code classes.

Other Activity Type: Major Project work
Organization: NJ DOL
Internal/External: External
From Date: November, 1987 , **To Date:** September, 2008
Other Activity: Second Class Engineer License Blue Seal
Comments:

Other Activity Type: Classes Taught
Organization: USN

Internal/External: External
From Date: January, 1986 , **To Date:** December, 1986
Other Activity: Propulsion Plant Operator Training
Comments:
Propulsion Plant Therory and operation

Other Activity Type: Major Project work
Organization: USN
Internal/External: Internal
From Date: June, 1985 , **To Date:** July, 1985
Other Activity: Command Assessment Team & Leadership Management Training
Comments:
Leadership and Command Assesment Team Training completed in 1981 and 1985

Other Activity Type: Major Project work
Organization: US DOL
Internal/External: Internal
From Date: March, 1984 , **To Date:** September, 2008
Other Activity: DOL Propulsion Plant Engineer
Comments:
Complete apprentiship program for certification

Other Activity Type: Major Project work
Organization: USN
Internal/External: Internal
From Date: June, 1981 , **To Date:** December, 1983
Other Activity: BWFW Lab Tech
Comments:
Certified BWFW Lab Tech and Fuel & lube oil test lab tech

CNA Honors and Awards

Award : CNA Focus - Silver
Date Received: October, 2009

Award : CNA Focus - Silver
Date Received: October, 2009

Award : CNA Focus - Gold
Date Received: July, 2009

Award : CNA Focus - Platinum
Date Received: April, 2008

Award : CNA Focus - Gold
Date Received: March, 2006

Award : CNA Focus - Gold
Date Received: November, 2005

Award : CNA Focus - Bronze
Date Received: June, 2004

Award : CNA Focus - Silver
Date Received: January, 2004

Career Mobility

Mobility: Qualified Mobility
Description:
Mobile for the right opportunity

Current Date: May, 2017

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PROPOSED INTERPRETATION

Inquiry No.	**20-3**
Source	Nathan Carter, Hartford Steam Boiler
Subject	Inspector Involvement for Fitness-for-Service Assessments **Background:** Background: The below questions are intended to gain clarity as to first which Inspector (i.e. "IS" Commissioned or "R" Endorsement) signs the FFSA Form NB-403 when an "R" Certificate Holder is involved with a repair in that region as well as determine what level of review of the Fitness-for-Service the Inspector is expected to complete. If it is an Inspector holding a "R" Endorsement with an AI Commission (not tested on NBIC Part 2), shouldn't the relevant pages in NBIC Part 2 concerning Fitness for Service be included in their tested body of knowledge, so they are aware of the detailed rules? The Body-Of-Knowledge for National Board Inspectors holding either an "IS" Commission or "R" Endorsement does not reference ASME FFS-1/API 579 Fitness-For-Service Standard or have any expectation that the Inspector be capable of determining if the correct Fitness for Service methodology was used or that the assumptions taken by the Engineer in the analysis were the most appropriate or accurate. Clarification is also requested due to the Form NB-403 signature block stating "Verified by" for the Inspector without any other disclaimers as typically found on other Forms signed by Inspectors such as ASME MDRs and NBIC Form R-1/R-2. An example is a R-Certificate holder was hired to repair a weld seam. It was discovered during a repair that multiple base metal laminations existed adjacent to the repair location. A Fitness for Services Evaluation was subsequently performed. The first question is whether or not it is the responsibility of the Repair Inspector to sign the FFSA form once everything has been properly vetted, since the defect being left in place is not necessarily within the scope of the initial repair being performed by the "R" Certificate Holder, or should this be signed off by a Commissioned Inservice Inspector, since they are examined on the rules of NBIC Part 2? Also, Form NB-403 is vague in the signature block region for the scope of what the Inspector is signed for. It could be alluded that without a statement, such as those found on the R-1 and R-2 forms, the Inspector is signing off on the appropriateness and adequacy of the Fitness-For-Service methodology performed by the Engineer.
Edition	2019; Part: Inspection & Repairs and Alterations; Section: 4 & 3; Paragraph: 4.4; Form NB-403; & 3.3.4.8
Question	**Question 1:** In accordance with NBIC Part 3, 3.3.4.8, a fitness-for-service condition assessment as described in NBIC Part 2, 4.4 shall be completed and adequately documented on the FFSA Form NB-403. Once Form NB-403 is completed, is it required that the Inspector signing this Form hold a National Board "R" Endorsement as described in RCI-1/NB-263? **Question 2:** NBIC Part 2 4.4.1 d) states that the Inspector shall indicate acceptance of the Report of FFSA by signing. Paragraph 4.4.3 b) states that the Inspector shall review the condition assessment methodology and ensure that the inspection data and documentation are in accordance with Part 2. Is the Inspector's signature on Form NB-403 an indication that the condition assessment and recommendations completed by the Engineer have been fully reviewed for appropriateness and accuracy by the Inspector?

	Question 3: If the answer to Question 2 is No, is the Inspector's signature on Form NB-403 an indication of acceptance solely on the basis of review of the Form for completeness and verification that the requirements outlined in 4.4 were addressed?
Reply	Proposed Reply 1: Yes Proposed Reply 2: No Proposed Reply 3: Yes
Committee's Question	
Committee's Reply	Question 1: Question 2: Question 3:
Rationale	

SUPPLEMENT 10
INSPECTION OF STATIONARY HIGH-PRESSURE (3,000-15,000 psi) (21-103 MPa) COMPOSITE PRESSURE VESSELS

S10.1 SCOPE

This supplement provides specific requirements and guidelines for inspection of high-pressure composite pressure vessels, hereafter referred to as vessels. This supplement is applicable to pressure vessels with a design pressure that exceeds 3,000 psi (21 MPa) but not greater than 15,000 psi (103 MPa), and is applicable to the following four types of pressure vessels:

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

b) Fully wrapped FRP vessel with a non-load sharing metallic liner.

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

d) Fully wrapped FRP vessel with load sharing metallic liner.

This supplement is intended for inspection of ASME Section X, Class III, vessels and ASME Section VIII, Division 3, Composite Reinforced Pressure Vessels (CRPVs). However, it may be used for inspection of similar vessels manufactured to other construction codes with approval of the jurisdiction in which the vessels are installed.

S10.2 GENERAL

a) High-pressure composite vessels are used for the storage of fluids at pressures up to 15,000 psi (103 MPa). Composite vessels consist of the FRP laminate with load sharing or non-load sharing metallic shells/liners, or nonmetallic liners. The FRP laminate with load sharing metallic liners form the pressure retaining system. The FRP laminate is the pressure-retaining material for composite vessels with non-load sharing metallic and nonmetallic liners. The purpose of the non-load sharing metallic and the nonmetallic liners is to minimize the permeation of fluids through the vessel wall.

b) Fluids stored in vessels are considered to be non corrosive to the materials used for vessel construction. The laminate is susceptible to damage from:

   1) External chemical attack.

   2) External mechanical damage (i.e. abrasion, impact, cuts, dents, etc.).

   3) Structural damage (i.e. over pressurization, distortion, bulging, etc.).

   4) Environmental degradation [i.e. ultraviolet (if there is no pigmented coating or protective layer), ice, etc.].

   5) Fire or excessive heat.

S10.3 INSPECTOR QUALIFICATIONS

a) The ~~The~~ Inspector referenced in this supplement is a National Board Commissioned Inspector complying with the requirements of NB-263. RCI-1 *Rules for Commissioned Inspector*.

b) The inspector shall be familiar with vessel construction and qualified by training and experience as described in NBIC Part 2, S4.5 to conduct such inspections. The inspector shall have a thorough understanding of all required inspections, tests, test apparatus, inspection procedures, and inspection

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techniques and equipment applicable to the types of vessels to be inspected. The inspector shall have basic knowledge of the vessel material types and properties. Refer to Part 2, S4.2 and S4.5

S10.4 INSPECTION FREQUENCY

a) Initial Inspection

The vessel shall be given an external visual examination by the Inspector or the Authority having jurisdiction where the vessel is installed and during the initial filling operation. The examination shall check for any damage during installation prior to initial filling and for any leaks or damage during and at the conclusion of filling.

b) Subsequent Filling Inspections

Before each refilling of the vessel, the manager of the facility shall visually examine the vessel exterior for damage or leaks. Refilling operations shall be suspended if any damage or leaks are detected and the vessel shall be emptied and subsequently inspected by the Inspector to determine if the vessel shall remain in service.

c) Periodic Inspection

Within 30 days of the anniversary of the initial operation of the vessel during each year of its service life, the vessel shall be externally examined by the Inspector or the Authority having jurisdiction where the vessel is installed. Internal inspections shall only be required if any of the conditions of S10.9 a) are met. These examinations are in addition to the periodic acoustic emission examination requirements of S10.5 c).

S10.5 INSERVICE INSPECTION

a) NBIC Part 2, Section 1, of this part shall apply to inspection of high-pressure vessels, except as modified herein. This supplement covers vessels, and is not intended to cover piping and ductwork, although some of the information in this supplement may be used for the inspection of piping and ductwork.

b) The inspection and testing for exposed load sharing metallic portions of vessels shall be in accordance with NBIC Part 2, Section 2.3.

c) All composite vessels shall have an initial acoustic emission examination per S10.10 ~~after the first three years from the date of manufacture. Thereafter, vessels shall have~~ at a maximum examination interval of five years which may be more frequent based on the results of any external inspection per S10.8 or internal inspections per S10.9.

All vessels shall be subject to the periodic inspection frequency given in S10.4.

S10.6 ASSESSMENT OF INSTALLATION

a) The visual examination of the vessel requires that all exposed surfaces of the vessel are examined to identify any degradation, defects, mechanical damage, or environmental damage on the surface of the vessel.

The causes of damage to vessels are:

1) abrasion damage;

2) cut damage;

3) impact damage;

4) structural damage;

5) chemical or environmental exposure damage or degradation; and

6) heat or fire damage.

The types of damage found are:

1) cracks;

2) discolored areas;

3) gouges and impact damage;

4) leaks;

5) fiber exposure;

6) blisters;

7) delaminations;

8) surface degradation; and

9) broken supports.

b) The visual examination of the vessel requires that the identity of the vessel shall be verified. This shall include the construction code (ASME) to which the vessel was constructed, vessel serial number, maximum allowable operating pressure, date of manufacture, vessel manufacturer, date of expiration of the service life of the vessel, and any other pertinent information shown on the vessel or available from vessel documents. The overall condition of the vessel shall be noted.

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S10.7 VISUAL EXAMINATION

a) Acceptable Damage

Acceptable damage or degradation is minor, normally found in service, and considered to be cosmetic. This level of damage or degradation does not reduce the structural integrity of the vessel. This level of damage or degradation should not have any adverse effect on the continued safe use of the vessel. This level of damage or degradation does not require any repair to be performed at the time of in-service inspection. When there is an external, non load bearing, sacrificial layer of filaments on the vessel, any damage or degradation should be limited to this layer. Damage or degradation of the structural wall shall not exceed the limits specified in Tables S10.7-a or S10.7-b.

b) Rejectable Damage (Condemned—Not Repairable)

Rejectable damage or degradation is so severe that structural integrity of the vessel is sufficiently reduced so that the vessel is considered unfit for continued service and shall be condemned and removed from service. No repair is authorized for vessels with rejectable damage or degradation.

c) Acceptance Criteria for Repairable Damage

Certain, specific types of damage can be identified by the external in-service visual examination. Indications of certain types and sizes may not significantly reduce the structural integrity of the vessel and may be acceptable so the vessel can be left in service. Other types and larger sizes of damages may reduce the structural integrity of the vessel and the vessel shall be condemned and removed from service. Tables S10.7-a or S10.7-b are a summary of the acceptance/rejection criteria for the indications that are found by external examination of the vessel.

d) Fitness for service

1) If a visual examination reveals that a vessel does not meet all criteria of Table S10.7-a or S10.7-b satisfactorily, it shall be taken out of service immediately, and either be condemned or a fitness for service examination be conducted by the original vessel manufacturer or legal successor who must also hold a National Board "R" certificate. When the vessel is taken out of service, its contents shall be immediately safely vented or transferred to another storage vessel per the owner's written safety procedures.

2) If a fitness for service examination is to be conducted, the original vessel manufacturer shall be contacted as soon as possible after the rejectable defects have been found. The manufacturer shall then determine the vessel fitness-for-service by applicable techniques, (e.g., acoustic emission testing, ultrasonic testing, and/or other feasible methods). The manufacturer shall have documentation that the evaluation method(s) used is satisfactory for determining the condition of the vessel. Repairs to the outer protective layer may be made by a "R" certificate holder other than the original manufacturer following the original manufacturer's instructions.

3) Determination of fitness for service is restricted to original manufacturer or legal successor.

TABLE S10.7-a

VISUAL ACCEPTANCE/REJECTION CRITERIA FOR COMPOSITE PRESSURE VESSELS (U.S. CUSTOMARY UNITS)

Type of Degradation or Damage	Description of Degradation or Damage	Acceptable Level of Degradation or Damage	Rejectable Level of Degradation or Damage
Abrasion	Abrasion is damage to the filaments caused by wearing or rubbing of the surface by friction.	Less than 0.050 in. depth in the pressure bearing thickness.	≥ 0.050 in. depth in the pressure bearing thickness.
Cuts	Linear indications flaws caused by an impact with a sharp object.	Less than 0.050 in. depth in the pressure bearing thickness.	≥ 0.050 in. depth in the pressure bearing thickness.
Impact Damage	Damage to the vessel caused by striking the vessel with an object or by being dropped. This may be indicated by discoloration of the composite or broken filaments and/or cracking.	Slight damage that causes a frosted appearance or hairline cracking of the resin in the impact area.	Any permanent deformation of the vessel or damaged filaments.
Delamination	Lifting or separation of the filaments due to impact, a cut, or fabrication error.	Minor delamination of the exterior coating less than a depth of 0.050 in.	Any loose filament ends showing on the surface at a depth ≥ 0.050 in. Any bulging due to interior delaminations.
Heat or Fire Damage	Discoloration, charring or distortion of the composite due to temperatures beyond the curing temperature of the composite.	Merely soiled by soot or other debris, such that the cylinder can be washed with no residue.	Any evidence of thermal degradation or discoloration or distortion.
Structural Damage – bulging, distortion, depressions	Change in shape of the vessel due to severe impact or dropping.	None	Any visible distortion, bulging, or depression.

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Type of Degradation or Damage	Description of Degradation or Damage	Acceptable Level of Degradation or Damage	Rejectable Level of Degradation or Damage
Chemical attack	Environmental exposure that causes a change in the composite or failure of the filaments.	Any attack that can be cleaned off and that leaves no residue or evidence of permanent damage.	Any permanent discoloration or loss or softening of material under the exterior coat.
Cracks	Sharp, linear indications	None	None
Scratches/Gouges	Sharp, linear indications caused by mechanical damage.	Less than 0.050 in. depth in the pressure bearing thickness No structural fibers cut or broken.	≥ 0.050 in. depth in the pressure bearing thickness or structural fibers cut or broken.
Soot	A deposit on the composite caused by thermal or environmental exposure.	Soot that washes off and leaves no residue.	Any permanent marking that will not wash off the surface under the exterior coating.
Over pressurization	Excessive pressure due to operational malfunction.	None reported Pressure between MAWP and test pressure, with approval of the manufacturer	Any report of pressurization beyond the MAWP test pressure or any indication of distortion.
Corrosion	Degradation of the composite due to exposure to specific corrosive environments.	None visible in excess of manufacturer's specification	Any surface damage to structural material identified as corrosion beyond the manufacturer's specification. (See Note 2)
Dents	A depression in the exterior of the vessel caused by impact or dropping.	< 1/16 in. in depth	Any dents with a depth ≥ 1/16 in. Or with a diameter greater than 2 inches.
Reported collision, accident, or fire	Damage to the vessel caused by unanticipated excursion from normally expected operating conditions.	None reported	Any indication or report of impact or heat damage.
Environmental Damage or Weathering	Ultraviolet or other environmental attack under the exterior coating..	None	Any discoloration that can not be washed off. (See Note 2)
Damage to a protective or sacrificial layer	Abrasion, cuts, chemical attack, scratches/gouges, corrosion, environmental damage, or crazing that are limited only to the protective or sacrificial layer.	The depth of any damage to the protective or sacrificial layer that does not exceed the thickness of the protective or sacrificial layer plus 0.050 inch.	The depth of any damage to the protective or sacrificial layer that exceeds the thickness of the protective or sacrificial layer plus 0.050 inch.
Crazing	Hairline surface cracks only in the composite resin.	Light hairline cracks only in the resin.	Any damage to the filaments.

Note 1:

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Only damage beyond the sacrificial or coated layer should be considered, and that any damage to sacrificial or coated layers should be repaired by suitable techniques (i.e. epoxy filler). Refer to Manufacturer's Data Report for sacrificial layer thickness.

Note 2:

Washing off UV scale will accelerate attack into lower composite layers. For this reason, if there is superficial UV damage the affected area should be cleaned and painted with a UV tolerant paint. If broken, frayed, or separated fibers to the non sacrificial layer greater than a depth of 0.050 in., are discovered during the cleaning process then the vessel shall be condemned.

TABLE S10.7-b

VISUAL ACCEPTANCE/REJECTION CRITERIA FOR COMPOSITE PRESSURE VESSELS (SI UNITS)

Type of Degradation or Damage	Description of Degradation or Damage	Acceptable Level of Degradation or Damage	Rejectable Level of Degradation or Damage
Abrasion	Abrasion is damage to the filaments caused by wearing or rubbing of the surface by friction.	Less than 1.3 mm. depth in the pressure bearing thickness.	≥ 1.3 mm depth in the pressure bearing thickness.
Cuts	Linear indications flaws caused by an impact with a sharp object.	Less than 1.3 mm. depth in the pressure bearing thickness.	≥1.3 mm depth in the pressure bearing thickness.
Impact Damage	Damage to the vessel caused by striking the vessel with an object or by being dropped. This may be indicated by discoloration of the composite or broken filaments and/or cracking.	Slight damage that causes a frosted appearance or hairline cracking of the resin in the impact area.	Any permanent deformation of the vessel or damaged filaments.
Delamination	Lifting or separation of the filaments due to impact, a cut, or fabrication error.	Minor delamination of the exterior coating less than a depth of 1.3 mm.	Any loose filament ends showing on the surface at a depth ≥ 0.050 in. Any bulging due to interior delaminations.
Heat or Fire Damage	Discoloration, charring or distortion of the composite due to temperatures beyond the curing temperature of the composite.	Merely soiled by soot or other debris, such that the cylinder can be washed with no residue.	Any evidence of thermal degradation or discoloration or distortion.
Structural Damage – bulging, distortion, depressions	Change in shape of the vessel due to sever impact or dropping.	None	Any visible distortion, bulging, or depression.
Chemical attack	Environmental exposure that causes a change in the composite or failure of the filaments.	Any attack that can be cleaned off and that leaves no residue or evidence of permanent damage.	Any permanent discoloration or loss or softening of material under the exterior coat.
Cracks	Sharp, linear indications	None	None
Scratches/Gouges	Sharp, linear indications caused by mechanical damage.	Less than 1.3 mm depth in the pressure bearing thickness No structural fibers cut or broken.	≥ 1.3 mm depth in the pressure bearing thickness or structural fibers cut or broken.

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Type of Degradation or Damage	Description of Degradation or Damage	Acceptable Level of Degradation or Damage	Rejectable Level of Degradation or Damage
Soot	A deposit on the composite caused by thermal or environmental exposure.	Soot that washes off and leaves no residue.	Any permanent marking that will not wash off the surface under the exterior coating.
Over pressurization	Excessive pressure due to operational malfunction.	~~None reported~~ Pressure between MAWP and test pressure, with approval of the manufacturer	Any report of pressurization beyond the ~~MAWP~~ Test Pressure or any indication of distortion.
Corrosion	Degradation of the composite due to exposure to specific corrosive environments.	None visible in excess of manufacturer's specification	Any surface damage to structural material identified as corrosion beyond the manufactuere's specificaton.
Dents	A depression in the exterior of the vessel caused by impact or dropping.	< 1.6 mm depth	Any dents with a depth ≥ 1.6 mm Or with a diameter greater than 51 mm.
Reported collision, accident, or fire	Damage to the vessel caused by unanticipated excursion from normally expected operating conditions.	None reported	Any indication or report of impact or heat damage.
Environmental Damage or Weathering	Ultraviolet or other environmental attack under the exterior coating.	None	Any discoloration that can not be washed off. (See Note 2)
Damage to a protective or sacrificial layer	Abrasion, cuts, chemical attack, scratches/gouges, corrosion, environmental damage, or crazing that are limited only to the protective or sacrificial layer.	The depth of any damage to the protective or sacrificial layer that does not exceed the thickness of the protective or sacrificial layer plus 1.3 mm.	The depth of any damage to the protective or sacrificial layer that exceeds the thickness of the protective or sacrificial layer plus1.3 mm.
Crazing	Hairline surface cracks only in the composite resin.	Light hairline cracks only in the resin.	Any damage to the filaments.

Note 1:

Only damage beyond the sacrificial or coated layer should be considered, and that any damage to sacrificial or coated layers should be repaired by suitable techniques (e.g., epoxy filler). Refer to Manufacturer's Data Report for sacrificial layer thickness.

Note 2:

Washing off UV scale will accelerate attack into lower composite layers.. For this reason, if there is superficial UV damage the affected area should be cleaned and painted with a UV tolerant paint. If broken, frayed, or separated fibers to the non sacrificial layer greater than a depth of 1.3 mm, are discovered during the cleaning process then the vessel shall be condemned.

S10.8 EXTERNAL INSPECTION

a) Vessel Service Life

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Vessels have been designed and manufactured for a limited lifetime; this is indicated on the vessel marking. This marking shall first be checked to ensure that such vessels are within their designated service lifetime.

b) Identification of External Damage

The external surface shall be inspected for damage to the laminate. Damage is classified into two levels as shown in Table S10.7-a or Table S10.7-b of this supplement. The acceptance/rejection criteria shown in Table S10.7-a or Table S10.7-b of this supplement shall be followed, as a minimum.

The external surface of the vessel is subject to mechanical, thermal, and environmental damage. The external surface of a vessel may show damage from impacts, gouging, abrasion, scratching, temperature excursions, etc. Areas of the surface that are exposed to sunlight may be degraded by ultraviolet light which results in change in the color of the surface and may make the fibers more visible. This discoloration does not indicate a loss in physical properties of the fibers. Overheating may also cause a change in color. The size (area or length and depth) and location of all external damage shall be noted. Vessel support structures and attachments shall be examined for damage such as cracks, deformation, or structural failure.

c) Types of External Damage

1) General

Several types of damage to the exterior of vessels have been identified. Examples of specific type of damage are described below. The acceptance/rejection criteria for each type of damage are described in Table S10.7-a or Table S10.7-b of this supplement.

2) Abrasion Damage

Abrasion damage is caused by grinding or rubbing away of the exterior of the vessel. Minor abrasion damage to the protective outer coating or paint will not reduce the structural integrity of the vessel. Abrasion that results in flat spots on the surface of the vessel may indicate loss of composite fiber overwrap thickness.

3) Damage from Cuts

Cuts or gouges are caused by contact with sharp objects in such a way as to cut into the composite overwrap, reducing its thickness at that point.

4) Impact Damage

Impact damage may appear as hairline cracks in the resin, delamination, or cuts of the composite fiber overwrap.

5) Delamination

Delamination is a separation of layers of fibers of the composite overwrap due to impact or excessive localized loading. It may also appear as a discoloration or a blister beneath the surface of the fiber.

Note: This does not apply to layers intentionally separated by the manufacturer.

6) Heat or Fire Damage

Heat or fire damage may be evident by discoloration, charring or burning of the composite fiber overwrap, labels, or paint. If there is any suspicion of damage, the vessel shall be qualified fit for service using an acoustic emission examination.

7) Structural Damage

Structural damage will be evidenced by bulging, distortion, or depressions on the surface of the vessel.

8) Chemical Attack

Some chemicals are known to cause damage to composite materials. Environmental exposure or direct contact with solvents, acids, bases, alcohols, and general corrosives can cause damage to vessels. Long-term contact with water can also contribute to corrosive damage, although may not be a problem by itself. Chemicals can dissolve, corrode, remove, or destroy vessel materials. Chemical attack can result in a significant loss of strength in the composite material. Chemical attack can appear as discoloration and in more extreme cases the composite overwrap can feel soft when touched. If there is any suspicion of damage, the vessel shall be re-qualified using acoustic emission examination.

S10.9 INTERNAL EXAMINATION

a) Requirements for Internal Visual Examination

Internal visual examination is normally not required. When vessels have been filled only with pure fluids, corrosion of the interior of the liner should not occur. Internal visual examination of the tanks shall only be carried out when:

1) There is evidence that any commodity except a pure fluid has been introduced into the tank. In particular, any evidence that water, moisture, compressor cleaning solvents, or other corrosive agents have been introduced into the vessel shall require an internal visual examination.

2) There is evidence of structural damage to the vessel, such as denting or bulging.

3) The vessel valve is removed for maintenance or other reason. Internal examination in this case is limited to examination of the threads and sealing surface. When an internal visual examination is conducted, the following procedures shall be followed.

b) Identification of Internal Damage

1) Vessels with Metallic Liners

For vessels with metallic liners, the objective of the internal visual examination is primarily to detect the presence of any corrosion or corrosion cracks.

The internal surface of the vessel shall be examined with adequate illumination to identify any degradation or defects present. Any foreign matter or corrosion products shall be removed from the interior of the vessel to facilitate inspection. Any chemical solutions used in the interior of the vessel shall be selected to ensure that they do not adversely affect the liner or composite overwrap materials. After cleaning the vessel shall be thoroughly dried before it is examined.

All interior surfaces of the vessel shall be examined for any color differences, stains, wetness, roughness, or cracks. The location of any degradation shall be noted.

Any vessel showing significant internal corrosion, dents or cracks shall be removed from service.

2) Vessels with Non-metallic Liners or No Liners

Vessels with non-metallic liners may show corrosion on the plastic liner or metal boss ends. Vessels with non-metallic liners or no liners may also show internal degradation in the form of cracks, pitting, exposed laminate, or porosity.

The internal surface of vessels shall be examined with adequate illumination to identify any degradation or defects present. Any foreign matter or corrosion products shall be removed from the interior of the vessel to facilitate examination. Chemical solutions used in the interior of the vessel shall be selected to ensure they do not adversely affect the liner or composite overwrap materials. After cleaning the vessel shall be thoroughly dried before it is examined.

c) The Inspector shall look for cracks, porosity, indentations, exposed fibers, blisters, and any other indication of degradation of the liner and/or laminate. Deterioration of the liner may include softening of the matrix or exposed fibers.

S10.10 ACOUSTIC EMISSION EXAMINATION

S10.10.1 USE AND TEST OBJECTIVES

All high-pressure composite pressure vessels shall be subject to an acoustic emission (AE) examination to detect damage that may occur while the vessel is in service. This method may be used in conjunction with the normal filling procedure.

S10.10.2 AE TECHNICIAN REQUIREMENTS

The acoustic emission technician conducting the examination required per S10.10.1 and in accordance with S10.10 shall be certified per the guidelines of ASNT SNT-TC-1A or CP-189 AE Level II or III. A technician performing this test shall have training in and experience with measuring C_e and C_f in composites and identifying wave modes.

S10.10.3 TEST PROCEDURE

AE transducers shall be acoustically coupled to the vessel under test and connected to waveform recording equipment. Waveforms shall be recorded and stored on digital media as the vessel is pressurized. All analysis shall be done on the waveforms. The waveforms of interest are the E (Extensional Mode) and F (Flexural Mode) plate waves.

Prior to pressurization, the velocities of the earliest arriving frequency in the E wave and the latest arriving frequency in the F wave shall be measured in the circumferential direction in order to characterize the material and set the sample time (the length of the wave window).

The E and F waves shall be digitized and stored for analysis. The test pressure shall be recorded simultaneously with the AE events. Permanent storage of the waveforms is required for the life of the vessel.

S10.10.4 EQUIPMENT

a) Testing System

A testing system shall consist of:

1) sensors;

2) preamplifiers;

3) high pass and low pass filters;

4) amplifier;

5) A/D (analog-to-digital) converters;

6) a computer program for the collection of data;

7) computer and monitor for the display of data; and

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8) a computer program for analysis of data.

Examination of the waveforms event by event shall always be possible and the waveforms for each event shall correspond precisely with the pressure and time data during the test. The computer program shall be capable of detecting the first arrival channel. This is critical to the acceptance criteria below.

Sensors and recording equipment shall be checked for a current calibration sticker or a current certificate of calibration.

b) Sensor Calibration

Sensors shall have a flat frequency response from 50 kHz to 400 kHz. Deviation from flat response (signal coloration) shall be corrected by using a sensitivity curve obtained with a Michelson interferometer calibration system similar to the apparatus used by NIST (National Institute for Standards and Technology). Sensors shall have a diameter no greater than 0.5 in. (13 mm) for the active part of the sensor face. The aperture effect shall be taken into account. Sensor sensitivity shall be at least 0.1 V/nm.

c) Scaling Fiber Break Energy

The wave energy shall be computed by the formula:

$$u = \int v^2 \, dt/z$$

FIGURE S10.10.4-a
ROLLING BALL IMPACT CALIBRATION SETUP

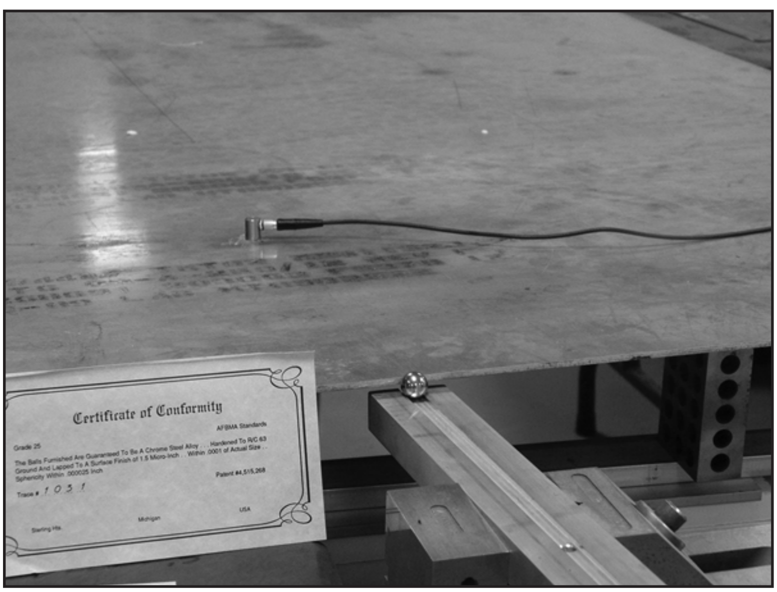
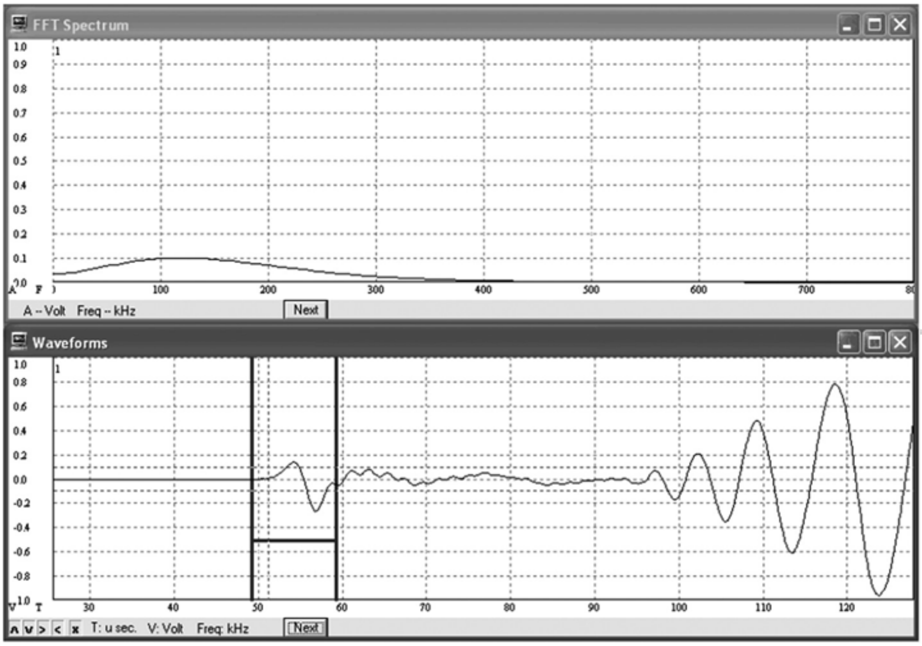


FIGURE S10.10.4-b
FRONT END WAVEFORM



which is the formula for computing energy in the AE signal, where V is the voltage in volts (V) and Z is the input impedance in ohms (Ω). A rolling ball impactor shall be used to create an acoustical impulse in an aluminum plate. The measured energy in the wave shall be used to scale the fiber break energy. This scaling is illustrated later on.

The impact setup, an example of which is shown in Figure S10.10.4-a, shall be arranged as follows. The steel ball shall be ½ inch (13 mm) in diameter. The steel ball is a type typically used in machine shops for measuring taper and is commercially available. The ball shall be made of chrome steel alloy hardened to R/C 63, ground and lapped to a surface finish of 1.5 micro-inch (0.0000381 mm), within 0.0001 inch (0.0025 mm) of actual size and sphericity within 0.000025 inch (0.00064 mm). The plate shall be made of 7075 T6 aluminum, be at least 4 ft x 4 ft (1200 mm X 1200 mm) in size, the larger the better to avoid reflections, be 1/8 inch (3.2 mm) in thickness and be simply supported by steel blocks. The inclined plane shall be aluminum with a machined square groove 3/8 inch (9.5 mm) wide which supports the ball and guides it to the impact point. The top surface of the inclined plane shall be positioned next to the edge of the plate and stationed below the lower edge of the plate such that the ball impacts with equal parts of the ball projecting above and below the plane of the plate. A mechanical release mechanism shall be used to release the ball down the plane.

The ball roll length shall be 12 inch (305 mm) and the inclined plane angle shall be 6 degrees. The impact produces an impulse that propagates to sensors coupled to the surface of the plate 12 inches (305 mm) away from the edge. The sensors shall be coupled to the plate with vacuum grease. The energy of the leading edge of the impulse, known as the wave front, shall be measured. The vertical position of the ball impact point shall be adjusted gradually in order to “peak up” the acoustical signal, much as is done in ultrasonic testing where the angle is varied slightly to peak up the response. The center frequency of the first cycle of the E wave shall be confirmed as 125 kHz ± 10 kHz. See Figure S10.10.4-b. The energy value in joules of the first half cycle of the E wave shall be used to scale the fiber break energy in criterion 2, as illustrated there. This shall be an “end to end” calibration, meaning that the energy shall be measured using the complete AE instrumentation (sensor, cables, preamplifiers, amplifiers, filters and digitizer) that are to be used in the actual testing situation.

Front end of waveform created by rolling ball impact calibration setup described herein. Fast Fourier transform (FFT) shows center frequency of first cycle is approximately 125kHz. The energy linearity of the complete AE instrumentation (sensor, cables, preamplifiers, amplifiers, filters and digitizer) shall be measured by using different roll lengths of 8, 12 and 16 inches (203, 305, and 406 mm). The start of the E wave shall be from the first cycle of the waveform recognizable as the front end of the E wave to the end of the E wave which shall be taken as 10 microsecond (μs) later. (The time was calculated from the dispersion curves for the specified aluminum plate.) A linear regression shall be applied to the energy data and a goodness of fit $R^2 > 0.9$ shall be obtained.

d) Preamplifiers and Amplifiers - See ASME Section V, Article 11.

e) Filters

A high pass filter of 20 kHz shall be used. A low pass filter shall be applied to prevent digital aliasing that occurs if frequencies higher than the Nyquist frequency (half the sampling rate) are in the signal.

f) A/D

The sampling speed and memory depth (wave window length) are dictated by the test requirements and calculated as follows: Vessel length = L inches (meters). Use C_E = 0.2 in./μs (5080 m/s) and C_F = 0.05 in./μs (1270 m/s), the speeds of the first arriving frequency in the E wave and last arriving frequency in the F wave, respectively, as a guide. The actual dispersion curves for the material shall be used if available.

L / C_E = T1 μs. This is when the first part of the direct E wave will arrive.

L / C_F = T2 μs. This is when the last part of the direct F wave will arrive.

(T2 – T1) x.1.5 is the minimum waveform window time and allows for pretrigger time.

The recording shall be quiescent before front end of the E wave arrives. This is called a "clean front end". Clean is defined in S10.10.6 b) 2) below.

The sampling rate, or sampling speed, shall be such that aliasing does not occur.

The recording system (consisting of all amplifiers, filters and digitizers beyond the sensor) shall be calibrated by using a 20 cycle long tone burst with 0.1 V amplitude at 100, 200, 300, and 400 kHz. The system shall display an energy of $uu = \frac{vv^{!}\ NNNN}{ZZZ}$ joules at each frequency, where V=0.1 volts, N = 20, Z is the preamplifier input impedance in ohms (Ω) and T is the period of the cycle in seconds (s).

S10.10.5 SENSOR PLACEMENT

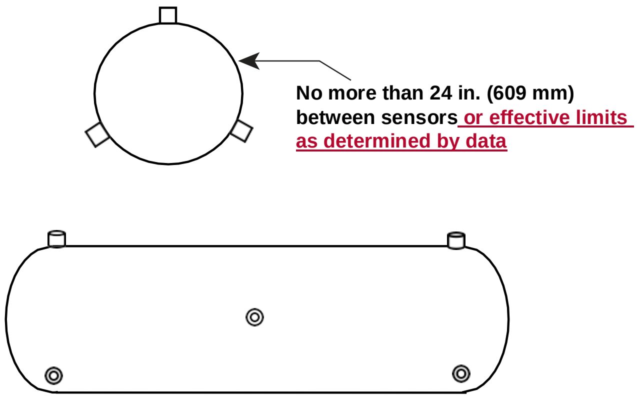
At least two sensors shall be used in any AE test regardless of vessel size so that electromagnetic interference (EMI) is easily detected by simultaneity of arrival. Sensors shall be placed at equal distances around the circumference of the vessel on the cylindrical portion of the vessel adjacent to the tangent point of the dome such that the distance between sensors does not exceed the greater of 24 in. (610 mm), or the effective sensing distance established by signal meaurement. Adjacent rings of sensors shall be offset by ½ a cycle. For example, if the first ring of sensors is placed at 0, 120, and 240 degrees, the second ring of sensors is placed at 60, 180, and 300 degrees. This pattern shall be continued along the vessel length at evenly spaced intervals, such intervals not to exceed the greater of 24 in. (610 mm), or the effective sensing distance established by signal meaurement, until the other end of the vessel is reached. See Figure S10.10.4. The diameter referred to is the external diameter of a vessel.

Maximum distance between sensors in the axial and circumferential directions shall not exceed 24 inches (609 mm) unless it is demonstrated that the essential data can still be obtained using a greater distance and the authority having the jurisdiction concurs.

This spacing allows for capturing the higher frequency components of the acoustic emission impulses and high channel count wave recording systems are readily available.

FIGURE S10.10.5

SENSOR SPACING AND PATTERN



S10.10.6 TEST PROCEDURE

Couple sensors to vessel and connect to the testing equipment per ASME Section V Article 11. Connect pressure transducer to the recorder. Conduct sensor performance checks prior to test to verify proper operation and good coupling to the vessel. The E and F waveforms shall be observed by breaking pencil lead at approximately 8 in. (200 mm) and 16 in. (410 mm) from a sensor along the fiber direction. All calibration data shall be recorded.

Recording threshold shall be 60 dB ref 1 μV at the transducer.

Performance checks shall be carried out by pencil lead breaks (Pentel 0.3 mm, 2H) six inches (150 mm) from each transducer in the axial direction of the cylinder and a break at the center of each group of four sensors.

Pressurize vessel to >98% of normal fill pressure and monitor AE during pressurization and for 15 minutes after fill pressure is reached. See Figure S10.10.5 for a schematic of the pressurization scheme. If at any time during fill the fill rate is too high in that it causes flow noise, decrease fill rate until flow noise disappears. Record events during pressurization and for 15 minutes after fill pressure is reached and save the data. Then conduct a post-test performance check and save data. Test temperature shall be between 50°F (10°C) and 120°F (49°C).

A threshold of 60 dBAE ref 1 μV at the sensor shall be used during all phases of testing.

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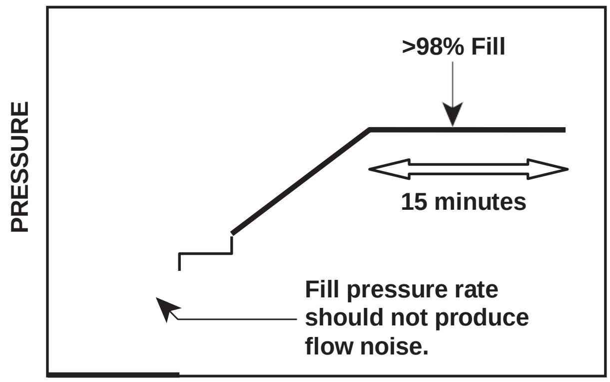
FIGURE S10.10.6
TYPICAL PRESSURIZATION PLAN WHEN FILLING VESSELS



AE shall be monitored for 15 min after operating fill pressure is reached.

S10.10.7 ACCEPT/REJECT CRITERIA

a) Stability Criterion

Theory of AE Monitoring of high-pressure composite pressure vessels for stability– A stable vessel will exhibit cumulative curves with exponentially decaying curvature. The shape of the cumulative events curve is similar for pressure vessels made of fiberglass, aramid and carbon fiber that exhibit a fiber dominated failure mode. This is essentially a test that demonstrates the composite is not progressing to failure at the hold pressure.

b) Analysis Procedure

Data will include matrix splits, matrix cracks, fiber breaks, and matrix chirps due to fracture surface fretting, and fiber/matrix debonding. Extraneous noise, identified by waveform characteristics, may also be included in the data.

1) Filter data to eliminate any external noise such as electromagnetic interference (EMI), mechanical rubbing, flow noise, etc. Identify noise events by their shape, spectral characteristics, or other information known about the test such as a temporally associated disturbance due to the pressurization system or test fixturing. EMI is characterized by a lack of any mechanical wave propagation characteristics, particularly a lack of dispersion being apparent. EMI can be further identified by simultaneity of arrival on more than one channel. The two criteria shall be considered together to ensure it’s not simply an event that happened to be centered between the sensors. Mechanical rubbing frequencies are usually very low and can be determined by experiment. There should be no flow noise. If the vessel, or a fitting, leaks, this will compromise the data as AE is very sensitive to leaks. Leak noise is characterized by waves that look uniform across the entire length of the waveform window. If a leak occurs during the load hold, the test must be redone. Flow noise is characterized by waves that fill the waveform window.

2) Use only events that have clean front ends and in which first arrival channel can be determined. Clean means having a pre-trigger energy of less than 0.01×10^{-10} joules. Energy is computed by the integral of the voltage squared over time.

3) Plot first arrival cumulative events versus time. Plots shall always show the pressure data.

4) Apply exponential fits by channel for pressure hold time and display both data and fit. The values are determined by the fit $y = ae^{Bt} + C$.

The B value is the shape factor of the cumulative curves. C is an intercept and A is a scale factor. The time t shall be equal intervals during the hold with events binned by time interval. Record exponents and goodness of fit (R^2). Plot energy decay curves. One third or one fourth of hold time shall be used for event energy binning (cumulative energy). The formula is $y = ae^{Bt}$.

The sequence of energy values must monotonically decrease.

This is similar to using other energy criteria, such as Historic Index. A sequence that is not properly decreasing will be indicated by a low R^2 value.

5) Save all plots (all channels) to report document.

6) Record exponents and R^2 values.

7) Vessel B Values

a. Vessel B values shall be tracked and compiled in order to develop a statistically significant database.

b. B is the critical value that measures the frequency of occurrence of events during pressure hold.

c. Not every vessel will have the exact same B value.

d. Data on B values should cluster.

S10.10.7.1 THE CRITERIA GIVEN BELOW APPLY TO EACH INDIVIDUAL SENSOR ON THE VESSEL

a) The stability criteria as described above shall be met. (Also see ASME Section X Mandatory Appendix 8.) Any vessel that does not meet the stability criteria must be removed from service. The criteria are:

1) Cumulative Event Decay Rate $-0.1 < B < -0.0001$, $R^2 \geq 0.80$

2) Cumulative Energy Decay Rate $-0.2 < B < -0.001$, $R^2 \geq 0.80$

If these criteria are not met, the vessel does not pass. The vessel may be retested. An AE Level III examiner must review the data from the initial testing and the subsequent loading test before the vessel can be passed. Retest loadings shall follow the original pressurization rates and pressures and use a threshold of 60 dBAE. If the vessel fails the criteria again, the vessel shall not be certified by the Inspector as meeting the provisions of this section.

b) Events that occur at the higher loads during pressurization having significant energy in the frequency band f > 300 kHz are due to fiber bundle, or partial bundle, breaks. These should not be present at operating pressure in a vessel that has been tested to a much higher pressures and is now operated at the much lower service pressure. For fiber bundles to break in the upper twenty percent of load during the test cycle or while holding at operating pressure, the vessel has a severe stress concentration and shall be removed from service.

S10.10.8 FIBER BREAKAGE CRITERION

a) Analysis Procedure

In order to determine if fiber bundle breakage has occurred during the filling operation the frequency spectra of the direct E and F waves shall be examined and the energies in certain frequency ranges shall be computed as given below.

b) Definitions

Energies (U) in the ranges are defined as:

50 – 400 kHz: U_0

100 – 200 kHz: U_1

250 – 400 kHz: U_2

The criteria for determining if high frequency spectrum events have occurred is given by the following formulas:

$U_0/(UF_{BB)} \geq 10\%$

$U_2 / (U_1 + U_2) \geq 15\%$

$U_2 / U_0 \geq 10\%$

U_{FBB} is the energy of a fiber bundle break calculated using the average breaking strength from the manufacturer's data or independent test data. The manufacturer's data shall be used if available. The formula that shall be used for calculating average fiber break energy in joules (J) is

$$UU_{!\cdot\cdot} = \frac{EE * AA * ll * \varepsilon\varepsilon^{!}}{2}$$

where E is the Young's modulus of the fiber in pascals (Pa), ε is the strain to failure of the fiber, A is area of the fiber in square meters (m^2), and l is the ineffective fiber length in meters (m) for the fiber and matrix combination. If the ineffective length is not readily available, four times the fiber diameter shall be used. Set U_{FBB} = 100 x U_{FB}, where U_{FB} has been calculated and scaled by the rolling ball impact energy as in the examples below. If these criteria are met, fiber bundle break damage has occurred during the test and the vessel shall be removed from service.

c) Example of Fiber Break Energy Calculation Suppose d = 7 µm, *E* = 69.6 GPa and ε = 0.01 (average breaking strain) for some carbon fiber. Using *A* = $\pi d^2/4$ and / = 4d,

$$UU_{!\cdot\cdot} = \frac{EE * AA * ll * \varepsilon\varepsilon^{!}}{2}$$

$$UU_{!\cdot\cdot} = \frac{EE69.6 * 10^{!}\,PPPP * \pi\pi * \frac{(7 * 10^{!!}mm)^{!}}{4} * 2.8 * 10^{!!}mm * (0.01)^{!}}{2}$$

$$UU_{!\cdot\cdot} = 3.75 * 10^{!!}jj$$

d) Example of Scaling Calculation

Suppose that the rolling ball impact (RBI) acoustical energy measured by a particular high fidelity AE transducer is U^{AE}_{RBI} = 5 x 10^{-10} J and the impact energy U_{RBI} = 1.9 x 10^{-3} J (due to gravity). Suppose d = 7 µm, *E* = 69.6 GPa and ε = 0.01 (average breaking strain) for some carbon fiber. Using *A* = $\pi d^2/4$ and l = 4d, U_{FB} = 3x10^{-8} J. A carbon fiber with a break energy of U_{FB} = 3x10^{-8} J would correspond to a wave energy.

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$$U^{AE}_{FB} = U_{FB} \times U^{AE}_{RBI} / U_{RBI}$$

$$U^{AE}_{FB} = 3\text{x}10^{-8} \text{J} \times 5 \times 10^{-10} \text{ J} / 1.9 \times 10^{-3} \text{ J}$$

$$U^{AE}_{FB} = 7.9 \times 10^{-15} \text{ J.}$$

This is the number that is used to calculate the value of U_{FBB} that is used in the fiber break criterion in the second acceptance criterion and the energy acceptance criterion in the third criterion below.

e) Amplifier Gain Correction

All energies shall be corrected for gain. (20 dB gain increases apparent energy 100 times and 40 dB gain 10,000 times.)

Fiber break waves may look similar to matrix event waves in time space but in frequency space the difference is clear. A fiber break is a very fast source, while a matrix crack evolves much more slowly due to greater than ten to one difference in their tensile moduli. The speed of the fiber break produces the high frequencies, much higher than a matrix crack event can produce. Frequencies higher than 2 MHz have been observed in proximity to a fiber break, however these very high frequencies are attenuated rapidly as the wave propagates. Practically speaking, the observation of frequencies above 300 kHz, combined with certain other characteristics of the frequency spectrum and pressure level, is enough to confirm a fiber break. It should also be noted that it is fiber bundle breaks that are usually detected in structural testing and not the breaking of individual fibers. The energies of individual fiber breaks are very small, about $3\text{x}10^{-8}$ Joules for T-300 carbon fibers for example.

S10.10.9 FRICTION BETWEEN FRACTURE SURFACES

Friction between fracture surfaces plays a very important role in understanding AE in fatigue testing. It is an indicator of the presence of damage because it is produced by the frictional rubbing between existing and newly created fracture surfaces. Even the presence of fiber bundle breakage can be detected by examining the waveforms produced by frictional acoustic emission or FRAE. Increasing FRAE intensity throughout a pressure cycle means more and more damage has occurred.

Therefore, for a vessel to be acceptable no AE event shall have an energy greater than (F) x U_{FB} at anytime during the test. F is the acoustic emission allowance factor. The smaller the allowance factor, the more conservative the test. An F = 10^4 shall be used in this testing. It is the equivalent of three plus fiber tows, each tow consisting of 3,000 fibers, breaking simultaneously near a given transducer.

S10.10.10 BACKGROUND ENERGY

Background energy of any channel shall not exceed 10 times the quiescent background energy of that channel. After fill pressure is reached, any oscillation in background energy with a factor of two excursions between minima and maxima shows that the vessel is struggling to handle the pressure. Pressure shall be reduced immediately and the vessel removed from service.

S10.11 DOCUMENT RETENTION

a) The vessel owner shall retain a copy of the Manufacturer's Data Report for the life of the vessel.

b) After satisfactory completion of the periodic in-service inspection, vessels shall be permanently marked or labeled with date of the inspection, signature of the Inspector, and date of the next periodic in-service inspection.

c) The vessel owner shall retain a copy of the in-service inspection report for the life of the vessel.

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

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.

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1.6 CHANGE OF SERVICE

Supplement 9 of this part provides requirements and guidelines to be followed when a change of service or service type is made to a pressure-retaining item.

Whenever there is a change of service, the Jurisdiction where the pressure-retaining item is to be operated, shall be notified for acceptance, when applicable. Any specific jurisdictional requirements shall be met.

1.7 SCRAPPING PRESSURE RETAINING ITEMS

The Owner/User shall deface the code nameplate(s) of any pressure retaining item that is scrapped. The removal or defacement of the Code nameplate(s) should be verified by the Inspector, and the National Board form NB-XXX shall be completed and submitted to the National Board and jurisdiction, if required.

ADD DEFINITION:

SCRAPPED – Permanent removal from service by owner/users procedures.

Scrapping of Pressure Retaining Items

In accordance with provisions of the National Board Inspection Code

1.Submitted to:

____
Name of Jurisdiction

____
Address

____
Phone Number

2.Submitted By:

____
(Name of Owner/User)

____
Address

____
Phone Number

3. Manufactured by: ______________________________
(name and address)
____
____

4. Location of Installation: ______________________________
(address)
____

5. Manufacturer's Data Report: ☐ YES ☐ NO

6. Item Registered with National Board: ☐ YES ☐ NO NB Number: ______________

7. Item Identification:

Year Built: ________________________ Mfr. Serial No.: ________________________

Type: ____________________________ Jurisdiction no.: ________________________

Dimensions: ______________________ MAWP: ______________________________

8. Date of removal or defacement of the Code nameplate(s) ______________

9. I certify that to the best of my knowledge and belief the statements in this report are correct, and with provisions of the National Board Inspection Code.

Name of Owner or User: ____

Signature: ____________________________________ Date: __________________________

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Instructions for Completing the Form NB-XXX, *Scrapping of Pressure Retaining Items Form*

Items 1-9 shall be completed by the owner, user, or "R" Stamp Holder making the request.

1) The name, address, and phone number of the Jurisdiction, Authorized Inspection Agency (when there is no Jurisdiction) the form is being submitted to for approval.
2) Enter the name and address of your company or organization.
3) Enter the name and address of the manufacturer shown on the name plate.
4) Enter the name and address of the location where the pressure-retaining item is installed. If this is the same as number 2, check the box "same as # 4."
5) Manufacturer's Data Report Attached-check the appropriate box.
6) Is the pressure-retaining item registered with the National Board? Check the appropriate box. If yes, provide the National Board Registration Number.
7) Provide as much information as known to help identify the pressure-retaining item.
8) Enter date the removal or defacement of the Code nameplate.
9) Enter the name and signature of the Owner, User, or "R" Stamp Holder (and "R" Stamp number if applicable).

Note: Once completed the requester shall file a copy with the Jurisdiction where the pressure retaining item is installed, the National Board, and the owner or user of the vessel if the request was made by an "R" Stamp Holder, and upon request to the Authorized Inspection Agency who witnessed the removal or defacement of the nameplate.

Item 19-78

Subject: Detailed Requirements for Inservice Inspection of Cast Iron Boilers.

NBIC Location: Part 2, 2.2.12.1 a)

Explanation of Need: The only reference to cast iron material in ASME Section I is PMB-5.4 that allows heads or parts of miniature boilers, when not exposed to direct action of the fire, may be made of cast iron or malleable iron provided it complies with a specification permitted by Section I. Heads and parts do not make up the complete boiler. ASME Section VIII Div. 1, UCI-2 states that cast iron boilers shall not be used in direct firing applications or in unfired steam boilers.

Background Information: The language to include "or high" pressure steam was added in the 2007Ed/2007Add of the NBIC Part 2. Unfortunately, there are no historical records or interpretations supporting the need for the revision in 2007. Both the 2004/2006 and 2007/2007 NBIC paragraphs have been provided for reference.

Proposed Revision:

2.2.12.1 CAST-IRON BOILERS

a) Cast-iron boilers are used in a variety of applications to produce low~~ or high~~ pressure steam and hot-water heat. Cast-iron boilers should only be used in applications that allow for nearly 100% return of condensate or water and are not typically used in process-type service. These boilers are designed to operate with minimum scale, mud, or sludge, which could occur if makeup water is added to this system.

Item 19-80

Subject: Conflicting statements in Part 1 and Part 2 about boiler controls

NBIC Location: Part 2, 2.2.10.6 l) 1)

Explanation of Need: Requirements in this section need to be consistent with Part 1, 2.8.4 a) to avoid confusion.

Background Information:
2.8.4 PRESSURE CONTROL (From NBIC Part 1)

Each automatically fired steam boiler shall be protected from overpressure by two pressure operated controls.

a) Each individual steam boiler or each system of commonly connected steam boilers shall have a control that will cut off the fuel supply when the steam pressure reaches an operating limit, which shall be less than the maximum allowable working pressure.

2.2.10.6 CONTROLS (From NBIC Part 2)

l) Check that the following controls/devices are provided:
1) Each automatically fired steam boiler is protected from overpressure by not less than two pressure operated controls, one of which may be an operating control.

The highlighted area is what was proposed to be removed.

Proposed Revision:
l) Check that the following controls/devices are provided:

1. Each automatically fired steam boiler is protected from overpressure by not less than two pressure operated controls, one of which may be an operating control.

   When required by the code of construction or the jurisdiction, the high pressure limit control shall be of the manual reset type.

2. Each automatically fired hot-water boiler or hot-water boiler system is protected from over-temperature by not less than two temperature operating controls, one of which may be an operating control.

   When required by the code of construction or the jurisdiction, the high temperature limit control shall be of the manual reset type.

3. Each hot-water boiler is fitted with a thermometer that will at all times, indicate the water temperature at or near the boiler outlet.

Item 19-89
January 13, 2020
NBIC Part 2

S2.7.3.2 SUBSEQUENT INSPECTIONS

a) Boilers that have completed the initial inspection requirements begin the subsequent inspection intervals. The following inspection intervals should be used unless other requirements are mandated by the Jurisdiction.

1) Interval #1 — One year following initial inspection. Inservice inspection per NBIC Part 2, S2.7.1.
2) Interval #2 — Two years following initial inspection. Visual inspection per NBIC Part 2, S2.5.2.2.
3) Interval #3 — Three years following initial inspection. A pressure test per NBIC Part 2, S2.6.1.
~~4) Interval #4 — Same as interval #1.~~
~~5) Interval #5 — Visual inspection per NBIC Part 2, S2.5.2.2 and UT thickness testing per NBIC Part 2, S2.6.2.~~
~~6) Interval #6 — Same as interval #3.~~

b) After interval #~~6~~ 3 is completed, the subsequent inspection cycle continues with interval #1.

c) Ultrasonic thickness testing per NBIC Part 2, S2.6.2 shall be performed twenty years from the original boiler manufacturing date and every ten years thereafter, or more frequently at the discretion of the Jurisdiction when applicable.

Item 19-93
January 7, 2020
Part 2, 5.3.2

Proposed

5.3.2 FORMS

a) REPLACEMENT OF STAMPED DATA FORM (NB-136), see Pg. ~~82~~86

b) FORM NB-4 NEW BUSINESS OR DISCONTINUANCE OF BUSINESS, see Pg. ~~84~~88

c) FORM NB-5 BOILER OR PRESSURE VESSEL DATA REPORT, see Pg. ~~85~~89

d) FORM NB-6 BOILER-FIRED PRESSURE VESSELS REPORT OF INSPECTION, see Pg. ~~87~~91

e) FORM NB-7 PRESSURE VESSELS REPORT OF INSPECTION, see Pg. ~~88~~92

f) FORM NB-403 REPORT OF FITNESS FOR SERVICE ASSESSMENT, see Pg. ~~90~~94