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Pressure Points

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Issues with formed Tees in high energy piping systems

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Recently, there have been a number of pressure part failures in both conventional and combined-cycle power plants involving formed Tees of various sizes that have been designed and manufactured in accordance with the requirements of ASME B16.9. These failures have occurred in Tees operating in high temperature steam line systems (Main or Hot Reheat) where the material of construction has been Grades 22, 91, or 92. The pattern of the failures has been similar, with leaks developing at one or both of two primary locations on the Tee (see Figure 1 below for explanation of nomenclature). The leaks occur either at fractures that initiate from the outside diameter "OD" surface in the Tee-side Heat-Affected Zones (HAZs) associated with the Branch and/or Run girth welds (i.e., circumferentially oriented fractures), and particularly where those welds are aligned with the crotch of the Tee; or they occur at fractures that initiate from the inside diameter "ID" surface at the center of the crotch in the Tee and propagate in a direction running parallel to the major axis of the Tee. The damage at all locations is creep-dominated, and at least in cases where it has been possible to carry out detailed analysis, it was clear that the damage is not a result of improper support of the piping system.

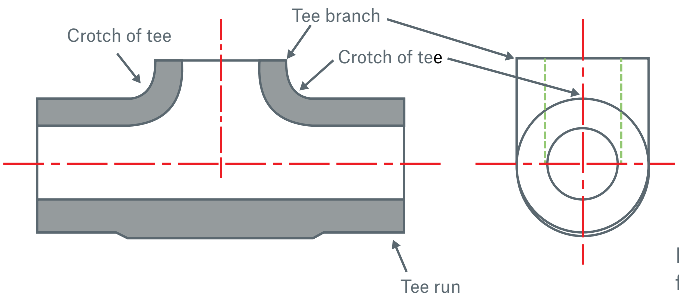

Figure 1 – Primary failure locations

For a Power Boiler designed and constructed in accordance with the rules of ASME Section I, B16.9 Tees are typically ordered and accepted per PG-11 "Prefabricated or Preformed Pressure Parts Furnished Without a Certification Mark" under the specific provisions of PG-11.3. For Boiler External Piping designed and constructed in accordance with the rules of ASME B31.1, paragraphs 106.1, 104.7, and 115.2 make reference to the material, size, pressure, and temperature limitations of the standards listed in Table 126.1-1, and B16.9 is listed in this Table as an acceptable standard for fittings. Additionally, paragraph 123.2.2(c) of B31.1 acknowledges that Section I materials are suitable for Boiler External Piping subject to the relevant applicable Section I requirements, such as PG-11.

Although SA-234, paragraph 18, requires that MTRs be supplied for all fittings, PG-11.3.6 states that inspection, mill test reports, and partial data reports are not required for pressure parts meeting the requirements of PG-11.3. Therefore, a B16.9 Tee received by a certificate holder that meets the marking requirements of the B16.9 standard alone will be acceptable for use in a power boiler. ASME Section I published Interpretation I-79-01 provides further clarification.

A quick review of how the P-T ratings are established for a B16.9 Tee under Section I rules is helpful at this point. The Note under PG-42.1 states that "When pressure ratings are established under the provisions of ASME B16.9, para. 2.1, they shall be calculated as for straight seamless pipe in accordance with this Section." Here is an example to demonstrate what this means for a 16" x 14" reducing Tee.

Design Conditions:
- Pressure: 2,630 psi
- Temperature: 1105°F

Details of the B16.9 Tee:
- Actual Thickness of Tee Main Run: 2.036"
- Actual Thickness of Tee branch: 1.781"
- OD: 16" x 14", Material: SA 234, WP91
- It is assumed that the run and branch thicknesses are uniform along their full lengths.
- Governing Code Edition: ASME Section I, 2017 Edition.

The required thicknesses for the run and branch for the Tee in accordance with PG-27 rules of Section I [as required by PG-42.1 and by paragraph 2.1 of B16.9] are 1.783" and 1.560", respectively. Since the values of these calculated thicknesses are below the actual thicknesses of the run and branch of the 16" x 14" Tee in this example, the Tee meets the minimum Section I requirements for the given design conditions.

Section I addresses rules for compensation/reinforcement required for openings in shells and dished heads in PG-33. Additional recommendations for larger openings are separately addressed in PG-32.3.3. It is interesting to consider how the opening in a B16.9 Tee would be compensated/reinforced using the Section I requirements. For the Tee in the above example, the required area "A" in accordance with PG-33.3 would be approximately 19 square inches. The combined available area from the run and the branch of the Tee as a result of the excess thicknesses, in accordance with Figure PG-33.1, is approximately only 3 square inches. Therefore, this Tee would not be properly reinforced relative to the Section I opening rules. It is understood that discontinuity stresses, well in excess of the average membrane stresses, exist around an opening in a branch connection, though these stresses attenuate with increasing distance from the opening. This is why Section I has established limits of metal available for compensation in PG-36 when reinforcing an opening. For the 16" x 14" reducing Tee used in the above example, Table 1 below compares the PG-36 limits with the Tee run and branch lengths based on Table 6.1-8 of ASME B16.9.

OD: 16" x 14" Thickness of Tee Main Run: 2.036" Thickness of Tee branch: 1.781"	Based on PG-36 of Section I	Based on the Reducing Tee actual dimensions of Table 6.1-8 from ASME B16.9.
The limits of metal available for compensation, measured parallel to the vessel wall	10.438 in	5 in
The limits of metal available for compensation, measured normal to the vessel wall	4.453 in	4 in

Table 1 – Limits of metal available for compensation

This example demonstrates that the Tee is not only under-reinforced but also has run and branch lengths that are shorter than they should be if designed in accordance with Section I opening compensation rules.

Paragraph 2.2 of B16.9 provides four options for the design of fittings. The option most frequently used by the industry is proof testing. B16.9 allows the manufacturer to conduct one test of a "representative" fitting at ambient temperature to prove the design of fittings for a wide range of material grades included in a given material group — and this test then validates the design for that specific fitting at all potential temperatures of use — including temperatures where creep properties govern the allowable stress values for the material. This means that the design validation of an SA 234 WP91 Tee can be performed using a carbon steel Tee burst test performed at ambient temperature since carbon and low-alloy steels belong to the same material group (i.e., Group 1) per Table 5-1 Material Groupings of B16.9. It is important to note that the Section I proof test requirements provided in A-22 are somewhat more stringent, requiring that separate tests be performed for each material grade. Additionally, A-22.8 requires consideration of the temperature of operation by mandating that the maximum allowable working pressure assigned for the fitting be determined by multiplying the maximum allowable working pressure at the test temperature by the ratio of the maximum allowable stress value at the design temperature/maximum allowable stress value at test temperature.

Readers may also want to refer to the PVP paper "PVP2014-28265," which summarizes the study of a small sample of ASME B16.9 welding Tee burst tests. The intent of this study was to make a comparison between what is commonly accepted in the industry as a B16.9 welding Tee to the burst test requirements of B16.9 paragraph 9.

The potential significance of these failures to the safety of plant personnel and the reliability of the units affected is sufficiently great that a program of assessment has been developed to identify Tees at risk of premature failure based on the Tee design, the material of construction, and the operating conditions. This program has five main objectives: (1) determine the critical dimensions of the Tee, particularly the wall thickness, in both the branch and the run; (2) evaluate the chemical composition of the Tee material to confirm conform with the applicable specification and qualitatively assess its creep resistance (e.g., Type 1 vs. Type 2 for Grade 91 Tees); (3) perform non-destructive examinations at critical areas of the Tee, particularly at the girth welds and the crotch, to detect signs of damage; (4) carry out hardness surveys to confirm proper processing of the Tees during manufacture, particularly for Tees fabricated from Grades 91 or 92; (5) develop an initial assessment of the Tee based on the results of the four stages of testing described above; the results of this assessment would be used to guide plant operators in determining the relative risk associated with continued operation of the Tee and, depending on the risk level, to provide guidance to plant operators on appropriate run/repair/replace options.

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Jay Vattappilly is currently a Vice-President for HSB, Global Inspection and Engineering Services division. He oversees the HSB Codes and Standards group (C&S), and all the services carried out by the group, including technical support, internal and external training, management of HSB knowledge databases, and global design review activity.

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Jay's work experience has principally been in the area of pressure equipment construction, working in the role of a QA/QC engineer, inspection engineer for a large engineering consulting firm servicing refineries and petrochemical plants, welding engineer responsible for both structural and pressure vessel welding activity, and as design engineer of pressure equipment constructed to ASME Sections I, IV, B31.1, and VIII.

Jay presently holds a Professional Engineering license from Ontario, Canada, and National Board Commissions "AI," "IS," and "R" endorsement. He is a member of Subgroup on Design (BPV I), Committee on Power Boilers (BPV I) and a member of the Technical Oversight Management Committee (TOMC). He is also a member of the Subgroup on Design (BPV VIII), Subgroup on Toughness (BPV VIII), Special Committee on Interpretations (BPV VIII), and Subgroup on General Requirements & Piping (BPV I). Jay provides technical support on ASME Boiler and Pressure Vessel Code Sections I, IV, VIII, and IX, and is HSB's subject matter expert on the Indian Boiler Regulations (IBR).

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Jeff Henry is currently President and Co-owner of ATC, Inc. His professional experience has been concentrated on the service performance of power plant materials, with particular focus on high temperature behavior, welding, manufacturing, and the creep strength-enhanced ferritic steels, such as Grade 91.

Jeff earned a Master of Science in metallurgical engineering from University of Tennessee-Knoxville, has authored over 60 technical papers, and is an ASME Fellow and active on a number of ASME Boiler & Pressure Vessel Code technical committees. Jeff is the former chair of BPV II, the Materials Standards Committee, and he chaired the Working Group on Creep Strength-Enhanced Ferritic Steels for the first ten years of its existence. He is a member of BPV I (Power Boilers) and the Management Oversight Technical Committee (TOMC).

ASME Section III executive summary

Author: Paul Coco, P.E., HSB Codes and Standards

ASME Section III Division 4 Fusion Energy Devices

The Rules for Construction of Nuclear Facility Components, specifically Division 4, have been newly published to address fusion energy devices. These rules provide guidelines and requirements for various components used in fusion energy systems, including vacuum vessels, cryostats, magnet structures, and their interactions.

Furthermore, the rules cover related support structures, such as metallic and nonmetallic materials, containment or confinement structures, and various in-vessel components like blankets, divertors, shields, fusion-system piping, vessels, valves, pumps, and supports.

The publication includes comprehensive requirements for materials, design, fabrication, testing, examination, inspection, certification, and stamping. These guidelines aim to ensure the safe and reliable construction and operation of fusion energy devices.

Initially, the BPV III Division 4 Fusion Energy Devices Code was released as a Draft Standard for trial use in 2018. Since then, the Standard Group (SG) on Fusion has gathered and considered feedback and comments from stakeholders, incorporating necessary revisions into the document.

It is important to note that this standard primarily focuses on magnetic fusion energy systems found in tokamak designs, which are confinement-based fusion systems. It does not encompass the inertial confinement method at this time.

Alternative treatments

Historically, regulations governing the design and operation of nuclear plants in the United States were primarily based on deterministic requirements. These requirements outlined a specific set of design events that the plants had to be able to withstand.

Over time, as more data became available on actual transients, accidents, and the performance of plant equipment, the industry recognized the need to incorporate this information into the regulatory framework. The data collected were used in modeling accident scenarios to estimate the overall risk associated with plant operation. To analyze this risk, U.S. nuclear plants began utilizing a probabilistic risk analysis (PRA) approach.

The insights gained from PRAs highlighted that certain plant equipment, which was deemed important to safety according to the deterministic regulatory requirements, had low safety significance when it came to ensuring safety. This realization prompted the Nuclear Regulatory Commission (NRC) to develop technical requirements that specifically defined the scope of structures, systems, and components (SSCs) governed by NRC alternative special treatment requirements. This initiative resulted in the establishment of a final rule, known as 10 CFR 50.69.

In line with its strategic initiatives, the American Society of Mechanical Engineers (ASME) Section III formed a special task group to propose alternate requirements for the construction of ASME Section III nuclear items. The aim was to align the construction process with the safety or risk contribution of each item, moving away from the traditional categorization of components based solely on deterministic processes. Instead, a risk-based safety classification system consistent with 10CFR50.69 and NEI 18-04 was considered, with the intention of enhancing the value of construction and meeting the design needs of advanced reactors.

The Task Group responsible for alternative treatments has presented a code update for the 2023 edition of ASME Section III Divisions 1 and 5. This update includes alternative material procurement requirements that expand the existing small products exclusions already outlined in paragraph NX-2610 of the code.

The revised code paragraph now allows for the integration of risk-based approaches into the construction of nuclear items when procuring materials. This means that the selection and acquisition of materials for nuclear item construction can take into account risk considerations, enhancing the overall safety and performance of the items.

However, it is important to note that the use of this code provision is subject to the approval of proposed alternative treatments by the Nuclear Regulatory Commission (NRC) or relevant regulatory authority. In the United States, the owner or their designee (Licensee) will need to seek approval from the NRC for any proposed modifications to design, construction, testing, inspection, and maintenance practices that involve the use of alternative treatments. This ensures that the changes comply with regulatory requirements and maintain the necessary safety standards.

It is crucial to understand that different countries may have different nuclear regulatory authorities with their own licensing processes. These authorities may have their specific requirements and may or may not allow for alternative treatments similar to those found in 10CFR50.69. International users should be aware of the specific regulations and licensing processes in their respective countries.

In the future, further efforts will be made to explore alternative treatments in areas such as non-destructive examination (NDE), testing, and quality requirements. These updates will likely take place in subsequent editions of the code or through the development of code cases.

ANSI/ASNT CP-189 standard for qualification and certification of nondestructive testing personnel

The 2023 Edition of Section III now includes a provision to utilize CP-189 in accordance with Section XI. Code users now have the flexibility to choose between SNT-TC-1a or CP-189, but it's important to note significant differences between the two.

Here are some key distinctions:

1. **Certification Approach:** SNT-TC-1A follows a recommended practice approach, providing guidelines for the qualification and certification of nondestructive testing personnel. CP-189, on the other hand, is a national standard that specifies mandatory requirements for the qualification and certification of NDT personnel.

2. **Written Practice vs. Certification Procedure:** SNT-TC-1A requires the implementation of a "Written Practice" that outlines the procedures for personnel qualification. In CP-189, a "Certification Procedure" is required instead. The Certification Procedure in CP-189 cannot be modified to suit company-specific requirements and must be approved by the Level III personnel.

3. **Vision Requirements:** CP-189 has more stringent vision requirements compared to SNT-TC-1A. For near vision acuity, CP-189 mandates the ability to read Jaeger #1, while SNT-TC-1A specifies Jaeger #2. The Jaeger notation signifies different levels of visual acuity.

4. **Levels of Qualification:** SNT-TC-1A has three levels of qualification: Level I, Level II, and Level III. CP-189 introduces two additional levels: "Instructor" and "Trainee," resulting in a total of five qualification levels.

5. **Minimum Training Hours:** CP-189 sets different minimum training hour requirements compared to SNT-TC-1A. For example, CP-189 does not reduce the minimum training hours for individuals holding a two-year degree in certain methods, as SNT-TC-1A does. CP-189 may have more or less stringent training hour requirements depending on the method and level of qualification.

6. **Certification Prerequisites:** In CP-189, Level III certification requires holding an ASNT Level III certificate in the specific method as a prerequisite. However, SNT-TC-1A does not have this specific prerequisite.

7. **Terminology and Verbs:** CP-189 emphasizes mandatory requirements by using the term “shall” throughout the document. In contrast, SNT-TC-1A uses the verb “should” to indicate recommendations rather than strict mandates.

Consolidated NCA-3800 through NCA-3900 into NCA-3300

In the 2023 Edition of Section III, the consolidation efforts for the duties and responsibilities of owners and certificate holders continued from the previous 2021 Edition. In particular, the requirements from the metallic and non-metallic materials organizations, previously found in NCA-3800-3900, have been consolidated into the new NCA-3300. Here are the major updates:

1. **Merging and Alignment:** The responsibilities outlined in NCA-3800/NCA-3900 have been merged and aligned into the new content numbering system of NCA-3300. This consolidation ensures that the requirements are organized and presented in a cohesive manner.

2. **Transfer of Requirements:** The requirements previously found in NCA-3862 have been moved to NCA-1225, providing a more logical placement of the content.

3. **Consolidated Content Title:** The content title has been modified to accurately reflect the paragraph numbering system and ensure consistency throughout the section.

4. **Introduction of Table NCA-3300-1:** A new table, Table NCA-3300-1, has been created to clearly outline the assigned responsibilities for each type of Material Organization. This table enhances clarity and makes it easier to understand the specific responsibilities.

5. **Updates to Reflect 2021 Edition:** The merged content of NCA-33xx and Table NCA-3300-1 have been updated to align with the requirements specified in the 2021 edition of the code. This ensures that the consolidated content is up to date and compliant with the latest standards.

6. **Realignment of Reference Numbers:** The reference numbers within the body of the respective NCA-33xx have been adjusted to reflect the current numbering format. This helps maintain consistency and clarity within the section.

7. **Explicit Requirement Statements:** Where there were previously implied requirements without explicit statements, explicit requirement statements have been added. This ensures that all necessary requirements are explicitly stated, leaving no room for ambiguity.

Digital pressure gauges

In NB-6412(b), there is a restriction on the combined error resulting from calibration and readability, which should not exceed 1% of the test pressure. However, it is worth noting that the term “readability” in this specific context has not been defined in NCA-9200 or provided as a footnote to NB-6412(b).

In the context of analog gauges, readability refers to the ability to accurately read and interpret the measurement based on the scale and marks on the gauge. For example, if the scale on an analog gauge is marked in 5 psig increments, the readability of the gauge would be 5 psig. It signifies the level of precision in reading the gauge.

Similarly, in the case of digital gauges, readability is often synonymous with resolution. Resolution refers to the smallest increment or change in pressure that the gauge can detect and display. For instance, a digital gauge with a resolution of 0.001 would display pressure values with three decimal places. However, if the third decimal place fluctuates rapidly or doesn't provide a stable reading, then the effective readability of the gauge would be limited to two decimal places.

Most gauges are designed to have stable resolution, matching their readability. The readability represents the value displayed on the gauge output and the increments at which changes in pressure are detected. This value is typically around 1 or 5 psig, depending on the specific gauge.

The new code update removes readability from the combined error resulting from calibration and only addresses accuracy provided the digits are "legible." Note that with legibility, the digits on the digital gauge should be clearly visible and easily readable. This ensures that the pressure measurement can be accurately observed and interpreted.

If the accuracy exceeds the legibility, it may be necessary to consider using a gauge with larger, more easily readable digits to ensure accurate interpretation of the pressure measurement. This way, the accuracy of the gauge can be effectively utilized and the pressure readings can be accurately read and understood.

Alternate methods for applying the ASME certification mark

Paragraph NCA-8212, which pertains to "Stamping with Certification Mark," has been revised to allow for an alternative marking method using laser etching. The revised paragraph now includes provisions that permit the use of laser etching to apply the "Code Symbol" and the markings required by NCA-8210.

Additionally, the title of NCA-8200 has been modified to better reflect the subject matter covered in that section. The specific new title is not provided.

These changes align with Interpretation III-1-92-47, which states that laser etching is an acceptable method for applying the "Code Symbol" and the required markings outlined in NCA-8210. This interpretation clarifies that laser etching can be used as an alternative to traditional stamping for these specific markings.

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Paul joined HSB in January 2014. Paul is a graduate of the United States Naval Academy where he earned a Bachelor of Science in aeronautical engineering. Paul also holds a Master of engineering management and a Master of Science in mechanical engineering. Paul served in the U.S. Navy from 2002 through 2010. During this time, one of his many responsibilities included the role of Reactor Mechanical Division Officer and Training Officer where Paul was responsible for the safe operation of a nuclear power plant onboard a Nuclear Powered Aircraft Carrier. From 2007 through 2010, Paul joined the Mechanical Engineering Department at the U.S. Naval Academy, where he taught Applied Engineering Thermodynamics for Naval Applications as a Military Professor. After Military Service, Paul then joined the U.S. Nuclear Regulatory Commission (NRC) as a Reactor Operations Engineer, where he conducted detailed technical reviews of nuclear licenses in accordance with federal codes and standards, and performed quality assurance inspections on domestic and international nuclear vendors for nuclear safety related components. Within the HSB Codes and Standards group, Paul is responsible for providing code technical support to internal and external clients with a focus on nuclear construction to ASME Section III and the associated nuclear conformity assessment programs. He is responsible for the development, maintenance, and delivery of technical training related to nuclear construction, as well as supporting the HSB NQA Services Program. Paul is also responsible for the development of HSB's remote inspection program and is the technical lead on emerging renewable technologies. He holds a Professional Engineer License in the state of Maryland, National Board Endorsements as an AI and ANI, and is a member of various ASME Section III committees.

Ask the engineer

Author: Tim Nuoffer, Field Services Manager

Q: Can I use Title 10 of the Code of Federal Regulations (10 CFR) Part 21, "Reporting of Defects and Noncompliance" commercial-grade dedication program to acquire code items used for ASME Section XI Repair/Replacement activities?

A: Whether you can or cannot depends on whether the nuclear facility is an ASME Section III plant or non-ASME Section III plant.

The technical and administrative requirements for items to be used for repair/replacement activities can be found in ASME Subsection IWA-4200 of Section XI. The reason an Owner may want to use their commercial grade dedication program is because the supplier of the item may not have a quality assurance program that meets the requirements of the construction code for the item to be used in the repair/replacement activity.

Dedication, within the realm of nuclear safety-related functions, entails an acceptance process grounded in reasonable assurance that an item can safely fulfill its intended functions. In contrast, certifying an item to a specific code or standard necessitates absolute assurance that the item adheres to all specified requirements.

The Electric Power Research Institute ("EPRI") 3002002982, Revision 1 to EPRI 5652 and TR 102260, titled "Plant Engineering: Guidelines for the Acceptance of Commercial-Grade Items in Nuclear Safety-Related Applications," dated September 2014, states that dedication should not serve as a basis for providing certification to a code or standard. EPRI 3002002982 is endorsed, exceptions or clarifications in Regulatory Guide ("RG") 1.164. According to EPRI, the item is ineligible for dedication, and the recommended approach is to procure it as a basic component or control it in accordance with a 10 CFR Part 50, Appendix B compliant Quality Assurance ("QA") program. Nevertheless, a crucial consideration is highlighted in ASME Section XI, the in-service code, where replacement programs, as per IWA-4000, do not support replacing a code-stamped item with one lacking code stamping prior to the 2023 Edition of Section XI. The NRC proposed regulatory update in 10CFR50.55(a) also supports this position in the 2023 edition of Section XI, based on recent code changes to IWA-4143(a).

Meeting a code, such as ASME Section III, or a standard, such as an ASTM material specification, is a decisive proposition. Certification to a code or standard demands 100% assurance; reasonable assurance is deemed inappropriate in such cases. The method used by ASME QSC or Certificate of Authorization (N certificate) holders to upgrade unqualified source material, in accordance with their Code-compliant QA programs and applicable code requirements (e.g., NCA-3855.5), involves controlling the item under a 10 CFR Part 50, Appendix B–compliant QA program. In this case, dedication is not obligatory because the certificate holder fulfills the requirements of 10 CFR Part 50, Appendix B, through compliance with the ASME Code and assumes responsibility for reporting defects and noncompliance in accordance with the requirements of 10 CFR Part 21 when providing the material as a basic component. Notably, ASME Section III has been recognized by the NRC through Information Notice 86-21 as programmatically meeting the requirements of 10 CFR Part 50 Appendix B. Please note that, except for computer software, commercial grade dedication is not permitted for use by Section III.

Historically, challenges have arisen, particularly in older plants originally constructed to non-nuclear codes such as Section VIII or B31.1. In such cases, the component being replaced may still adhere to the required code. However, due to the non-nuclear nature of these codes, there is still a need for some form of nuclear quality assurance program. Here, dedication would emphasize programmatic controls without necessarily dedicating to meeting a Commercial Code of the replacement item where stamping and certification are still required.

In summary, commercial grade dedication is utilized for replacement components permitted by the owners in the in-service program for nuclear power facilities whose original code of construction was based on earlier codes other than ASME Section III.

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Tim Nuoffer, Field Services Manager at HSB, is responsible for providing technical oversight and support for Transportation Services, which include U.S. DOT, Transport Canada, and Carriage of Dangerous Goods. Tim has more than 32 years of experience with ASME Codes and International Standards, performing duties as an inspector, supervisor, auditor, and manager. He currently holds the following National Board Commissions and Endorsements: AI, IS, N, I, B, C, NS, NSI, and R. Additionally, Tim serves as a member on several ASME Section XI committees.

Tim is a U.S. Navy Veteran and served as a Machinist Mate Nuclear Propulsion Plant Operator while assigned to the USS Hyman G. Rickover (SSN-709), a Los Angeles Class Submarine, where he performed as Engine Room Supervisor, Divisional QA Supervisor, and Ship's Welder.

He earned a Bachelor of Science in general business from Excelsior College and a Master of Business Administration from Northwest Missouri State University.

Take note!

Join us May 1-3 at Boiler2024. You can find us at Booth #617, where our experienced and knowledgeable staff is looking forward to meeting you. We also hope you check out the amazing lineup of guest speakers, including our own Jay Vattappilly (HSB Codes and Standards) presenting with ATC President and co-owner Jeff Henry.

Events calendar

2024 virtual technical training seminar topics – click here to register

April 2-4	ASME Section VIII, Division 1 - Boiler & Pressure Vessels (E23)
May 21-23	ASME Section I and B31.1 - Power Boilers and Components (E23)
June 11-13	ASME Section III, Division 5 - High Temperature Reactors and SMR Overview (E23)
August 20-22	ASME Section I and B31.1 - Power Boilers and Components (E23)
September 17-19	ASME Section VIII, Division 1 - Design (E23)
September 17-19	ASME Section III, Division 5 - High Temperature Reactors and SMR Overview (E23)
October 8&9	NBIC Repairs and Alterations (E23)
October 15-17	ASME Section III, Division 1 - Overview and Nuclear Certification Process (E23)
November 13&14	ASME Section IX - Welding Requirements (E23)

2024 on-site technical training seminars – click here to register

April 23-25	Hartford, CT	Hydrogen Storage Training Course
June 4-6	Euclid, OH	ASME Section IX - Welding Requirements with WPS and PQR (E23)

2024 industry events

May 1-3	Denver, CO	ABMA Boiler 2024 (Booth #617)	click here for more information
June 10-13	St. Louis, MO	HRSG Forum (Booth #46)	click here for more information
June 11&12	Washington, D.C.	Hydrogen Americas Summit (Booth #B18)	click here for more information

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