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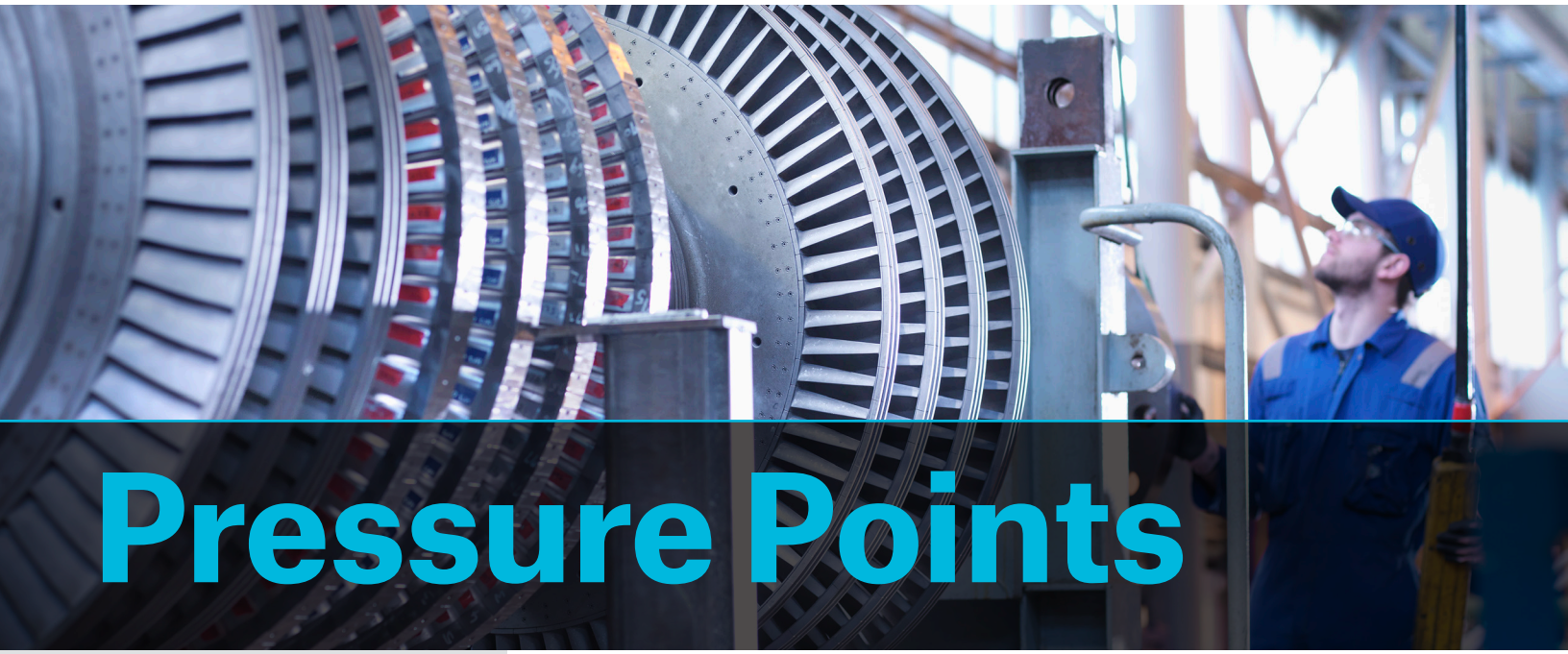

Pressure Points

Table of contents

Changes to ASME B31.1 Qualification Requirements for Nondestructive Examination (NDE) Personnel

Author: Alex Garbolevsky, Senior Engineer, Codes & Standards

While most of us have been diligently poring over the 2023 ASME Boiler and Pressure Vessel Code ("BPVC") for revisions and changes here's an item of particular importance to boiler external piping (BEP) Manufacturers and Assemblers that cannot be overlooked.

ASME BPVC Section I, Power Boilers, and ASME B31.1, Power Piping, make it clear in their respective Figures detailing "Code Jurisdictional Limits for Piping" that ASME Section Committee B31.1 is assigned technical responsibility for Boiler External Piping (BEP). Furthermore, the 2023 Edition of ASME BPVC Section I, Table A-360, assigns the B31.1-2022 Edition as the governing technical Code for BEP.

B31.1-2022 Qualification Requirements for NDE Personnel were significantly revised, made prescriptive, and in some cases, more severe than in ASME BPVC Section I. To find out what prompted this revision, it is necessary to look at ASME B31.3-2018 Process Piping.

Paragraph 342.1 of ASME B31.3-2018 required personnel performing nondestructive examination to be qualified and certified for the NDE method as described in ASME BPVC, Section V, Article 1, T-120(e) or (f). Since B31.3 is designated on its cover as "An International Piping Code ®", there was a consensus that these requirements were too restrictive in referring only to Section V. B31.3-2022 Edition revised the requirements and the employer's written practice (NDE personnel qualification and certification program) are now to be based on the training, examination, and experience requirements of one of

the following: (a) ASME BPVC, Section V, Article 1 [latest edition]; (b) ASNT CP-189 [2016]; (c) ASNT SNT-TC-1A [2016]; or (d) other national or international central certification programs or standards.

ASME B31.1-2022 followed suit by revising paragraph 136.3.2 "Qualification of NDE Personnel" in essentially the same way. New subparagraph 136.3.2(a) now states the employer's written practice must be based on the training, examination, and experience requirements of one of the following: (1) ASME BPVC, Section V, Article 1 [latest edition]; (2) ASNT CP-189 [2020]; (3) ASNT SNT-TC-1A [2020]; (4) ISO 9712 [2012]; or (5) other national or international central certification programs or standards.

The option to use visual examination (VT) personnel qualified to AWS QC1, provided they meet the annual visual acuity examination and the J1 visual acuity requirements of ASME BPVC, Section V, Article 9, remains in effect as described in new subparagraph 136.3.2(b).

Under B31.1-2020 Edition, and for several previous editions, para. 136.3.2 required Power Piping organizations to qualify and certify NDE personnel for each method under a relatively nonprescriptive program. Minimum requirements were: (a) instruction in the fundamentals of each NDE method; (b) on-the-job training for a length of time considered sufficient by the employer; (c) an annual visual acuity examination as required for the NDE method, with Jaeger 1 required for VT; and (d) written and performance examinations as determined by the employer.

Furthermore, certification could be extended based on performing a minimum of one examination in the NDE method within a year plus a successful annual visual acuity re-examination.

For "S", "A" and "PP" Certificate Holders whose NDE Examiners were certified strictly to Section I requirements, RT, UT, MT and PT Examiners could meet the pre-2022 B31.1 requirements with relative ease based on compliance with PW-50 and Appendix A-260 and A-270, respectively.

VT Examiners for BEP could be "certified" by passing employer-specified written and performance examinations and a Jaeger 1 near vision test. The VT Examiner certification could be extended indefinitely as long as VT was performed within 1 year and the annual Jaeger 1 test was passed. Alternatively, an AWS QC1 Inspector qualification with Jaeger 1 vision tests would be sufficient.

ASME B31.1-2022 makes drastic changes to the previous NDE personnel qualification requirements. The five options listed in para. 136.3.2(a) replace the less stringent previous Editions' requirements, established at the discretion of the "S", "A" or "PP" Certificate Holder, with Level I, II, and III Examiner-type qualification requirements.

The new requirements for BEP NDE personnel are even more severe than what is called out in Section I (2023) for MT (in A-260) and PT (in A-270) Examiners. VT Examiners for BEP would require qualification and certification to an SNT-TC-1A-type program or as an AWS QC1 Inspector. The latter remains unchanged as described in new B31.1-2022 para. 136.3.2(b).

"S", "A" and "PP" Certificate Holders who currently rely on NDE personnel qualification programs developed under B31.1-2020 to qualify and certify their "in-house" surface and visual NDE examiners may now need to radically revise those programs or enlist subcontractors who can implement the stricter B31.1-2022 requirements. We should also not forget the new requirements would apply to repair and alteration of BEP by "R" Certificate of Authorization holders as well.

Nonboiler External Piping (NBEP) organizations have been living with the new qualification requirements as of the B31.1-2022 mandatory implementation date of April 10, 2023.

A Code Case request seeking permission to use pre-B31.1-2020 NDE personnel qualification requirements was submitted to the B31.1 Subgroup on Fabrication & Examination for its consideration at their September 2023 meeting. That request was denied.

A similar Code Case request was submitted in October 2023 for Section I consideration and discussed at the November 2023 Code Week. The ballot was issued and closed without approval; however, that doesn't mean the item is excluded from further reconsideration.

BEP organizations should keep a close eye on the progress of Section I's activity, keeping in mind that Code Cases provide optional, alternative rules. Should a Code Case not be available to offer relief, the B31.1-2022 NDE personnel qualification requirements will take effect on January 1, 2024.

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Alex joined HSB in 1979, after serving in the US Navy as a Main Propulsion Assistant. He holds a B.A. in Chemistry from the College of the Holy Cross, and an M.S. in Engineering Science from the Rennselaer Polytechnic Institute. Prior to his assignment to Codes and Standards in 2000, he spent 13 years in Germany and represented HSB in more than 25 countries, serving in positions ranging from Authorized Inspector to Technical Managing Director of our subsidiary - HSB International GmbH.

Alex concentrates in providing support for ASME Section V and IX as well as for the European Union Pressure Equipment Directive "PED" (2014/68/EU) and ASME Section III. He is actively involved in inspector training within the company as well presenting external ASME and National Board Code-related seminars Mr. Garbolevsky holds National Board "AI" and "IS" Commissions with "B", "I", "N", "NS" and "R" endorsements. From 1993 - 2002, he served as Chairman of ISO/TC-11 Technical Committee for Boilers and Pressure Vessels and currently is a member of ASME's Standards Committee on Nondestructive Examination, Subgroup on International Materials Specifications, Subgroup on Volumetric Methods, Working Group Radiography, Subgroup on Surface Examination Methods and Subgroup on Brazing. He is a Registered Professional Engineer (Mechanical) in the Commonwealth of Massachusetts.

Oxygen Equivalent

Author: Philip Gilston, Principal Engineer, Codes & Standards

Background

The 2023 edition of Section IX has revised the rules of QW-408.2 which is an essential variable for shielding gas for the GMAW, FCAW, GTAW, EGW, Stud Welding, LBW, and LLBW processes. In the previous edition of ASME Section IX there were four conditions described for this variable, now only two conditions are described:

a) the addition or omission of shielding gas, and
b) a change in the composition.

There is a modification as to how a change in the composition is addressed. Previously, any change in the specified percentage composition of a shielding gas mixture required requalification. Now, for weld consumables classified to SFA-5.18, SFA-5.20, SFA-5.28, or SFA-5.29 that include an optional "Oxygen Equivalent" shielding gas designator, a WPS does not require a separate qualification when the shielding gas is changed, and the Oxygen Equivalent is within the range listed in the classification of that electrode. Oxygen equivalency only applies to the GMAW and FCAW processes, not the other processes for which QW-408.2 is an essential variable.

AWS consumable specifications A5.18, A5.20, A5.28, and A5.29 (which will be adopted in the 2023 edition of ASME Section II, Part C) include a new optional designator known as 'Oxygen Equivalent'. Shielding gases can be specified based on classifications in accordance with SFA-5.32.

What is the 'Oxygen Equivalent" (OE)?

Electrodes are classified with one shielding gas as specified in each of the standards (e.g. CO_2) for GMAW in A5.18. In practice,

carbon and low-alloy steel electrodes often are used with other shielding gas compositions. By understanding the response of an electrode and the resulting weld metal properties to different shielding gases other than the one used for classification, then within the scope of the referencing Codes rules, it may be possible to change the shielding gas composition without the need for requalification.

The oxidation potential of a shielding gas is represented by the 'oxygen equivalent'. This is expressed as a percentage, calculated per Equation 1:

> Equation 1:
> % Oxygen Equivalent of a shielding gas (OE) = % O2 in the shielding gas + (0.5 × % CO2 in the shielding gas)

This equation is derived empirically to correlate to the composition and properties of the weld metal. It is not a stoichiometric calculation of the oxygen contained in a shielding gas. This oxidation equivalence allows the ability to predict the weld metal's chemical composition and properties. For example, for a weld consumable depositing weld metal at the same welding conditions, with different shielding gases, the manganese and silicon content of the deposited weld metal will be lower with a high oxidation equivalence shielding gas than with a low oxidation equivalence shielding gas.

"OE" Optional Supplemental Shielding Gas Range Designator
The Oxygen Designator (OE) is an optional designator for an electrode. The "OE H/L" designation added to the end of the classification (e.g. SFA-5.18 ER70S-6 – OE 50/4) as with other optional supplemental designators, does not constitute a part of the electrode classification.

Testing
The determination of the OE H/L designation is achieved by using a bracketed testing approach testing gases at both the high and low ends of an oxidation equivalence range to allow an optional shielding gas designator to be applied. The term 'bracketed testing' as used is addressed in a new definition in QG-109.2 of the 2023 edition of ASME Section IX:

> bracketed qualification: A procedure qualification performed by preparing test coupons using combinations of high and low values of specified variables to establish the upper and lower range of qualification for those variables. (ASME Section IX 2023 Edition. © American Society of Mechanical Engineers. All rights reserved.)

For OE H/L determination a minimum of two shielding gases are tested. All the same tests shall be conducted, and all the same requirements shall be met with those gases as those for the electrode classification and any optional, supplemental designators.

The oxygen equivalent designators for the highest and lowest oxygen equivalent shielding gases that were tested that met the requirements may be added to an electrode classification, in the format OE H/L with "H" being the designator for the highest oxygen equivalent and "L" being the OE designator for the lowest oxygen equivalent of the shielding gas tested that met all requirements for classification. For example, if an ER70S-6 electrode is tested with a CO2 shielding gas and with a 92Ar/8CO2 shielding gas, and both gases meet all the requirements, the classification may have the optional designator "OE 50/4" applied.

> OE = % O2 in the shielding gas + (0.5 × % CO2 in the shielding gas)
> For the CO2 = 0% + 0.5 x 100% = 50
>
> For 92Ar/8CO2 = 0% + 0.5 x 8% = 4
> Therefore, OE H/L = OE 50/4

How does this work for the revised QW-408.2?
In the editions of Section IX prior to 2023, any change in the composition of the shielding gas would require a requalification. Within these new rules, this may not be the case.

For the wire classification determined in the previous section (ER70S-6 OE 50/4), a change in the shielding gas composition is permitted without requalification if the Oxygen Equivalent of the proposed shielding gas is between 4 and 50. In this example, the OE 50/4 was based on two gases,

100% CO2 (OE = 50%), and 96% Ar/4% O2 (OE = 4%)

What if I want to use an 80% Ar/20% CO2?
Oxygen Equivalent value of this gas = % oxygen + (0.5 x % carbon dioxide) = 0 + 0.5 x 20 = 10
The value falls within the range 4 to 50 and the gas can be changed without requalification.

For a flux cored electrode, SFA-5.20 E71T-12C for example, which is tested and can meet the E71T-12C requirements for classification with CO2 shielding gas and with 92Ar/8CO2 shielding gas, it may have the "OE 50/4" optional shielding gas range designator applied.

What if the user had qualified a WPS using a 75Ar/25CO2 shielding gas which would have an oxygen equivalent of 12.5, but this gas was not available? The user could change to an 80Ar/20CO2 shielding gas, oxygen equivalent = 10, both gases meet the SFA-5.20 E71T-12C-OE 50/4, and so could be changed without requalification.

Remember the WPS would require revision to reflect the change in shielding gas, but this is a lot easier than having to run a new qualification test, saving time and money.

But now the cautionary note!
Not all welding electrodes work well with all shielding gases. Shielding gases can have influences on transfer modes, fusion characteristics, weld metal properties, etc. Careful consideration should be given when considering a change of one shielding gas to another. Along with knowledge, experience, and engineering judgment, advice should also be sought from the weld consumables manufacturer as to what gases are suitable for different classes of welding wire.

When considering transfer modes for GMAW using wires classified to SFA-5.18, spray transfer is typically obtained with Argon shielding gases with up to 15% CO2. If CO2 content is increased beyond this 15% threshold, then it tends to suppress the spray transfer and move the transfer mode towards globular and onto short-circuit transfer.

In the short-circuiting mode, a 50-80% argon with a balance of CO2 is suitable for thinner materials, but moving to 100% CO2 provides greater penetration which is better for thicker sections.

If we consider the FCAW process, for an SFA-5.20 EXXT-1C or EXXT-1M, classification is made using CO2 gas. CO2 is a lower-cost gas option and can give good productivity, but can produce higher levels of spatter. Also, it limits the process for use out of position. Using Ar-CO2 mixes will improve usability, giving smoother arcs with less spatter and allowing use for out-of-position applications. Increasing the amount of Ar in the Ar-CO2 mixture will increase the manganese and silicon contents in the weld metal. The increase in manganese, silicon, or other alloys will increase the yield and tensile strengths and may affect impact properties.

Conclusion
The revised rules in ASME Section IX should permit more flexibility with shielding gas selection.

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Phil joined Hartford Steam Boiler in February 2022. He holds a Bachelor's degree in Metallurgy and a Master's degree in Welding Technology. He is a Chartered Engineer registered with the UK Engineering Council, and holds an International Welding Engineer diploma.

Prior to joining HSB, Phil worked for a major power company providing welding and materials support for large industrial boiler projects, as well as QA management for Code Certification of Authorization. Within Codes and Standards, Phil provides technical support and training in the areas of welding and fabrication for boilers and pressure vessels.

Phil is also very active on ASME Boiler and Pressure Vessel Committees. He currently serves as the Vice Chair for Subgroup Fabrication & Examination of Section I, Member SG Materials – BPV I, Member Section I Executive Committee, Member of Section IX SG General Requirements and BPV IX Committee. Phil is also a member of two NBIC committees, Subcommittee Repairs & Alterations and Task Group Interpretations.

Ask the engineer!

Author: Sandy Babka, Principal Engineer, Codes & Standards

Question: What is a vapor or distribution belt?

Response: Generally, the ASME Boiler and Pressure Vessel Code (BPVC) associates either a "vapor belt" or "distribution belt" (hereinafter "belt") with fixed tubesheet heat exchanger designs. A belt is a chamber with a larger diameter than the shell that it surrounds. From the outside of the shell of the heat exchanger, the belt would resemble an Appendix 9 Type 1 jacket. However, inside, it is open to the shell section by holes or slots in the shell. Usually, there is still some shell material remaining. The amount of shell material that remains is critical when determining if the chamber is acting like a jacket or as an expansion joint. BPVC, Section VIII, Division 2, 4.18.3(d) (for both Division 1 or 2 as of the 2023 Edition) addresses how to design the component and how it affects the exchanger;

(1) if there is still enough shell material in between the holes or slots that can carry the axial stress of the exchanger, then the vapor belt behaves like a jacket. It is calculated using Appendix 9 or 4.11, depending on whether this is a Division 1 or Division 2 vessel.

(2) if there is not enough shell material remaining between the holes/slots to carry the axial stress, then the vapor belt behaves like a flexible shell element expansion joint. The component is calculated using Appendix 5 or 4.20, depending on whether this is a Division 1 or Division 2 vessel. The design of the heat exchanger in 4.18.8 also needs to take into account the stiffness/spring rate of the expansion joint.

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Sandy joined HSB in 1993. He is a Registered Professional Engineer and holds a Bachelor of Science degree in Mechanical Engineering from Worcester Polytechnic Institute. He holds a National Board of Boiler & Pressure Vessel AI and IS Commission. Since joining HSB he has worked in the Pressure Equipment Technology Group, the Insurance Inspection Services Division as a Boiler and Machinery Inspector, and has been in the Codes & Standards group since 1998. Since 2008 he has been the Design Manager for design review activity involving pressure equipment exported to countries such as Australia, New Zealand, Malaysia, Singapore, Brazil, and India, as well as general Third Party for fee design reviews. In addition to this, he provides technical assistance for ASME Boiler and Pressure Vessel Non-Nuclear Codes as well as some International Standards and regulations.

Sandy is currently a member of the Committee on Pressure Vessels (BPV VIII), Subgroup on Design (BPV VIII), Subgroup on Heat Transfer Equipment (BPV VIII), Subgroup on Interpretations (BPV VIII), and Working Group on Plate Heat Exchangers (BPV VIII).

Take note!

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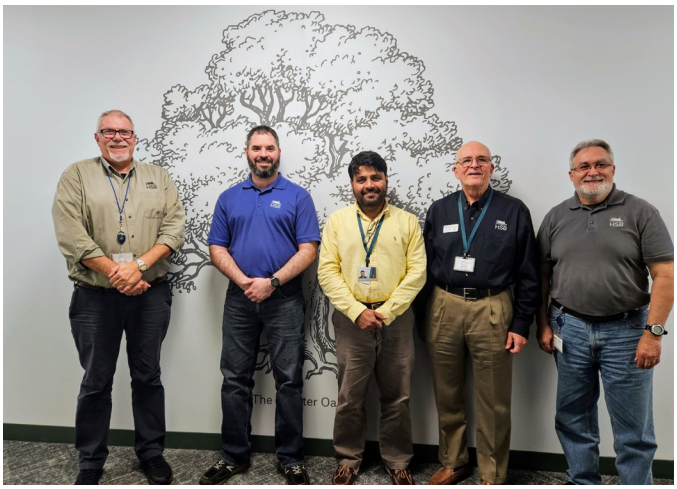

HSB Global Inspection and Engineering Services hosted the first Hartford Technical Training Seminar Series October 23-28 in our Hartford, CT home office. It was a very successful event where attendees were able to discuss various topics with our knowledgeable Codes & Standards staff including:

– ASME Nuclear Code and industry updates (including Advanced Reactors)
– ASME Section IX (2023 Edition)
– ASME 2023 Code Synopsis Sections I, II, V, VIII (Divisions 1 and 2)
– ASME Section VIII, Division 1 (2023 Edition)

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