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Understanding A-No. 1 filler metal chemistry requirements for ER70S-6 weld consumables in ASME Section IX

Author: Philip Gilston, Principal Engineer, Codes & Standards

Weld Consumable SFA-5.18/SFA-5.18M - ER70S-6

ER70S-6 electrodes are commonly used in welding applications requiring qualification to the ASME Boiler and Pressure Vessel Code, Section IX. ASME Section IX uses the A-number to classify ferrous weld metal chemistries for procedure qualification, and it is an essential variable. Since the A-number is an essential variable, it must be addressed on both the procedure qualification record (PQR) and welding procedure specification (WPS).

"A-Number 1" (A-No. 1) is commonly specified for welding mild steels and has maximum limits for manganese (Mn) of 1.60% and silicon (Si) of 1.0% in accordance with Table QW-442 in ASME Section IX 2023 Edition.

SFA-5.18/SFA-5.18M Classification ER70S-6 is often identified on Welding Procedure Specifications (WPSs) and Procedure Qualifications Records (PQRs) as A-No. 1 for filler metal chemistry per ASME Section IX Table QW-442. However, in classification ER70S-6 in the editions of AWS A5.18 and SFA-5.18, preceding 2021 and 2023, respectively, the permitted manganese and silicon ranges exceed those allowed for assignment as "A-No. 1."

Historically, if the user wanted to list ER70S-6 as an A-No. 1 weld metal on the PQR and WPS, then this could be addressed in one of two ways:

1. Do not specify an A-number, list the ER70S-6 classification. The final paragraph of QW-404.5 permits this, stating: "Designation of nominal chemical composition may also be by reference to the AWS classification."
   - If you follow this option, welding documents are restricted to the use of ER70S-6 weld wire only.

2. If the chemistry of the lot of weld wire for ER70S-6 was determined to meet the requirement of A-No. 1 by the acceptable means as prescribed in Section IX QW-404.5, then this may be stated on the PQR and WPS. However, in this case, controls for the purchasing of the welding wire will need to be established to ensure that the Mn and Si limits are met. This approach is permitted in other Code Sections; for example, in Section I, Tables PW-39, when a chemistry limit is invoked, it typically states: "...except when further limited by the Purchaser to a value within the specification limits."
   - If you follow option 2, then by assigning A-No. 1, other wires meeting the same F-No. and A-No. may be permitted for other WPSs.

AWS A5.18/A5.18M:2021 and ASME SFA-5.18/SFA-5.18M 2023, New Optional, Supplemental Designator

The latest edition of AWS A5.18/A5.18M:2021, *Specification for Carbon Steel Electrodes and Rods for Gas Shielded Arc Welding*, contains a new, optional, supplemental designator "A." This AWS specification is adopted in the 2023 edition of Section II Part C as SFA-5.18/SFA-5.18M.

When used as an option in the supplemental designator, the letter "A" (e.g., ER70S-6A) indicates that an electrode of this classification meets all requirements for classification as ER70S-6 as well as chemistry limits for manganese and silicon for assignment as A-No. 1 per Section IX Table QW-442.

Moving forward, an organization wishing to use ER70S-6 as an A-No. 1 filler metal can update the WPS and purchase ER70S-6A to ensure the chemistry requirements are met per the rules of Section IX.

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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.

Impact test striker radius in material testing: ISO 148 vs. SA-370

Author: Alex Garbolevsky, Senior Engineer, Codes & Standards

The question has been raised whether it is acceptable to use a 2 mm impact test striker radius rather than an 8 mm. A 2 mm striker radius is permitted under ISO 148; however, 2 mm is the only striker radius permitted in SA-370.

Since ASME Code Section VIII, Division 1, 2023 Edition, para. UG-84(b)(1) allows the use of either ISO 148 or SA-370 for compliance, the choice is a matter of contractual agreement between the vessel manufacturer and the material manufacturer. Technical literature provides evidence that there is no significant difference in absorbed energy values until they are above approximately 217 J. The choice of striker radius should be guided by a balance of safety, regulatory compliance, and technical feasibility.

In material testing, even seemingly intricate details like impact test striker radius can carry significant implications. A common query in this domain revolves around the acceptability of using a 2 mm impact test striker radius as opposed to the more conventional 8 mm radius. While ISO 148 permits the former, SA-370 mandates the latter. To some, this may raise concerns relating to compliance, contractual agreements, and the technical validity of such choices.

The choice of impact test striker radius holds relevance in various industries, particularly in contexts where materials are subjected to impact loading. ISO 148, an international standard for metallic materials – Charpy V-notch impact test, allows for the use of a 2 mm radius striker. On the other hand, SA-370, a specification within the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, stipulates the use of an 8 mm radius striker.

The problem arises when ASME Code Section VIII, Division 1, UG-84(b)(1) permits the use of either ISO 148 or SA-370 for compliance. This presents a contractual agreement matter between the vessel manufacturer and the material manufacturer. The decision rests on factors such as industry standards, contractual obligations, and technical feasibility.

From a technical perspective, research and technical literature has provided insights into the impact of striker radius on absorbed energy values. Surprisingly, studies have shown that there is no significant difference in absorbed energy values until reaching approximately 217 joules. This finding suggests that within certain energy thresholds, the choice of striker radius may not drastically affect test outcomes or material performance assessments.

However, it is essential to consider the broader implications of diverging from established standards such as SA-370. While ISO 148 may offer flexibility in striker radius, adherence to industry-specific standards like SA-370 may be necessary for regulatory compliance, contractual obligations, or industry best practices.

Furthermore, the choice between impact test striker radii should be informed by a comprehensive understanding of the material properties, intended application, and regulatory requirements. Deviations from standard practices should be carefully evaluated, considering potential implications on safety, performance, and regulatory compliance.

The debate surrounding impact test striker radius underscores the complexities inherent in material testing and compliance. While ISO 148 offers flexibility, adherence to industry-specific standards like SA-370 may be warranted in certain contexts. Ultimately, the decision should be guided by a balance of technical feasibility, regulatory compliance, and industry best practices to ensure the integrity and safety of materials in various applications.

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Alex joined HSB in 1979, after serving in the U.S. 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, Alex 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. Alex holds National Board “AI” and “IS” Commissions with “B,” “I,” “N,” “NS,” and “R” endorsements. From 1993 to 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.

Ask the engineer

Author: Julie Hoskinson, Senior Engineer, Codes & Standards

Q: According to Section VIII, Division 1, Figure UCS-66 Note (2)(a), an SA-105 custom flange with fine grain practice and normalized heat treatment is assigned to Curve B. However, Note (3)(b) states that all materials listed in Note (2)(a) for Curve B, when produced to fine grain practice and normalized, may be assigned to Curve C. Can this flange, meeting the criteria described above, be assigned to Curve C?

A: SA-105 forged flanges cannot be assigned to Curve C under any circumstances. Currently, SA-105 (as forged) is assigned to Curve A. When supplied with fine grain practice and normalized heat treatment, SA-105 flanges are upgraded to Curve B under Note (2)(a). It is important to note that only one curve upgrade is permitted, a point addressed in several Interpretations available through our Front Door customer portal:

BPV VIII-1 - RN15-951
https://hsbfrontdoor.com/content/munichre/hsbgrp/technical-resources/en/dashboard/code-interpretations/11e19b1519e8bcf085258035004b56ff.html

VIII-1-92-122
https://hsbfrontdoor.com/content/munichre/hsbgrp/technical-resources/en/dashboard/code-interpretations/ae50add3c1ad6e5e8525665d0061731d.html

VIII-1-92-142
https://hsbfrontdoor.com/content/munichre/hsbgrp/technical-resources/en/dashboard/code-interpretations/331f2a08b83cb24b8525665d006161d1.html

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Julie joined HSB in 2006 and has been part of the Codes & Standards group since 2014. She has been successful in several different roles within the company starting as a project manager serving several of HSB's largest customers and supporting their international pressure equipment inspection and certification needs. In 2009, Julie completed a temporary assignment as the design manager for the HSB International design office in Socx, France. Beginning in August 2011, Julie worked as a program manager responsible for DOT/Transport Canada Cylinder and Cargo Tank Inspections and European Pressure Equipment Directive (PED) Services, including managing two major transitions of the HSB Notified Body.

Julie is a graduate of the University of Minnesota with a B.S. in chemical engineering and is pursuing an M.S. in material science and engineering from University of Florida. She is a National Board of Boiler and Pressure Vessel Commissioned Inspector, holding an "AI" and "IS" Commission. Julie is currently chair of ASME BPV VIII Subgroup on General Requirements and chair of Task Group Fired Pressure Vessels. She provides technical support and training on ASME Boiler and Pressure Vessels Codes and other international pressure equipment regulations/standards, including the Pressure Equipment Directive.

Take note!

It is important to give recognition where recognition is due.

The Melvin R. Green Codes and Standards Medal recognizes outstanding contributions to (1) the development, promulgation, or management of documents, objects, or devices used in ASME programs of technical codification, standardization, and conformity assessment, or (2) the acceptance of ASME Codes and Standards within the United States or internationally.

This medal was established in 1976 as the Codes and Standards Medal and renamed the Melvin R. Green Codes and Standards Medal in 1996 to honor the memory and extraordinary contributions of Melvin R. Green, an ardent supporter of industrial standards. He was a past recipient of the Codes and Standards Medal, an ASME Fellow, and a longtime employee of the Society.

This year's award was presented to HSB's very own Jay Cameron, P.E., at the 2024 ASME Boiler and Pressure Vessel Code Week in Scottsdale, Arizona, by Thomas Costabile, executive director/CEO American Society of Mechanical Engineers.

"Jay's contributions to the preservation and advancement of engineering codes and standards are quite significant, and his dedication to ASME (The American Society of Mechanical Engineers) is very much appreciated!", said Thomas Costabile.

Jay Cameron joined HSB in 1992 providing technical assistance for all non-nuclear ASME Boiler and Pressure Vessel Codes and the National Board Inspection Code (NBIC), while also supporting clients with design reviews. His technical expertise is in pressure vessel design and repair, stress analysis, and materials.

Jay currently serves as a member of BPV II (Materials), Subgroup on Materials (BPV VIII), and Special Committee on Interpretations (BPV VIII). He has presented courses on pressure vessel design and materials to audiences around the world.

Thank you, Jay, for your service and dedication to the industry.

Events calendar

2024 virtual technical training seminar topics – click here to register

July 19&20	ASME Section VIII, Division 1 (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 industry events

August 7-9	The Woodlands, TX	Welding Summit 2024 (Booth #TBD)	click here for more information

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