EPRI | ELECTRIC POWER RESEARCH INSTITUTE

Guidelines for Using a Single Weld Qualification Code in Nuclear Power Plant Applications

2013 TECHNICAL REPORT

Guidelines for Using a Single Weld Qualification Code in Nuclear Power Plant Applications

This document does NOT meet the requirements of 10CFR50 Appendix B, 10CFR Part 21, ANSI N45.2-1977 and/or the intent of ISO-9001 (1994).

EPRI Project Manager
D. Couch

ELECTRIC POWER RESEARCH INSTITUTE

3420 Hillview Avenue
Palo Alto, CA 94304-1338
USA

PO Box 10412
Palo Alto, CA 94303-0813
USA

800.313.3774
650.855.2121

askepri@epri.com

www.epri.com

3002000618
Final Report, August 2013

DISCLAIMER OF WARRANTIES AND LIMITATION OF LIABILITIES

THIS DOCUMENT WAS PREPARED BY THE ORGANIZATION(S) NAMED BELOW AS AN ACCOUNT OF WORK SPONSORED OR COSPONSORED BY THE ELECTRIC POWER RESEARCH INSTITUTE, INC. (EPRI). NEITHER EPRI, ANY MEMBER OF EPRI, ANY COSPONSOR, THE ORGANIZATION(S) BELOW, NOR ANY PERSON ACTING ON BEHALF OF ANY OF THEM:

(A) MAKES ANY WARRANTY OR REPRESENTATION WHATSOEVER, EXPRESS OR IMPLIED, (I) WITH RESPECT TO THE USE OF ANY INFORMATION, APPARATUS, METHOD, PROCESS, OR SIMILAR ITEM DISCLOSED IN THIS DOCUMENT, INCLUDING MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, OR (II) THAT SUCH USE DOES NOT INFRINGE ON OR INTERFERE WITH PRIVATELY OWNED RIGHTS, INCLUDING ANY PARTY'S INTELLECTUAL PROPERTY, OR (III) THAT THIS DOCUMENT IS SUITABLE TO ANY PARTICULAR USER'S CIRCUMSTANCE; OR

(B) ASSUMES RESPONSIBILITY FOR ANY DAMAGES OR OTHER LIABILITY WHATSOEVER (INCLUDING ANY CONSEQUENTIAL DAMAGES, EVEN IF EPRI OR ANY EPRI REPRESENTATIVE HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES) RESULTING FROM YOUR SELECTION OR USE OF THIS DOCUMENT OR ANY INFORMATION, APPARATUS, METHOD, PROCESS, OR SIMILAR ITEM DISCLOSED IN THIS DOCUMENT.

REFERENCE HEREIN TO ANY SPECIFIC COMMERCIAL PRODUCT, PROCESS, OR SERVICE BY ITS TRADE NAME, TRADEMARK, MANUFACTURER, OR OTHERWISE, DOES NOT NECESSARILY CONSTITUTE OR IMPLY ITS ENDORSEMENT, RECOMMENDATION, OR FAVORING BY EPRI.

THE FOLLOWING ORGANIZATION, UNDER CONTRACT TO EPRI, PREPARED THIS REPORT:

Flenner Engineering Services, LLC

THE TECHNICAL CONTENTS OF THIS DOCUMENT WERE **NOT** PREPARED IN ACCORDANCE WITH THE EPRI NUCLEAR QUALITY ASSURANCE PROGRAM MANUAL THAT FULFILLS THE REQUIREMENTS OF 10 CFR 50, APPENDIX B AND 10 CFR PART 21, ANSI N45.2-1977 AND/OR THE INTENT OF ISO-9001 (1994). USE OF THE CONTENTS OF THIS DOCUMENT IN NUCLEAR SAFETY OR NUCLEAR QUALITY APPLICATIONS REQUIRES ADDITIONAL ACTIONS BY USER PURSUANT TO THEIR INTERNAL PROCEDURES.

NOTE

For further information about EPRI, call the EPRI Customer Assistance Center at 800.313.3774 or e-mail askepri@epri.com.

Electric Power Research Institute, EPRI, and TOGETHER…SHAPING THE FUTURE OF ELECTRICITY are registered service marks of the Electric Power Research Institute, Inc.

Copyright © 2013 Electric Power Research Institute, Inc. All rights reserved.

Acknowledgments

The following organization, under contract to the Electric Power Research Institute (EPRI), prepared this report:

Flenner Engineering Services, LLC
6537 Wyndham Dr.
Kalamazoo, MI 49009

Principal Investigator
P. Flenner

This report describes research sponsored by EPRI.

This publication is a corporate document that should be cited in the literature in the following manner:

Guidelines for Using a Single Weld Qualification Code in Nuclear Power Plant Applications.
EPRI, Palo Alto, CA: 2013.
3002000618.

Product Description

This report and the appended guideline provide the justification and direction needed to use American Society of Mechanical Engineers (ASME) Section IX welding qualifications for ASME applications and American Welding Society (AWS) structural applications.

Background

The use of multiple welding qualification codes has long been a problem for plants with different design codes. The most frequently followed welding qualification codes are those in ASME Section IX, Welding and Brazing Qualifications, and AWS D1.1, Structural Welding Code—Steel. However, several other codes could be used in nuclear power plants and other applications.

Objectives

Because AWS D1.1 allows other standards for welding qualifications with consideration of specific structure and/or service conditions, it can be said that the ASME Section IX welding qualifications meet the requirements of AWS D1.1 if the conditions are appropriately addressed. Although the regulatory requirements differ from the requirements for the balance-of-plant systems in nuclear power plants, the same approach can be taken with regard to welding qualifications for structures.

Approach

Our approach shows that ASME Section IX qualifications are appropriate for the structural applications; therefore, they become an acceptable alternative within AWS D1.1.

Results

The use of ASME Section IX welding qualifications is acceptable and allowed for structural welding within the rules of AWS D1.1, Structural Welding Code—Steel. The ASME Section IX approach is acceptable under the conditions set forth in this report. If the guideline contained in Appendix A is followed, the welding qualifications of ASME Section IX will meet the AWS D1.1 requirements.

Applications, Value, and Use

Owners and operators of nuclear power plants can adopt this report as a guideline to justify the use of a single welding qualification code rather than multiple codes.

Keywords

American Society of Mechanical Engineers (ASME)
American Welding Society (AWS)
Qualification
Single code
Weld

Abstract

The use of multiple welding qualification codes has long been a problem for plants with different design codes. The most frequently followed welding qualification codes are those in American Society of Mechanical Engineers (ASME) Section IX, Welding and Brazing Qualifications, and American Welding Society (AWS) D1.1, Structural Welding Code—Steel. However, several other codes could be used in nuclear power plants and other applications. Regulatory requirements are not consistently applied in that ASME Section IX might be required for any of the following:

- All safety-related applications
- ASME Boiler and Pressure Vessel Code and B31.1 applications only
- All safety-related applications, provided that the requirements of AWS D1.1 are met for the structural applications

Because AWS D1.1 allows other standards for welding qualifications with consideration of specific structure and/or service conditions, it can be said that ASME Section IX welding qualifications meet the requirements of AWS D1.1 if these conditions are appropriately addressed. Although the regulatory requirements differ from the requirements for the balance-of-plant systems in nuclear power plants, the same approach can be taken with regard to welding qualifications for structures.

- This report and the appended guideline provide the justification and direction needed to use ASME Section IX welding qualifications for ASME applications and AWS structural applications. Our approach shows that ASME Section IX qualifications are appropriate for the structural applications; therefore, they become an acceptable alternative within AWS D1.1.

Table of Contents

Section 1: Background 1-1

Section 2: Code and Regulatory Requirements 2-1
2.1 General.....2-1
2.2 Regulatory Requirements 2-1
2.3 ASME Section IX – Welding and Brazing Qualifications 2-3
2.4 AWS D1.1 Structural Welding Code – Steel.....2-4
2.5 Other Related Welding Qualification Codes.....2-6

Section 3: Engineering Technical Acceptance 3-1
3.1 Welding Procedure Qualification Approaches 3-1
3.2 Welder and Welding Operator Performance Qualification Requirements.....3-3
3.3 Materials and Design Considerations.....3-4
3.4 Fabrication and Examination Requirements.....3-5

Section 4: Conclusions 4-1

Section 5: Recommendations 4-1

Section 6: References 6-1

Appendix A: Guideline for Using ASME Section IX Qualifications for AWS D1.1 Welding..... A-1
Attachment 1 ..... A-2

Section 1: Background

This report may be used as a guideline by Owners and Operators of Nuclear Power Plants to justify the use of a single welding qualification code rather than multiple codes. The intent is to demonstrate that qualifications per the requirements of ASME Section IX [1] are adequate and justified for structural applications of welding within nuclear facilities and that these qualifications also meet the American Welding Society (AWS) D1.1 Structural Welding Code – Steel [2]. It is important to note that using ASME Section IX for welding qualifications for welds made in accordance with the AWS D1.1 Structural Welding Code does not mean that AWS D1.1 is not being met. The welding requirements are still valid; it is only the qualification of WPSs and the performance qualifications that may be done provided the engineer has accepted the use of ASME Section IX qualifications as being applicable to the structure and service required.

Section 2: Code and Regulatory Requirements

2.1 General

The qualifications of welding procedures and the performance qualification of welders and welding operators are done in accordance with a number of different codes or standards during the construction phase of a nuclear power plant. All of the construction codes used for pressure containing applications (including the ASME Boiler & Pressure Vessel Code (B&PV) and the ASME B31.1 Power Piping Code [3]) reference the ASME B&PV, Section IX, Welding and Brazing Qualifications as the standard for welding qualifications. ASME Section IX is also the qualification code referenced for welding required on component hangers and supports within the boundaries required by the ASME B&PV and ASME B31.1 Construction Codes. However, the primary structure designed in accordance with the American Institute of Steel Construction Steel Construction Manual [4] references AWS D1.1 for welding qualifications. Certain applications may have required the use of other welding qualification standards, but the vast majority of welding in an operating nuclear plant is done using welding qualifications in accordance with either ASME Section IX or AWS D1.1.

This report is intended to provide uniform justification for using ASME Section IX welding qualifications for nearly all welding within operating nuclear power plants, eliminating the need for duplicated welding qualification programs to address each code. This provides the approach that would justify using ASME Section IX welding qualifications for welding on either pressure containing components or structural components. It could be applied to develop a one-tiered approach for welding qualifications regardless of the requirements of the safety analysis report.

2.2 Regulatory Requirements

ASME B&PV Section XI [5], Paragraph IWA-4440(a) requires that "All welding shall be performed in accordance with Welding or Brazing Procedure Specifications that have been qualified by the Owner or Repair/Replacement Organization in accordance with the requirements of the codes specified in the Repair/Replacement Plan." Section XI, paragraph IWA-4221, also requires that the requirements of the original construction code or later editions of the original

construction code be met or reconciled to the design requirements. In addition, the Final Safety Analysis Report (FSAR) or the Updated FSAR (UFSAR) may specify the welding qualification codes that should apply within individual units of operating nuclear power plants. Surveys were done by the EPRI Repair and Replacement Applications Center (RRAC) [6][7]. It was determined that the FSARs and UFSARs have varying approaches to this issue. These are:

1. ASME Section IX shall be used for all welding qualifications
2. ASME Section IX shall be used for ASME B&PV and B31.1 applications and D1.1 shall be used for structural applications
3. ASME Section IX shall be used for ASME B&PV and B31.1 applications and D1.1 shall be used for structural applications. However ASME Section IX may be used in lieu of D1.1 if the requirements of D1.1 are met.

In at least one case, it was reported that the state law required the use of D1.1 for structural applications.

Nuclear Quality Assurance requirements include a criterion to control "special processes" where a special process is defined in ASME NQA-1 [8] as:

"*. . . a process, the results of which are highly dependent on the control of the process or the skill of the operators, or both, and in which the specified quality cannot be readily determined by inspection or test of the product.*"

This approach provides the real target of welding qualifications, whether they are done in accordance with ASME Section IX or AWS D1.1 (or any other code). ASME Section IX clearly separates the requirements for the qualification of WPSs (to prove the required properties will result) and the requirements for the qualification of personnel (to prove their ability to make sound welds using WPSs). AWS D1.1 is also primarily concerned with the same approach but adds some requirements for the WPS qualification that do not affect the resulting properties. AWS D1.1 also addresses issues other than welding qualifications.

The differences between welding qualification codes are largely the result of differences in the committees that write them as much as the different services they address. Even so, the differences may be accommodated by meeting all of the requirements of the multiple codes. This can be a difficult approach to follow however, since the differences (even though they are intended to accomplish the same result) do not always fit into the same criteria. A clearer approach is to provide engineering justification to use ASME Section IX welding qualifications in lieu of the AWS D1.1 welding qualifications, as permitted by AWS D1.1, paragraphs 4.2.1.2 and 4.2.2.1. The proposed Guideline (Attachment 1) provides the program requirements that are needed to achieve this.

2.3 ASME Section IX – Welding and Brazing Qualifications

ASME Section IX is a reference code in that it provides standard approaches for qualification of welding procedure specifications (WPS) and the performance qualification of welders and welding operators. It is specifically required by all of the ASME B&PV Codes and of the B31.1 Power Piping Code to provide direction for the welding qualifications needed for welding . The purpose of ASME Section IX is not to direct or specify the welding to be done but rather only to provide a standard approach to the qualification of WPSs and personnel. Construction codes such as AWS D1.1, ASME Section III or ASME B31.1 include direction on how the welds shall be made and examined.

ASME Section IX states that the purpose of welding procedure qualifications is to prove the ability to provide welds with the required mechanical properties. The variables for WPSs therefore are based on whether they could be expected to influence the mechanical properties of the weldment (essential variables) or if they only provide direction for making the weld (nonessential variables). There is also a third category of variables, supplementary essential variables, which are additional essential variables when the WPS is applied to materials required to meet specified impact toughness by the construction codes. All of the specified variables for each process are required to be included in the WPS. Only the values of the essential variables used during the procedure qualification form the basis of the properties of the weldment. The WPS qualification is done therefore, using mechanical tests to verify the desired properties have been achieved while using the set of parameters which reflect the essential variables. The desired properties are the minimum strength and ductility (and toughness if applicable) requirements for the material being welded.

Some AWS Standard Welding Procedure Specifications (SWPS) [9] have been accepted by ASME Section IX on a conditional basis (ASME Section IX currently accepts 33 SWPSs). The SWPSs that are listed as acceptable may be used only if an acceptable demonstration test is performed to show the ability of the organization to use them. These SWPSs may then be used instead of the traditional qualified WPSs if the applicable construction code allows their use.

Welder performance qualification is done in accordance with the rules of ASME Section IX in order to prove that the welder has the capability to produce sound welds following the requirements of the WPSs. The variables for performance qualification (all considered essential) are those that have been determined to affect the capability of the welder to make a sound weld.

ASME Section IX also provides for performance qualification of welding operators; personnel who operate machine or automatic welding equipment. The variables for welding operators of machine welding equipment are those parameters that the operator has the capability to change during the welding operation and which may therefore affect the soundness of the weld. Welding operators of automatic welding equipment (where the operator cannot change

the welding parameters during the welding operation) are qualified based only on a change in the welding process. The need for qualification is generally attributed to the set up and loading of the equipment prior to making the weld.

2.4 AWS D1.1 Structural Welding Code – Steel

The AWS D1.1 Structural Welding Code – Steel provides additional rules for welding joint design and acceptance of production welds as well as for welding qualification. The design of a structure is not included. This is a significant difference between the AWS D1.1 Code and ASME Section IX. This guideline only deals with the qualification aspects of the AWS D1.1 Code and the qualification requirements of the ASME Section IX Code.

The basic approach used by the AWS D1.1 Code regarding welding qualifications is basically identical to that in ASME Section IX (i.e., those WPSs are qualified to prove that adequate properties are achieved and that personnel performance qualifications are done to prove the welder's ability to deposit sound welds). However, there are differences in the variables and in the testing requirements between the two codes. WPS qualification in accordance with AWS D1.1 is slightly more restrictive than it is in ASME Section IX. There are nondestructive examinations required in addition to the mechanical testing. There are also cross section macro examinations for the partial joint penetration (PJP) joint types, if used.

However, AWS D1.1 allows extensive use of WPSs that have not been specifically qualified by the employer of the welder or even qualified at all. These are of two different types - prequalified WPSs and AWS Standard Welding Procedure Specifications (SWPSs). Prequalified WPSs are exempted from the qualification tests that are required for other WPSs. A written WPS must be generated by the user but no qualification by testing is required. SWPSs are developed by the AWS B2 Committee and are available for purchase from the AWS. The rules that apply to the prequalified WPSs and SWPSs follow.

Prequalified WPSs may be used for AWS D1.1 applications when they meet the requirements. The requirements are imposed by D1.1 Section 3 Prequalification of WPSs. There are some very specific limitations. The welding processes are limited to SMAW, SAW, GMAW (except short circuiting), and FCAW. The joint designs are further limited with limitations on process, specific joint types, joint dimensions, material thicknesses, positions, and weld sizes (that may be used in the design). If all of the conditions set for prequalified WPSs are met, AWS D1.1 does not require qualification of the WPS. These conditions are explicitly described in paragraph references within Annex Q of AWS D1.1. While the specific references are extensive, many of them are good practices for welding that are addressed within WPSs qualified per ASME Section IX. Other details relate to the weldment design.

Most of the SWPSs are not qualified since there are no procedure qualification records showing tests with the specific SWPS. The SWPS is justified based on a number of procedure qualification records contributed by the industry. The

majority of the procedure qualification records (PQR) that were used for the plate and pipe application SWPS were ASME Section IX PQRs. As stated earlier, all of the SWPSs that are applicable to AWS D1.1 welding may be accepted based on consideration of the specific structure and service conditions (these are the same conditions which would be required when ASME Section IX welding qualifications would be used). The SWPSs are based on a set of procedure qualification records so they are based on external proof that the properties of the weldment are acceptable rather than being specifically qualified.

SWPSs are very specific and if used, must be followed without deviation and with the additional requirement that the applicable construction code must also be followed. SWPSs have been created by the AWS to provide direction to the following:

- Carbon Steel - Plate or Pipe
- Carbon Steel - Primarily Pipe Applications
- Carbon Steel Sheet Metal
- Austenitic Stainless Steel - Plate or Pipe
- Austenitic Stainless Steel – Primarily Pipe Applications
- Austenitic Stainless Steel – Sheet Metal
- Aluminum Sheet Metal
- Chromium-Molybdenum Steel

The SMAW, GTAW, GMAW, and FCAW processes are used in these SWPSs, although not all are applied to each category. SWPSs are also qualified for the as-welded and the post weld heat treated conditions as applicable for the materials and thicknesses being welded.

As stated, all of the SWPSs published by the AWS are accepted by AWS D1.1 if they are applicable (ASME Section IX only accepts some of the AWS SWPSs). There is no additional demonstration test required by AWS D1.1. It should be noted that AWS SWPSs are very closely aligned with ASME qualified WPSs since the information gathered for the development of the SWPSs was primarily procedure qualification records (PQRs) resulting from ASME WPS qualification.

Performance qualification for welders, welding operators, and tack welders is required by AWS D1.1. The intent is stated to be the same as the intent in ASME Section IX, which is to determine the ability of the personnel to produce sound welds. Again, there are differences in the variables and the testing requirements between the two codes, with the AWS D1.1 Code slightly more restrictive.

The AWS D1.1 Code allows qualification in accordance with other standards, both for WPSs and for personnel. There are no specific rules on how this is to occur but it is left up to the Engineer. The only requirements are to consider the specific structure and/or service conditions.

AWS D1.1-2010 states:

"***4.2.1.2 WPS Qualification to Other Standards.*** *The acceptability of qualification to other standards is the Engineer's responsibility, to be exercised based upon the specific structure, or service conditions, or both. AWS B2.1.XXX-XX Series on Standard Welding Procedure Specifications may, in this manner, be accepted for use in this code.*"

And:

"***4.2.2.1 Previous Performance Qualification.*** *Previous performance qualification tests of welders, welding operators, and tack welders that are properly documented are acceptable with the approval of the Engineer. The acceptability of performance qualification to other standards is the Engineer's responsibility, to be exercised based upon the specific structure, or service conditions, or both.*"

Additionally, the Commentary Section of AWS D1.1 also states:

"C-4.2.2.1 Previous Performance Qualification. *Standards other than D1.1 have welder and welding operator qualification tests that are similar or even identical to those required by this standard. This provision allows the Engineer to accept other qualification tests if in his/her judgment, the skills measured by these alternate tests are essentially the same as the tests prescribed by this code. For example, AWS B2.1, Specification for Welding Procedure and Performance Qualification, as well as the ASME Code, may be used in this manner for qualification of welding personnel. … The engineer is assigned the responsibility of determining the acceptability of qualification to other standards as there are differences between these standards, and such differences may be significant, depending on the specific structure, or service conditions, or both.*"

AWS D1.1 covers a limited range of base materials – carbon or low-alloy steels with specified yield strengths less than 100 ksi and with thicknesses greater than 1/8 inch. As with most welding qualification codes, the materials are grouped in order to reduce the number of qualifications required.

2.5 Other Related Welding Qualification Codes

ASME Section IX and AWS D1.1 are not the only welding qualification codes that are used within nuclear power plants but they do provide the qualification rules for the vast majority of the welds made, particularly within an operating plant environment. Experience has shown that welds are made in a number of

applications where the ASME B&PV or the AISI Steel Construction Manual construction codes do not apply and the materials used do not lend themselves to typical Section IX qualification. Examples include:

- Sheet metal such as used in HVAC systems
- Coated or plated structural sheet metal such as often used in cable tray supports
- Armor plate such as used in security doors
- Aluminum buss bars
- Concrete reinforcing bars
- Internal pump components

When welding is required on applications such as these, the construction codes that apply, if any, should be followed for the qualification. If there is no specific construction code or design specification that specifies the qualification requirements, then ASME Section IX rules are appropriate for guidance on meeting the quality program criterion on "Control of Special Processes".

While not directly required by codes that are used in nuclear power plants, AWS B2.1:2000 [10], Specification for Welding Procedure and Performance Qualification, is a national standard that is closely aligned to ASME Section IX in its approach and requirements for qualification. It is also a basis document for the AWS B2.1.XXX-XX SWPSs. It is specifically referenced as an alternate standard for WPS qualifications in AWS D1.1. Also, in the 2010 edition of AWS D1.1, both the AWS B2.1 specification and the ASME code are specifically referenced within the Commentary as welder and welding operator qualification standards that may be considered for acceptance to meet the requirements of D1.1.

The National Board Inspection Code (NBIC), NB-23, [11] has also accepted the use of SWPSs for repair applications (particularly applicable in balance of plant applications in states where the NBIC is required) as an alternative to ASME Section IX qualified WPSs. No demonstration test is required by NB-23.

Section 3: Engineering Technical Acceptance

Engineering technical acceptance is needed to use ASME Section IX welding qualifications for AWS D1.1 applications. When the NRC approved FSARs or UFSARs require only ASME Section IX welding qualifications for nuclear safety related applications, the need for this engineering acceptance is clear. Plants may also wish to use a single tiered (ASME Section IX) approach when both AWS D1.1 and ASME Section IX welding qualifications are specified for nuclear safety related applications and for balance of plant applications. This section is intended to provide a basis for that engineering technical acceptance.

In order to use ASME Section IX welding qualifications for D1.1 Code applications, the requirement which must be met is that imposed by AWS D1.1 that the Engineer must determine the acceptability of welding qualifications per other standards based on the specific structure or service condition. It is therefore only necessary to show that ASME Section IX welding qualifications are applicable to the specific structures or service conditions while maintaining the design imposed by AWS D1.1. Once this is done, the ASME Section IX welding qualifications may be accepted within the rules of AWS D1.1 and any regulatory or design requirement to use both ASME Section IX and AWS D1.1 would be met. This is essentially no different than the application of ASME Section IX welding qualifications to any of the ASME construction codes in that the design requirements must still be met. When the item is considered to be a structural component, the rules for structural design and acceptance would still be followed but the welding could be done using WPSs and welder/welding operator qualifications following ASME Section IX. It bears repeating that the acceptance by the engineer for welding qualifications done to a different standard than AWS D1.1 is acceptable to the AWS D1.1 Code, rather than a deviation from it.

3.1 Welding Procedure Qualification Approaches

As stated previously, the primary purpose of WPS qualification is to prove that the weld will have satisfactory properties, regardless of the qualification code being used. The default approach (and the approach typically used by ASME Section IX) is to run tests on sample welds to show that the required properties can be achieved. However, both ASME Section IX and AWS D1.1 allow some exceptions to the requirement to qualify a WPS, avoiding the need to run the

qualification tests. As stated earlier, ASME Section IX also has accepted some of the AWS SWPSs based on a technical and administrative review. When SWPSs are used rather than the qualified WPSs of ASME Section IX, a demonstration test is required of the user. This is not a qualification requirement but rather is a proof of the user's ability to follow the SWPS. AWS D1.1 also allows the use of specific WPSs which do not require qualification at all such as prequalified WPSs and SWPSs which were described in section 2.

ASME Section IX is not specifically listed by AWS D1.1 as an alternate standard for WPS qualification. However, the fact that both AWS D1.1 and ASME Section IX accept the use of SWPSs without further qualification is evidence that a bridge has been established between the AWS D1.1 and the ASME Section IX requirements (i.e., if A = B, and C = B, then A = C).

While this comparison addresses differences in the qualification testing and the ranges qualified, there are exceptions to what the qualification covers. Qualified WPSs in accordance with ASME Section IX include base material groups called P Nos. based on weldability. Any material used for qualification will provide qualification for any other material contained in the same P No. (With additional limitations required for impact tested materials). However, not all of the materials used for structural applications are contained within the ASME Section IX P Nos. The result is that a special WPS qualification would be required to use a Section IX WPS for that unlisted material. While this is a potential problem, there are very few materials used for power plant structures that are not listed in ASME Section IX with a P No. Even for the structural materials that do not have P Nos., ASME nuclear Code Case N-71 [12] assigns P No. equivalents called S Nos. to a long list of structural grade materials used for hangers and supports. This Code Case has been conditionally accepted by the NRC Regulatory Guide 1.84 [13]. The conditions of acceptance listed for this Code Case do not restrict the use of ASME Section IX for welding qualifications. In addition, Code Case N-71 requires the use of ASME Section IX for welding qualifications by a required reference to ASME Section III, Subsection NF.

ASME B31.1 references Manufacturing Standardization Society's standard MSS-SP-58, Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation [14] for structural hangers and supports used for B31.1 piping applications. This document also provides for structural materials other than those listed for piping. Code Case N-71 is referenced as a source of P No. (S No.) assignments within MSS-SP-58. Welding qualifications are required to be done using ASME Section IX but AWS D1.1 is allowed as an alternative.

A second issue is the need to meet all of the design requirements of AWS D1.1. This is no different than the need to meet the design requirements of any specific construction code (e.g., ASME Section III, ASME B31.1). For example, since the welds made in ASME applications are most often full penetration butt joints, the WPSs written for them are not likely to adequately cover achieving the depth of penetration required for structural partial joint penetration welds. The depth of penetration for partial penetration welds are covered within the joint details of

AWS D1.1, Figure 3.3. Other issues may be the requirements for filler metal strength and fatigue design. It is always necessary for the designer to be specific in establishing the design criteria required to be met by the fabrication.

For those plants that are allowed to use the AWS D1.1 code for their structural welds, often they have used only AWS D1.1 prequalified WPSs for structural welding. Although the use of SWPSs is a more recent development within both AWS D1.1 (and in ASME Section IX), this would provide another avenue for WPSs that do not require qualification. More materials are contained in the AWS B2.1 weldability groups (called M/P/S Nos.) than in ASME Section IX P No. groups. The use of either prequalified WPSs or applicable SWPSs would make the need to use ASME Section IX qualified WPSs unnecessary for structural welding, except where such procedures are not available. This alternative for structural welds may not be available if ASME Section IX welding qualifications are required or if the plant desires to use a single tiered approach to welding qualifications.

3.2 Welder and Welding Operator Performance Qualification Requirements

As stated earlier, the purpose of welder and welding operator qualification is to demonstrate the ability of the person to make sound welds using an acceptable WPS. Also, similar to the requirements for WPS qualification, AWS D1.1 permits the qualification of welders and welding operators in accordance with other standards, based on the specific structure and service conditions (paragraph 4.2.2.1 and C-4.2.2.1 in AWS D1.1). This was discussed previously in Section 2.

One performance qualification test difference in AWS D1.1 is a requirement to qualify welders in a special test configuration for T, K, and Y structural weldments. This test includes a ring adjacent to the joint which restricts the welder's access. While ASME Section IX (or AWS B2.1) does not require this type of test, the AWS D1.1 requires the consideration of the specific structure and service conditions. Therefore, this should be considered when access concerns exist for welders. Two requirements drive this consideration for ASME Section IX qualified welders in a nuclear plant. One, ASME Section IX, paragraph QW-322.1(b) states:

"(b) When there is a specific reason to question his ability to make welds that meet the specification, the qualifications that support the welding he is doing shall be revoked."

Two, the NRC Regulatory Guide RG 1.71, Welder Qualification for Areas of Limited Accessibility [15], requires consideration of access conditions and may require special welder qualifications when those conditions are restrictive. (Not all plants are committed to following RG 1.71 specifically but access conditions need to be considered.)

These access restrictions would therefore need to be considered within the rules for ASME Section IX qualifications as well as AWS D1.1.

Welding operators are defined as personnel who may operate machine or automatic welding equipment. Welding Operator qualification is rarely applied for structural welding within an operating nuclear plant but it may be needed frequently during shop fabrication of structural components. Should welding operator qualification be needed for structural applications, the same approach would be used to justify using ASME Section IX qualification as an alternative to AWS D1.1 qualification.

3.3 Materials and Design Considerations

The required AWS D1.1 consideration for specific structure and service conditions applies to those design assumptions that are inherent with the welding qualifications. As stated previously, WPS qualification is done to determine that the needed properties will result from the welding and welder/welding operator qualification is done to determine that the weld will be sound. These are design assumptions that need to meet the requirements of the design code for the particular structure or service condition being considered. While the ASIC Steel Construction Manual would address the overall structural design, AWS D1.1 addresses the design of the weld joint. Included in this design are weld size requirements, effective throat calculations, weld strength requirements, weld joint design, and material considerations (such as material strength, toughness, specification, etc.). These design requirements must be met during the production welding and within the range of the welding qualifications in order to support the assumptions made by the designer.

The design assumptions that are most affected by the welding qualifications are the materials being welded, the properties of the weldment, and the soundness of the weld. The materials being welded are qualified within the weldability groups. The ASME Section IX Code groups base materials identified as P Nos. AWS D1.1 groups materials simply as Groups. In order to use ASME Section IX WPS qualifications, the P No. from ASME Section IX must contain the applicable D1.1 structural materials. Where there is no P No. identified, the WPS must be specifically qualified with that material. Where Code Case N-71 or MSS-SP-58 can be applied, the additional materials classified as S Nos. may also be welded. For ASME Section IX welder qualification, it is necessary to either be listed as a P No. or it shall be of a similar chemical composition to the P No. material.

The weld filler strength properties are generally required to be at least equal to the base metal strength for ASME applications and for structural applications where the tension direction is normal to the weld. This is more controlled by the selection of the filler to be used than by the qualification since the filler metals that are qualified may cover a wide range of base materials strengths. This is often more explicitly covered in the construction code rather than the welding qualification code. The designer needs to be specific about the required properties of the weld filler.

3.4 Fabrication and Examination Requirements

The soundness of the weld is primarily verified by the welder and welding operator qualification tests. However, each construction code has examination criteria that provide an additional check on the weld soundness. These examinations must be done in accordance with the construction code being used.

There may also be problems such as certain crafts that are not familiar with ASME Section IX and differences in the ranges within the WPS (e.g., the WPS may be qualified with a required PWHT only on heavy wall thicknesses but the structural application may not require it). These problems may be dealt with as exceptions to using only ASME Section IX welding qualifications or the ASME WPS can be qualified within the required ranges. Otherwise, it will be necessary to follow the WPS in the case where the WPS ranges may not allow the structural exceptions to the ASME rules.

Section 4: Conclusions

The use of ASME Section IX welding qualifications is acceptable and allowed for structural welding within the rules of AWS D1.1, Structural Welding Code – Steel. While some plants are required by the FSAR to use AWS D1.1 for structural welding, this does not require that the rules allowing other welding qualification standards are not valid. What is required is that the specific structure and the service conditions be considered when using other welding qualification standards. This is done by specifically following the design requirements of AWS D1.1 and addressing the access conditions (particularly for T, K, and Y type of joints) for the welder. The design requirements include issues such as filler metal strength requirements, effective throat requirements (for partial joint penetration welds), weld size, and joint design.

There could still be occasions where the ASME Section IX WPSs may not cover the materials being welded (i.e., no P No. assigned) in which case special WPS qualifications may be necessary. This is expected to be rare in nuclear power plants since the materials used are generally common materials that have existing P Nos. assigned by ASME Section IX. For those cases where P Nos. are not assigned, it may be possible to use the S Nos. assigned by Code Case N-71 or MSS-SP-58. The more likely problems with only having an ASME Section IX program are those occasions where codes other than ASME Section IX or AWS D1.1 would apply. This may include structural sheet steel (less than 1/8 inches thick) and some equipment.

Although ASME Section IX WPSs can be used on structures covered by AWS D1.1, an alternative would be to use prequalified WPSs or Standard WPSs. These WPSs are already accepted for use in AWS D1.1 in lieu of qualifying the WPSs. Welder and welding operator qualification would still need to be done.

There are distinct benefits to maintaining only an ASME Section IX welding program for qualification in an operating plant. These benefits include avoiding duplication of welding programs, simplification of welding programs, and familiarity with qualification requirements. There will likely be exceptions where the existing WPSs or personnel qualifications will not apply but these are not expected to be frequent. There may also be problems such as overview acceptance, certain crafts that are not familiar with ASME Section IX, and differences in the ranges within the WPS (e.g., the WPS may be qualified with a required PWHT only on heavy wall thicknesses but the structural application may not require it). These problems may be dealt with as exceptions to using only ASME Section IX welding qualifications.

Section 5: Recommendations

The use of a single welding qualification approach is desired by many operating nuclear plants in order to reduce duplication of effort. In some cases this is a result of a regulatory requirement by reference in the UFSAR or FSAR for an operating nuclear plant. In either case, the ASME Section IX approach is acceptable under the conditions set forth in the guideline. If the guideline (attachment A) is followed, the welding qualifications of ASME Section IX will meet the AWS D1.1 requirements. The guideline addresses issues needed for consideration of the specific structure and service conditions. All of the pressure containing applications per the ASME B&PV Code and B31.1 require the use of ASME Section IX. The ASME Section IX welding qualifications may therefore be used as the single approach for most welding applications in an operating nuclear power plant.

Section 6: References

1. Section IX, Welding and Brazing Qualifications, ASME, 2010 with 2011 Addenda.
2. D1.1, Structural Welding Code – Steel, AWS, 2010.
3. B31.1, Power Piping Code, ASME, 2012.
4. Steel Construction Manual, American Institute of Steel Construction.
5. Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components, ASME, 2010 with 2011 Addenda.
6. Single Code Welding Program, RRAC Information Exchange, EPRI RRAC, 2003.
7. Discussion of ASME Section IX Qualifications for AWS D1.1 Structural Steel Applications, EPRI RRAC, 1999.
8. NQA-1, Quality Assurance Program Requirements for Nuclear Facilities, ASME, 2000.
9. B2.1.XXX-XX, Standard Welding Procedure Specifications, AWS, various dates.
10. B2.1, Specification for Welding Procedure and Performance Qualification, AWS, 2009.
11. NB-23, National Board Inspection Code, The National Board of Boiler and Pressure Vessel Inspectors, 2011.
12. Code Case N-71-18, "Additional Materials for Subsection NF, Class 1, 2, 3, and MC Supports Fabricated by Welding, Section III, Division I," ASME, Nuclear Code Cases, 2010.
13. Regulatory Guide 1.84, Rev. 35, "Design, Fabrication, and Materials Code Case Acceptability, ASME Section III", U.S. Nuclear Regulatory Commission, October 2010.
14. MSS-SP-58, Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation, Manufacturing Standardization Society, 2009.
15. Regulatory Guide 1.71, "Welder Qualification for Areas of Limited Accessibility", U.S. Nuclear Regulatory Commission, March 2007.

Appendix A: Guideline for Using ASME Section IX Qualifications for AWS D1.1 Welding

Attachment 1

GUIDELINE FOR USING ASME SECTION IX QUALIFICATIONS FOR AWS D1.1 WELDING

The American Welding Society Standard D1.1, Structural Welding Code – Steel, provides the requirements for welding qualifications, for welding procedure specifications (WPS) and welder/welding operator, for welding being done on structural components. The AWS D1.1 Code allows and accepts the use of welding qualifications in accordance with other standards, specifically ASME Section IX, Welding and Brazing Qualifications. The use of other standards for qualification is only acceptable if the Engineer bases his/her acceptance considering the effects on the specific structure and the service conditions. This guideline provides the direction needed for the Engineer to accept ASME Section IX welding qualifications for use with AWS D1.1 welds.

The designer must specify:

1. The base material to be used.
2. The weld size.
3. The effective throat of the weld if less than full penetration.
4. The weld joint design
5. The filler metal if specific strength levels or composition are required.

The ASME Section IX WPS must be qualified to weld:

1. The P No. or S No. (Ref. code Case N-71 or MSS-SP-58) of the structural material being welded or the specific material being welded.
2. Using the filler metal specified by the design.
3. On impact tested material if required by the design.
4. Within the ranges needed for the structural design (e.g., PWHT, base metal thickness, deposit thickness)

The ASME Section IX welder or welding operator must be qualified to weld:

1. Using the WPS that is being used.
2. Under the access conditions that are present.

The post weld examination and verification of the weld size and effective throat shall be in accordance with the AWS D1.1 Code.

Export Control Restrictions

Access to and use of EPRI Intellectual Property is granted with the specific understanding and requirement that responsibility for ensuring full compliance with all applicable U.S. and foreign export laws and regulations is being undertaken by you and your company. This includes an obligation to ensure that any individual receiving access hereunder who is not a U.S. citizen or permanent U.S. resident is permitted access under applicable U.S. and foreign export laws and regulations. In the event you are uncertain whether you or your company may lawfully obtain access to this EPRI Intellectual Property, you acknowledge that it is your obligation to consult with your company's legal counsel to determine whether this access is lawful. Although EPRI may make available on a case-by-case basis an informal assessment of the applicable U.S. export classification for specific EPRI Intellectual Property, you and your company acknowledge that this assessment is solely for informational purposes and not for reliance purposes. You and your company acknowledge that it is still the obligation of you and your company to make your own assessment of the applicable U.S. export classification and ensure compliance accordingly. You and your company understand and acknowledge your obligations to make a prompt report to EPRI and the appropriate authorities regarding any access to or use of EPRI Intellectual Property hereunder that may be in violation of applicable U.S. or foreign export laws or regulations.

The Electric Power Research Institute, Inc. (EPRI, www.epri.com) conducts research and development relating to the generation, delivery and use of electricity for the benefit of the public. An independent, nonprofit organization, EPRI brings together its scientists and engineers as well as experts from academia and industry to help address challenges in electricity, including reliability, efficiency, affordability, health, safety and the environment. EPRI also provides technology, policy and economic analyses to drive long-range research and development planning, and supports research in emerging technologies. EPRI's members represent approximately 90 percent of the electricity generated and delivered in the United States, and international participation extends to more than 30 countries. EPRI's principal offices and laboratories are located in Palo Alto, Calif.; Charlotte, N.C.; Knoxville, Tenn.; and Lenox, Mass.

Together...Shaping the Future of Electricity

Program:

Welding and Repair Technology Center

© 2013 Electric Power Research Institute (EPRI), Inc. All rights reserved. Electric Power Research Institute, EPRI, and TOGETHER...SHAPING THE FUTURE OF ELECTRICITY are registered service marks of the Electric Power Research Institute, Inc.

3002000618

Electric Power Research Institute
3420 Hillview Avenue, Palo Alto, California 94304-1338 • PO Box 10412, Palo Alto, California 94303-0813 USA
800.313.3774 • 650.855.2121 • askepri@epri.com • www.epri.com