Summary of Changes in

ASME Section IX, 2006 Addenda

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The following is a summary of the changes that appear in 2006 addenda of ASME Section IX. These changes and related discussion are reported by Walter J. Sperko, P.E., Vice-chairman of Subcommittee IX. Readers are advised that the opinions expressed in this article are those of Mr. Sperko and not the official opinion of Subcommittee IX. These changes became mandatory January 1, 2007.

Welding Procedure (QW-200) Changes

It has always been required that the organization that qualified a WPS or a welder certify the qualification records. Back around 1978, someone asked Subcommittee IX if that certification had to be by signature, and the answer was yes. These addenda recognizes that there are ways of certifying a document by means other than by signature. QW-103.2 has been modified to allow certification by signature *or by other means* as described in the manufacturer or contractor's Quality Assurance System. This would largely allow electronic or any other form of certification that one chooses to use as an alternative to signature. A certification statement similar to that found on forms QW-483 and QW-484 found in Non-mandatory Appendix B, however, still needs to be on qualification record regardless of the certification method.

QW-407.4, which governs the thickness of base metal qualified when the weld will be heat treated above the upper transformation temperature, has been revised to make life easier for non-metallurgist users of Section IX to specifically identify the materials to which this variable applies. Previously, the variable used the term "upper transformation temperature" with the intent that it only applied to steels that went through a solid-state phase change. It would not, therefore, apply to austenitic stainless steel such at type 304L since those materials do not go through any phase change during heating or cooling. However, some aluminum alloys can be heat treated above the upper transformation temperature during solutionizing, and QW-407.4 was never intended to apply to aluminum alloys. It has been revised to apply only to ferrous materials except for those that are classified as P-numbers 7, 8 or 45.

Impact Tested Qualifications

The first change is in QW-403.5 which deals with Group numbers. As we are already aware, Code materials are assigned P or S-numbers, and iron-based alloys are also assigned Group numbers. When impact-tested qualification of a WPS is required, QW-403.5 requires that testing be performed using materials from the same P-number and Group number as the material that will used in production. This revision clarifies that, if one has a WPS already qualified with impact testing using, for example, P-1, Group 1 material, one can add a additional PQR showing the same P-number material but a different group number such as P-1 Group 2. If the essential and supplementary essential variables are the same in both PQRs (except for the Group numbers), the WPS is qualified to weld not only P-1 Group 1 materials to themselves and P-1 Group 2 materials to themselves, but it is also qualified to weld P-1 Group 1 materials to P-1 Group 2 materials.

When welding P-11 materials (quenched and tempered high-strength low alloy steels), there has always been a requirement buried in QW-213 that, if thermal cutting or thermal backgouging is going to be used in production welding, those practices had to be included in the procedure qualification test coupon. QW-213 has been deleted in these addenda, but the requirement has been moved into the tables of variables in QW-250 as essential variable QW-410.64 for all processes. This should make it more obvious to users and less likely to be missed.

Heat input measurement has been traditionally measured using the heat input formula, V x A X 60/ Travel speed. Section IX, QW-409.1 provides control of the length of the weld bead per unit length of deposit (a real simple way to control heat input with SMAW) or bead size. While QW-409.1 has always permitted using bead size, it has never said that the bead size is measured by multiplying the width of the bead by the thickness of the bead; that has been clarified in these addenda.

Tube-to-tubesheet Welding

For those who build heat exchangers, Section IX has added rules to QW-193 for making tube-to-tubesheet welds. These rules are very similar to those found in Section VIII, Division 2, Article F-3 and identical to the rules in Section III, NB/C/D-4350.

Tube-to-tubesheet welding is qualified by welding ten mock-ups of the tube-to-tubesheet joints using the same geometry holes in the tubesheet and the same tube size and thickness as that to be used in production. Testing consists of performing liquid penetrant examination followed by cross-sectioning of each joint and examining it at 10X magnification for cracks or flaws. The minimum leak path (distance from the root of the weld to the surface nearest the root) must equal that required by the design or by the Construction Code, typically two-thirds of the tube thickness.

The new Section IX tube-to-tubesheet welding rules only become mandatory when the applicable Construction Code (Section VIII, Section III, etc.) invokes them. If they are not invoked, tube to tubesheet welds have to be qualified by groove or fillet weld testing. Both Sections VIII and III are proceeding to drop their rules for tube-to-tubesheet welding and will be referring to the Section IX rules in the future. Those accustomed to following the Section VIII rules should be aware that the Section IX rules have added current, current type and polarity, type of welding (manual, machine, etc.), diameter, progression, cleaning method and the addition of expansion prior to welding to the list of essential variables. Whether or not WPSs qualified under old Section VIII rules would be acceptable for new work once the Section IX rules are adopted by Section VIII would have to be addressed by Subcommittee VIII by inquiry. For welder and welding operator qualification, QW-305.5 specifies that the standard rules for groove and fillet weld qualification apply when the WPS is qualified by groove or fillet weld test, but if the WPS is qualified by mock-up, the welder or welding operator has to be qualified by mock-up.

High-performance Chromium Molybdenum Welding (e.g., Grade 91)

Those who work with Grade 91 and the other high-performance chromium-molybdenum (Cr-Mo) steels (grades 92, 911, etc) need to pay attention to two changes that have been made in the construction codes (Section I, PW-39, and B31.1, Table 132) regarding postweld heat treatment (PWHT) of these materials.

When joining the high-chromium alloys to lower-chromium alloys or carbon steel, carbon in the lower-chromium steels will migrate to the higher-chromium steel during PWHT. This will result in a soft zone in the lower chromium steel. The higher the PWHT temperature and the longer the joint is held at PWHT temperature, the more diffusion occurs and the bigger the soft zone becomes. While the minimum PWHT temperature for welds involving Grade 91 welded to itself have been raised, the PHWT temperature for dissimilar joints remains at 1300°F (705°C) to minimize this undesirable effect. To minimize the size of the soft zone, do not heat treat dissimilar metal joints at temperatures much over minimum, and don't hold them at temperature longer than required.

The second changes deal with PWHT when the 1425°F (775°C) upper temperature limit is exceeded as sometimes may happen due to errant thermocouples, power surge or temporary insanity by the operator. For most materials, such excursions have little consequence since the material properties return to practically their original condition when the material cools down. The worst case scenario for the old Cr-Mo steels -- the WPS might have to be requalified since the lower transformation temperature was exceeded. However, high-performance Cr-Mo steels develop their properties via normalizing and tempering; this results in the precipitation of the carbides that give these materials their superior elevated-temperature performance. If the lower transformation temperature is exceeded (it can be as low as 1450°F), the carbide matrix is destroyed and the material loses its elevated temperature strength. Since it is not possible to reform the normalized and tempered microstructure using local heating, it is necessary to cut out and replace the weld joint, including a minimum of 3 inches of base metal on each side of the joint that was overheated. Alternative solutions include normalizing and tempering of the entire assembly that includes the overheated joint or justifying use of the weld based on using properties of materials that do not achieve their performance by normalizing and tempering (e.g., using the allowable stress values for Grade 9 instead of those for Grade 91).

It is anticipated that B31.3 and Section III will also adopt what is described above, but they will undoubtedly have small differences, so be sure to follow the rules in the specific Code Section in which you are working. In addition, it is sound engineering practice to follow the Section I or equivalent rules for these materials even if one is not required to comply with them since the effects are so significant to the performance of the welds.

Temper Bead Welding

There have been additional tweaks to the rules for temper bead welding. While no construction code has invoked the Section IX temper bead rules, Section XI, *In-service Inspection for Nuclear Power Plant Components*, has proposed a Code Case allowing their use, and other Code Sections are in the process of adopting them with the National Board Inspection Code leading the way.

Grinding weld beads between layers addressed in QW-410.65 was expanded from simply allowing grinding to be used as a cleaning method to requiring that the same extent of grinding be used in production as was used in qualification. That is, if one ground a weld layer on a test coupon sufficiently to remove half the previous layer, or one ground enough to remove any ripples or if one ground just enough to clean the surface, that same technique must be specified in the temper bead WPS. The intent of this variable is to control the effective thickness of the layers, although the words do not say that.

Placement of surface temper bead near the toe of the final weld layer (the distance S in Figure QW-462.12) has to be within ±1/16 inch (± 1.5 mm) of the distance from the toe of the weld used on the test coupon according to the new and improved QW-410.61. Alternatively, one can establish a wider range for this distance by welding and testing multiple test specimens that were welded using different bead placement distances. In all cases, the ratio of heat input of the surface temper bead to that of the layer against the base metal at the weld toe that was used in qualification has to be used on the production part.

Finally, the bead overlap has to be controlled. A new figure QW-462.13 (Figure 1) was added showing how overlap is measured, and as long as the overlap is between 25 and 75%, no special testing is required. However, if the qualifier wishes to use overlap less than 25% or greater than 75%, the extent of overlap must be qualified and restricted to what was used on the test coupon. Not surprisingly, qualifications made using temper bead techniques have shown that an overlap of about 50% is optimum. When looking at completed temper bead layers, the optimum condition is for the surface of each layer to be as flat and uniform as possible, and to have the least possible depth of ripples. This, along with control of the ratio of heat input as specified by QW-409.29 will result in optimum properties in the heat-affected zone.

Welder Qualification (QW-300) Changes

There were no significant changes to the rules for welder qualification.

Base Metals and Filler Metals

Several new materials were added to QW/QB-422, and several editorial errors were corrected.

AWS has revised several filler metal specifications that have been adopted by ASME in these addenda. SFA5.1, which covers carbon steel electrodes for SMAW, has added limits on the chemical analysis of E60XX series filler metals such as E6010. Since there were no limits on the chemical analysis of, for example, E6010 electrode, one could not simply assume that the weld metal chemical analysis of E6010 was A-1; one had to establish it by obtaining a chemical analysis from the PQR test coupon or from the supplier's data and record it on the PQR. This revision limits the chemical composition of all E60XX electrodes to an A-1 chemical analysis.

Revisions to SFA 5.28, which covers low-alloy bare and composite wires, has some errors in the chemical analysis limits for B9 filler metals. The maximum limit for nickel should be 0.80%, manganese is limited to 1.20%, silicon should be 0.15 to 0.50%, chromium should be 8.00 to 10.50%, molybdenum, 0.80 to 1.20% and vanadium should be 0.15 to 0.30%.

It should also be noted that a cross-reference table to metric and ISO designations for welding electrodes are now included in some of the filler metal specifications. For example, Table A1 of SFA5.1 shows E7018 as E4918 (metric) and as H38xB32 (ISO 2560).

SFA5.11 has been revised to assign AWS Classifications to Hastelloy 231 (ENi-CrMo-9). Hastelloy G-30 (ENiCrMo-11), AVESTA P-12R (ENiCrMo-12), Hastelloy C2000 (ENiCrMo-17), Nicrofer 5020hMo (ENiCrMo-18), INCONEL Filler Metal 52M (ERNiCrFe-7A), VDM Nicrofer 6025HT (ERNiCrFe-12[1]), VDM Nicrofer 45 (ERNiCrFeSi-1) and Haynes HR160 (NiCoCrSi-1) among other commercial nickel-alloy filler metals.

Brazing (QB) Changes

There were no significant changes to the rules on Brazing except for the modification to certification by signature or other means as describe earlier for welding.

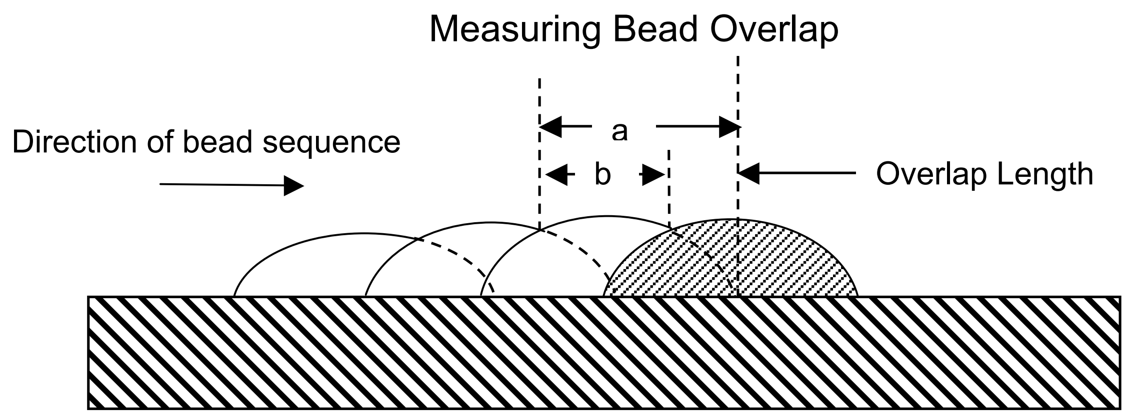
[1] Corrected from Welding Journal article

Coming Attractions

In the area of maintenance of welder qualification, Section IX will be revised to address who may perform updates of continuity. The subcommittee is also going to attempt to eliminate S-numbers from QW/QB-422 by reassigning them as P-numbers. The subcommittee attempted to make this simplification to QW/QB-422 about 10 years ago, but it was met with strident opposition at the Standards Committee; opposition this time around does not seem to be quite so firm.

Readers are advised that ASME Code Committee meetings are open to the public; the schedule is available on the writer's web site and at www.asme.org.

Figure 1



NOTE: Measurement of bead overlap: % overlap length = (a-b)/a X 100%. In this figure, the shaded bead overlaps previous bead by 30 to 40%. The distance "a" is measured before the next bead is deposited

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