Summary of Changes to

ASME Section IX, 2015 Edition

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Prepared by

Walter J. Sperko, P.E.
Sperko Engineering Services, Inc
4803 Archwood Drive
Greensboro, NC 27406 USA
Voice: 336-674-0600
FAX: 336-674-0202
e-mail:sperko@asme.org
www.sperkoengineering.com

The following article by Walter J. Sperko, P.E. discusses the significant changes that appear in ASME Section IX, 2015 Edition; all changes can be readily identified in the "Summary of Changes" found in the front matter of Section IX. Readers are advised that the opinions expressed in this article are those of Mr. Sperko, not the official opinion of ASME BPV Standards Committee IX. These changes become mandatory January 1, 2016.

Administrative Changes

Several items were discovered to have slipped through the cracks during creation of Part QG General Requirements in the 2013 Edition, and these are corrected in this edition.

In the 2011 and prior editions of Section IX, the requirement that the welding of procedure and performance qualification test coupons be supervised and controlled by the manufacturer or contractor who will have responsible operational control of welding and brazing was quite explicit. In the 2013, this requirement was unintentionally made less explicit. As a result, the committee clarified its position with the following inquiry:

> Question: Is it the intent of QG-106.1(a) and QG-106.2(a) that personnel who produce test joints for procedure or performance qualification shall produce those joints under the full supervision and control of the qualifying organization using those procedures or personnel?
>
> Reply: Yes

Because this was an "intent" inquiry, ASME's ANSI-accredited procedures required that parallel Code changes be made at the same time, so the first sentences of QG-106.1(a) and QG-106.2(a) were revised to say that personnel who produce test joints for procedure or performance qualification shall be under the full supervision and control of the qualifying organization during the production of qualification test joints. Organizations are defined as a manufacturer, contractor, assembler, installer, or some other single or combined entity having responsibility for operational control of the material-joining methods. The organization that will give the welder the WPS to follow and tell him what to weld each day is the organization that has "operational control" over welding, and that is the organization that has to supervise the welding of any procedure and performance qualification test coupons.

QG-106.2 was further modified to explain that the purpose of requiring that each organization qualify its own welders is to ensure that the qualifying organization has determined that each welder following its procedures is capable of achieving the

minimum requirements specified for an acceptable joint. This, the committee hopes, ensures a modicum of competence in welding oversight by that organization.

The definitions of essential, supplementary and nonessential variables were moved from Parts QW, QB and QF and consolidated into Part QG. A new paragraph QG-105.2 was added defining an essential variable for performance qualification as a condition in which a change, as described in the specific variable, will affect the ability of the person to produce a sound joint. Also, the definition of nonessential variable in QG-105.3 was modified to emphasize that nonessential variables have to be addressed in the procedure specification.

The date when Section IX became mandatory was historically covered in the Foreword of Section IX, but in the 2013 Edition, the Foreword was revised by ASME staff to make the Foreword the same in all ASME BPV Code Sections, and effective date rules were deleted. A new paragraph QG-100(e) has been added stating that new editions of Section IX may be used as soon as the edition is published and that the new edition becomes mandatory for new qualifications six months after the date of publication. It also addresses Code Cases stating that:

- they may be used beginning with the date of approval by ASME;
- qualifications using the provisions of a Code Case remain valid after the Code Case has been annulled;
- and that the Code Case number shall be listed on the qualification record(s).

Welding Procedure (QW-200) Changes

Throughout the variables in QW-400, the phrase "over that qualified" or a variation thereof appears many times in some -- but not all essential variables. What this phrase really means is "over what is recorded on the PQR" relative to any specific essential variable, and that is redundant since QG-102 already says the PQR shall document the essential variables applied during welding of the test coupon. The 2015 Edition deleted this potentially confusing phrase in the QW-409 variables, and ongoing action will identify and remove the remainder of them in the 2017 Edition.

QG-105.3 introduces supplementary essential variables and refers the reader to QW-401.1. This paragraph allows one to "upgrade" an existing WPS for toughness-tested applications by simply welding a test coupon big enough to extract the necessary toughness specimens, recording the essential and supplementary essential variables on the PQR and only doing the required toughness testing (i.e., there is no need to repeat tension and bend tests when testing this supplementary test coupon.). In the 2013 and prior editions, this paragraph was read by some that one had to use *exactly* the same essential variables, including test coupon material and thickness, as was used when welding the original PQR test coupon. After determining that that was an overly restrictive understanding of the rules, the paragraph

was revised to require that the existing WPS be followed and that the essential and supplementary essential variables applicable to the additional test coupon would be recorded on the new PQR.

While on the subject of toughness-tested qualifications, QW-409.1 was not clear that the heat input or volume of weld metal deposited per unit length of weld had to be recorded on the PQR *for each process* used on the test coupon. This Edition adds that the heat input for each process must be recorded on the PQR when more than one process is used to weld the test coupon. When qualifying more than one welding process in a single test coupon, readers should note that QW-462 says that weld metal from all welding processes and filler materials to be qualified must be included in the test specimens. This means that, in addition to removing specimens as required by the applicable construction code, an additional set of impact test specimens may have to be removed from the other process weld metal depending on the construction code specimen location requirements.

QW-404.12, which applies to impact-qualified WPSs for several welding processes, allows use of AWS classifications where impact testing is performed at a lower temperature than that of the classification used to weld the test coupon (i.e, if one qualified using E7018 which is impact tested at -20°F, it was permissible to specify E7018-1 which is impact tested at -50°F without requalification). However, when using SAW, QW-404.35 limits the wire/flux combination to the AWS classification that was used on the test coupon with no allowance for using AWS classifications that were tested at a lower temperature than was used on the test specimens. That has been corrected in this edition by allowing a classification to be specified in the WPS that has a larger number indicating toughness than that of the classification used on the test coupon. That is, if the wire/flux classification recorded on the PQR was F7A2-EA1-A1, one could specify F7A4-EA1-A1 on the WPS and not have to requalify the WPS. Since this change was passed in conjunction with an intent interpretation, it is applicable to previously qualified WPSs, so you might want to review your SAW WPSs to take advantage of this provision.

Finally on the subject of toughness testing, QW-171 provides general guidance on performing impact testing and requires that impact testing be performed in accordance with SA-370. Section VIII, *Unfired Pressure Vessels*, now permits use of impact specimens in accordance with ISO 148. As a result, QW-171 was revised to allow impact test specimens to be in accordance with SA-370 or any other standard permitted by the construction code. Since Section IX defaults to the construction code for the test temperature, acceptance criteria, specimen location and orientation, etc. this was a logical change.

For organizations that deposit corrosion-resistant or hardfacing overlay using strip rather than wire, a new essential variable was added making an increase in the nominal thickness or width of the strip an essential variable, and the method of

measuring the heat input when using strip was adjusted:

$$\text{Heat input} = \frac{\text{Volts X Amps X 60}}{\text{Travel Speed X Strip Width}}$$

When doing EBW or LBW, Table QW-451, *Groove Weld Tension Tests and Transverse Bend Tests* does not apply; rather, QW403.3 provides the base metal thickness limits for these processes. These limits depend on whether or not root penetration can be visually verified on the production part, and these rules were simplified. When penetration can be verified, the WPS is limited to the test coupon thickness plus 20%, when it cannot, the WPS is limited to the test coupon thickness plus 10% for test coupons less than 1 inch (25 mm) thick and plus 5% for thicknesses greater than 1 inch (25 mm).

In the 2013 Edition, variables covering hybrid laser-GMAW and hybrid plasma-GMAW processes were added to Section IX; they will be deleted in the 2015 Edition. During the exercise of putting these hybridized variations in Section IX, the committee noted that the number of possible hybrid combinations that some welding wizard might come up with was large. The exercise also made it clear that the variables for each welding process involved needed to be addressed and qualified, but that there were also small factors addressing the interface between the processes. As a result, a more generic approach to hybrid welding was developed.

To understand this approach, one needs to recognize that "hybrid welding" is welding in which two or more welding processes are used *in the same weld pool*. One process followed – even closely – by another is not hybrid welding if each process produces its own weld pool. When two processes are hybridized, the essential variables for each individual process apply, and the following are also essential variables:

(a) A change in in the essential variables of one or more processes.
(b) A change in the process sequence (i.e., which process leads and which follows in the pool)
(c) A change in the process separation greater than 10% (e.g., the distance between the welding torch and laser) measured at the work piece surface.
(d) A change in the angle between a process and the material to be welded or a change in any angle between a processes of greater than 10°.
(e) A change in the height between the individual welding processes and the material surface greater than 10%.
(f) The hybrid welding is limited to machine or automatic welding.

With this approach, any hybrid process combinations can be evolve and the rules for qualification will already exist.

For those lucky people who do friction stir welding, the use of filler metal in a joint now has to be qualified. Any increase in the thickness or width of the preplaced filler metal or a change in the type or grade of the filler material is an essential variable. If filler metal was not used on the qualification test coupon, the PQR has to say that none was used and the WPS must prohibit its use.

Section IX has added a helpful hint for those who weld on aluminum; Figure QW-466.1 (the bend test fixture diagrams) recommends use of a wrap-around bend test fixture when qualifying aluminum. Because an aluminum heat-affected zone (HAZ) becomes soft when aluminum is welded, coining and push-through fixtures can concentrate the strain of bending in the soft HAZ material overstraining the HAZ and leading to unwarranted failure. Wrap-around bending fixtures preclude this. It is not often that Section IX gives its readers a useful heads-up, so you who weld on aluminum -- count your blessings!

The Form QW-482 for WPSs was revised to clarify the philosophy of what belongs on a WPS – direction to the welder. Some notes on the form regarding base metal and filler metal combinations, preheating and electrical parameters, indicated that those parameters should be "recorded." While "recorded" is appropriate for a PQR (a PQR is a record of what happened during welding of a procedure qualification test coupon), a WPS will provide direction to the welder. Accordingly, the notes were revised to say that the base metals and filler metals, the preheat and the welding parameters should be "specified" on the WPS rather than "recorded." While not technically significant, recognizing that one is specifying direction to the welder in the WPS, not recording something, is important in the mindset of the welding engineer, and the Code forms should not mislead him or her.

Welder Qualification (QW-300) Changes

The committee had several requests to add special test positions where a weld might be rotated during welding but in positions other than 1GR. For example, a socket weld might be welded in the 2F position with the parts are rotated, not fixed, making the test position non-standard. Several attempts to define various non-standard test positions were proposed, but none seemed to answer all the questions without adding a whole new collection of rarely-used testing position figures. While QW-461.9 listed "special positions" as a possible testing position, a visitor to the committee noted that the term "special position" was not defined. New paragraph QW-124 adds a definition for "special position" defining it as any position that is not defined by in QW-120 or QW-130. QW-303.3 already defines the ranges of position qualified by testing in a special position as permitting the position tested with an angular deviation of ±15° for both the inclination axis and the face rotation. In other words, while there are standard test positions such as 1G, 5G, 3F, etc. which are discreetly defined, and QW-461.9 gives the ranges qualified when a welder tests in one of those positions, one can also test a welder in any position, but the position of

the test coupon is the only position for which that welder is qualified, plus or minus a little.

QW-423 is the table that allows one to test a welder using base metal different from that to be welded in production. That table does not address unassigned base metals (i.e., those that do not have P-numbers). Three lines were added to the table specifying that, when you qualify a welder using an unassigned base metal, the welder is only qualified to weld on that base metal. While this completes the table, Code users should be aware that paragraph QW-423.1 says that once a welder tests using a base metal that is assigned a P-number, that welder is qualified to weld on all materials assigned to the P-numbers listed in the right column of Table QW-423, including *unassigned metals of similar chemical composition to those metals*. Note that the words are "similar to" and not "the same composition as" or "the same properties as." In looking at the first line in Table QW-423, a welder who tests using a P-1 test coupon material is qualified to weld on all base metals from P-1 through P-15F; the chemical composition range between P-1 and P-15F is huge, and finding a composition "similar" to an unlisted iron-based alloy should not be difficult. The smart welding engineer qualifies welders on materials that are assigned a P-number, then takes advantage of the above to allow them to weld on unassigned base metals without requalification. While Section IX is quite liberal when it comes to base metals used for welder qualification, the rules for unassigned filler metals – those without F-numbers – are much more restrictive. A welder has to qualify using the trade name filler metal he will use in production if that trade name material does not comply with an SFA specification, and that welder may only weld using that trade name material.

The definition of "bare electrode" was revised. While a bare electrode obviously is a wire, strip, or bar with no coating or covering other than that incidental to its manufacture, a phrase was added to the definition to include coatings that were added for preservation, feeding or electrical contact. Strictly speaking, that ER70S-2 with the flash copper coating that we all thought was bare wire really was coated wire -- and should have been qualified as an unlisted material. Thankfully revising the definition fixes that, so there is no need to rush out and requalify your WPSs that allow copper-coated bare wires.

Base Metals and Filler Metals

The biggest change in welding consumables was the updating of the following filler metal specifications to SFA specifications with no changes from the AWS versions -- probably including any typos:

A5.5/A5.5M:2014 Specification for Low-Alloy Steel Electrodes for Shielded Metal Arc Welding
A5.16/A5.16M:2013 Specification for Titanium and Titanium-Alloy Welding Electrodes and Rods
A5.11/A5.11M:2010 Specification for Nickel and Nickel-Alloy Welding Electrodes for Shielded Metal Arc Welding

A5.34/A5.34M:2013 Specification for Nickel-Alloy Electrodes for Flux Cored Arc Welding
A5.01/A5.01M:2013, Procurement Guidelines for Welding Consumables
A5.1/A5.1M:2012 Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding
A5.4/A5.4M:2012 Specification for Stainless Steel Electrodes for Shielded Metal Arc Welding
A5.9/A5.9M:2012 Specification for Bare Stainless Steel Welding Electrodes and Rods
A5.22/A5.22M:2012 Specification for Stainless Steel Flux Cored and Metal Cored Welding Electrodes and Rods

Several new alloys were assigned P-numbers:

- A-694, grades F48 and F50, carbon steel forgings were assigned to P-1, Group 1.
- A-860 high-strength ferritic steel seamless and welded fittings, grades WPHY 42, 46 and 52, were assigned to P-1, Group 1, grades WPHY 60 and 65 were assigned to P-1, Group 2, and grade WPHY 70 was assigned to P-1, Group 3.
- A928, grade 2304, duplex stainless steel pipe, was assigned to P-10H. Group 1
- UNS N06025, a 63Ni-25Cr-10Fe-2Al-Ti-Y-Zr alloy was assigned to P-43.
- UNS N10362, a 62Ni-22Mo-15Cr alloy was assigned to P-43.
- UNS S31266, a 24Cr-22Ni-6Mo-3Mn-Cu-W-N alloy was assigned to P-45.
- UNS S30432, a 18Cr-9Ni-3Cu-Cb-N alloy was assigned to P-8, Group 1.
- UNS S31726, a 19Cr-15.5Ni-4Mo alloy was assigned to P-8, Group 4.

For those working with materials made to non-US standards, Section IX committee will assign P-numbers to any material where the appropriate supporting weldability information has been submitted; see Mandatory Appendix J: *Guideline for Requesting P-Number assignment for Base Metals Not Listed in Table QW/QB-422*

Several new aluminum alloy filler metals were added to the F-number table as a consequence of adoption of A5.10, *Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods* in the 2013 Edition. QW-432 now lists ER4018, ER4043A, ER 4046, ER4047, ER 4943, ER 4018, RA356.0, R357.0 and R206.0. These last several are for welding casting alloys and were sufficiently different from the existing F-numbers that F-number 26 was created just for them. These F-26 alloys are not as ductile as steel, so Figure QW-466.1 allows these alloys to be bent over a radius of 8-1/4 times the bend test specimen thickness rather than 2 times the thickness as is common for most metals that are in assigned F-numbers in Section IX.

Brazing (QB) Changes

The brazing subgroup reviewed the latest edition of AWS B2.2 and adopted a couple of its approaches to brazing qualification. A change in the brazing time was added as an essential variable for furnace, induction, resistance and dip brazing. The variable that addresses precleaning of the joint prior to assembly was modified slightly.

An additional variable was added to both brazing procedure and performance qualification addressing changing from mechanically fed or manually fed filler metal to preplaced filler metal. While a change from preplaced filler metal to mechanically fed or manually fed filler metal is an essential variable for the brazer, changing ei-

ther way is an essential variable for the procedure. Please note that this change does not apply to either procedures or brazers who are already qualified; see QG-108.

Plastic Fusing – Part QF

A new process has been added to Part QF: electrofusion. Electrofusion is used to join pipe to fittings in a socket configuration. The fitting manufacturer implants resistance heating wires into the body of the socket. After the pipe is inserted, power is applied to the heating wires, the fitting plastic expands against the pipe outside wall, heats it and and fuses to it. After a predetermined heating time, the power is cut and the assembly is allowed to cool. There is another configuration where a saddle with an outlet nozzle is contoured to fit the outside surface of the pipe has heating coils implanted in a similar manner; in this case, the saddle is pressed against the outside of the pipe and the same process – melting and bonding – occurs.

For electrofusion, the joint design is qualified by the electrofusion fitting manufacturer in accordance with ASTM F1055 and the essential variables identified in QF-253. The requirements include an sustained pressure test at 176 ± 4°F (80 ± 2°C) for as long as 1000 hours at 570 psi, a quick-burst pressure test, a joint integrity crush test, a bend test, a peel test, a short term hydrostatic test and an impact resistance test. These tests are conducted for size increment below NPS 8, over NPS 8 to NPS 12 and over NPS 12. Fortunately, the fitting manufacturer conducts these tests and provides a Manufacturer's Qualified Electrofusion Procedure Specifications (MEFPS) to the installing contractor that can be used without further qualification. That is similar to the standard butt fusing procedure specifications (SFPS) which is based Plastics Pipe Institute (PPI) Technical Note TN-34 or ASTM F1290.

The rules specify visual examination of each electrofusion joint for excess internal melting caused by overheating, fitting malfunction and incomplete fusion. The fit-up gap, axial misalignment and out-of-roundness must be within the MEFPS limits.

Performance qualification consists of making a joint and either cutting strips out and doing bend tests or splitting the fitting down its length and doing a crush test.

Simultaneous Qualification of Welding Personnel Under both ISO and ASME Standards

A new Appendix providing guidance for those who wish to qualify welders under ISO 9606-1:2012 or welding operators under ISO 14732:2013 and also under ASME Section IX will be published in this Edition. AWS represents the United States at meetings of ISO TC44, *Welding and Allied Processes*, and, after more than15 years of debating and discussing the rules on personnel qualification, the above ISO

standards were revised and are now close enough to ASME Section IX rules that, with attention to some small details, personnel qualified under the ISO standards are also qualified to Section IX. To achieve this goal, the ISO committee made two major changes: first was a shift from base metal ("parent metal" in ISO terms) as the primary basis for qualification to the filler metal or electrode; second was to allow continuity of qualification to be maintained without biennial testing of welders and operators.

When qualifying personnel under ISO standards, the following administrative issues need to be addressed:

1) The WPS followed during the test must be a WPS that meets the requirements of Section IX.
2) Welding of the test coupon must be done under the full supervision and control of the organization that will employ that welder or welding operator.
3) The completed qualification record must be certified by that organization.
4) The qualification record must record the essential variables for the welding process and list the ranges qualified.

The following technical issues must be addressed:

1) A base metal that is assigned a P-number and consumables that conform to an SFA specification and are assigned an F-number must be used.
2) When evaluating radiographs, indications characterized as linear slag may not exceed the thickness of the test coupon divided by three (i.e., the flaw length may not exceed t/3); this is more restrictive than ISO 5817 which allows slag inclusions to be equal in length to the thickness of the test coupon.
3) Test coupons tested by fracture test according to ISO 9017 do not satisfy the requirements of Section IX.

Inquiries

When you send a test coupon to an outside lab for testing and the lab reports the results, is it permissible to reference and attach that lab's test report to a PQR form in lieu of transferring the test results to the form? While the reply from the committee was a simple "yes," in my opinion, simply attaching the lab report without referencing the lab report's unique number on the PQR form is insufficient. Since you have to certify the qualification record and that record must include the test results, the lab report has to be incorporated into the qualification record either by transferring the data or by showing the lab's unique identification number on the PQR.

Interpretations can be found at: http://cstools.asme.org/Interpretations.cfm

Possible Coming Attractions

A new form of laser welding using a diffuse beam rather than a penetrating beam will appear in the 2017 edition and is available for use already via Code Case. This variation of LBW allows a laser to be used like GTAW but without the torch.

A proposal to allow welders to be qualified by an AWS Authorized Test Facility is being discussed. That proposal requires the organization taking advantage of this option to have an AWS Qualified Welding Supervisor on staff. This proposal has met with much resistance.

The temper bead rules are being modified to allow use of temper bead welding where neither toughness nor hardness limits are imposed by the applicable code.

Section IX specifies the nominal width of a plate tension test specimen as ¾ inches, but several other codes require the width of the specimen to be 1 inch. Section IX is being tweaked to allow tension test specimens that are nominally greater than ¾ inches in width to be used. This will reduce costs for those who work with multiple welding standards.

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. Errata and editorial corrections are posted at http://www.asme.org/kb/standards/publications/bpvc-resources so that Code users can readily see revisions and corrections.

Mr. Sperko is President of Sperko Engineering, a company that provides consulting services in welding, brazing, metallurgy, corrosion and ASME Code issues located at www.sperkoengineering.com. He also teaches publicly offered seminars sponsored by ASME on how to efficiently and competently use Section IX. He can be reached at 336-674-0600 and by e-mail at: sperko@asme.org.