

# Auditing of Welding Under ASME Section IX

## Introduction

This document has been prepared by ASME Subcommittee IX to provide guidance to Jurisdiction, ASME and National Board auditors when conducting surveys in evaluating welding as a controlled manufacturing process. This document is divided into two parts:

Part 1 discusses what has to be on a WPS and a PQR relative to the requirements of Section IX. Specific examples and suggestions are provided.

Part 2 was written to help auditors understand what Subcommittee IX thinks manufacturers and contractors should have under control when using welding as a manufacturing process. A method of demonstrating that WPSs have been properly implemented is provided as well as specific suggestions regarding technical aspects of welding that could be examined to establish the level of competence of the manufacturer or contractor. It should be recognized that Part 2 is simply suggestions to auditors regarding what to look for, not requirements for him to follow nor requirements for the manufacturer or contractor, except for the discussion of welder qualifications. Phrases such as “It is suggested that. . .” or similar wording are used extensively to emphasize that what is in Part 2 are suggestions of what to look for when evaluating a welding program, not specific requirements. Auditors are cautioned not to consider these suggestions as anything more than indicators that the manufacturer or contractor is either competent or that the auditor needs to look more closely.

This revised document is based on the 2010 Edition, 2011 addenda of ASME Section IX and may not be accurate at later dates as the result of changes that may be made in subsequent editions of Section IX. This is particularly true of examples.

## Part 1 -- Contents of WPS/PQR

As the result of a number of inquiries, the question of what has to be specifically addressed on a WPS and on a PQR was discussed in depth by Subcommittee IX, and appropriate words were added to Section IX to make the requirements more clear. This Part discusses those requirements and provides guidance and examples of how those requirements should be translated into properly qualified WPSs.

### Background

Section IX changed to its current format in the 1974 Edition. At that time, the concept of essential, supplementary essential and nonessential variables was introduced. In that Edition and in the 1977 Edition, QW-201.1 said that the WPS had to list in detail the base metals, filler metals, pre-heat, PWHT “and other variables described for each welding process as essential or nonessential.” The 1977 Edition also said that the PQR form had to “document the essential variables of the specific welding process. . .”

These words were apparently not clear enough, since, in the late 1970s, there were several inquiries related to what was required to be on the WPS and on the PQR relative to the essential and

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nonessential variables. As a result of these inquiries, the words in the 1980 Edition of Section IX were strengthened to make it clearer that *each* of the essential and the nonessential variables for each process *had to be addressed* on the WPS and that each of the essential variables *had to be documented* on the PQR. (Supplementary essential variables have to be similarly addressed on the WPS and documented on the PQR when the WPS will be used on materials where impact testing is required by the construction code.) The words in the 1980 Edition are the same as what is in the current Edition relative to this subject, except for some editorial massaging.

## Present Requirements

It should be noted that the current Edition says the following:

**“QW-200.1(b) Contents of the WPS:** The completed WPS shall describe all of the essential, nonessential and, when required, supplementary essential variables for each welding process used in the WPS.” These variables are listed in QW-250 through QW-280 and are defined in Article IV, Welding Data.

and:

**“QW-200.1(d)** The information required to be in the WPS may be in any format . . . as long as every essential, nonessential and, when required, supplementary essential variable . . . is included or referenced.”

These words are reinforced by Interpretation IX-89-03, which clearly says that even variables which do not appear to be applicable in a particular shop must be addressed. See the “Examples” section for more discussion of this requirement.

The above requirement can be reduced to two functional concepts:

- 1) if Section IX lists a variable as essential, what was done relative to that variable on the test coupon has to be documented on the PQR. Variables recorded should be the actual values, not the limits specified on the WPS that was followed during welding of the test coupon.
- 2) if Section IX lists a variable as essential or nonessential, the WPS has to say something about that variable (with, of course, the essential variables consistent with the data recorded on the supporting PQRs and the rules of Section IX relative to that variable).
- 3) if the construction code requires the WPS to be qualified with impact testing, any variable listed as a supplementary essential variable has to be documented on the PQR and addressed on the WPS as an essential variable as described in in 1) and 2) above.

Various organizations have prepared checklists of the variables for each welding process. Such checklists can be used during audits to make it simple to review WPSs, PQRs and Welder Performance Qualification Records (WPQRs). The use of such checklists by auditors to determine that every essential and nonessential variable has been addressed by the “auditee” is highly en-

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couraged. Checklists ought to be more than just a copy of the "Brief of Variables" column unless the auditor is intimate with Section IX; the variables in the checklist ought to be written out completely, and other considerations, such as verifying the correct number and results of tensile, impact tests and bend test specimens, revision control and appropriate certification statements and signature on qualification records (imposed in 2006) should also be on such a checklist. The auditor should also understand how to handle qualification using more than one welding process or set of variables and how to apply QW-451 properly. See the attached "QW-451 Examples."

Miscellaneous stuff shows up in the construction codes such as, when impact testing is required, the heat treatment condition of the test coupon material has to be the same as that of the test piece:

- \* As-Rolled
- \* Normalized
- \* Quenched and tempered welding.

The user of the code is required to take them into consideration when qualifying a WPS. Auditors need to verify qualification aspects of the applicable construction code.

## Examples

The following shows some typical samples of how to address typical variables; it should be recognized that these examples show *some* acceptable ways in which variables may be addressed -- *not the only* acceptable way to address the variables, nor does it show *all* of the acceptable ways. The auditor should keep an open mind to the creative ways that manufacturers and contractors may acceptably address the variables in the Code, always keeping in mind that the *objective is to provide direction to the welder (i.e., tell him what to do . . . )*

The requirement to address each essential and nonessential variable occasionally leads to some curious situations for the welding engineer when he writes the WPS. For example, when using GMAW or SAW, Section IX requires that the use of supplemental filler metal (QW-404.24) be addressed in the WPS. The shop may not have equipment for adding supplemental filler metal. However, supplemental filler metal *has to be* addressed on the WPS and whether it was used or not used on the test coupon must be documented on the PQR because -- it is a essential variable. It can easily be addressed in a shop which has no equipment for adding supplemental filler metal by saying something such as: "Supplemental Filler Metal: Not Permitted" on the WPS and "Supplemental Filler Metal: Not Used" on the PQR.

Another example of curious is the requirement to address pulsed power source (QW-409.3) when using GTAW in a shop that has no pulsed power source. This nonessential variable can be easily addressed by saying something such as: "Pulsed Power Source: Not Permitted," or similar phrase - even though the shop has no pulsed power source. However, in a shop that has one, being required to address pulsed power sources should tweak the welding engineer to ask himself if the welder has adequate training or direction to use such a power source.

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Section IX means what it says: the WPS may contain any information that the Welding Engineer chooses to include, "as long as every essential, nonessential and, when required, supplementary essential variable . . . is included or referenced."

It should be clear, however, that only those welding conditions that Section IX lists as variables for a particular process are required to be addressed in the WPS. For example, in GMAW, the transfer mode (QW-409.2) is an essential variable, so it has to be addressed, but for SMAW, it is not, so it is not necessary to address transfer mode when writing a WPS for SMAW. Some Welding Engineers may consider other welding conditions, such as whether the welder uses a pushing or dragging torch angle in GMAW, to affect welding; however, since the torch angle is not listed as a variable for GMAW, it is *not required* to be addressed on the WPS or recorded on the PQR, but the Welding engineer *may* choose to address it on the WPS and the PQR if he thinks such direction is appropriate for the process and production situation. Finally, take note that Section IX considers FCAW (flux cored arc welding) to be a variation on GMAW, so it is a permitted process (see QW-255 and QW-355 table headers.)

The auditor should keep in mind that any additional direction that the Welding Engineer chooses to put on the WPS -- just like direction addressing the essential, nonessential and the supplementary essential variables -- is required to be followed by the welder in production. Any welding practice specified on the WPS must be followed by the welder, whether it is a code variable or it is some other condition that the welding engineer chooses to specify. If a welder cannot follow the WPS, his training should be to notify his supervisor who should notify the welding engineer so that the WPS can be appropriately revised -- or other appropriate action taken. If the welder is caught welding outside the WPS, a nonconformance should be written.

The electrode and filler metals should have tensile strengths and chemical analysis comparable to or otherwise suitable for the application for the base metals being welded or otherwise be justified; this is not a Section IX issue, but a Construction Code and engineering issue that the auditee ought to address together with the end user and the design engineer.

## Blanks on Forms

It should be noted that Interpretation IX-83-03 says that omission of an essential or nonessential variable from a WPS (for example, by leaving a space on a form blank or simply not addressing the variable) does not meet the Section IX requirement to address the variable. For example, if a WPS is qualified without PWHT, the organization should document on the PQR that PWHT was not performed (e.g., PWHT: Not Performed, PWHT: None, No PWHT, etc.), and the organization should specify on the WPS that PWHT is not permitted (e.g., PWHT: Not Permitted; PWHT: None; PWHT: As-welded only; No PWHT; etc.). Leaving a blank or "N/A" on the PQR would not document whether or not PWHT had been performed on the test piece, and leaving a blank or "N/A" on the WPS would not prohibit PWHT from being done. If Section IX identifies a variable as essential, nonessential or supplementary essential for a process, that variable *is applicable* to that process. Section IX does not specify the manner in which this is documented on the PQR or specified on the WPS. The method of recording information on the PQR and WPS may be by statement, sketch or other means as long as the essential variables are addressed (IX-10-1159).

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## "Describing" a Variable

Although Section IX says that the WPS or PQR shall describe all of the variables listed for each welding process, this should not preclude the use of judgment in going through the checklist of variables for a process and recognizing that some variables are *conditional*, some are *intrinsically addressed* by other information specified elsewhere on the WPS.

### Conditional Variables

- QW-410.7 says: "For machine and automatic welding processes, a change of more than  $\pm 10\%$  in the width, frequency or dwell time of oscillation technique." If the WPS identifies the welding process type as semi-automatic, oscillation does not need to be addressed directly on the WPS.
- QW-405.3, addresses progression in any pass of a vertical weld; if the WPS limits welding to the flat position, the WPS does not have to say anything about progression.
- QW-406.2, deals with maintenance of preheat prior to postweld heat treatment. For a weld that will remain in the as-welded condition, this variable is adequately addressed without writing a word directly about maintaining preheat since PWHT is not going to be performed.
- QW-408.2(c) requires that the percentage composition of a shielding gas be given for a gas *mixture*; if the WPS specifies a single shielding gas, the percentage composition does not have to be specified

### Intrinsically Addressed Variables

- QW-410.64 deals with the use of thermal process when welding on P-11A or P-11B materials. A WPS or PQR dealing only with P-1 materials does not need to say anything specifically about the use of thermal processes since recording "P-1 to P-1" on the PQR and specifying "P-1 to P-1" on the WPS precludes the possibility that P-11A or P-11B materials are involved.
- QW-404.23 deals with filler metal product form (solid, metal cored and flux cored fillers); if the WPS specifies ER70S-2, the "S" in this classification uniquely identifies the filler metal as a solid wire, so the WPS does not have to specifically identify the filler metal as "solid."
- QW-404.34 which deals with flux type (neutral or active) when welding P-1 metals using SAW; if the WPS is for welding P-5A, the flux type does not have to be specifically addressed.

These variables can be considered *conditional* variables or *intrinsically described* by the other welding variables specified in the WPS or recorded on the PQR and, therefore, are adequately addressed even though there is no specific, individual mention of them on the WPS or PQR. This list should not be considered all-inclusive – there are obviously other variables which can be conditional or intrinsically by others.

A variable which requires careful consideration but is not so straightforward is backing (see QW-402.2, QW-402.4 and QW-402.5). These are nonessential variables for the common processes,

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and they must be addressed in the WPS. In a *multi-process* WPS where backing is specifically addressed for the root process (e.g., GTAW), but not specifically addressed for the fill processes (e.g., SMAW), one could argue that backing for the fill process (SMAW) is intrinsically addressed by the root process (GTAW) since the root process is backing for the fill process. In this example, the GTAW process is the backing for the SMAW process. However, if the manufacturer allows the welder to use SMAW by itself, then the WPS must address backing when using SMAW (e.g., “Backing: Optional for GTAW, Required for SMAW”).

Another way to handle the nonessential variable of backing when multiple processes are used in a WPS is to address backing specifically for each process. Such an approach might be by saying: “Backing is optional for GTAW, and backing is required for SMAW.” That way, there is no doubt that Section IX is satisfied, and the fabricator can use each process separately if he so desires within the restrictions stated above. There may be other ways of addressing this variable, and this one should not be considered the only acceptable way.

Sometimes variables may be addressed more specifically by reference in the WPS to other documents. It is entirely acceptable to specify various types of grooves by listing V-groove, J-groove, etc. directly in the WPS. This satisfies the requirement of QW-402.1 to address groove design. However, if the product that is being built by a manufacturer or contractor is the same product over and over, it is reasonable (but not required) to specify a single joint design. Such a manufacturer may choose to go so far as to specify the specific dimensions, bevel angle, root face thickness, etc. of the groove preparation by using a diagram. This clearly satisfies the requirement to address groove type per QW-402.1. When this is done, however, the parts being assembled must be as specified in the WPS!

In a shop where a large variety of joint designs and details are used, it is also acceptable (but not required) for the WPS to refer the welder to the construction drawing or other source document, standard procedure, standard drawing, etc. for the specific type of groove and its details rather than to use the perfectly acceptable practice of listing by name a collection of groove types on the WPS (i.e., Single V-groove, J-groove, etc.). The former practice does, in fact, provide the welder with better guidance than the latter practice. When the welder is referred to the construction drawing or other documents, however, the auditor should check the drawings or other documents to be sure that some type of groove is actually provided on those drawings, and that the welder knows to go there. Another item to check when the specific groove design is on the fabrication drawing is QW-402.10, root spacing, to be sure that root spacing is also addressed in conjunction with the groove details.

The subject of weld build-up, repair welding and fillet welds should be addressed on the WPS if these are used in production unless separate WPSs are used for this work. A general statement that weld build-up, repair welding and fillet welds are permitted indicates that the welding engineer has considered these types of welds and found the WPS to be suitable for such work.

Impact qualified WPSs present some challenges. We know that supplementary essential variables apply when a WPS is qualified with impact testing, and that those variables include limitations

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on base metal thickness (QW-403.6) and the use of single-pass welds (QW-410.9); these limitations also apply to fillet welds.

Another difficult area is impact-tested qualifications, particularly regarding heat input measurement (QW-409.1) during qualification and how it is specified on the WPS in such a way that the welder can use it. Impact test specimen locations are given in the applicable Construction Code Section, except that, if multiple welding processes are used during qualification, it may be necessary to prepare two sets of weld metal specimens to satisfy both the Construction Code requirements and Section IX's requirement to include weld metal from each process when more than one process is used in the test coupon. Section IX has no parallel requirement for HAZ specimens. Also, Section IX does not have a requirement to attempt to locate impact test specimens at the location of the highest heat input; specimen removal location is specified by the construction codes.

A common practice when addressing heat input controls is to specify the volts, amps and a minimum travel speed based on the highest voltage and amperage permitted without exceeding the qualified heat input. Sometimes this is done in sets of parameters in table form with the minimum travel speed changing proportionately with amperage changes. There are other methods and formats; however, regardless of the method or format, the welding parameters permitted by the WPS should not exceed the qualified heat input. This is determined for any *combination* of volts, amps and travel speed that is permitted, by multiplying the *maximum* voltage times the *maximum* amperage times 60 and dividing that by the *minimum* travel speed and comparing the product to the maximum qualified heat input recorded on the PQR.

Specifying heat input controls on the WPS should be done in such a way that the welder can understand what he has to do to stay within the qualified heat input limit. It is usually inadequate for a WPS to specify a broad range of volts, amps and travel speed and to address heat input limits by specifying in the WPS that "heat input shall not exceed 50,000 joules per inch," unless each welder has a calculator and a stop watch and knows how to do the appropriate calculations relating amps, volts and travel speed. If WPSs simply specify the maximum heat input, the auditor should have the welder demonstrate his ability to determine the minimum travel speed for the amps he is using.

Another acceptable way of controlling heat input is by control of bead size. If this method is selected, the bead *width* and *thickness* have to be controlled, and the product of any permitted width X thickness may not exceed the product of the width X thickness qualified.

For SMAW, the easiest way to control heat input is to control the length of weld bead deposited per unit length of electrode consumed. Since it takes a certain amount of energy (watts, joules, etc.) to melt a specific length of electrode, the heat input depends on the length of weld metal deposited per unit length of electrode consumed. That is, the heat input is doubled if the heat from a given length of electrode is spread out over a 2 inch long bead as compared to spreading it out over a 4 inch long bead. With this method, the actual deposit length per unit length of electrode (e.g., "4 inch long bead per 12 inches of electrode length consumed") should be recorded on the PQR, and the WPS should specify a minimum bead length per unit length of electrode (e.g., "for

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each 6 inches of electrode length consumed, deposit a weld bead at least 2 inches long”) that does not exceed the unit length qualified.

## Welder Qualifications

Another indicator a successful welding program is whether or not the auditee's responsible person can properly complete a welder qualification record or explain what the data in the "Range Qualified" column of a welder qualification record permits the welder to do in production. This line of questioning is very effective in determining what the manufacturer's or contractor's current personnel know about the Code with which they are working and if can apply it properly.

Each welder performance qualification essential variable applicable to those processes for which a welder tested should be documented in the "Actual Values" column of the welder qualification record, and the appropriate ranges for which the welder is qualified should be listed in the "Range Qualified" column for each variable on the form. If the auditee is using his own form, it should be checked against the applicable variables since the required variables may not be listed on the form. See the form and instructions at the end of this document for guidance on how to record variables. Please note that QW-301.4 only requires that ranges of qualification be provided in the "Range Qualified" column for diameter and thickness.

In addition to being qualified in accordance with Section IX, welders should have the required skill to produce welds that meet requirements of the construction code and specifications; meeting these usually require ability and skill exceeding that needed to pass a test in a test booth; if a manufacturer has a system in place for tracking the quality of workmanship of his welders (e.g., NDE reject rate, visual examination reject rates, repair rates, etc.), that is a good sign especially in a large shop or field site where supervision may not be fully aware of welder performance.

Continuity of qualification under QW-322 (6-month rule) should be reviewed. Persons who use the same welding process as welders (i.e., those doing manual or semi-automatic welding) and as welding operators (i.e. those using machine or automatic welding equipment) must be qualified separately and their continuity must be maintained separately. Continuity only needs to be maintained for each process, not for each WPS, electrode type, base metal, or any other variable. In all cases, the manufacturer or contractor should be able to show when the last date was that a welder or operator use a process, and that date should not be more than six months previous to the audit date if the welder or operator is currently using the process. In order to demonstrate continuity of qualification prior to the most recent weld date, many manufacturers and contractors have records that track back to the date of qualification without a break of more than six months; however, this historical record is not necessary provided the manufacturer or contractor has a system which identifies when a six month period has been exceeded and the welder is automatically moved into the inactive file for that process. Regardless of which system is used, the system should be set up to be sure that those responsible for assigning work to the welder or operator know what a welder is qualified to do and that his qualifications are current.

## Conclusions and Summary of Part 1

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The above describes specific Section IX details regarding what has to be on a WPS, on a PQR and the relationship between the two. This evaluation may not establish anything about the welding knowledge that is present in the organization being audited; an evaluation of welder qualification and how it is implemented may tell you something about the current technical and QC oversight knowledge.

## Part 2 -- Auditing Welding Activities

This leads us to Part 2, which is a suggested approach to auditing implementation of Code welding in a shop and a list of things that an auditor can look at to evaluate the ability of a shop to demonstrate its ability to comply with the welding requirements of the Code.

The following is one approach to determine that those controlling welding at the manufacturer or contractor's facility know enough about welding to control it properly. There may be other suitable approaches. Unlike the previous Part, which dealt with how to review WPSs for code compliance, the following is to be used in an *informal manner as guidance* to auditors in evaluating a manufacturer or contractor's control of welding as a manufacturing process. It is important, however, to recognize that some of the suggestions in this Part are related to the implementation of the WPSs that were reviewed in Part 1, and that the auditor should establish by some method to assure himself that the WPSs are being properly implemented, not just that they meet code.

It should be noted that Section IX does not require that the welder have a copy of the WPS with him or immediately accessible while he is welding. On the other hand, the purpose of the WPS is to provide the welder with direction. It is an acceptable practice for the welder's supervisor to provide verbal direction to the welder based on the requirements of the WPS. Normally, the WPS will be immediately available to the supervisor who is providing the direction, but there may be other ways of accomplishing the same goal -- providing direction to the welder.

### Initial Review of Welds and Responsible Personnel

The auditor should see some welding going on during his audit; for example, you might want to request that the demonstration piece (or at least part of it) be welded out while you watch. Before welding is started, check the fit-up on some welds (select a couple of welds, such as one circumferential butt weld, one large nozzle weld and one small (less than 2-1/2 inch OD) nozzle) and verify conformance to the WPS joint design and root spacing and alignment (which may be dictated by the construction code). When welding is complete, perform visual examination of some welds for surface appearance, undercut and reinforcement on all accessible surfaces, including the inside of nozzle welds using a flashlight and mirror to check for incomplete penetration (where required), paying special attention to those areas that are not easy to examine visually.

The auditor should ask the welders (or supervisor, if direction is provided by the supervisor) and the inspector how they know what welding electrode/filler metal they should be using, including how to go from the classification or other identification on the WPS to the identification on the actual product being used (e.g., the WPS specifies ER309LSi, how does the welder know that he is

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using ER309LSi?). Other items, such as shielding gas, gas flow rate, volts, amps, initial cleaning, preheat, etc. should be similarly checked against the WPS as applicable.

If impact testing is involved, the auditor should ask the welder how and when he measures the interpass temperature and how he knows what to do to control heat input (i.e., how does he know the amperage (or comparable power supply setting) and the travel speed that he is required to use and how does he measure these during welding.)

The auditor should involve the auditee's inspection personnel in these examinations and verify that they have the tools to perform fit-up inspection and final inspection; one suggested method is to have those persons perform an examination first, then perform the examination yourself to determine whether the inspector did the job properly or not. The auditee's inspector should show the auditor what he uses as a basis for performing his examinations (drawings, standards, WPSs, etc.), how he performs visual examination and how he knows whether or not what he inspected is acceptable (construction code itself, cheat-sheets, inspector's handbook based on construction code requirements, etc.). The auditor should verify that such working documents address the applicable Code Section weld quality criteria (soundness, surface condition, reinforcement, undercut, penetration, etc.).

## In-depth Review of a Few Good Welds

In conjunction with the above, the auditor should conduct a detailed review of documentation.

The WPSs that were followed for these specific welds should be reviewed in detail against Section IX as described in Part 1 of this document.

The auditor should verify that the joint design and fit-up are adequately detailed for the welding process being used. He should also check to be sure that the sizes of fillet welds are specified on the drawings, and that there is a limit on or a standard practice for compensation for fillet weld root openings which are above a certain size for attachments and supports.

The auditor should verify that the equipment needed for beveling to the required angles and to the accuracy specified in the WPS and cleaning equipment as specified by the WPSs is available.

The Auditor should verify that the welding electrodes or fillers used on the selected sample welds were those specified in the WPSs that were specified on the traveler.

The auditor should examine how welding consumables (including electrodes, filler metals, shielding gases and fluxes) are controlled. This review should closely examine whether or not responsible personnel can identify different consumables properly, how they are controlled and distributed to ensure that the consumables specified on the WPS are used and how consumables are stored to avoid contamination, including storage of coated electrodes in rod ovens. Shielding gases should be checked to be sure that they are of the composition or trade name specified on the WPS.

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When preheating is anticipated, the methods and equipment used for maintaining minimum pre-heat temperature during welding should be examined for adequacy of heating capacity. The availability of tools (pyrometer, crayons, etc.) to measure preheat temperature and, when specified by the WPS, the interpass temperature, should be examined. Whether or not personnel know how to use them should be demonstrated. The auditor should use his judgment when the likelihood of exceeding an interpass temperature limit is not likely (e.g., SMAW on field-erected tanks) making it unnecessary to have interpass temperature measuring equipment.

Any welding done by machine or automatic methods should have volt and ammeters (or wire feed speed meters) that are periodically checked for accuracy. Other methods for checking wire feed speed may be used in lieu of meters, but welders should be able to demonstrate that they know how to use them. Welding leads and connections should be tight since loose connections will affect arc voltage.

The supervision of the welder should be reviewed. If the welder actually has the WPS in his work package, his depth of understanding of the WPS (and other documents related to proper Code construction) should be established. If he receives direction from his foreman, the foreman's sources and the foreman's depth of understanding of the WPS and other related documents should be established, and the accuracy of the information passed to the welder should be checked. That the welder actually does what is required by the WPS and other fabrication documents should be verified.

For each welder or operator who welded on selected welds, qualifications should be reviewed against the variables in QW-350 or QW-360 as applicable. Once proper qualification as required by Section IX has been established, the conditions in the "Range Qualified" column should be compared against what the welder actually did in production. The following are some commonly missed items against which welder's qualifications should be compared:

Welders should only have welded using the process(es) for which they are qualified.

When checking any welder who welds on pipe or makes a nozzle weld, the diameter for which he qualified should be checked against the diameter of the welds that he made in production.

Welders who qualify using gas backing must use gas backing during production welding, even though the materials on which they may be welding do not normally require use of gas backing.

Welders who qualify using GMAW spray, globular or pulsed welding may not use short circuiting transfer welding and vice-versa.

Welders who qualify using E6010 (F-No. 3 electrode) may not make welds using any other F-number electrode unless welding with that other electrode is done on backing.

Welders who qualify using GTAW in combination with some other process may not make welds using the other process unless that welding is done on backing.

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If any bend test specimens are available, they should be examined, paying particular attention to the fact that the radius of the bend is normally 2 times the test specimen thickness, i.e., a 1/4" thick specimen should be bent around a 1/2" radius, not the standard 3/4" radius (This general rule may not be true for materials other than carbon and alloy steels; see QW-466). The inspector, the welder's supervisor and the welder should be asked how they know what each welder is qualified to do -- that information does no good stuffed away in QC files; it has to be provided to those who will supervise the welders.

## **Summary of Part 2**

Part 2 of this document lists what auditors should look at when reviewing the welding aspects of a shop for a Code stamp. Reviewing the competence of a shop's welding practices in the depth described above requires a reasonable level of knowledge in welding, including reasonable understanding of what Section IX and the applicable Construction Codes require related to welding.

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## QW-451.1, Illustrated

### Single Process

PQR No.	Test coupon thickness (T)	Base Metal Thickness Range (T) qualified	Test Coupon Weld Metal Thickness (t)	Maximum Weld Deposit Thickness (t) Qualified
1	3/16 in. (5mm)	1/16 to 3/8 in (1.5 to 10 mm)	SMAW t=3/16 in (5 mm)	3/8 in (10mm)
2	3/8 in (10 mm)	1/16 to 3/4 in. (1.5 to 20 mm)	SMAW t=3/8 in. (10 mm)	3/4 in. (20 mm)
3	1/2 in. (12 mm)	3/16 to 1.0 in (5 to 24 mm)	GTAW, t=1/2 in. (12 mm)	1 in (24 mm)
4	1 in (25 mm)	3/16 to 2 in. (5 to 50 mm)	GMAW-FC, t=1 in. (25 mm)	2 in. (50 mm)
5	2 in (50 mm)	3/16 to 8 in (5 to 200 mm)	SAW. t=2 in. (50 mm)	8 in (200 mm)
6	10 in (250 mm)	3/16 to 13.3 in (5 to 333 mm)	SAW, t = 10 in (250 mm)	13.33 (333 mm)

### Multiple Processes

PQR No.	Test coupon thickness (T)	Base Metal Thickness Range (T) qualified	Test Coupon Weld Metal Thickness (t)	Maximum Weld Deposit Thickness (t) Qualified
6	3/8 in (9 mm)	1/16 to 3/4 in. (1.5 to 18 mm)	GTAW, t=1/8 in. (3 mm) SMAW t=1/4 in. (6 mm)	GTAW, 1/4 in (6 mm) SMAW, 1/2 in. (12 mm)
7	1/2 in. (12 mm)	3/16 to 1.0 in (5 to 24 mm)	E6010 t=1/8 in. (3 mm) E7018 t=3/8 in (9 mm)	E6010, 1/4 in.(6 mm) E7018, 3/4 in. (18 mm)
8	1 in (25 mm)	3/16 to 2 in. (5 to 50 mm)	GMAW-FC, t=1/2 in. (12.5 mm) GTAW t= 1/2 in. (12.5 mm)	GMAW-FC, 1 in. (25 mm) GTAW, 1 in. (25 mm)
9	1 in (25 mm)	3/16 to 2 in. (5 to 50 mm)	GTAW t= 1/4 in. (6 mm) GMAW-FC, t=3/4 in. (19 mm)	GTAW, 1/2 in. (12 mm) GMAW-FC, 1 in. (50 mm)
10	1.5 in (38 mm)	3/16 to 8 in (5 to 200 mm)	SAW. t=3/4 in. (19 mm) GMAW-FC t=3/4 in. (19 mm)	SAW, 8 in (200 mm) GMAW-FC, 8 in (200 mm)
11	2 in (50 mm)	3/16 to 8 in (5 to 200 mm)	GTAW t=1/2 in. (12 mm) SAW. t=3/4 in. (19 mm) GMAW-FC t=3/4 in. (19 mm)	GTAW, 1 in. (24 mm) SAW, 8 in (200 mm) GMAW-FC, 8 in (200 mm)
12	10 in (250 mm)	3/16 to 13.3 in (5 to 332 mm)	GTAW t= 1/4 in. (6 mm) GMAW-FC, t=3/4 in. (19 mm) SAW, t = 9 in (225 mm)	GTAW, 1/2 in. (12 mm) GMAW-FC, 13.3 in. (333 mm) SAW, 13.3 (333 mm)

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## Welder Qualification Record (WQR)

Welder's Name: \_\_\_\_\_ 1  
 Clock or Social Security No: \_\_\_\_\_ 2 Stamp No: \_\_\_\_\_ 3

### Test Description

Identification of WPS followed: \_\_\_\_\_ 4  5 Test coupon  6 Production Weld  
 Specification of Base Metal(s): \_\_\_\_\_ 7 Thickness: \_\_\_\_\_ 8

### Testing Conditions and Qualification Limits

Welding Variables	Actual Values	Range Qualified
Welding Process(es) Used:	9	10
Type of welding (manual or semi-automatic):	11	12
Base Metal P-Number _____ 13 to P-number:	14	15
<input type="checkbox"/> 16 Plate <input type="checkbox"/> 17 Pipe (enter diameter if pipe or tube):	18	19
Backing (metal, weld metal, backwelded, etc.):	20	21
Filler Metal or Electrode Specification (e.g., SFA) (info only):	22	
Filler Metal or Electrode Classification (info only):	23	
Filler Metal or Electrode F-Number(s):	24	25
Solid, Metal Cored and Flux Cored Wire Type for GTAW:	26	27
Consumable Insert for GTAW or PAW:	28	29
Deposit Thickness* for each process, electrode type, etc. (in.):	30	31
Position (2G, 6G, 3F, etc.):	32	33
Progression (Uphill or Downhill):	34	35
Fuel Gas for OFW, Backing Gas for GTAW, PAW, GMAW:	36	37
GMAW Transfer Mode (Short Circuiting, Spray, etc.):	38	39
GTAW Current Type/Polarity (AC, DCEP, DCEN):	40	41

\* an asterisk after the actual deposit thickness indicates that there were at least 3 layers of weld metal for that process, electrode type, etc. per QW-306

### Test Results

Visual Examination of Completed Weld: \_\_\_\_\_ 42 Date of Test: \_\_\_\_\_ 43

Bend Test  44 Transverse Root and Face  45 Longitudinal Root and Face  46 Side

Type	Result	Type	Result	Type	Result
47	48				

Alternative Volumetric Examination Results: \_\_\_\_\_ 49 Lab Test No. \_\_\_\_\_ 50

Fillet Weld - Fracture Test: \_\_\_\_\_ 51 Length and Percent of Defects: \_\_\_\_\_ 52

Macro Examination: \_\_\_\_\_ 53 Fillet Size (in): \_\_\_\_\_ 54 X \_\_\_\_\_ 54 Concavity/Convexity (in) \_\_\_\_\_ 55

Other Tests: \_\_\_\_\_ 56

Film or Specimens Evaluated By: \_\_\_\_\_ 57 Company: \_\_\_\_\_ 58

Welding Supervised By: \_\_\_\_\_ 59 Company: \_\_\_\_\_ 60

We certify that the statements in this record are correct and that the test coupons were prepared, welded and tested in accordance with the requirements of Section IX of the ASME Code.

Company: \_\_\_\_\_ 61

By \_\_\_\_\_ 62 Date: \_\_\_\_\_ 63

# Auditing of Welding Under ASME Section IX

## Guidance for Completion of Welder Qualification Record Form QW-484A

This is intended to serve as a general guideline for manufacturers and contractors in completing welder qualification records; it also works well as a guide in reviewing welder qualification records.

There are more ways of entering data on these records than are shown below. The data entered in the "Actual Values" column can be different from that shown below as long as they accurately describe what the welder did when the welded the test coupon. The data entered in the "Range Qualified" column is based on what is in the "Actual Values" column as applied to the specific variable. The range qualified can be more restrictive than what is permitted by Section IX.

The paragraph numbers correspond to the numbers on the lines on Form QW-484A. These instructions are applicable to SMAW, GTAW, PAW, GMAW (including FCAW), OFW and semi-automatic (hand-held) SAW. When completing the "Testing Conditions and Qualification Limits" section, the general guidance is in the format: "If you put this in the "Actual Values" column, this is what goes in the "Range Qualified" column." *Sentences in italics are the references to the applicable paragraphs in Section IX that address the item.*

1. Enter the Name of the Welder who has been tested. *See QW-306.*
2. Enter the Welder's Clock or SS Number. CAUTION: There may be privacy issues with recording SS Numbers.
3. Enter the Number(s), Letter(s) or Symbol(s) that the Welder has been assigned to identify his or her work. *See QW-301.3.*
4. Enter the number(s) and/or letters which identify the WPS which the Welder or Operator followed during welding of the test coupon. Include the Revision Number and/or date of issue. *See QW-304, second paragraph.*
5. Mark this box if the test was given on a test coupon. *See QW-304.*
6. Mark this box if the test was given using a production weld. Use of production welds is not permitted when the welding process is GMAW-S (i.e., in the short-circuiting transfer mode) since welders who use GMAW-S must be qualified by bend test -- unless the examination is by UT and the test coupon is over ½ inch thick. *See QW-304.*
7. Enter the Specification, type and grade of the base metal(s) which made up the test coupon. *See QW-310.1 and QW-423.2.*
8. Enter the thickness of the base metal. It is customary to enter the nominal thickness; however one may measure and record the actual thickness if desired.
9. Enter the Welding Process or Processes that the Welder used to weld the test coupon. When more than one process, electrode type or other variation on a process is used, separate these by a slash (/). (e.g. GTAW/SMAW). *See QW-306.* Continue this practice for other variables that might be different for different processes or other variables used in the same test coupon.
10. Enter the same process(es) in this space as was entered in space 9. *See QW-306.*
11. Enter the Welding Process Type. Types are: Manual (MA), Semi-Automatic (SA), Machine (ME) and Automatic (AU). A person who qualifies using manual or semi-automatic welding is a Welder. *See QW-304.* A person who qualifies using machine or automatic welding is an operator, and Form QW-484B should be completed instead of this form. *See QW-305.* Separate qualifications (i.e., two tests) are required for the same person using the same process as both a welder and as an operator. *See QW-300.1, second paragraph.*
12. Enter the same type of welding in this space as was entered in space 11. If the welder will use both manual and semi-automatic GTAW, both types of welding maybe entered (i.e. "Manual, Semi-auto"). *See QW-300.1, second paragraph.*
13. Enter the P-number(s) of the one material making up the test coupon. *See QW-403.18.* P-number assignments are listed by specification, type and grade in QW/QB-422. If either material does not have a P-number, see QW-420.1, QW-420.2 and QW-423.1 and QW-423.2. If there is no way to assign the base metal a P-number under the provisions of these paragraphs, write down the specification and grade of the test coupon material -- and write small.

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14. Enter the P-number(s) of the other material making up the test coupon. See 13.
15. Enter the P-number (or the range of P-numbers) of the materials that is qualified by the test coupon *per QW-403.18 which leads to QW-423.1*. If unclassified materials are to be welded, examine the right-hand column of QW-423.1 carefully and also QW-423.2 to see if unclassified materials can be assigned a P-number. If there is no way to assign the base metal a P-number, write down the specification and grade of the test coupon material shown in steps 12 and 13.
16. Mark this box if the test coupon is plate. See *QW-310.1*
17. Mark this box if the test coupon is pipe, tube or other hollow product form. See *QW-310.1*
18. Enter the nominal thickness of the test coupon base metal(s). See *QW-403.2 if OFW*. Measured thickness may also be entered, but the fact that the thickness was measured should be noted since this practice is nonstandard. When using pipe, enter the pipe size (NPS) or outside diameter. When using tube or other hollow shape, enter the outside diameter (OD) of the material. See *QW-403.16*.
19. Enter the minimum outside diameter qualified based on *QW-452.3* if the test coupon was a pipe or tube groove weld qualification. Use *QW-452.4* if the coupon was a pipe fillet qualification. Enter "over 24 in. OD" if the coupon was plate. Note that a welder qualified on plate may weld on pipe down to 2-7/8 in. OD if welding is done in the flat position. This not customarily entered on the qualification record except if the qualification is limited to the flat position. See *QW-403.16 which leads one to QW-452.3 and QW-452.4 for pipe test coupons*. Also see *QW-405.1 which leads to QW-461.9 for plate test coupons*. If OFW, enter the thickness of the test coupon. See *QW-403.2*.
20. Enter the type of backing used. Backing can be a backing strip, nonfusing metal backing (e.g. copper), flux, tape and weld metal deposited by another process. A weld made from two sides of a groove is considered welding on backing, as is a fillet weld test. Potential entries are "None," "Used," "Weld metal," "welded both sides." See *QW-310.2 and QW-310.3*. If more than one process or variation of process is used (See *QW-306*), it must be recorded that backing was "used" for the subsequent processes or variations of process.
21. If backing was "used" in space 20, enter "Required." If backing was not used, enter "Optional." See *QW-402.4*. If the welding process was OFW, it is the opposite. See *QW-402.7*.
22. Enter the specification (e.g. SFA 5.4) of the electrode or filler metal that was used. If the weld was made without the addition of filler metal, enter "None." See *QW-404.4 and QW-404.14*.
23. Enter the Classification (e.g. E309-16) of the electrode or filler metal that was used. If the weld was made without the addition of filler metal, enter "None." See *QW-404.4 and QW-404.14*.
24. Enter the F-number of the filler metal. See QW-432 of Section IX. The F-number depends on the welding process and electrode or filler metal that was used. See *QW-404.15 which leads to QW-433*. If the weld was made using GTAW, PAW or OFW without the addition of filler metal, enter "None." See *QW-404.14*.
25. Enter the F-number or range of F-number filler metals that the welder is qualified to use. See *QW-404.15 which leads to QW-433*. If the weld was made without the addition of filler metal, enter "None." See *QW-404.14*.
26. For GTAW or PAW, record whether solid, metal cored or flux cored wire was used. Leave blank (or enter "NA") if the welding process is other than GTAW or PAW. See *QW-404.23*
27. Leave blank (or enter "NA") if the process is not GTAW or PAW. If solid or metal cored was recorded in space 26, enter "solid, metal cored" in this space. If flux cored was recorded in space 26, enter "flux cored" in this space. See *QW-404.23*
28. If a consumable insert was used in the root pass, enter "Used;" If an insert was not used, enter "None." Leave blank (or enter "NA") if the Process is not GTAW or PAW. See *QW--404.22*.
29. Leave blank (or enter "NA") if the Process is not GTAW or PAW. If an insert was used during the qualification test, enter "Required." If no insert was used, enter "Not Permitted." See *QW-404.22*.
30. Enter the approximate deposit thickness for each welding process, each F-number and for each set of essential variables. See *QW-306*. That is, if more than one process or variation on a process is used (e.g. E6010 root/E7018 balance, downhill root/uphill fill, etc.), enter a separate deposit thickness for each variation. See *QW-452.1(b) Note 1 and QW-351, third paragraph*. Also, if the deposit thickness for any process or set of variables equals or exceeds ½ inch thickness, enter an asterisk (\*) after that thickness value.

If you are using the Section IX form, follow these instructions for the lines following "Deposit thickness

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for each process” in lieu of items 30 and 31.

1. Enter the deposit thickness for each process and variation as above. If the welder used 3 or more passes with a process, check "Yes" for that process.
2. If the welder also deposited at least 1/2 inch of weld metal with that process and set of variables, in the "Range Qualified" column enter "Unlimited" for that process.
3. If the welder did not use 3 or more passes or he did not deposit at least 1/2 inch of weld metal with a process and set of variables, multiply the value in the actual values column by 2 (1.1 for GMAW-S) and record that in the range qualified column.
  
31. Enter the maximum thickness of weld metal that the welder is qualified to deposit for each process, electrode type or set of essential variables. If the welder deposited at least 1/2 inch of weld metal with a process and set of variables, enter "Unlimited" for that process. If the welder did not use 3 or more passes or he did not deposit at least 1/2 inch of weld metal with a process and set of variables, multiply the value in the actual values column by 2 (1.1 for GMAW-S, 1.0T for OFW) and enter that value. *See QW-404.30 which leads to QW-452.1(b) and QW-451.2. For GMAW-S, See QW-404.32. For OFW, see QW-404.31. Also note that QW-433 may permit F-1 through F-4 electrodes other than the F-number that was used on the test coupon.*
32. Enter the position in which the test coupon was welded. These are 1G, 3G, 6G, 3F, etc. *See QW-405.1, QW-303.1, QW-303.2 and QW-303.3 for requirements. See QW-120, QW-130 for definitions of testing positions. These paragraphs lead to QW-461.3 through QW-461.6 sketches.*
33. Enter the welding positions in which the welder may weld. These are Flat (F), Vertical (V), Horizontal (H), Overhead (OH) and "All." *See QW-405.1 which leads to Table QW-461.9. Use QW-461.9 to determine the positions qualified based on the type of test coupon and position(s) of the test coupon. See QW-110 which leads to figures QW-461.1 and QW-461.2 that define weld orientations for production groove and fillet welds respectively.*
34. Enter the progression ("Uphill" or "Downhill") that the welder used if the test coupon was welded in the 3G, 5G, 6G, 3F or 5F positions. Enter nothing (or enter "NA") if welding was done in any other position. *See QW-405.3.*
35. Enter the same data ("Uphill" or "Downhill" or nothing [or enter "NA"]) as in space #34. Welders are generally limited to welding in the progression in which they test. *See QW-405.3. Although QW-405.3 permits welders to make root welds that will be removed by backgouging and the cover or wash pass to be made either uphill or downhill, this is not customarily mentioned on the qualification record.*
36. Enter "Used" if backing gas was used. Enter "None" if no gas backing was used. Leave blank (or enter "NA") if the process is not GMAW, GTAW or PAW. *See QW-408.8* If OFW, enter the fuel gas used by the welder (e.g. "acetylene"). *See QW-408.7*
37. If gas backing was used, enter "Required." If gas backing was not used, enter "Optional." If space #36 is blank (or "NA"), enter nothing (or "NA"), as appropriate. *See QW-408.8* If OFW, enter the fuel gas entered in space 36. *See QW-408.7.* It should be noted that, if qualification was done "on backing" and no backing gas was used, "optional" or "with and without" are correct entries in this space since the welder is qualified to weld with and without backing gas. This is somewhat strange since backing gas is not normally used when welding "on backing" except for P-10I, P-51 through P-53 and P-61 metals; however, recording the fact that backing gas is "optional" documents the range qualified properly.
38. Enter Spray (SP), Globular (G), Spray Pulse(P) or Short Circuiting (S) if the process used is GMAW. Leave blank (or enter "NA") if the process is not GMAW *See QW-409.2.* (Note: GMAW includes FCAW [*See the header of QW-355 and the definition for FCAW.*]) FCAW transfer mode is either Spray or Globular unless it is was used for open root welding, in which case it is short-circuiting.
39. Enter Spray, Globular and Spray Pulse (SP,G,P) if any of these were entered in space #38. Enter Short Circuiting (S) if short-circuiting was entered in space #38. Leave blank (or enter "NA") if the process is not GMAW or FCAW. *See QW-409.2.*
40. Enter the current type (AC or DC), and if DC, enter the polarity (Straight (SP) or Reverse (RP)). Leave blank (or enter "NA") if the process is not GTAW. *See QW-409.4.*
41. Enter the same data in this space as is in space 40. *See QW-409.4.*

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## Examination and Testing

42. Enter "Acceptable" for the results of visual examination of the completed test coupon. Visual examination of the coupon is required for coupons that will be mechanically tested and is recommended for those that will be radiographed. *See QW-304 and QW-452.1(a)*
43. Record the date that the test coupon was welded. *See QW-322.*
44. *See QW-160 for preparation of bend test specimens.* If bend tests were performed and the bend test specimens were transverse root and face bends, check this box. Face and root bends are required for test coupons up to 3/8 inches thick. Between 3/8 and 3/4 inches thick, root and face bends are optional. *See QW-452.1, notes 5 and 7.*
45. If bend tests were performed and the bend test specimens were longitudinal root and face bends, check this box. Longitudinal bend specimens may be used in lieu of transverse specimens when the bending properties of the weld metal and/or the base metals vary markedly. *See QW-161.5.* Face and root bends are required for all test coupon thicknesses. *See QW-452.2* Hopefully, you will never have to use this test since the test coupon is quite long.
46. If bend tests were performed and the bend test specimens were side bends, check this box. Side bend specimens may be used for test coupon thicknesses between 3/8 and 3/4 inches thick, and side bends are required for coupons over 3/4 inch thick. *See QW-452.1.*
47. Enter the type of bend specimen (i.e., Face, Root, Side).
48. Enter the results of each bend specimen. All results such as "Acceptable," "OK" or similar word must indicate that each specimen was or was not acceptable. The results may describe in detail the extent of discontinuities found (e.g., 42 openings < 1/8 long, 14 pinholes, < 1/8" long, no open discontinuities, etc.). "Acceptable," "OK" or similar word indicating conformance to QW-163 should also be entered when discontinuities are described. *See QW-163.*
49. If the test coupon was volumetrically examined instead of mechanically tested, enter the test method and the results. All results must indicate that each coupon was or was not acceptable. It is good practice to attach the test laboratory's report to the qualification record. It is not smart to keep radiographs since they are always subject to deterioration and to reinterpretation by others at a later date. *See QW-302.2 and QW-304.1. Note that at least 6 inches of weld length are required to be examined.*
50. Enter the identification number assigned by the testing lab if a lab was used. If radiographic reader sheets are identified by a lab number or similar unique identifier, enter that identification.
51. Enter the results of the fillet weld fracture test, if fillet weld tests are conducted. *See QW-452.5 and QW-181.2*
52. Enter the length and percent of defects found during the fracture test, if fillet weld tests are conducted. *See QW-452.5 and QW-182.*
53. Enter the results of the fillet weld macro fusion test, if fillet weld tests are conducted. *See QW-452.5 and QW-184.*
54. Enter the size of the fillet weld legs from the fillet weld macro fusion test, if fillet weld tests are conducted. *See QW-184.*
55. Enter the measured concavity or convexity from the fillet weld macro fusion test if fillet weld tests are conducted. *See QW-184.*
56. Enter the description and results of any other testing that was done.
57. Enter the name and title of the individual who evaluated the mechanical or volumetric tests. Qualifications for those who performed volumetric examination shall be as required by Section IX, QW-190 (ASNT-SNT-TC-1A). *See QW-190.* Persons who evaluate bend test coupons shall determine that the bend test specimens have been prepared in accordance with *QW-161* and that they were bent around the correct radius per *QW-162 and QW-466.1*, and that each specimen meets the acceptance criteria of *QW-163*.
58. Enter employing company of the individual who evaluated the mechanical or radiographic tests.
59. Enter the name and title of the individual who supervised the actual welding of the test coupon. This person must be an employee who works for the company that is qualifying the welder. This person does not have to witness welding of the entire test coupon, but he should see enough to verify that the data that will be recorded on the qualification record form is an accurate record of what the welder actually did. *See QW-300.2.*

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60. Enter employing company of the individual who supervised the welding of the test coupon. This should be the same company name as is shown in space 61. *See QW-300.2*
61. Enter the name of the company that is qualifying the welder or operator. *See QW-103.2*
62. Signature and title of the individual certifying the qualification record of the welder or operator for the qualifying organization. *See QW-103.2*. This does not need to be the same individual as entered in space 59.
63. Date of certification. This date will usually be sometime after the date of the test shown in space 43. If qualification records are ever reformatted, the test date should remain unchanged and the certification date (space 43) should be the actual date of certification.

**Interpretation: IX-89-03**

Subject: Section IX, QW-100.1 and QW-200.1

Question (1): Is it required that all of the essential and nonessential variables listed in QW-250 through QW-280 for each welding process be addressed in the WPS, even though some of these variables are not applicable?

Reply (1): Yes.

**Interpretation: IX-83-03**

Subject: Section IX, QW-200

Question (1): Is omission of an essential, nonessential (or supplementary essential) variable from a WPS interpreted to be a negative response for that variable? .

Reply (1): No. The Code requires that every variable for the appropriate welding processor processes (QW-252 through QW-282) be listed on the WPS.

**Interpretation: IX-79-108**

Subject: Section IX, Identification of Essential and Nonessential Variables

Question: Is it required by Section IX that every applicable essential and nonessential variable be identified on a single document called a WPS, or may the variables be addressed on one or more documents identified on the WPS form for use in conjunction with the WPS?

Reply: The format of the WPS may be any which will fulfill the needs of the stamp holder: a single document, a series of documents properly referenced together, a welding drawing, etc. The WPS, regardless of the format selected, shall include all essential, nonessential, and, when required, supplemental essential variables for the process or processes within the document or documents comprising the WPS.

**Interpretation: IX-79-75**

Subject: Section IX, Regarding Clarification of QW-200.1

Question: Is any further information other than that which appears on Form QW-482 required for a welding procedure specification (WPS)?

Reply: Form shown in QW-482 is a suggested format for the required information; a WPS may be presented in any form as long as every essential and nonessential variable covered by QW-252 through QW-282 is presented. Any additional information is not required but may be attached to the WPS at the option of the manufacturer.

**Interpretation: IX-79-73**

Subject: Section IX, Regarding the Preparation of a Procedure Qualification Record, QW-100 and QW-200

Question (1): Does QW-100.1 require the PQR to identify the actual amperage and voltage used and prohibit the PQR from showing voltage and amperage ranges when voltage and amperage are nonessential variables?

Reply (1): No. Voltage and amperage ranges may be recorded within the limits of a narrow range, rather than the full range of the variables allowed.

Question (2): QW-200.2 states, "The PQR form shall list the actual variables used within the limits of a narrow range rather than the full range of variables allowed. A manufacturer may include all additional variables he may consider helpful such as the nonessential variables, but is only required to record the essential variables used. Does this permit the manufacturer to leave the PQR blank where nonessential variables are concerned or to fill in the nonessential variables in any manner considered to be helpful at the manufacturer's option?"

Reply (2): A manufacturer is only required to list the essential variables on the PQR; any further information may be included at his option.

Question (3): Must every WPS supported by a given PQR be listed on that PQR?

Reply (3): No.

**Interpretation: IX-80-23**

Subject: Section IX. Recording of Measured Values of Variables in the PQR, QW 200.2

Question: Is it required to record the actual values of nonessential variables in the Procedure Qualification Record?

Reply: No.

**Interpretation 10-16**

Background: QW-404.24 and QW-404.27 are essential variables for the SAW process. A procedure qualification test was conducted using the SAW process without the use of supplemental filler metal.

Question: Is it required that the PQR indicate that supplemental filler metal was not used and must the WPS prohibit its use.

Reply: Yes, however, Section IX does not specify the manner in which this is documented on the PQR or specified on the WPS. The method of recording information on the PQR and WPS may be by statement, sketch or other means as long as the essential variables are addressed.