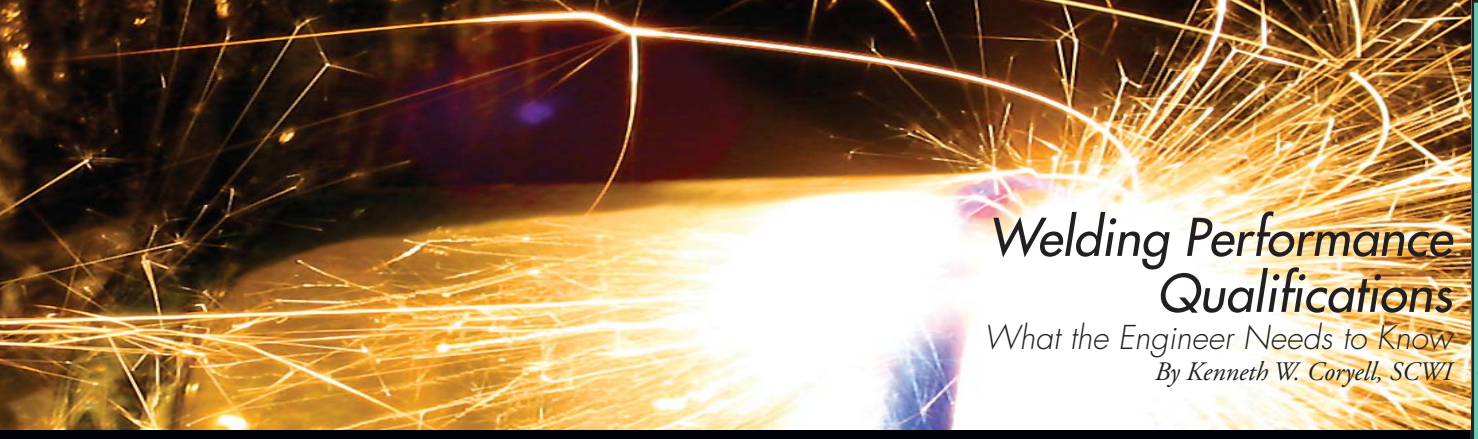

Welding Performance Qualifications

What the Engineer Needs to Know

By Kenneth W. Coryell, SCWI

Welding performance qualifications (WPQ's) are a second crucial element in the control of welding quality. An earlier article, *Welding Procedure Specifications — What the Engineer Needs to Know* (STRUCTURE®, November 2005), discussed the first crucial element. Structural welding is governed by AWS D1.1/D1.1M *Structural Welding Code - Steel*, which is published by the American Welding Society. The Engineer is responsible for development of the contract documents for work performed under this Code, and must address provisions for the welding performance qualifications. The Code has some flexibility as to how personnel can be qualified, but the Engineer is responsible for accepting programs which are different than described in the Code. Engineers that are familiar with welding and welding requirements will be more effective in avoiding some of the vagueness that often appears in a number of contracts. This helps improve overall welding quality, reduces costs, and reduces probability of weld failures.

Why a formal WPQ?

Welding performance qualifications are intended to help assure that individuals performing welding operations have adequate ability and skill to produce acceptably sound welds using an approved welding procedure specification (WPS). Soundness is a qualitative assessment of how free the deposited weld metal is from flaws and imperfections. The Code requires that each manufacturer or contractor shall be responsible for the qualification of welders, welding operators and tack welders, whether the qualification is conducted by the manufacturer, contractor, or by an independent testing agency. Further, written verification of the qualification is to be provided on a Welding Performance Qualification Record (WPQR). Suggested formats are shown in *Figure 1* (D1.1) and *Figure 2* (B2.1) on pages 15 and 16. The WPQR documents the manufacturer or contractor's fulfillment of their statutory and legal responsibilities. Fabricators have been fined for failing to maintain such records, and in at least one case, an engineer was also fined for not verifying their existence.

Is Qualification the same as Certification?

No, and some confusion exists on this point. The Code provides some formal definitions:

> *Qualification* is the demonstration of welding personnel's ability to produce welds meeting prescribed standards.
> *Certification* is the formal written verification that a welder has produced welds meeting a prescribed standard of welder performance.

The principal difference, therefore, is the documentation and who is responsible for issuing the documentation. Qualifications are generally obtained by passing prescribed welding tests administered by a welding school, an employer, or an independent agency. A document can be issued, stating that the welder has successfully passed certain tests. This is a common practice, especially with welding schools. Welders often incorrectly claim that they have been "certified" and they have passed qualification tests. The welds made in these qualification tests are often different to the welds that will be made in production. A welder's training should be more extensive and cover all the procedures and joint details that will be encountered on the job. The responsibility for this must be with the employer.

The WPQR that is applicable to the work being performed is the employer's responsibility (not the welding school's) under the Code, even if the qualification testing was performed by an independent testing agency. This is the relevant certification. When a welder is no longer employed, he or she is no longer certified by that employer but is still qualified and may even have documents to support it. Welding personnel cannot be certified on their own. Certain jurisdictions, such as cities or states, may require a specific welder certification for work performed within their jurisdiction. The employer is still responsible for the performance of the welder. The engineer should be familiar with any local certifications that may be required and ensure they are specified in contract documents. Inspectors will then verify that certification, and monitor that welder's performance as appropriate.

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What about centralized qualification and certification?

Qualification of welding personnel is an extremely technical process and frequent errors occur. Additionally, considerable expense is involved in requalifying and recertifying welding personnel when they change employers. The American Welding Society has established a centralized program, AWS QC-7, "Standard for AWS Certified Welders". In this program, welders take a series of welding skills tests at an accredited test facility. Accreditation of these test facilities is by AWS after an on-site assessment to ensure minimum quality program standards, testing equipment, and test personnel capabilities. Welders can maintain this certification individually even when they change employers. Some fabricators accept the AWS certification as verification of the minimum welding skills, and supplement and qualify for their job unique procedures and joint details. The Engineer must approve this based on specific structures, service conditions, or local jurisdictional requirements. The employer is still responsible to ensure that the welder is capable of performing the work required by the employer. Some local jurisdictions have adopted a similar concept. For example, the state of Washington requires that all welders be certified by the Washington Association of Building Officials (WABO). Welders must pass their skills test at a test center accredited by WABO.

What are the different welding personnel classifications?

For the purposes of qualification, there are three classifications of welding personnel: welders, welding operators, and tack welders.

A welder is one who performs a manual or semiautomatic welding operation. This includes welding with a torch, gun, or electrode holder held and manipulated by hand. Part motion devices and manually controlled filler metal feeders may be used. Semiautomatic welding is manual welding with equipment that automatically controls one or more of the welding conditions, usually filler wire feed. A welder would commonly perform shielded metal arc, gas metal arc, and flux cored arc welding.

A welding operator is one who operates adaptive control, automatic, mechanized, or robotic welding equipment. Automatic welding is with equipment that requires only occasional or no observation of the welding, and no manual adjustment of the welding controls. Mechanized welding is with equipment that requires manual adjustment of the equipment controls in response to visual observation of the welding, with the torch, gun, or electrode holder held by a mechanical device. Most submerged arc welding set-ups would fit into this category.

A tack welder is a fitter, or someone under the direction of a fitter, who tack welds parts of a weldment to hold them in proper alignment until the final welds are made.

Welding performance qualification tests are to assess that the individual has a minimum skill level. The skills required of a welder, a welding operator, and a tack welder are quite different, thus different qualification tests and variables are used for each type of individual. A welder is not qualified to be a welding operator and vice versa.

Confusion sometimes arises with payroll, or quality system classifications and performance qualifications. Welders, for payroll purposes, are classified as "operators" and root cause analysis for corrective and remedial action in quality programs sometimes assigns the cause of welding defects as "operator error". The use of the term welding operator in this context has nothing to do with performance qualification testing.

What is involved in a WPQ test?

Although there are similarities, a welding performance qualification test is different from a procedure qualification test. A sample weld is made under controlled conditions and that sample is subjected to different tests. The code describes the details for the various weld configurations and specifies what testing must be performed. It is not practical to test a welder for all the different combinations of variables that will be encountered in production. The code has established limitations of ranges for certain welding variables. These variables are called essential variables (or sometimes qualification variables) and performing outside the variable range requires significantly different skills. If it is necessary to work outside this established range, then a new performance test is required. The essential variables for performance qualification testing are different from those required for procedure qualification testing. The variables are different for welders, welding operators, and tack welders, but generally they include:

Welding Process
Personnel are qualified only to use welding process(s) for which they tested. The short circuiting mode of metal transfer for gas metal arc welding requires a separate qualification.

SMAW Electrode Group
Electrodes are divided into groups and assigned "F"numbers based on usability characteristics. Higher "F" numbers require more skill than the lower numbers, so qualifying with a higher 'F" number qualifies the individual for lower numbers, but not vice versa.

Welding Position
Qualifying in more difficult positions automatically qualifies the individual for some of the easier positions.

Thickness Range and Diameter

Vertical Welding Progression
Different skills are required for welding vertically upwards and downwards. Vertical upwards does not qualify vertical downwards and vice versa.

Omission of Backing
Qualification on an open root qualifies for backing, but not vice versa.

WELDER, WELDING OPERATOR, OR TACK WELDER QUALIFICATION TEST RECORD

Type of Welder _____

Name _____ Identification No. _____

Welding Procedure Specification No. _____ Rev _____ Date _____

Variables	Record Actual Values Used in Qualification	Qualification Range
Process/Type [Table 4.11, Item (1)]		
Electrode (single or multiple) [Table 4.11, Item (8)]		
Current/Polarity		
Position [Table 4.11, Item (4)]		
Weld Progression [Table 4.11, Item (6)]		
Backing (YES or NO) [Table 4.11, Item (7)]		
Material/Spec.	to	
Base Metal		
Thickness: (Plate)		
Groove		
Fillet		
Thickness: (Pipe/tube)		
Groove		
Fillet		
Diameter: (Pipe)		
Groove		
Fillet		
Filler Metal [Table 4.11, Item (3)]		
Spec. No.		
Class		
F-No. [Table 4.11, Item (2)]		
Gas/Flux Type [Table 4.11, Item (3)]		
Other		

VISUAL INSPECTION (4.8.1)

Acceptable YES or NO _____

Guided Bend Test Results (4.30.5)

Type	Result	Type	Result

Fillet Test Results (4.30.2.3 and 4.30.4.1)

Appearance _____ Fillet Size _____

Fracture Test Root Penetration _____ Macroetch _____

(Describe the location, nature, and size of any crack or tearing of the specimen.)

Inspected by _____ Test Number _____

Organization _____ Date _____

RADIOGRAPHIC TEST RESULTS (4.30.3.2)

Film Identification Number	Results	Remarks	Film Identification Number	Results	Remarks

Interpreted by _____ Test Number _____

Organization _____ Date _____

We, the undersigned, certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in conformance with the requirements of Section 4 of AWS D1.1/D1.1M, (_____) Structural Welding Code—Steel.
(year)

Manufacturer or Contractor _____ Authorized By _____

Form E-4 Date _____

Figure 1: AWS D1.1 Suggested Format for Welding Performance Qualification Record

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PERFORMANCE QUALIFICATION TEST RECORD

(SMAW, GMAW, GTAW, FCAW, SAW, OFW, PAW)

Test Joint Sketch

Name: Welder / Welding Operator
ID No: WPS Used:
Process(es): Transfer Mode (GMAW):
Test Base Metal Specification: To
Material Number: To
Fuel Gas (OFW):
AWS Filler Metal Classification(s): F No.:
Backing: Yes / No Double Side / Single Side
Current/Polarity: AC / DCEP / DCEN
Consumable Insert: Yes / No Backing Gas: Yes / No

Test Weldment	Position Tested						Weldment Thickness (T)	
Groove: Pipe	1G	2G	5G	6G			Thickness:	Diameter:
Plate	1G	2G	3G	4G			Thickness:	
Fillet: Pipe	1F	2F	2FR	4F	5F		Thickness:	Diameter:
Plate:	1F	2F	3F	4F			Thickness:	
Cladding:	1C	2C	3C	4C	5C	6C	Thickness:	
Hardfacing:	1C	2C	3C	4C	5C	6C	Thickness:	

Progression: Vertical Up / Vertical Down

Test Results

Visual Test:	Pass	Fail	n/a
Bend Test:	Pass	Fail	n/a
Macro Test:	Pass	Fail	n/a
Break Test:	Pass	Fail	n/a
Radiographic Test:	Pass	Fail	n/a

Remarks

Qualification Limits

Process(es):

Weldment	Position					Deposit Thickness:		
Groove: Pipe:	F	H	V	O	All	t min.:	t max.:	Dia. min.:
Plate:	F	H	V	O	All	t min.:	t max.:	
Cladding:	F	H	V	O	All	t min.:	t max.:	
Hardfacing:	F	H	V	O	All	t min.:	t max.:	
						Base Metal Thickness:		
Fillet: Pipe:	F	H	V	O	All	T min.:	T max.	Dia. min.:
Plate:	F	H	V	O	All	T min.:	T max.:	

Progression: Vertical Up / Vertical Down

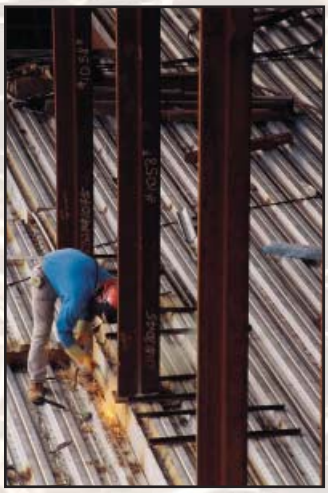
Base Metal M No(s).:
Filler Metal F No(s).:
Current/Polarity: AC / DCEP / DCEN
Backing Gas:

Fuel Gas (OFW):
Backing: Yes / No
Consumable Insert: Yes / No
Transfer Mode (GMAW):

I certify that the statements in this record are correct and the test welds were prepared, welded, and tested in accordance with the requirements of AWS B2.1 Specification for Welding Procedure and Performance Qualification.

Date Tested: Qualifier Signature:

Figure 2: AWS B2.1 Suggested Format for Welding Performance Qualification Record



The qualification weld must be welded in accordance with a suitable WPS. Often, this will be a production WPS, but frequently it is a special WPS used for qualification testing only. For example, power wire brushing and grinding may not be permitted during a qualification test, but they may be permitted in production.

The weld must pass a visual exam and is subjected to additional testing. A plate test would require two bends.

A welder who performs a procedure qualification test can also receive a performance qualification, but only within the limitations of the performance qualification essential variables.

Can radiography be substituted for bends?

Generally yes, but not with the short circuiting mode of metal transfer for gas metal arc welding. The low heat input with this technique is prone to incomplete fusion and is not reliably detected by radiography. Bends are required in this case.

Welding operators can be qualified by radiography on their initial production weld instead of a standard qualification test assembly. This provision does not apply to welders, however.

When do qualifications expire?

Under the Code, a welder's or welding operator's qualifications remain in effect indefinitely unless (1) they are not engaged in a given process of welding for which they are qualified for a period exceeding six months, or unless (2) there is some specific reason to question the welder or welding operator's ability. This means that the manufacturer or contractor must be able to certify that a welder or welding operator has been engaged in their qualified process at least every six months tracing back to the initial qualification test. This is commonly done by a qualification maintenance log book, which is sometimes computerized. Many employers update qualifications on a monthly basis, some do it more or less frequently.

Tack welder qualifications remain in effect indefinitely, unless there is some specific reason to question the tack welder's ability.

Conclusion

Welder, welding operator, and tack welder performance qualification tests provide some assurance that certain minimum welding skill levels have been met. They do not necessarily serve as an indicator of how the individual will perform on production work. The employer is still responsible for welding performance on a given job. Even with a good WPS and properly qualified and certified personnel, close monitoring of production quality should be monitored before, during, and after the actual welding.▪

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Further Reading

1. AWS D1.1/D1.1M-2004, Structural Welding Code-Steel
2. AWS A3.0-2001, Standard Welding Terms and Definitions
3. AWS B2.1-2005, Specification for Welding Procedure and Performance Qualification
4. AWS QC-7, Standard for AWS Certified Welders