

Best Practices for Performing a Welder Qualification Test



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Best Practices for Performing a Welder Qualification Test

Abstract

This document is designed as a high-level reference guide to facilitate welder performance qualification testing done in accordance with a variety of codes and standards. This document is not an official AWS standard, but does reflect the opinions of subject matter experts in the field.



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Foreword

American Welding Society (AWS) Qualification & Certification Committee has published this technical manual, the *Best Practices for Performing a Welder Qualification Test*, First Edition, to assist quality oriented professionals (inspectors and supervisors) and quality-conscious engineers and managers to apply the best practices for conducting a qualification test to a welding code or standard. This is a technical manual that was written to provide a reference guide of recommended best practices for a test supervisor and welding inspector to perform a welding test. Due to the generic nature of this technical manual, it is presented only as a guide. It is not intended to be the only source of information for conducting a welder qualification test. It is a tool that should also be considered along with applicable welding codes and standards, as well as any other relevant resources.

AWS appreciates feedback from participants in its Certification programs. Please send comments or questions to certification@aws.org or:

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Additional information on AWS products and services may be found on our website at www.aws.org.

Disclaimer

Safety and health issues and concerns are beyond the scope of this guide and therefore are not addressed in detail herein. Work performed in accordance with this nonstandard publication may involve the use of materials that have been deemed hazardous and may involve operations or equipment that may cause injury or death. This best practice document does not purport to address all safety and health risks that may be encountered. The user of this guide should establish an appropriate safety program to address such risks as well as to meet applicable regulatory requirements. *ANSI Z49.1* should be considered when developing the safety program.

Safety and health information is available from the following sources:

American Welding Society:

1. *ANSI Z49.1*, Safety in Welding, Cutting, and Allied Processes
2. AWS Safety and Health Fact Sheets
3. Other safety and health information on the AWS website

Material or Equipment Manufacturers:

1. Safety Data Sheets supplied by materials manufacturers
2. Operating Manuals supplied by equipment manufacturers
3. Applicable Regulatory Agencies

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Best Practices for Performing a Welder Qualification Test

Introduction

The purpose of this technical manual is to define the best practices for qualification testing of welders. This manual is designed as a high-level reference guide, meaning it is purposely generic in order to facilitate qualification testing done to a variety of qualification standards and influenced by the needs of employers and individual welders. Due to the generic nature of this manual, the qualifier (person administering the test) cannot rely only on this content when conducting welder qualification testing. This manual is a crucial tool, but qualifiers will also need the applicable qualification standard and a WPS appropriate for the test being conducted, as well as, any other resources relevant to the process.

This manual is divided into sections based on the three phases of welder performance qualification testing: Pre-Test Investigation, Conducting the Test, and Post-Test Activities. Further resources are included in the appendices, including sample documents the qualifier is encouraged to customize to their own needs and integrate into their regular procedures.

Welder Qualification Testing Best Practices

A qualifier should establish and then maintain a set of best practices to help ensure accuracy, repeatability and code compliance in welder performance qualification testing. Documentation is a vital part of the qualification and certification processes. The following lists of best practices and procedures should be considered and, if implemented, should be well documented.

Best Practices

- In order to avoid the appearance of any conflicts of interest, the person who trained the welder should not be the same person to conduct the welder performance qualification test. It is understood that instructors will test students during the course of their training, but the results of this testing should not then be transmitted outside of the training facility as evidence of welder competence.
- Qualifiers should not let personal preferences affect their decision to pass or fail the welder. For instance, an attractive weld may not meet acceptance criteria, whereas a weld that seems unattractive to the qualifier may still satisfy the requirements of the applicable qualification standard. When conducting and inspecting qualification tests, qualifiers should focus only on applying the acceptance criteria in the applicable qualification standard and any additional requirements imposed by the employer.
- It is the responsibility of the welder to wear personal protective equipment (PPE) appropriate for the test facility to ensure the safety of the welder. Some PPE may be provided to the welder by the facility, but this is not required. It is a best practice to identify required PPE with welders prior to the date of the test.
- The welder should be made aware the test can be terminated at any time if the qualifier deems the test is being performed in an unsafe manner or the welder has refused to comply with the safety regulations of the facility.
- Qualifiers should use a routing sheet or checklist when conducting a test in order to standardize the testing process. The routing sheet also helps the qualifier to control the testing environment when testing multiple welders. (See the Terms and Concepts to Understand section for more information about routing sheets. A sample routing sheet is also available in Appendix 1 [pg A1:1].)

Procedures

Qualifiers should have written procedures in place that are always followed when conducting welder performance qualification testing. These procedures assist in the standardization of administrative policies the qualifier follows and protect the qualifier from complaints by welders and employers. These procedures should include the following:

- **Control and traceability of materials used for the test:** The qualifier should be able to quickly identify whether a material is appropriate for the qualification test being performed. This means materials should be acquired from reputable sources, properly marked, and stored in an organized manner with relevant information about each material readily accessible.
- **Welding Procedure Specifications (WPS) used for testing:** The qualifier should ensure an appropriate WPS is available to the welder and followed during welding of the test coupon. This document can either be supplied by the qualifier or the employer. (See the Terms and Concepts to Understand section for more information about a WPS.)
- **Reference library:** Qualifiers should have a library of commonly referred to qualification standards for performance qualification testing. At a minimum, the qualifier must have access to the applicable qualification standard(s) being used for the qualification test throughout the testing process.
- **Unique identifier:** A unique identifier must be assigned to each test or to each welder to ensure the test is correctly attributed to the welder who was tested. The unique identifier can be anything the qualifier wishes to use, as long as the qualifier remains consistent. The uniqueness should be to the test and not necessarily to the welder, who may take multiple tests (but with differing WPSs) given by the qualifier.
 - Some identifiers commonly used to identify welders include the last four digits of the welder's Social Security number, the welder's union number, a government-issued ID number, etc.
 - Some identifiers commonly used to identify tests include the WPS number, test position, test process, facility, etc. Combinations of these examples, or of any other unique identifiers can be used. Whichever identifier(s) are used, the qualifier must ensure each test can be isolated from all others conducted at that same facility.
- **Measuring and testing equipment:** The qualifier is responsible for verifying the calibration and operation of any testing equipment, whether that equipment is provided by the testing facility or employer.
- **Off-site testing practices:** Welder performance qualification testing may sometimes need to be conducted outside the qualifier's testing facility. General best practices should be established for such an event, taking into account that the qualifier is responsible for the safety of the testing environment (lighting, ventilation, etc.), for verifying the performance of power sources not owned by the qualifier, and that the qualifier may not have ready access to resources normally available at their own testing site.
- **Retention and disposal:** Procedures should be established for retention and disposal of test coupons, specimens, and radiographic film. Retention and disposal procedures may need to be customized per employer specifications. These customization requests should be recorded during the Pre-Test Investigation phase so appropriate steps can be taken to prepare for them.
- **Qualification of personnel and contracted services:** The qualifications of any personnel involved in the welder performance qualification testing must be verified by the qualifier and documentation confirming their legitimacy should be established. For instance, if external personnel are engaged to conduct special assessments, such as non-destructive testing (NDT), the qualifier must obtain records signifying that each contracted person is properly qualified for the task.
- **Document retention policy:** Documentation of all tests performed and interactions between the qualifier and the welder or employer should be kept for a specified amount of time and organized for easy recall should they need to be referenced at a future date.
- **Confidentiality policies:** Qualifiers often collect personal information about welders and are responsible for keeping that information secure. Policies should be in place for ensuring security and the confidentiality of personal information. WPSs that are provided by the employer for qualification testing should be treated as proprietary information that should not be divulged to outside parties without the express permission of the employer.

Terms and Concepts to Understand

The following list provides explanations and descriptions of several important terms qualifiers should know to most effectively implement the information in this manual:

- 1) **Certification:** A certification is documentation by a certifying entity that a set of qualification requirements has been met at a certain place and time and maintained over time. The credibility of the entity that is conducting the certification establishes the value of that certification. Certification also implies that over time the certified individual has maintained the skills and knowledge of the original qualification requirements.
- 2) **Qualification to a Standard vs. Certification by an Organization:** A welder may take a qualification test to any one of many standards. The outcome of that qualification test may result in a welder certification being issued by a certifying entity. While the welder is qualified under the requirements of the standard, they are certified by a certifying entity. When a welder is qualified to an AWS code or standard, it does not necessarily mean they are certified by the AWS.

If the end user requires an “AWS Certified Welder,” the welder must be tested at an AWS Accredited Test Facility, not simply qualified according to a specific standard. The end user determines the standard that will be followed during the test.

- 3) **Essential Variable:** Essential variables (qualification variables) are conditions described in the applicable qualification standard that, if changed, will affect the ability of the welder or welding operator to produce a sound weld.
- 4) **Maintenance of Qualification vs. Maintenance of Certification:** The applicable qualification standard a welder is qualified to determines the time limit of that qualification. The following descriptions briefly identify the difference between the maintenance of a qualification and of a certification:
 - A welder’s qualifications remain in effect, provided he or she meets the requirements of the applicable qualification standard. For example, most standards state that as long as the welder welds using a specific process within a specific time-frame and their employer documents the use of that specific process, the welder will continue to be considered qualified to weld in that process under that standard. It is ultimately the welder’s responsibility to record his or her maintenance of qualification or certification.
 - Certification has a “maintenance of certification.” In other words, the certifying body (i.e., AWS, Canadian Welding Bureau [CWB], etc.) may require the welder to take action in addition to the requirements of the standard to which the welder has been qualified in order to maintain their certification. For example, the certifying body may require the welder to send in a renewal form and fee periodically to have their certification renewed.
- 5) **Performance Qualification Test:** A test given to a welder to demonstrate his or her ability to deposit sound weld metal following a specific qualification standard. A welder who passes a performance qualification test will use the results of the test to indicate to employers that the welder is able to meet the requirements of a specific task. The employer is ultimately responsible for the qualification of all personnel involved in welding at their job sites, even if they choose to subcontract the welder testing.
- 6) **Qualifier:** The employer, organization, or individual responsible for conducting and supervising qualification testing.
- 7) **Routing Sheet:** A routing sheet is a checklist of the sequence of tasks to be followed during the testing process and ensures consistency across tests. The routing sheet can also act as legal documentation when qualifiers record on it what happened during the test and then save that record for a specified amount of time. This length of time is determined by the qualifier and should be included in a document retention policy. (See the sample routing sheet in Appendix 1 [pg A1:1] for more information.)
- 8) **Standard Welding Procedure Specifications (SWPS):** AWS publishes Standard Welding Procedure Specifications that provide consensus-approved welding procedures for what is considered to be common welding applications used by the industry. The purpose of these specifications include the following:
 - Minimizes the cost of repeated qualification of the common applications, using the common welding processes on the common materials.

- **Common applications:** sheet, plate, structures, and pipe
- **Common welding processes:** gas tungsten arc welding (GTAW), shielded metal arc welding (SMAW), gas metal arc welding (GMAW), and flux-cored arc welding (FCAW).
- **Common materials:** carbon steels, stainless steels, and select low-alloy steels
- Minimizes the cost associated with the review of common welding procedures by the industry.
- Provides a uniform format addressing the common variables mandated by the major qualification standards, such as AWS, ASME, the National Board Inspection Code (NBIC), and the various military standards.

The following are a few points to remember regarding the use of an AWS SWPS:

- SWPSs must be purchased from the AWS.
 - The employer decides which SWPS best fits the production work.
 - Each SWPS comes with a license and cannot be further distributed beyond the licensee.
 - Most AWS SWPSs are accepted by other standards (but not all).
- 9) **Welder Performance Qualification Record (WPQR):** A WPQR is a record of the variables that were followed during the welding of a test coupon and the results of any required testing. This record typically also indicates the range(s) and/or limitations for which the welder is qualified to weld within. This document should not be confused with a Procedure Qualification Record (PQR), which is associated with qualification of the WPS, not the welder.

A WPQR is known by many names. The following is a list of some of the most common names given to this document:

- Welder Qualification Test Record (WQTR)
 - Performance Qualification Test Record (PQTR)
 - Welder Performance Qualification (WPQ)
 - Welding Operator Performance Qualification (WOPQ) (applies to machine and/or automatic welding)
- 10) **Welding Procedure Specifications (WPS):** A WPS is a document that establishes the required welding variables for a specific application to ensure repeatability by properly trained welders and welding operators. In other words, a WPS provides the welder with a set of instructions that must be followed to correctly make a weld.

A WPS can be developed by anyone trained to do so, provided it addresses all the requirements of the standard to which it is written, which must be the same standard as that to which the welder is being qualified. The qualifier must verify the WPS to be used includes the proper parameters for the test being given.

A WPS specifies the following:

- Base metals that may be welded
- Filler metals and electrodes that must be used
- Joint design
- Preheating requirements
- Post weld heat treatment
- Any other conditions that must be satisfied to make a weld

Pre-Test Investigation

The qualifier is responsible for collecting relevant information and establishing certain criteria prior to conducting any welder performance qualification test. A routing sheet, like the sample in Appendix 1 (pg A1:1), can be used to standardize the information gathering process to ensure no necessary information is overlooked during the pre-test investigation.

As the sample routing sheet indicates, the first criteria the qualifier needs to establish is the standard under which qualification is being performed. This **qualification standard** identifies requirements (such as visual examination, acceptance criteria, mechanical and nondestructive testing) that determine which materials, equipment, and resources should be available during the test. The qualification standard also determines the preparations that should be made by the qualifier before testing begins.

The same process may be tested to different qualification standards and each standard will include its own requirements. Because these requirements may vary from standard to standard, the qualifier must take great care when shifting from one standard to another to make sure all requirements of each specified standard are met.

Sometimes requirements vary from edition to edition of the same standard. The qualifier should identify the correct edition during the pre-test investigation and should work only from that specified edition when planning for and conducting the welder performance qualification test. If a specific edition is not specified, the qualifier should use the latest edition of the standard. It is also important that the qualifier record the exact edition of the standard being used for the test. It is not sufficient to simply list “AWS D1.1” but rather “AWS D1.1:2015” if that is the actual edition used.

While identifying the applicable qualification standard, other information can also be gathered, such as any coupon disposal requirements or any other special requirements from the employer, such as visual appearance, that are not already in the qualification standard.

The **Welding Procedure Specifications (WPSs)** should also be acquired from the employer during the pre-test investigation and reviewed by the qualifier to ensure it is appropriate for the intended test and that there are no glaring inconsistencies or errors. If a welder attempts to engage a qualifier for the purpose of conducting a welder performance qualification test and does not provide a WPS, the qualifier should interview the welder or employer to determine exactly what the welder is supposed to be qualified to do. Alternatively, the qualifier may use a Standard Welding Procedure Specification (SWPS) from AWS to qualify a welder as long as it meets the requirements of the employer.

GOOD TO KNOW:

AWS suggests that the minimum qualification for someone to develop a WPS should be a Senior Certified Welding Inspector (SCWI). The employer is ultimately responsible for the qualification of personnel and is responsible for ensuring the accuracy of the WPS; however, the qualifier can and should bring attention to obvious errors. (See *AWS B2.1, Specification for Welding Procedure and Performance Qualification*, for more information on employer/qualifier responsibilities.)

Beside the applicable qualification standard and the WPS, the pre-test investigation typically results in the collection of at least the following information:

- Welding process to be used (e.g., SMAW, GTAW, GMAW, etc.)
- Pipe size and the schedule or the thickness of plate making up the test coupon (e.g., NPS 3, Schedule 80, NPS 6, 0.432” wall thickness, 3/8” thick plate, etc.)
- Test coupon specification, including type and grade (e.g., SA-106 Gr. B, SA-53 Gr. B, A-36, etc.)
- Position of the test coupon (e.g., 1G, 2G, 3G, etc.)
- Whether the joint is welded from one side or from both sides:
 - If the joint is to be welded from one side, it should be decided whether backing, a consumable insert (for GTAW only), or no backing is going to be used.
- Whether or not backing gas is used:
 - This is only applicable when welding is done from one side of the groove.
 - This is typically applicable for GTAW, GMAW, and PAW.
- Type and mixture of shielding gas (when applicable, e.g., AWS A5.32 (ISO14175)-M20-ArC10)
- The identification number, revision, and date of the WPS to be followed
- The electrode(s) or filler metal that will be used and how to identify them:

- Classification (e.g., E7018)
- Specification (e.g., AWS A5.1)
- Electrical characteristics:
 - The current type and polarity for the applicable welding process (e.g. Direct Current Electrode Positive, Direct Current Electrode Negative, or Alternating Current)
 - The transfer mode: GMAW and FCAW
- The direction of progression (uphill or downhill) that the welder will use:
 - Progression may be different for the root pass than for the fill passes. If this is the case, the approximate deposit thickness for each direction of progression should be recorded.
- The approximate thickness of weld metal deposited with each process or electrode type when more than one process or electrode type is used on the test coupon
- Any other relevant elements or special considerations or requests from the employer:
 - Note that some employer requirements are much more rigorous than those in the common qualification standards.

Logistical Preparation for the Test

The qualification standard, as well as any special requirements, affect the preparations and scheduling necessary to successfully conduct a welder performance qualification test. The qualifier is responsible for ensuring all such preparations are completed prior to testing.

This section explains some of the most common logistics to be considered before conducting a test.

Scheduling and Capacity

The qualifier should know the answer to all the following questions and have the logistics worked out for each before the test date:

- **Number of Welders:** How many welders will be tested at once?
 - A qualifier should never test more people at a time than can be effectively supervised or more than is safe to test using the available workstations, equipment, and materials.
- **Number of Tests per Welder and Session:** Will welder(s) be attempting multiple tests or one test in the same session?
- **Estimated Duration of Test:** How long will each test take to complete?
- **Time Limitations:** Is there a time limit?
 - The qualifier should contact the employer to find out if there is a time limit for completion of the test. The welder should be given a reasonable time to set up the machine and run a few practice beads.

Facility Set Up

In general, a facility where welder performance qualification testing is being administered should satisfy the following requirements:

- Welding equipment used for welder performance qualification testing must be capable of delivering the power required by the WPS. Welding power sources used for welder performance qualification tests must have the electrical output of the machine verified using a calibrated volt-amp meter on the machine or the qualifier must have calibrated voltmeters and ammeters in place.
- The facility must be safe. The qualifier is responsible for inspecting all tools, power equipment, and power sources. The qualifier is responsible for ensuring the environment is suitable for conducting the test, including lighting, ventilation, weld curtains, fire extinguishers, first aid, and safety.

- The qualifier must have the equipment and tools needed to test and inspect the welds in accordance with the acceptance criteria in the applicable qualification standard.
- The qualifier should verify that **Post-Weld Heat Treatment (PWHT)** is either not required by the WPS or that the applicable qualification standard exempts welder test coupons from PWHT. If PWHT is required, the qualifier must arrange for this heat treatment by a qualified organization.
- If **power tools** are allowed during the test, they may be supplied by the facility; otherwise, the welder should provide their own. The question of who is supplying power tools should be determined ahead of time.
 - **NOTE:** Even if power tools are supplied by the welder, the qualifier is responsible for ensuring they are safe to use during the test.

GOOD TO KNOW:

See *AWS B5.4, Specification for the Qualification of Welder Test Facilities*, to find more detailed guidelines for setting up a welder performance qualification test facility.

See *AWS QC47, Specification for AWS Certification of Welders and Accreditation of Test Facilities*, to find guidelines on how to become an AWS Accredited Test Facility.

Cost Factors

To appropriately price welding qualification tests, qualifiers should take the following into account:

- Equipment
- Materials (including practice materials)
- Time
- Labor
- Administrative and application fees
- Destructive and nondestructive testing (NDT) requirements
- Any other fees or consumables necessary to complete the test
- Standard Welding Procedure Specifications (SWPSs)

GOOD TO KNOW:

Welders are often confused by the administrative fee and the certification application fee, thinking these are the full cost of the test. Welders or employers should be made aware of the full cost prior to testing.

Testing Materials

The qualifier should determine who will be supplying the test coupons. The coupons and the base metal from which the coupons will be made should always come from a reputable source. Often the qualifier supplies these materials.

Whether or not testing materials are supplied by the qualifier, it remains the qualifier's responsibility to validate that the material meets the requirements of the qualification standard and is in compliance with the WPS. This verification can be done using Material Test Reports (MTRs), manufacturer's markings on the material, or through other valid documentation or traceability procedures. Best practice is to keep materials organized, segregated, and secured.

The qualifier should not accept materials from the welder without further investigation.

Traceability

Test materials can be purchased from sources that have procedures for traceability of materials. As a minimum, the specification and grade should be marked on the material or should be traceable by other means, such as color coding. If traceable by other means, a written procedure should be implemented.

Consumables:

Consumables are things that can be bought or replaced and are consumed during the testing process. The qualifier must validate the consumables are correct for the WPS. Consumables might include, but are not limited to, any of the following:

- Electrodes
- Filler material
- Temperature measuring crayons
- Contact tips
- Grinding wheels
- Torch shielding gas
- Root shielding gas

Retention and Disposal

Prior to the test, the qualifier and employer should determine who will be responsible for storing or disposing of test specimens or radiographic film. Some contracts require qualifiers to retain bend specimens for a given amount of time, such as six months. When no requirement is in place, the best practice is to include retention time and proper disposal in the qualifier's written procedures.

Conclusion

When the pre-test investigation is comprehensively performed, a welder performance qualification test can be successfully conducted with minimal errors, delays, or mishaps. Routing sheets (like the sample in Appendix 1 [pg A1:1]) and/or other checklists standardize the pre-test investigation process. Regular use of routing sheets and other written procedures help ensure accuracy and consistency and help protect the qualifier from potential disputes.

During the pre-test investigation, the qualifier should determine the applicable qualification standard (including which edition of that qualification standard should be applied) and acquire the WPS from the employer. Alternatively, the qualifier may use Standard Welding Procedure Specifications (SWPSs) from AWS to qualify a welder as long as it meets the requirements of the employer. Any other relevant information and requirements should also be collected during this stage. Scheduling and preparation of the facility are also the responsibility of the qualifier during the pre-test investigation.

The next chapter describes the process for conducting a welder performance qualification test.