

Weld Procedure Qualification Instructions

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1 Purpose

The purpose of this document is to provide guidance and information to supplement and clarify the requirements of welding procedure qualification specification S9074-AQ-GIB-010/248 when it is invoked.

2 Scope

At a minimum, the supplier must become familiar with the following documents and specifications in order to understand the requirements for procedure qualification tests. If the qualification tests are done in accordance with NAVSEA S9074-AQ-GIB-010/248, all technical publications must be used as follows:

- S9074-AQ-GIB-010/248 for procedure qualification requirements
- S9074-AR-GIB-010/278 for fabrication and inspection requirements (if applicable to the purchase order)
- T9074-AD-GIB-010/1688 for fabrication and inspection requirements (if applicable to the purchase order)
- MIL-STD-22D for welding joint design
- T9074-AS-GIB-010/271 requirements for NDT methods
- MIL-STD-2035 for NDT acceptance criteria
- AWS B4.0 Standard Methods for Mechanical Testing of Welds

3 Requirements for a Procedure Qualification

Tech Pub S9074-AQ-GIB-010/248 provides the requirements for welding and brazing procedure and performance qualification. The minimum requirements for a welding procedure are provided in Table V. It should be noted that not all of the essential elements are listed in Table V. If, when reviewing sections 4.7 and 4.8 for developing a weld procedure, it is found that varying a parameter requires requalifying, then that parameter is an essential element that must be listed in the welding procedure. This type of extra parameter is normally limited to machine and automatic welding, plasma arc welding, and cladding with A-45 materials. A supplier procedure qualification package, which is commonly referred to as a Procedure Qualification Record (PQR), consists of a record of the actual parameters used for welding the procedure qualification test assembly, copies of the original test reports, and any other supporting documentation. Reporting welding parameters in terms of ranges is not acceptable. The PQR must report actual values used. For example, if the welder deliberately varies the current, then each of the current values used must be individually reported together with the pass number where that current was used. For those materials with heat input limitations, amperage, voltage, and travel speed must be reported for each weld pass. With the exception of the root area, every effort should be made to weld the remainder of the test assembly at approximately the same heat input. A PQR is reviewed for acceptability by CEPEDA and their customer using the attached checklist form. In addition, the following sections provide further guidance to ensure that the PQR will conform to specification requirements.

3.1 Unique Identification

Each PQR must be uniquely identified. Each page of the PQR package must be dated and contain the unique PQR identification. If a procedure requires requalification, then the new PQR must be assigned a new identification. A PQR does not require revision control. The date should be adjusted if changes are required during the initial review cycle. Once the Authorized Representative (as defined in paragraph 3.1.6 of S9074-AQ-GIB-010/248) approves a PQR, no changes should be made unless it is found that the PQR contained an error. In that case, the revised PQR should be presented back to the original approver of the PQR for reevaluation and acceptance with the change and reason for the change clearly identified.

When a PQR, previously approved by an Authorized Representative, is used in support of a procedure being submitted for approval, the PQR and a copy of the document that originally approved the PQR should be attached to the procedure being submitted for approval.

3.2 Weld Joint Design

Qualification data must identify the test assembly weld joint in accordance with MIL-STD-22D. If a weld joint not listed in MIL-STD-22D is used, geometric details must be provided together with justification for the use of that joint design. In all cases, although not required, the use of dimensioned sketches is recommended in order to clearly show actual test assembly dimensions such as root gap and included angle. Test assemblies used for hardfacing and cladding must be in accordance with the appropriate figure of S9074-AQ-GIB-010/248. Hardfacing and cladding test assemblies must be documented in the PQR in such a way that all key dimensions (i.e., dimensions of base metal and deposit) and the number of weld layers are clearly presented.

Backing bar material type and dimensions, consumable insert size, class, and material type, and root gap and land dimensions for open root type joints must be shown.

3.3 Base Metal

Base metal used in the qualification shall be a listed S-numbered base material in Table I of S9074-AQ-GIB-010/248 when the production application uses a listed material. If an unlisted material is used, then a request must be submitted to use this material as a listed material. If the production application uses a base material that cannot be considered part of an S-numbered group, then the PQR must use the same base metal. In all cases, enough information about the base metal must be provided in the PQR in order to determine the required mechanical properties from the base metal specification. When in doubt submit the mill certification.

3.4 Cleaning Statement

Cleaning methods must be described in all PQRs. Cleaning statements in PQRs may either state what cleaning was performed, may include a statement similar to that presented in the welding procedure, or may reference the paragraph of the welding procedure. Please note that titanium PQRs must address the additional titanium cleaning requirements contained in S9074-AR-GIB-010/278.

3.5 Nondestructive Testing

Copies of original NDT reports are to be submitted with the qualification data. These reports must address all testing required by Table VII of S9074-AQ-GIB-010/248 (including footnotes). The tests must meet the requirements of paragraph 4.5.1 and associated subparagraphs. NDT is to be performed in

accordance with T9074-AS-GIB-010/271 with acceptance criteria in accordance with MIL-STD-2035, Class I.

3.6 Destructive Testing

Copies of original destructive test reports are to be submitted with the qualification data. These reports must address all testing required by Table VII of S9074-AQ-GIB-010/248 (including footnotes).

Destructive testing is to be performed in accordance with AWS B4.0 with acceptance criteria in accordance with S9074-AQ-GIB-010/248, paragraph 4.5.2 and associated subparagraphs.

- When transverse tensile testing is required, only Ultimate Tensile Strength (UTS) and the location of the failure must be reported. Although round tensile specimens (Figure A11 of AWS B4.0) are not excluded from use, transverse tensile test specimens are normally produced to Figure A12 of AWS B4.0-98 for plate and Figure A14 or A15 for pipe.
- All-weld-metal tensile tests (when required) must meet all of the tensile properties listed in the filler metal specification. Titanium specimens must meet the tensile properties of the applicable base metal specification when no tensile requirements exist in the filler metal specification.
- Guided bend testing is required for most qualifications. Refer to S9074-AQ-GIB-010/248, Table VII with notes 7 and 10 to determine the number and type of bend tests required. Guided bend tests are to be performed with a bend radius based upon the base metal elongation using the formula found in Figure A4 of AWS B4.0. The bend radius for base metals with elongation greater than 20% may use the bend radius based upon 20% elongation. The bend radius may round up based upon the accuracy of the measurement specified in Figure A4 of AWS B4.0. This rounding up allowance should be utilized in order to be able to use a standard size mandrel or plunger. It may not be used to purposely relax the bend radius of the sample. The bend test report must contain the following information: bend radius, bend angle, specimen thickness, type of bend test (e.g., transverse side bend), number of tests performed, the results of each test, and any observation of unusual characteristics of the specimens. The report should identify the number and size of defects. Terms like "sat" or "acceptable" may only be used if the acceptance criteria are clearly referenced in terms of specification and paragraph. The acceptance criteria are specified in paragraph 4.5.2.3.1 of S9074-AQ-GIB-010/248.
- Charpy V-notch impact testing shall be performed when production welding meets the requirements specified in footnote 2 of Table VII of S9074-AQ-GIB-010/248. Test specimens shall be machined in accordance with paragraph 4.5.2.4 of S9074-AQ-GIB-010/248 and Figure A16 of AWS B4.0. Weld metal tests must be performed in sets of 5 and must meet the requirements of the filler metal specification. Heat affected zone (HAZ) and base metal tests (when required) must be performed in sets of 3 and shall meet the requirements of the base metal specification. Test results should include: test temperature; energy absorbed; fracture appearance and any observation of unusual characteristics of the specimens.
- Hardness testing shall be performed and evaluated in accordance with paragraph 4.5.2.4 of S9074-AQ-GIB-010/248. As required by Note 2 to Figure 6 of S9074-AQ-GIB-010/248, a minimum of 5 hardness tests must be performed on the test specimen when hardness testing is required by Table VII. The acceptance standard and minimum hardness shall be identified.
- Macro-etch testing shall be in accordance with paragraph 4.5.2.6 of S9074-AQ-GIB-010/248. The number of specimens is identified in Table VII of S9074-AQ-GIB-010/248, except that socket weld joints in pipe test assemblies with wall thickness less than 3/16" shall have 4 macro-etch

specimens and butt welds in sheet test assemblies with thickness less than or equal to 0.058" shall have 2 macro-etch specimens. The report shall specify the type of etchant, the number of specimens, and the number and size of defects. Terms like "sat" or "acceptable" may only be used if the acceptance criteria are clearly referenced in terms of specification and paragraph. The acceptance criteria are specified in paragraph 4.5.2.6(a), (b), or (c) of S9074-AQ-GIB-010/248.

3.7 Certification Statement

Paragraph 4.2.2 of S9074-AQ-GIB-010/248 states, "After testing, the responsible official of the activity shall certify that the tests and the test results meet all requirements of this document and that the welding procedure meets all requirements of this document and the applicable fabrication document." Please add a statement that accomplishes this requirement prior to the signature. The following text is suggested:

"I certify that the tests and the test results meet all requirements of S9074-AQ-GIB-010/248 and that the welding procedure meets all requirements of S9074-AQ-GIB-010/248 and S9074-AR-GIB-010/278" (or T9074-AD-GIB-010/1688 as applicable).

If the PQR was unable to meet a requirement of S9074-AQ-GIB-010/248 and the supplier considers that the requirement does not affect the integrity of the PQR or weld procedure, the supplier may request to waive that requirement and provide significant supporting technical justification as allowed by paragraph 4.2.2 of S9074-AQ-GIB-010/248. It is advisable to consult with CEPEDA prior to submittal, concerning the acceptability of the waiver request. If a waiver is requested, the certification statement above should be modified to, "I certify that the tests and the test results meet all requirements of S9074-AQ-GIB-010/248 except (state exception) and that..."

3.8 Requirements for Special Welds

Special welds are defined in paragraph 3.2.12 of S9074-AQ-GIB-010/248. The base materials not covered in Table I should be interpreted to mean base materials that cannot be considered for inclusion to Table I as allowed by Table I, footnote 1. Testing of special welds shall include testing of Table VII to the maximum extent practicable. However, some special welds must utilize production mock-up welds that do not lend themselves to full mechanical testing. In such cases, the minimum requirements shall be VT, PT, and 4 macro etch specimens. The supplier is responsible for assuring that any tests that would produce results that could be used to evaluate the welds are specified, along with the associated acceptance criteria. Production weld mock-ups are for a particular application and are not generally given a range of material thickness listed in Table VI. Along with all of the required data in the PQR, the supplier shall submit a proposed welding performance qualification test program that specifies the testing required and what limitations are invoked for production welding using the proposed performance qualification. PQR for special welds must receive NAVSEA approval (not Authorized Representative) if a special weld procedure is to be used in any application specified in paragraph 4.2.5 of S9074-AQ-GIB-010/248. Therefore the associated special weld procedure must be limited from any of the applications listed in paragraph 4.2.5 if the application does not require NAVSEA approval.

4 Requirements for a Welding Procedure

4.1 Unique Numbering

Each procedure must be uniquely identified. Each page of the procedure must be dated and contain the unique procedure identification and revision identification. The procedure should also reference the number(s) of the supporting PQR(s). The procedure must be revision controlled such that the revision letter or number is changed whenever a change is made to the procedure after it has been released for production. Within a revision cycle, changes may be made to a procedure draft that has not been released for production without changing the revision letter or number. However the date should be changed in order to identify draft versions of the procedure.

4.2 Essential Elements

When developing welding procedures, care must be taken to ensure that the welding procedure does not violate any requirements of the fabrication document and that the parameter ranges specified in the procedure fall within the requirements of sections 4.7 and 4.8 of S9074-AQ-GIB-010/248.

4.3 Base Materials

Base materials for non-special weld procedures must utilize materials specifically listed in Table I of S9074-AQ-GIB-010/248. If the base material specification and class to be used in production is not listed in Table I, the supplier must request that that material be considered as part of a particular S-numbered group. The supplier should provide a comparison between the chemistry and mechanical properties for the material to be used and similar listed materials as part of the request.

4.4 Filler Materials

Filler materials used in production welding must be procured in accordance with the specified military specification and type listed in Table II of S9074-AQ-GIB-010/248. If Table II specifies a commercial (AWS) specification, then the weld procedure must specify that the filler material be procured in accordance with AWS 5.01 and must as a minimum contain the testing of Schedule J and the lot definition of S2 (for bare solid electrodes and wire) or C3 (for covered electrodes). Use of alternate specifications for filler material requires separate Authorized Representative approval as specified in paragraph 5.2.1 of S9074-AR-GIB-010/278.

A-45 filler materials require additional testing and acceptance criteria as specified in S9074-AR-GIB-010/278 Table II footnote 8 (for covered electrodes) or footnote 9 (for bare solid electrodes and wire).

4.5 Weld Joint Design

Most procedures do not qualify for welding of all joint designs specified in MIL-STD-22D. The procedure should specify those joint designs that the supplier will be welding or should specify the joint designs that the procedure is not qualified to perform. The following is an example of the latter. Please note that some of these joints may not be applicable for the welding being performed and do not require listing in such procedures.

Qualified within the stated limits of process, position, base metal, and thickness to weld all MIL-STD-22D joint designs except:

- 1. Joints welded with pre-placed filler metal inserts*

2. *Butt joints welded from one side with no backing or pre-placed filler metal insert*
3. *Seal welds other than edge or fillet types*
4. *Socket welds and fillet type seal welds in pipe with nominal wall thickness less than 3/16"*
5. *Tube-to-tube sheet welds*
6. *Cladding (for dissimilar metal weld joints)*
7. *Weld joints with included angles less than XX degrees. (For semi-automatic and automatic processes see S9074-AQ-GIB-010/248, paragraph 4.8(c))*
8. *Single pass welds for pressure containing joints*

4.6 Thin Wall Socket Weld Procedures

It is recommended that weld procedures for socket weld joints with nominal pipe wall thickness less than 3/16" be contained in a separate weld procedure. This is because these procedures are limited to $\pm 15\%$ of the welding current used during qualification as specified in paragraph 4.7.5(c) of S9074-AQ-GIB-010/248. If needed, more than one range of welding current may be specified for different pipe wall thicknesses provided that they are supported by the appropriate number of welder procedure qualification tests.

4.7 Cleaning Statement

The cleaning requirements of S9074-AR-GIB-010/278, paragraph 7.2 (or T9074-AD-GIB-010/1688, paragraph 14.2.2, as applicable) are required to be in all welding procedures. The words below are from S9074-AR-GIB-010/278. The wording may be changed to fit the standard practices as long as the intention is met.

"The joint members to be welded, including the base metal surfaces, shall be cleaned to remove foreign material for a minimum of 1 inch from the weld edge. Mill scale or metallic oxides shall be removed from surfaces on which weld metal will be deposited. Slag shall be removed from all weld metal surfaces prior to depositing subsequent passes or layers and upon completion of the weld."

Please note that titanium welding procedures must address the additional cleaning requirements contained in S9074-AR-GIB-010/278.