PIP PLSC0018
Requirements for Welder Qualifications in Accordance with API 1104
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Table of Contents

1. Scope ........................................... 2

2. References .................................. 2
   2.1 Process Industry Practices .......... 2
   2.2 Industry Codes and Standards ....... 2

3. Definitions ................................... 2

4. Requirements .............................. 2
   4.1 General ..................................... 2
   4.2 Qualification Test ....................... 3
   4.3 Visual Examination of a Qualification
       Weld ......................................... 3
   4.4 Destructive Testing ...................... 4
   4.5 Alternative Qualification Test .. 8
   4.6 Re-Test of a Failed Destructive
       Qualification Exam ...................... 8
   4.7 Requalification by Non-Destructive
       Testing ................................... 9
   4.8 Re-Test of a Failed Non-Destructive
       Qualification Exam .................... 10
   4.9 Revoking Certifications ............ 10
   4.10 Certification Re-instatement .... 10
   4.11 Records .................................. 10
1. **Scope**

This Practice provides minimum requirements for qualifying welders in accordance with API 1104. Welder qualification tests are given to determine the ability of the welder to make sound welds using qualified weld procedures (WPS).

For welder qualification requirements in accordance with ASME Section IX, see PIP PLSC0017.

2. **References**

Applicable parts of the following Practices and industry codes and standards shall be considered an integral part of this Practice. The edition in effect on the date of contract award shall be used, except as otherwise noted. Short titles are used herein where appropriate.

2.1 **Process Industry Practices (PIP)**

- PLSC0017 - Standards for Welder Qualifications per ASME Section IX

2.2 **Industry Codes and Standards**

- American Petroleum Institute (API)
  - API 1104 - Welding of Pipelines and Related Facilities
- The American Society of Mechanical Engineers (ASME)
  - Boiler and Pressure Vessel Code, Section IX: Welding and Brazing Qualifications

3. **Definitions**

*owner:* The party who owns the facility wherein the piping will be used

*purchaser:* The party who awards the contract to the supplier. The purchaser may be the owner or the owner's authorized agent.

*supplier:* The party responsible for providing the installation of the piping

4. **Requirements**

4.1 **General**

4.1.1 The qualification of welders shall be performed by and in the presence of an American Welding Society Certified Welding Inspector (CWI).

4.1.2 All welders shall initially qualify by destructive testing, unless non-destructive testing (NDT) is authorized for butt welds only as an exception by the authorized CWI.

4.1.3 Before starting the qualification test, the welder shall be permitted a reasonable amount of time to adjust the welding equipment used in the test.

4.1.4 The welder shall use the same welding techniques and comply with all essential and non-essential variables of the qualified welding procedure during the test.
The welder shall demonstrate safe welding practices and wear appropriate personal protection equipment (PPE) during the qualification test.

4.2 Qualification Test

4.2.1 A welder who has successfully completed a qualification test in accordance with Sections 4.3, 4.4, or 4.5 of this Practice shall be permitted to perform production welding for one six-month qualification interval.

4.2.2 The qualification can be extended an additional six months by non-destructive qualification in accordance with Section 4.7.

4.2.3 The API 1104 qualification test shall consist of two weld samples joined in accordance with API 1104, Section 6.3 (Multiple Qualification).

4.2.4 Unless otherwise approved by the owner representative, a welder shall test on pipe greater than or equal to 12.750 inches (323.8 mm) OD.

4.2.5 A welder who has successfully completed the butt-weld qualification test on pipe with an outside diameter less than 12.750 inches (323.8 mm) OD and a full size branch connection weld on pipe with an outside diameter less than 12.750 inches (323.8 mm) diameter shall be qualified to weld in all positions, on all wall thickness, joint design, fittings and on pipe diameters less than or equal to the outside diameter of the pipe that was welded during the qualification test.

4.2.6 A welder who has successfully completed the butt-weld qualification test on pipe greater than or equal to 12.750 inches (323.8 mm) OD and a full size branch connection weld on pipe greater than or equal to 12.750” (323.8 mm) OD shall be qualified to weld in all positions, on all wall thickness, joint design, fittings and on all pipe diameters.

4.3 Visual Examination of a Qualification Weld

4.3.1 For a qualification test weld to be in accordance with the requirements for visual examination, the weld shall be free of cracks, inadequate penetration, un-repaired burn through, and other defects, and shall present a neat, workmanlike appearance.

4.3.2 Undercutting adjacent to the final bead on the outside of the pipe shall be in accordance with the following:

a. Undercutting shall not be greater than 1/32-inch (0.79 mm) in depth or 12.5 percent of the pipe wall thickness, whichever is smaller

b. Undercutting in any continuous 12- inch (304.8 mm) length of weld shall not be greater than 2-inches (50.8 mm).

4.3.3 If automatic or semiautomatic welding is used, filler wire protruding into the inside of the pipe shall be ground out or shall be cause for rejection and subsequent failure.

4.3.4 Failure to meet the requirements of this Section shall be adequate cause to eliminate additional testing.
4.4 **Destructive Testing**

4.4.1 **General**

4.4.1.1 All butt welds shall have specimens cut from each test weld.

4.4.1.2 The locations from which the specimens are to be removed are predetermined and shown in Figure 1.

4.4.1.3 If the test weld consists of segments of pipe nipples, an approximately equal number of specimens shall be removed from each segment.

4.4.1.4 The total number of destructive test specimens that are to be submitted for testing shall be in accordance with Table 1.

<table>
<thead>
<tr>
<th>Outside Diameter of Pipe</th>
<th>Number of Specimens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inches</td>
<td>Millimeters</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>&lt;2.375</td>
<td>&lt;60.3</td>
</tr>
<tr>
<td>2.375 - 4.500</td>
<td>60.3 - 114.3</td>
</tr>
<tr>
<td>&gt;4.500 - 12.750</td>
<td>&gt;114.3 - 323.9</td>
</tr>
<tr>
<td>&gt;12.750</td>
<td>&gt;323.9</td>
</tr>
<tr>
<td>Wall Thickness &gt; 0.500 inches (12.7 mm)</td>
<td></td>
</tr>
<tr>
<td>≤4.500</td>
<td>≤114.3</td>
</tr>
<tr>
<td>&gt;4.500 - 12.750</td>
<td>&gt;114.3 - 323.9</td>
</tr>
<tr>
<td>&gt;12.750</td>
<td>&gt;323.9</td>
</tr>
</tbody>
</table>

\(^a\)For pipe less than or equal to 1.315 inches (33.4 mm) in outside diameter, specimens from two welds or one full-section tensile-strength specimen shall be taken.

4.4.1.5 The authorized CWI may choose to omit the tensile-strength test. If the test is omitted, the specimens designated for the test shall be subject to the nick break test outlined in Section 4.4.3.

4.4.1.6 The specimens shall be air-cooled to ambient temperature before testing.

4.4.1.7 For pipe equal to and less than 1-5/16 inches (33.4 mm) OD, one full pipe section specimen can be substituted for the root bend and nick break specimens.

4.4.2 **Tensile Testing of Butt Welds in Pipe**

4.4.2.1 Tensile test specimens shall be broken under tensile load using a calibrated gauge.
4.4.2.2 The specimen removed for tensile test shall be approximately 9 inches (230mm) long and approximately 1 inch (25mm) wide. The specimen may be machine cut or oxygen cut. Additional preparation is not required unless the sides are notched or not parallel.

4.4.2.3 For the tensile-strength test, if any of the reduced section specimen breaks in the weld or at the junction of the weld and the parent material the exposed surfaces shall be subject to visual examination.

4.4.2.4 Acceptance Criteria

Failure to meet the following acceptance criteria shall disqualify the welder.

1. Specimen shall show complete penetration and fusion.
2. The greatest dimension of any gas pocket shall not be greater than 1/16 inch (1.6 mm).
3. The combined area of all gas pockets shall not be greater than 2% of the exposed surface area.
4. Slag inclusions shall not be greater than 1/32 inch (0.8 mm) in depth and shall not be greater than 1/8 inch (3 mm) or one-half the nominal wall thickness in length, whichever is smaller.
5. The separation between adjacent slag inclusions shall be 1/2 inch (13 mm) minimum.
6. Fisheyes caused by plastic deformation shall not be a cause for rejection.

4.4.2.5 The tensile strength of the coupons shall be calculated to verify the strength is greater than the minimum specified tensile strength of the base metal at failure.

4.4.3 Nick Break Testing of Butt Welds

4.4.3.1 The specimens shall be as follows and in accordance with Figure 2:

a. Approximately 9 inches (230 mm) long and 1 inch (25 mm) wide
b. Machine cut or oxygen cut
c. Notched with a hacksaw on each side of the center of the weld
d. Each notch shall be approximately 1/8 inch (3.18 mm) deep

4.4.3.2 Nick break specimens prepared in this manner from welds made with certain automatic and semiautomatic processes can fail through the pipe instead of the weld. If previous testing experience indicates failures through the pipe are to be expected, the external reinforcement may be notched to a depth equal to or less than 1/16 inch (1.59 mm) measured from the original weld surface.

4.4.3.3 The specimens shall be broken by pulling in a tensile machine, by supporting the ends and striking the center, or by supporting one end and striking the other end with a hammer. The exposed area of the fracture shall be 3/4 inch (19.0 mm) wide minimum.
4.4.3.4 The dimensions of the discontinuities shall be measured as shown in Figure 3.

4.4.3.5 Acceptance Criteria

Failure to meet the following acceptance criteria shall disqualify the welder.

1. The exposed surfaces of each specimen shall show complete penetration and fusion.
2. The greatest dimension of any gas pocket shall not to be greater than 1/16 inch (1.59 mm).
3. The combined area of all gas pockets shall not be greater than 2% of the exposed nick break fracture area.
4. Slag inclusions shall not be greater than 1/32 inch (0.8 mm) in depth and shall not be greater than 1/8 inch (3 mm) or one-half the nominal wall thickness in length, whichever is smaller.
5. The separation between adjacent slag inclusions shall be 1/2 inch (13 mm) minimum.
6. Porosity (i.e., cylindrical gas pockets or inclusions) shall not be cause for rejection.

4.4.4 Bend Testing of Butt Welds

4.4.4.1 The root and face bend specimens shall be as follows and in accordance with Figure 4:

a. Approximately 9 inches (230 mm) long and 1 inch (25 mm) wide and the long edges rounded.
b. Machine cut or oxygen cut.
c. Cover and root bead reinforcement shall be removed flush with the surface of the specimen.
d. Surfaces shall be smooth and any scratches which exist shall be light and transverse to the weld.

4.4.4.2 The side bend specimens shall be as follows and in accordance with Figure 5:

a. Approximately 9 inches (230 mm) long by 1/2 inch (12.7 mm) wide and the long edges rounded.
b. Machine cut or oxygen cut to approximately a 3/4 inch (19.0 mm) width and then machined or ground to the 1/2 inch (12.7 mm) width.
c. Sides shall be smooth and parallel.
d. Cover and root bead reinforcements shall be removed flush with the surfaces of the specimen.

4.4.4.3 The specimens shall be bent in a guided bend test jig similar to that shown in Figure 6. Each specimen shall be placed on the die with the weld at mid-span. The placement of the specimens shall be as follows:
a. Face bend specimens shall be placed with the face of the weld directed toward the gap.
b. Root bend specimens shall be placed with the root of the weld directed toward the gap.
c. Side bend specimens shall be placed with the face of the weld at 90 degrees to the gap.

4.4.4.4 The plunger shall be forced into the gap until the curvature of the specimen is approximately U-shaped.

4.4.4.5 Acceptance Criteria

1. The bend test shall be considered acceptable if no crack or other defect exceeding 1/8 inch (3.18 mm) or one-half the nominal thickness, whichever is smaller, in any direction is present in the weld, or between the weld and the fusion zone after bending.

2. Cracks which originate along the edges of the specimen during testing and which are less than 1/4 inch (6.4 mm) measured in any direction shall not be cause for rejection unless obvious defects are observed.

3. Welds in high yield strength test pipe may not bend the full U-shape. These welds shall be considered acceptable if the specimens which crack are broken apart and their exposed surfaces meet the requirements of the nick break test.

4. Cracked specimens shall be acceptable only if the authorized CWI is satisfied that the cracking is caused by the pipe and not the welder.

5. If one of the bend test specimens fails to meet these requirements and, in the opinion of the authorized CWI, the lack of penetration observed is not representative of the weld, the test specimen may be replaced by an additional specimen cut adjacent to the one that failed. The welder shall be disqualified if the additional specimen also shows defects outside the specified limits.

6. If any specimen shows defects exceeding those described in this Section, the welder shall be disqualified.

4.4.5 Testing of Fillet Welds

4.4.5.1 The locations from which the specimens are to be removed are shown in Figure 7.

4.4.5.2 The specimens shall be prepared as follows and as shown in Figure 8:

a. Machine cut or oxygen cut.

b. Sufficiently long so that they can be broken in the weld.

4.4.5.3 For pipe less than 2-3/8 inches (60.3 mm) OD, two test welds may be needed to obtain the required number of test specimens.

4.4.5.4 The specimens shall be air-cooled to ambient temperature before testing.

4.4.5.5 The specimens shall be broken by supporting both ends of the specimen and striking the center or by supporting one end and striking the other.
4.4.5.6 The specimens shall be broken so that the root of the weld is subjected to the greater strain.

4.4.5.7 Acceptance Criteria

1. The exposed surfaces of the specimen shall show complete penetration and fusion.
2. The greatest dimension of any gas pocket shall not be greater than 1/16 inch (1.59 mm).
3. The combined area of all gas pockets shall not be greater than 2% of the exposed nick break fracture area.
4. Slag inclusions shall not be greater than 1/32 inch (0.8 mm) in depth and shall not be greater than 1/8 inch (3 mm) or one-half the nominal wall thickness in length, whichever is smaller.
5. The separation between adjacent slag inclusions shall be 1/2 inch (13 mm) minimum.

4.5 Alternative Qualification Test

4.5.1 API 1104 permits both single procedure qualification and multiple qualification. Unless otherwise approved by the owner representative, all welders shall test to the multiple qualification requirements.

4.5.2 A welder who may reasonably be expected to butt and fillet weld on a variety of pipe diameters, wall thicknesses, and yield strengths shall complete the multiple qualification test.

4.5.3 A welder who successfully completes the single qualification butt or fillet test is limited to the joint configuration, thickness, and diameter range as listed on that qualifying procedure.

4.6 Re-Test of a Failed Destructive Qualification Exam

4.6.1 A welder who fails a welder certification test shall be classified into one of the following categories:

a. New Welder: No prior certification on file, or has failed a previous attempt and is past the 30-day wait period after a failure.

b. Proven Welder: Currently welding on a contractor’s project, or returning to service after expiration of certification with a record on file in the contractor data base.

c. Compound Welder: A current certification is on file and, at the request of a contractor representative, the welder is seeking a secondary certification.

4.6.2 Criteria for Retesting

4.6.2.1 New Welder

1. A new welder who attempts and fails a qualification test shall not be eligible to re-test until the expiration of a 30-day wait period. The 30-day wait period shall start the day after the failed attempt.
2. A second failure of a new welder shall result in another 30-day wait period from the date of last failure before the welder is eligible to retest.

3. Three consecutive failures shall result in a one year wait period before the welder is eligible to retest.

4.6.2.2 Proven Welder

1. At the option of the authorized CWI, a proven welder who accepts the reason for test failure and acknowledges appropriate remedial action can retest on the next business day following the failed attempt.

2. A proven welder who challenges or disputes the reason for failure or the need for remedial action shall require a 30-day wait period before the welder is eligible to retest.

3. A second failure of a proven welder shall result in an additional 30 day wait period before the welder is eligible to retest. At the option of the designated CWI, a proven welder may be allowed to repeat this requirement until a successful test is obtained.

4.6.2.3 Compound Welder

1. A compound welder shall not have his primary certification revoked upon failure of a secondary certification attempt unless there is a specific reason to question the welder’s ability to make welds under the welder’s primary certification.

2. At the option of the authorized CWI, a compound welder can make up to three attempts to obtain a secondary certification.

3. Time constraints shall not be placed on the three attempts for a secondary certification.

4. If the compound welder reaches the three failed attempt limit, the welder shall wait a minimum of one year from the date of last failure before retesting for another secondary certification.

4.7 Requalification by Non-Destructive Testing

4.7.1 A welder qualified by destructive testing can extend that qualification for one additional six month period by an acceptable radiographic examination of either a production or test weld made by the welder.

4.7.2 The NDT examinations shall be completed by the end of the sixth month following destructive testing.

4.7.3 Failure to document acceptable NDT examinations in the six-month period shall disqualify the welder and require re-qualification by destructive testing in accordance with Sections 4.4, 4.5 and 4.6.

4.7.4 The Radiographic Testing (RT) report shall include the welder’s name or stencil number and indicate that the results are for a requalification weld in accordance with the acceptance criteria of API 1104, Section 9.
4.7.5 The results shall be documented on Welder Qualification by Non-Destructive Testing Forms (See Appendix for sample form).

4.7.6 All completed requalification forms shall be signed by the authorized CWI and submitted to the owner representative.

4.7.7 RT interpretation shall be performed by an American Society of Non-destructive Testing (ASNT) - Level II or higher RT technician.

4.7.8 RT examination may be performed in the field or on a test sample at the discretion of the CWI. The actual weld may be all or a portion of a production assembly.

4.8 Re-Test of a Failed Non-Destructive Qualification Exam

A welder who fails to produce an acceptable non-destructive requalification weld shall be required to retest in accordance with Sections 4.4, 4.5 and 4.6.

4.9 Revoking Certifications

4.9.1 At any time during production welding, qualifications can be revoked if the welder’s performance results in a reject ratio higher than considered acceptable.

4.9.2 The following criteria shall be considered a base line that a welder should not exceed:

   a. Three percent defective welds of any project total
   b. Three defective welds in a six month qualification interval

4.9.3 A welder may also have their certification revoked if the welder is unable to meet acceptable production rates, or does not follow safe welding practices.

4.9.4 A welder who has his/her certification revoked shall not be eligible to test, qualify or hold a welding certification except as permitted in Section 4.10.

4.9.5 The contractor who employs the welder shall be responsible for directing or enforcing this Section and communicating revocations to the authorized CWI.

4.10 Certification Re-instatement

Reinstatement of a welder’s certification that has been revoked can be granted if all of the following conditions are met:

1. The welder acknowledges that the behavior that caused the revoked status is not permitted or tolerated.

2. The contractor who employs the welder shall notify the QA/QC group to initiate the welder’s status change within the Welder Certification Management System.

3. All current and previous held certifications held by the welder shall be changed to an expired status.

4. The welder shall be required to complete the destructive examination in accordance with Sections 4.4, 4.5 and 4.6.

4.11 Records

4.11.1 A record shall be made of the tests given to a welder regardless of outcome.
4.11.2 The record shall include the details and results of each test, whether pass or fail.

4.11.3 Document submission can be accomplished by any of the following methods:
Welder Qualification Form

4.11.4 The welder test records shall be submitted by the DESIGNATED CWI to the Owner.
Figure 1. Specimen Locations

Notes:
1. At the company's option, the locations may be rotated, provided they are equally spaced around the pipe; however, specimens shall not include the longitudinal weld.
2. One full-section tensile-strength specimen may be used for pipe with an outside diameter less than or equal to 1.315 in. (33.4 mm).
Figure 2. Nick-Break Test Specimen
Figure 3. Dimensioning of Imperfections in Exposed Weld Surfaces

Figure 4. Root- and Face-bend Test Specimen: Wall Thicknesses Less than or Equal to 0.500 inch (12.7 mm)
Notes:
1. The weld reinforcement shall be removed from both faces flush with the surface of the specimen.
2. Specimens may be machine cut to a width of 1/2 inch (13 mm), or they may be oxygen cut to a width of approximately 0.75 inch (19 mm) and then machined or ground smooth to a width of 0.50 inch (13 mm). Cut surfaces shall be smooth and parallel.

Figure 5. Side-bend Test Specimen: Wall Thicknesses Greater than 0.500 inch (12.7 mm)

Note: This figure is not drawn to scale

Radius of plunger, A = 1 3/4 inches (45 mm)
Radius of die, B = 2.5/16 inches (60 mm)
C = 2 inches (51 mm)

Figure 6. Jig for Guided-Bend Tests
Two specimens from crotch and two at 90° to crotch

Note: This figure shows the location of test specimens for joints with an outside diameter greater than or equal to 2.375 inches (60.3 mm). For joints with an outside diameter less than 2.375 inches (60.3 mm), specimens shall be cut from the same general location, but two specimens shall be removed from each of two test welds.

Figure 7. Location of Nick-break Test Specimens: Fillet-Weld Procedure and Welder Qualification Test Welds

Figure 8. Location of Nick-Break Test Specimens: Fillet-weld Procedure and Welder Qualification Test Welds, Including Size-to-Size Branch-connection Welder Qualification Test.
API 1104 Welder Qualification by Non-Destructive Testing – Butt Welds Only – PIP Form No. _____

Company ________________________________

Welder’s Name ____________________________

NDT test method – RT per Procedure _______________

UT per Procedure _______________

(Attach NDE report for weld qualification)

Welding Procedure Number Qualified by NDE Method __________________________

Test Date ________________ CWI Inspector witness ________________________

Base Material #1 ________________________ Base Material #2 __________________________

(Attach Material Test Reports for record of qualification)

Filler Metal AWS Classification Electrode ________________________ Flux (if applicable) ____________

(Attach Material Test Report of electrode material(s) used and Flux Report)

DC/AC Voltage ____________ AMPS ____________________ Weld Position ________________________

Material Thickness ______________ Size of Base Material __________________________

Shielding Gas Used __________________ Flow Rate _____________________________

Speed of Travel __________________________

Preheat (if needed) ____________________ PWHT ___________________________

Passed ____________________ Failed ____________________ per NDE results

Date of NDE test __________________________

NDE Test technician Name and initials for review of data and results ________________________

NDE Company technician works for ____________________ Technician ASNT No. _____________

Authorized CWI Inspector Name ________________ CWI No. _____________________________

Date of Acceptance by CWI Inspector ________________ File number for record purposes ________