



## Guidance on Auditing Welding Process

This document provides guidance to API Monogram/APIQR auditors conducting API Monogram/APIQR audits. This document does not prescribe any requirements that must be complied with by Licensed and/or Registered organizations. Actual requirements are listed in API product specifications and quality management system standards. Specifically, auditors are expected to ensure that the facility is conforming to; (1) applicable product specification requirements for this activity, and (2) quality management system requirements, such as conformance with the company's own procedures, regulatory requirements, or contract requirements.

Auditors should familiarize themselves with standards referenced in the applicable API product specification. In the case of Welding, such referenced standards may include AWS D1.1 and ASME BPVC Section IX. Auditors may review the following areas of emphasis:

### Documentation:

- Identify which welding code(s) is (are) used by the organization. Note that some API specifications require that welding conform to AWS D1.1, API 1104, or ASME Section IX.
- Auditors may review Procedure Qualification Record(s) PQR(s) that support the Welding Procedure Specification (WPS) and consider whether the WPS has been properly qualified.
  - Does the PQR identify actual welding parameters used?<sup>1</sup>
  - Are all essential, supplementary essential and nonessential (when required) variables documented in the PQR?
  - Are all required non-destructive and destructive test results included in the PQR?
  - Welders are identified
- Auditors may review PQR test results, including (as applicable):
  - Tension Test
  - Bend Test (face, side, and/or root)
  - Charpy Impact testing (CVN)
  - Macro Examination
  - Hardness Testing
  - Fracture Toughness Test (if required)
  - Radiographic or other NDE report
- Auditors may review the WPS parameters and consider whether they conform to the PQR(s) or the prequalified WPS, including (as applicable):
  - Welding process (e.g., FCAW, GMAW, GTAW, SMAW, SAW, etc.)
  - Base metals<sup>2</sup>
  - Welding electrode/filler metal<sup>3</sup>
  - Pre-heat and interpass temperatures
  - Time between root and hot pass
  - Joint design, including bevel geometry, root gap, and backing
  - Shielding gas composition
  - Gas flow rate
  - Voltage
  - Current (amps)
  - Travel speed

- Heat input<sup>4</sup>
- Welding and welder position
- PWHT
- Refer to the essential, non-essential, and when required, supplementary essential variables identified in the relevant welding code.
- Verify qualification of personnel that oversaw procedure qualification and ensure it is consistent with code requirements
- If the root pass requirements are different, have they been identified?
- If an essential or supplementary essential variable was changed, was the WPS was requalified, and if necessary, was the welder requalified.
- Was (were) the welder(s) qualified as a welder or a weld operator (for automatic equipment). The qualification requirements for each may be different.
- Auditors may review the WPQ or WOPQ for the welder. Are test results available, including (as applicable):
  - Was the WPS used in welder qualification qualified?
  - Destructive (mechanical) testing
  - NDE: e.g. Radiography test, Ultrasonic test
  - Extent of welder qualification based on welder essential variables of the code and the welder qualification coupons that passed
  - Qualification of personnel that oversaw welder qualification and whether it is consistent with code requirements
- Auditors may review the welder continuity log.
  - If time between welds exceeds minimum requirements, has the welder been requalified?

### Interview and observations:

If possible, auditors should perform interviews and observations in the welding area with a qualified welder.

If possible, the auditor should observe a welder performing a welding activity to confirm requirements are being met. For example:

- Drawings:
  - Does the welder understand the welding symbols and call outs?
  - Is the weld size in accordance with the drawing?
  - How does the operator measure the weld size?
- Are personnel using the correct WPS for the job they are working on.
- Are personnel qualified as a welder or weld operator for the particular WPS, including (as applicable):
  - Processes
  - Position
  - Material
  - Material size ranges (e.g. thickness, diameter, etc.)
- Is equipment calibrated, including equipment used to control:
  - Voltage
  - Current (amps)
  - Wire feed speed

- Temperature
- Gas flow
- Storage of consumables
- Do the required variables meet the requirements of the WPS, including (as applicable):
  - Welding process (e.g., FCAW, GMAW, GTAW, SMAW, SAW, etc.)
    - Is the welder using the correct process?
  - Base metals<sup>5</sup>
    - Is the MTR of the base metals available? Do the material requirements conform to the PQR and WPS?
  - Welding consumables (including electrodes, filler metal, shielding gases and fluxes):
    - Are the correct consumables identified, clearly marked, and used by the personnel?
    - How does the operator control the shielding gas flow rate?
    - Are the consumables stored in accordance with manufacture's requirements prior to and after use?
  - Joint design, including shape, spacing, and backing
    - Is the operator ensuring the appropriate spacing and/or backing per the WPS
    - Are the weld joints prepared (grinding, brushing, chemical cleaning) in accordance to the WPS
  - Pre-heat and interpass temperatures
    - What tools are used to measure temperature (pyrometer, crayons, etc.), and are they calibrated.
    - Are the preheating and interpass temperatures measured properly and do they meet requirements.
  - Tacking and clamping
    - Is the weld joint held in place by acceptable weld tacks or clamps
    - Is sufficient weld deposited before weld clamps are removed
  - Voltage, current, travel speed, and heat input
    - How does the welder/operator ensure the correct heat input?
    - Is the travel speed measured by a welding inspector, TMME or does the operator calculate the travel speed? If the latter, does the operator understand how to calculate it.
  - Welding position
  - PWHT
    - Was the required PWHT performed?
- Are the weld number and stenciling per requirements?
- Does the traceability for each welder to his/her work meet requirements?
- Has the required visual inspection, NDE, and/or hardness test been performed (as applicable)? Has inspection been performed at the required stages (when applicable)?
- If welds are repaired, has an acceptable repair welding procedure been used?
- If the organization welds corrosion resistant alloy (CRA), are tools for welding and cleaning CRAs identified and segregated from tools used for welding and cleaning carbon steel?

**Notes:**

Notes provide additional guidance regarding some items identified above. Any findings raised during audits must reference specific requirements from normative documents and cannot be raised based on this document.

1. Based on actual as-run data on a per-pass basis for all weld passes
2. Including Specification, Grade, Mill Certificate.
3. Welding electrode/filler metal can include AWS Specification, AWS Classification and Manufacturer's trade name.
4. Heat input can be calculated using the formula

$$\frac{60 \times \text{Amps} \times \text{Volts}}{1,000 \times \text{Travel Speed (in/min)}} = \text{Heat Input (KJ/in)}$$

Based on actual heat input measured during procedure qualification, not parametric combinations of maximum and minimum values recorded.

5. Includes verification of proper ASME P-number, and Group number classification or AWS Group number classification.
6. Due to time constraints, it may not be possible to cover every item on this checklist. Auditors should prioritize the "Interview and Observations" section as well as personnel qualifications.