Welding

Subpart "E"

Not applicable to welding during manufacture of pipe and components
§192.225 WELDING - GENERAL

- Performed by a Qualified Welder
- Using Qualified Welding Procedures
- Procedures Qualified by Destructive Testing
"Qualified Procedure" vs "Qualified Welder"

"qualified procedure test" verifies integrity/metallurgy of that weld

"qualified welder test" verifies ability of that welder
§192.225 Welding procedures

- Welding Performed by “Qualified” Welder
- Welding Procedures “Qualified” Using API 1104 Section 5 or ASME B&PV Section IX
- Recorded in Detail and “Qualified” by Destructive Testing
- Followed when the Procedure is Used
Procedure must be qualified by Destructive Testing
Section 5, Figure 3

Number, Type, and Locations of Test Straps Required for Procedure Qualification Tests

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 specimen may be used for pipe with an outside diameter less than or equal to 1.315 in. (33.4 mm).

Figure 3—Location of Test Butt-Weld Specimens for Procedure Qualification Test
**PROCEDURE SPECIFICATION NO.**

For: ____________________________ Welding of: ____________________________ Pipe and fittings

Process: ____________________________
Material: ____________________________
Pipe outside diameter and wall thickness: ____________________________
Joint design: ____________________________
Filler metal and no. of beads: ____________________________
Electrical or flame characteristics: ____________________________
Position: ____________________________
Direction of welding: ____________________________
No. of welders: ____________________________
Time lapse between passes: ____________________________
Type and removal of lineup clamp: ____________________________
Cleaning and/or grinding: ____________________________
Preheat/stress relief: ____________________________
Shielding gas and flow rate: ____________________________
Shielding flux: ____________________________
Speed of travel: ____________________________
Plasma gas composition: ____________________________
Plasma gas orifice size: ____________________________
Sketches and tabulations attached: ____________________________

Tested: ____________________________ Welder: ____________________________
Approved: ____________________________ Welding supervisor: ____________________________
Adopted: ____________________________ Chief engineer: ____________________________

---

**ELECTRODE SIZE AND NUMBER OF BEADS**

<table>
<thead>
<tr>
<th>Bead Number</th>
<th>Electrode Size and Type</th>
<th>Voltage</th>
<th>Amperage and Polarity</th>
<th>Speed</th>
</tr>
</thead>
</table>

---

Note: Dimensions are for example only.

---

**Standard V-Bevel Butt Joint**

- Approximately 1/32" (1.6 mm)
- 1/16" to 1/8" (1.6 mm ± 0.8 mm)

**Sequence of Beads**

- Approximately 1/32" (3 mm)
<table>
<thead>
<tr>
<th>Procedure Specification No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>For: Welding of: Pipe and fittings</td>
</tr>
</tbody>
</table>

**Process**

- Pipe outside diameter and wall thickness
- Joint design
- Filler metal and no. of beads
- Electrical or flame characteristics

**Position**

- Direction of welding
- No. of welders
- Time lapse between passes

**Type and removal of lineup clamp**

- Cleaning and/or grinding
- Preheat/stress relief
- Shielding gas and flow rate
- Shielding flux
- Speed of travel
- Plasma gas flow rate
- Plasma gas composition
- Plasma gas orifice size
- Sketches and tabulations attached

**Tested**

- Welder
- Approved
- Welding supervisor
- Adopted
- Chief engineer
Essential Variables

API 1104 Procedure Qualification

- Change in Process or Method of Application

- Pipe Grades
  - ≤ 42,000 SMYS
  - > 42,000 but < 65,000
  - ≥ 65,000 - Separate Test for Each Grade
Essential Variables

API 1104 Procedure Qualification

- Joint Design (U or V groove)
- Position (fixed or rolled, horizontal or tilted)

- Wall Thickness Group
  - < 3/16” (.188)
  - 3/16” - 3/4” (.188 - .750)
  - > 3/4” (.750)
Essential Variables
API 1104 Procedure Qualification

- Time Between Passes
  - Max time between root and second

- Direction of welding
  - Uphill or downhill
Essential Variables
API 1104 Procedure Qualification

- Shielding Gas and Flow Rate
- Shielding Flux
- Speed of Travel
- Filler Metal

<table>
<thead>
<tr>
<th>Group</th>
<th>AWS Specification</th>
<th>Electrode</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A5.1  A5.5</td>
<td>E6010  E6011 E7010 E7011</td>
</tr>
<tr>
<td>2</td>
<td>A5.5</td>
<td>E8010  E8011 E9010</td>
</tr>
<tr>
<td>3</td>
<td>A5.1 or A5.5</td>
<td>E7015  E7016 E7018</td>
</tr>
<tr>
<td></td>
<td>A5.5</td>
<td>E8015  E8016 E8018 E9018</td>
</tr>
</tbody>
</table>
§192.227 Qualification of Welders

- Section 6 of API Standard 1104
- Section IX of ASME Boiler and Pressure Vessel Code
- Less than 20% SMYS - Appendix “C”
§192.227 Qualification of Welders

- Welder Qualified under Earlier Edition of API 1104 or ASME Section IX---
  - May Continue to Weld
  - May Not Re-qualify under that Edition
Qualified Welders

I don’t Think So
API 1104 Welder Single Qualification (Butt or Fillet)

- If Qualified on Butt Welds in Fixed Position @ 45° Angle, Qualified for Butt Welds and Lap Fillet Welds in all Positions
Essential Variables - Welder Single Qualification

Change in any one of:

- Process
- Direction of Welding
- Filler-metal Classification
- Outside Diameter Group
  - < 2.375"
  - 2.375 – 12.750"
  - > 12.750 "
- Wall Thickness Group
- Position
- Joint Design
API 1104 Welder Multiple Qualification

- Must Make Butt Weld First
- Layout, Cut & Fit Branch Connection
- Cut Hole in Run for Branch
- Make Fillet Weld on Branch/Run Joint
API 1104 Welder Multiple Qualification

- Butt & Branch Welds Must Be Made on Pipe at Least 6.625”
- 12.75” Qualifies for all Pipe Diameters
- Butt Weld Made in Fixed Horizontal or 45° Angle Position
API 1104  Welder Multiple Qualification

- Cut Full-Size Hole in Run Pipe
- Run Pipe Shall Be Horizontal
- Branch Shall Extend Vertically Downward From Run Pipe
Essential Variables Welder
Multiple Qualification

- Change in welding processes
- Change in direction of welding
- Change in filler metal classifications
§192.229 Limitations on Welders

- Welder whose qualification is based on nondestructive testing may not weld on compressor station pipe and components.
- Must have welded with particular process within the preceding 6 calendar months.
192.229 Additional Limitations

- Welder qualified under Section 6 of API 1104 or Section IX of ASME

To weld on pipe operating at 20% SMYS or more, must have weld tested:
- Every 6 months per API 1104 Section 6 or 9, or
- Twice each CY at intervals Not exceeding 7-1/2 months
§192.229 Additional Limitations

- Welder qualified under Section 6 of API 1104 or Section IX of ASME

To weld on pipe operating $>20\%$ SMYS, must:

- Have weld tested every 6 months per API 1104 Section 6 or 9, or

- Re-qualify under Appendix “C” every calendar year not to exceed 15 months, or

- Cut out and test a production weld twice each calendar year
§192.229 Additional Limitations

- Welder qualified under Appendix “C”
  - Must re-qualify under Appendix “C” every calendar year not to exceed 15 months, or
  - Must cut out and test a production weld twice each calendar year (interval cannot exceed 7 1/2 months), or
  - For service lines 2 inches and smaller only, 2 welds tested per App. “C”, Sec. III
§192.231 Protection from Weather

The welding operation must be protected from weather conditions that would impair the quality of the completed weld.
§192.233 Miter Joints

- 30% or more SMYS, Maximum of 3°
- >10% SMYS <30%, Maximum of 12\(\frac{1}{2}\)°
  Must be one diameter from any other miter
- 10% or less SMYS, Maximum of 90°
§192.235 Preparation for Welding

Before beginning any welding, the welding surfaces must be clean and free of any material that may be detrimental to the weld, and

Must be aligned to provide the most favorable condition for depositing the root bead. This alignment must be preserved while root is deposited.
§192.241 Inspection and Test of Welds

- Visual inspection (by individual qualified by training & experience) of the WELDING must be done to insure --
  - Welding is done according to procedure, and
  - Weld is acceptable per API 1104 Section 9.
§192.241 Inspection and Test of Welds
§192.241 Inspection and Test of Welds
§192.241 Inspection and Test of Welds

- Welds on pipelines operating ≥ 20% SMYS must be NDT’d, except:
  - Welds visually inspected and approved by a welding inspector qualified by training & experience if:
    - Pipe is < 6” nom. dia.; or
    - Line operates below 40% SMYS and welds are limited in number.
Alternative Acceptance Criteria

API 1104 – Appendix “A” (20th Edition Errata/Addendum July 2007)

Appendix A *Is Incorporated by Reference in Part 192.241 (c) as an alternative acceptance criteria if API 1104 Section 9 requirements cannot be met for any reason other than a crack.

Alternative Acceptance Criteria

API 1104 – Appendix “A” (20th Edition
Errata/Addendum July 2007)

- Uses “Fracture Mechanics Analysis” and “Fitness-for-Purpose Criteria” to Determine Weld Alternate Acceptance Criteria.
- Additional Qualification Tests, Stress Analysis, and Inspection are required to use the “Fitness-for-Purpose” criteria.
- Restricted use, not applicable in all conditions.
§192.243 Nondestructive Testing

NDT must be performed by any process, other than trepanning, which will clearly indicate defects that may affect the integrity of the weld.
§192.243 What is Trepanning?
§192.243 Nondestructive Testing

- NDT must be performed:
  - In accordance with written procedures; and
  - By persons trained and qualified in the procedures and with the equipment being utilized
§192.243 Nondestructive Testing

- Procedures must be established for interpretation of each test to ensure acceptability of the weld per API 1104 Section 9.
§192.243 Nondestructive Testing

When required, (20% or more SMYS) random testing of each day's welds must be tested at the following rates:

- Class 1 areas - 10%
- Class 2 areas - 15%
- Class 3 & 4, offshore, rights-of-way, road & RR crossings 100%, unless impracticable, then 90%
- Tie-Ins (including replacement sections) 100%
§192.243 Nondestructive Testing

- Must test some of each welders work each day
- Must retain for life:
  - Record by milepost, engineering station, etc.;
    - Number of welds
    - Number tested
    - Number rejected
    - Disposition of rejects
§192.245 Repair or Removal of Defects

- Each unacceptable weld under §192.241 (c);
  - Must be removed or repaired.
  - Removed if crack is > 8% of weld length

- For repairs, must remove defect down to sound metal, pre-heat if necessary, and re-inspect
§192.245 Repair or Removal of Defects

- Repair of a crack or defect in a previously repaired area must be done in accordance with written repair procedures that have been qualified under §192.225
(c) Each arc burn on steel pipe to be operated ≥ 40% SMYS must be repaired or removed. If repaired by grinding, must check remaining wall thickness.

Use dilute solution of ammonium persulfate to check for cracking.
Part 192
Appendix “C” Basic Test

- Test on pipe 12” or smaller
- Weld in horizontal, fixed position
- Weld according to a qualified, written procedure
Part 192
Appendix “C” Basic Test

- Cut weld into four coupons
- Subject to a root bend test
- If two or more have a crack >1/8”, weld is unacceptable
- Successful test qualifies welder to weld on pipe diameters ≤ 12 inches
Part 192 - Appendix “C”
Service Connections To Mains

- Weld service connection to pipe of typical main size in same position as in field
- Test destructively
Part 192 - Appendix “C”
Small Service Lines

- Two samples 8” long are cut with weld in center
- Subject one to guided bend test
- Subject second to tensile test
  - If tensile machine not available, bend test
What About Maintenance/Hot Welding?

- Covered in API 1104 (20th ed.) Appendix “B” (prev. API RP 1107)

- Appendix “B” **NOT** incorporated by reference in Part 192

- Maintenance Welding includes OQ Covered Tasks

- Operators must qualify Welders for Maintenance Tasks
What About Maintenance/Hot Welding?

Two Primary Concerns – Welding on In-Service Pipelines

- Burn-Through
- Hydrogen Cracking
Burn-Through

- Unlikely on Wall Thicknesses $\geq 0.250$ in.

- Low-Hydrogen Electrodes (EXX18) and Normal Welding Practices Followed

- Thinner Wall Pipelines Require Special Precautions (e.g., Limits on Heat Input)
Low –Hydrogen Electrodes

- Don’t “dig” like Cellulose electrodes
- Require Uphill Direction in Procedure
- Must Be Properly Stored (Heater Box) and Maintained
Hydrogen Cracking

To Occur, 3 Conditions Must Occur:

1. Hydrogen Gas in the Weld
2. Development of Crack-Susceptible Weld Microstructure
3. Tensile Stress Acting on the Weld
Hydrogen Cracking Prevention

Must Eliminate One or More of the 3 Conditions
Hydrogen Cracking Prevention

- Use Low-Hydrogen Electrodes, Process and/or Procedures
- High Heat Input Levels to Overcome Cooling Effect of Product Flow
- Procedure Qualified for In-Service Welding
- Preheating (where Practicable and Effective)
- Use of Temper-Bead Deposition Sequence
- Attention to Proper Fit-Up to Minimize Stress
What should State/Federal inspectors or operators check for compliance regarding Subpart E?

- Written welding procedures with qualifying test results available
- How welders are qualified (API, ASME, Appendix “C”)
- Verification of use of qualified welders
- How welders maintain qualification/re-qualify
- Qualifications of welding inspectors
What should State/Federal inspectors or operators check for compliance regarding Subpart E?

- Adherence to welding procedures/code requirements/housekeeping during field welding
- Use of N.D.T./N.D.T. procedures/qualifications of N.D.T. technicians
- Special procedures for “hot” or repair welding
- Repair criteria for defective welds
- Maintenance of required records
192 Subpart “E”

The End