## Welding Procedure Specification (WPS)

**ASME Boiler and Pressure Vessel Code, Section IX**

### BASE METALS (QW-403)

<table>
<thead>
<tr>
<th>P-No.:</th>
<th>Group No.:</th>
<th>Material Specification</th>
<th>Type or Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>1</td>
<td>SA-335</td>
<td>P11</td>
</tr>
</tbody>
</table>

Welded to:

<table>
<thead>
<tr>
<th>P-No.:</th>
<th>Group No.:</th>
<th>Material Specification</th>
<th>Type or Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>1</td>
<td>SA-234</td>
<td>WP11, Class 1</td>
</tr>
</tbody>
</table>

### OTHER INFORMATION

- N/A

### FIRST PROCESS

**Welding Process(es):**

Gas Tungsten Arc Welding (GTAW)

**Type(s):**

Manual

### SECOND PROCESS

**Welding Process(es):**

Shielded Metal Arc Welding (SMAW)

**Type(s):**

Manual

### FILLER METALS (QW-404)

<table>
<thead>
<tr>
<th>Classification</th>
<th>AWS Classification</th>
<th>Electrode-Flux Class (SAW)</th>
<th>SFA Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrode-Flux Class</td>
<td>ER80S-G</td>
<td>E8016-B2</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Material F-No.</th>
<th>Filler Metal F-No.</th>
<th>SFA 5.28</th>
<th>SFA 5.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Weld Metal Analysis A-No.</th>
<th>Weld Metal Analysis A-No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Size of Filler Metals mm (in)</th>
<th>Size of Filler Metals mm (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0 mm (see sheet 3)</td>
<td>3.25 mm (see sheet 3)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Filler Metal Product Form</th>
<th>Filler Metal Product Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid copper coated wire</td>
<td>Iron powder low hydrogen</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Max. Weld Pass Thickness mm (in)</th>
<th>Max. Weld Pass Thickness mm (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/8 in.</td>
<td>3/16 in.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Qualified Weld Metal Range: Groove mm (in)</th>
<th>Qualified Weld Metal Range: Groove mm (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 mm (3/8 in.)</td>
<td>60 mm (2.36 in.)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Qualified Weld Metal Range: Fillet mm (in)</th>
<th>Qualified Weld Metal Range: Fillet mm (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unlimited</td>
<td>Unlimited</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Weld Deposit Chemistry</th>
<th>Weld Deposit Chemistry</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Flux Trade Name and Flux Type (SAW)</th>
<th>Flux Trade Name and Flux Type (SAW)</th>
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</thead>
<tbody>
<tr>
<td>N/A</td>
<td>N/A</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Consumable Insert, Class and Size</th>
<th>Consumable Insert, Class and Size</th>
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</thead>
<tbody>
<tr>
<td>N/A</td>
<td>N/A</td>
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</tbody>
</table>

### POSITIONS (QW-405)

<table>
<thead>
<tr>
<th>Position (s) of Groove</th>
<th>ALL Position</th>
<th>ALL Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Welding Progression</td>
<td>Up</td>
<td>Up</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Position (s) of Fillet</th>
<th>ALL Position</th>
<th>ALL Position</th>
</tr>
</thead>
</table>

### PREHEAT (QW-406)

<table>
<thead>
<tr>
<th>Preheat Temp. °C (°F)</th>
<th>150 °C</th>
<th>150 °C</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Interpass Temp. Max. °C (°F)</th>
<th>280 °C</th>
<th>280 °C</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Preheat Maintenance °C (°F)</th>
<th>New Joint</th>
<th>New Joint</th>
</tr>
</thead>
</table>

### GAS (QW-408)

<table>
<thead>
<tr>
<th>Shielding Gas Type (Mixture)</th>
<th>100% Ar</th>
<th>N/A</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Flow Rate lt/min. (CFH)</th>
<th>7 to 9 lt/min.</th>
<th>N/A</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Trailing Gas Type (Mixture)</th>
<th>N/A</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Flow Rate lt/min. (CFH)</th>
<th>N/A</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Gas Backing (Mixture)</th>
<th>N/A</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Flow Rate lt/min. (CFH)</th>
<th>N/A</th>
</tr>
</thead>
</table>

### POSTWELD HEAT TREATMENT (QW-407)

<table>
<thead>
<tr>
<th>Holding Temperature Range °C (°F): 680 °C + or - 10 °C</th>
<th>Holding Temperature Range: 1 hr/in. (15 minutes Min.)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Heating Rate °C/hr (°F/hr): 120 °C/hr</th>
<th>Method: Furnace</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Cooling Rate °C/hr (°F/hr): 120 °C/hr</th>
<th>Method: Open Air</th>
</tr>
</thead>
</table>
WPS No. DEMO-WPS  Rev. (0)  Sheet 2 of 3

ELECTRICAL CHARACTERISTICS (QW-409)

Following data may also shown on Table below in this sheet

<table>
<thead>
<tr>
<th>FIRST PROCESS</th>
<th>SECOND PROCESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current/ Polarity</td>
<td>DCEN</td>
</tr>
<tr>
<td>Amps (Range)</td>
<td>90 to 120</td>
</tr>
<tr>
<td>Volts (Range)</td>
<td>18 to 25</td>
</tr>
<tr>
<td>Wire Feed Speed (Range) mm/min (in/min)</td>
<td>_</td>
</tr>
<tr>
<td>Travel Speed (Range) mm/min (in/min)</td>
<td>Manual control</td>
</tr>
<tr>
<td>Mode of Metal Transfer for GMAW (FCAW)</td>
<td>N/A</td>
</tr>
<tr>
<td>Tungsten Electrode Size mm (in)</td>
<td>2.5 mm</td>
</tr>
<tr>
<td>Tungsten Type</td>
<td>SFA 5.12 EWTb-2</td>
</tr>
</tbody>
</table>

TECHNIQUE (QW-410)

<table>
<thead>
<tr>
<th>Description</th>
<th>FIRST PROCESS</th>
<th>SECOND PROCESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>String or Weave Bead</td>
<td>String Bead</td>
<td>String and Weave Bead</td>
</tr>
<tr>
<td>Multiple or Single Electrodes</td>
<td>Single</td>
<td>Single</td>
</tr>
<tr>
<td>Multiple or Single Pass (per side)</td>
<td>Multiple</td>
<td>Multiple</td>
</tr>
<tr>
<td>Orifice or Gas Cup Size</td>
<td>5/8 in. Nozzle Size</td>
<td>_</td>
</tr>
<tr>
<td>Initial and Interpass Cleaning</td>
<td>Brushing</td>
<td>Brushing and Grinding</td>
</tr>
<tr>
<td>Method of Back Gouging</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Oscillation</td>
<td>_</td>
<td>_</td>
</tr>
<tr>
<td>Peening</td>
<td>Not Required</td>
<td>Not Required</td>
</tr>
</tbody>
</table>

Other information: Clean each layer before start welding new passes/layers

JOINTS (QW-402)

Joint Design: Groove Design Used  Backing Type: Metal  Backing Material (Refer to both backing and retainers.): Same as base metals

Joint Details/ Sketch:

Table for recorded welding parameters; Refer to QW-409

<table>
<thead>
<tr>
<th>Weld Layer(s)</th>
<th>Pass No. (s)</th>
<th>Process</th>
<th>Filler Metal Classification</th>
<th>Filler Size Diameter mm (in)</th>
<th>Current Amps Range</th>
<th>Current Type &amp; Polarity</th>
<th>Wire Feed Speed Range mm/min (in/min)</th>
<th>Volts Range</th>
<th>Travel Speed Range mm/min (in/min)</th>
<th>Max. Heat Input kJ/mm (kJ/in) Or Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>GTAW</td>
<td>ER80S-G</td>
<td>2.0 mm</td>
<td>90-120</td>
<td>DCEN</td>
<td>N/A</td>
<td>18-25</td>
<td>_</td>
<td>Root Pass</td>
</tr>
<tr>
<td>2</td>
<td>2 to 3</td>
<td>GTAW</td>
<td>ER80S-G</td>
<td>2.0 mm</td>
<td>90-120</td>
<td>DCEN</td>
<td>N/A</td>
<td>18-25</td>
<td>_</td>
<td>_</td>
</tr>
<tr>
<td>3 to n</td>
<td>4 to n</td>
<td>SMAW</td>
<td>E8016-B2</td>
<td>3.25 mm</td>
<td>100-130</td>
<td>DCEP</td>
<td>N/A</td>
<td>20-28</td>
<td>_</td>
<td>Fill and Cap Passes</td>
</tr>
</tbody>
</table>

Additional Notes: This is a DEMO-WPS prepared by online welding software of www.WPSAmerica.com

Manufacturer or Contractor’s Welding Engineer:  Authorized by:
Name: Jim Clark  Name: John Smith
Signature: J.C.  Signature: J.S.
Title: Welding Engineer  Title: QA Manager
Date: 12, 12, 2005  Date: 12,12, 2005
Heat Treatment (ASME Code’s Guideline):

PREHEAT TABLE:
ASME Section I: Preheating from Appendix A (A-100)
(a) 250 °F (120 °C) for material which has either a specified minimum tensile strength in excess of 60,000 psi (410 MPa) or a thickness at the joint in excess of 1/2 in. (13 mm):
(b) 50 °F (10 °C) for all other materials of P-No. 4 group.

POSTWELD HEAT TREATMENT TABLE:
ASME Section I: Mandatory Requirements for PWHT of Table PW-39
Min. Holding Temperature: 1,200 °F (650 °C)
Min. Holding Time for Weld Thickness (Nominal):
Up to 2 in. (50 mm): 1 hr/in. (2 min/mm), 15 min Min.
Over 2 in. (50 mm) to 5 in. (125 mm): 1 hr/in. (2 min/mm)
Over 5 in. (125 mm): 5 hr plus 15 min for each additional inch over 5 in. (125 mm)
Heating rate: The weldment shall be heated slowly to the holding temperature, Min. 100 °F (55 °C)/hr
Cooling rate: Cool slowly in a still atmosphere to a temperature not exceeding 800 °F (425 °C)
For Non-Mandatory conditions of PWHT, See Notes (1), (2) of Table PW-39

WPS Qualified Range (ASME IX Guideline):

Qualified Positions (Groove, Fillet): All Positions for Plate or Pipe
Unless specifically required otherwise by the welding variables (QW-250), a qualification in any position qualifies the procedure for all positions. The welding process and electrodes must be suitable for all positions permitted by the WPS (ASME Section IX, QW-203). (For impact test application, there are some restrictions for welding in vertical-uphill progression position; See ASME Section IX, QW-405.2)

Qualified Thicknesses (Groove, Fillet): 5/16 in. (5 mm) Min., 2T Max. (Plate or Pipe)
[For GMAW-Short Circuit Arc, when T is less than 1/2 in. (13 mm): 1.1T Max. ASME IX, QW-403.10]
[For impact test application, except ESW process: Min. Qualified Thickness is either T or 5/8 in. (16 mm), whichever is less; This variable does not apply when a WPS is qualified with a PWHT above the upper transformation temperature or when an austenitic material is solution annealed after welding, ASME IX, QW-403.6]
[For ferrous base metals other than P-No. 7, 8 and 45 (when test coupon receives a PWHT above the upper transformation temperature): 1.1T Max. ASME IX, QW-407.4]
[For any weld pass greater than 1/2 in. (13 mm) thick: 1.1T Max. (Except GTAW process). ASME IX, QW-403.9]
T: Thickness of Test Plate or Pipe Wall in PQR (ASME Section IX, Table QW-451.1)

Qualified Diameters (Groove, Fillet): All Nominal Pipe (Tube) Sizes, within Qualified Thicknesses in PQR

WPS Base Metal P-Numbers Allowed by PQR: Any metals of the same P-No. 4, plus combination between any metal from P-No. 4 to any metal from P-No. 3 or P-No. 1 (ASME Section IX, QW-424)

Qualified WPS Filler Metal Allowed by PQR: Only Filler Metal categories with the same F-number and same A-number tested in PQR. Any electrode diameter sizes can be used in WPS as it is not an essential variable for the most process and conditions. For Non-impacted test applications only, filler metal classification within an SFA specification, with the same F-number and the same A-number and the same minimum tensile strength and the same nominal chemical composition can be used in WPS. (ASME Section IX, QW-250)