

Welding Procedure Specifications (WPS)

Fermilab	Fermi National Accelerator Laboratory <i>Technical Division-Machine Shop</i>
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Welding Procedure Specification No.	Fermi WPS Ti-5	Date	2/20/2009
Revision # 1-Changed preheat to minimum from maximum Revision #2-Added Tungsten requirements		Date	1/22/2009
		Supporting PQR No.(s)	Fermi PQR Ti-3
Welding Processes	(1) GTAW-Orbital	Type 1	(Manual, Auto, Semi) Automatic/Manual
Welding Processes	(2) GTAW-Manual	Type 2	(Manual, Auto, Semi) GTAW/Manual

Joints (QW-402)					
Joint Design	Square Butt Groove		Backing	Gas	
Backing Material (Type) Root	Gas		Remainder		
Retainer	Yes	No X	Type	Non-Metallic	Metallic(non-fusing)

Details:
3" ASTM B 861/ASME SB 861, Grade 2
0.078 Wall



0.078

No root opening-1pass-no filler
Autogenous

Manual GTAW tacking of joint out of chamber

Base Metals (QW -403)					
P No. 51	Group No.	TO	P No. 51	Group No.	
Specification Type & Grade	ASTM B 861/ASME SB 861, Grade 2	TO	Specification Type & Grade	ASTM B 861/ASME SB 861, Grade 2	
OR/Chemical Analysis & Mechanical Properties					
TO: Chemical Analysis & Mechanical Properties					
Thickness Range	Process 1/Orbital		Process 2/GTAW-Manual Tack Weld		
Base Metal	Groove 0.078	Fillet	Groove 0.078	Fillet	
Deposited Weld Metal	Groove 0.078 to 0.156	Fillet	Groove 0.078 to 0.156	Fillet	
Pipe Diameter Range	Groove 2.875 Min.	Fillet	Groove 2.875 Min.	Fillet	
Other:					

Filler Metals (QW-404)	Process 1	Process 2
Specification No. (SFA)	None-Autogenous	None-Autogenous
AWS No.		
F No.		
A No.		
Size of Filler Metals		
Deposited Weld Metal		
Thickness Range		
Electrode-Flux (Class)		
Consumable Insert		
Other		

Each Base Metal-Filler Metal combination should be recorded individually



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Positions (QW-405)			Postweld Heat Treatment (QW-407)		
Positions of Groove	<i>All</i>		Temperature Range	<i>None</i>	
Welding Progression	<i>Orbital</i>		Time Range	<i>N/A</i>	
Positions of Fillet	<i>All</i>		Other		

Preheat (QW-408)		Gas (QW-408)				Gas (QW-408)		
Preheat Temp-Minimum	<i>32°F</i>	Process 1/Orbital-Automatic				Process 2/GTAW-Manual		
Interpass Temp Maximum	<i>350°F</i>		Gas	Mixture	Flow Rate	Gas	Mixture	Flow Rate
Preheat Maintenance	<i>N/A</i>	Shielding	<i>Argon</i>	<i>99.995></i>	<i>30 CFH</i>	<i>Argon</i>	<i>99.995></i>	<i>15CHF</i>
		Trailing	<i>None</i>					
		Backing	<i>Argon</i>	<i>99.995></i>	<i>7 CHF</i>	<i>Argon</i>	<i>99.995></i>	<i>12 CFH</i>

Electrical Characteristic (QW-409)				
Current AC or DC	<i>Direct</i>	Polarity	<i>Straight</i>	Characteristics: <i>Orbital with Pulse Current</i>
AMPS (Range)	<i>See Chart</i>	Volts (Range)	<i>10-15</i>	
Tungsten Electrode Size & Type:		<i>1/16 EWCe-2 (Manufacturer pre-ground, shaped & sized Tungsten—TC06-1085-03)</i>		
Mode of Metal Transfer for GMAW:		<i>N/A</i>		
Electrode Wire Feed Speed Range:		<i>N/A</i>		

Technique (QW-410)	
String or Weave Bead	<i>Stringer</i>
Orifice or Gas Cup Size	<i>Closed Chamber AMI Orbital Head Model 8-4000</i>
Initial/Interpass Cleaning (Brushing, Grinding, ect.)	<i>Initial cleaning with solvent</i>
Method of Back Gouging	<i>None</i>
Oscillation	<i>None</i>
Contact Tube to Work Distance	<i>N/A</i>
Multiple or Single Pass (per side)	<i>Single</i>
Multiple or Single Electrodes	<i>Single</i>
Travel Speed (Range)	<i>As Required</i>
Peening	<i>None</i>
Other	<i>AMI Orbital Welding Machine Model 227 with Model 8-4000 Welding Head Manual GTAW tacking of joint</i>

Sequence Chart										
Weld Levels	Pulse	Rotation	RPM		Time	AMPS		PULSE		Other
			Primary IPM	Back IPM		Primary	Back	Primary Per sec	Back Per sec	
<i>1</i>	<i>ON</i>	<i>Continuous</i>	<i>0.42</i>	<i>---</i>	<i>5</i>	<i>103</i>	<i>50</i>	<i>0.30</i>	<i>0.30</i>	<i>GTAW/Manual tack welds shall be made by a GTAW/Manual qualified welder</i>
<i>2</i>	<i>ON</i>	<i>Continuous</i>	<i>0.42</i>	<i>---</i>	<i>50</i>	<i>103</i>	<i>50</i>	<i>0.30</i>	<i>0.30</i>	
<i>3</i>	<i>ON</i>	<i>Continuous</i>	<i>0.42</i>	<i>---</i>	<i>46</i>	<i>102</i>	<i>50</i>	<i>0.30</i>	<i>0.30</i>	
<i>4</i>	<i>ON</i>	<i>Continuous</i>	<i>0.42</i>	<i>---</i>	<i>21</i>	<i>102</i>	<i>50</i>	<i>0.30</i>	<i>0.30</i>	
<i>5</i>	<i>ON</i>	<i>Continuous</i>	<i>0.42</i>	<i>---</i>	<i>25</i>	<i>102</i>	<i>50</i>	<i>0.30</i>	<i>0.30</i>	
<i>6</i>	<i>ON</i>	<i>Continuous</i>	<i>0.42</i>	<i>---</i>	<i>30</i>	<i>102</i>	<i>50</i>	<i>0.30</i>	<i>0.30</i>	