Welding Procedure Specifications (WPS)

Fermilab ***Fermi National Accelerator Laboratory***

Welding Procedure Specification No.	***Fermi Ti-4***	**Date**	*12/10/2008*
Revision # *3*	**Date** *2/2/2009*	Supporting PQR No.(s)	***Fermi PQR Ti-4***
Welding Processes	**(1)** *GTAW-Orbital*	**Type 1**	**(Manual, Auto, Semi)** *Automatic*
Welding Processes	**(2)**	**Type 2**	**(Manual, Auto, Semi)**

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:
1.5 ASTM B 861 Grade 2
0.109 Wall

No root opening-1pass-no filler
Autogenous

Base Metals (QW -403					
P No. *51*	Group No.		TO	P No. *51*	Group No.
Specification Type & Grade	*ASTM B 861,Grade 2*		TO	Specification Type & Grade	*ASTM B 861, Grade 2*
OR/Chemical Analysis & Mechanical Properties					
TO: Chemical Analysis & Mechanical Properties					

Thickness Range	**Process 1**		**Process 2**	
Base Metal	Groove *0.109*	Fillet	Groove	Fillet
Deposited Weld Metal	Groove *0.109 -.218*	Fillet	Groove	Fillet
Pipe Diameter Range	Groove *1"Min.>*	Fillet	Groove	Fillet
Other:				

Filler Metals (QW-404)	**Process 1**	**Process 2**
Specification No. (SFA)	*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	*All*		Temperature Range	*None*
Welding Progression	*Upward & Downward*		Time Range	*N/A*
Positions of Fillet	*All*		Other	

Preheat (QW-408)		**Gas (QW-408)**			
Preheat Temp-Maximum	*32°F*	*Closed Chamber Welding Head*			
Interpass Temp Maximum	*350° F*		Gas'(s)	Mixture	Flow Rate
Preheat Maintenance	*N/A*	Shielding	*Argon*	*99.995>*	*30 CFH*
		Trailing	*None*		
		Backing	*Argon*	*99.995>*	*7 CHF*

Electrical Characteristic (QW-409)				
Current AC or DC	*Direct*	Polarity	*Straight*	Characteristics:
AMPS (Range)	*See Chart*	Volts (Range)	*See Chart*	*Orbital with Pulse*
Tungsten Electrode Size & Type:	*3/32 EWCe-2 Pre-ground/pre-shaped (TC09-1635-04)*			
Mode of Metal Transfer for GMAW:	*N/A*			
Electrode Wire Feed Speed Range:	*N/A*			

Technique (QW-410)	
String or Weave Bead	*Stringer*
Orifice or Gas Cup Size	*Closed Chamber AMI Orbital Head Model 8-4000*
Initial/Interpass Cleaning (Brushing, Grinding, ect.)	*Initial cleaning with solvent*
Method of Back Gouging	*None*
Oscillation	*None*
Contact Tube to Work Distance	*N/A*
Multiple or Single Pass (per side)	*Single*
Multiple or Single Electrodes	*Single*
Travel Speed (Range)	*As Required*
Peening	*None*
Other	*AMI Orbital Welding Machine Model 227 with Model 8-4000 Welding Head* *Mfg. pre-ground/pre-shaped tungsten (TC09-1635-04) required*

Sequence Chart 1.5 ASTM B 861 x .109 wall (sch. 10)

Weld Levels	Pulse	Rotation	RPM		Time	AMPS		PULSE		Other Requirements
			Primary IPM	Back IPM	Sec	Primary	Back	Primary Per sec	Back Per sec	
1	*ON*	*Continuous*	*0.20*	*---*	*15*	*116*	*50*	*0.40*	*0.30*	*Voltage preset by Mfg.* *Mfg. pre-ground/pre-shaped and sized Tungsten required* *Mfg. Part # TC09-1635-04* *Arc gap set at .070 in.*
2	*ON*	*Continuous*	*0.30*	*---*	*62*	*115*	*50*	*0.40*	*0.30*	
3	*ON*	*Continuous*	*0.30*	*---*	*62*	*121*	*50*	*0.40*	*0.30*	
4	*ON*	*Continuous*	*0.30*	*---*	*33*	*119*	*50*	*0.40*	*0.30*	
5	*ON*	*Continuous*	*0.30*	*---*	*36*	*115*	*50*	*0.40*	*0.30*	
6	*ON*	*Continuous*	*0.30*	*---*	*46*	*113*	*50*	*0.40*	*0.30*	

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