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Plant & Equipment Division

WELDING PROCEDURE SPECIFICATION

MANUAL GAS TUNGSTEN ARC (DC) AND SEMIAUTOMATIC
GAS METAL ARC WELDING OF 6XXX ALUMINUM

C. H. Wodtke
D. R. Frizzell
W. A. Plunkett

MASTER

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ABSTRACT

Procedure WPS-1009 is qualified under Section IX of the ASME Boiler and Pressure Vessel Code for manual gas tungsten arc (DC) and semiautomatic gas metal arc (DC) welding of aluminum alloys 6061 and 6063 (P-23), in thickness range 0.187 to 2 inch; filler metal is ER4043 (F-23); shielding gases are helium (GTAW) and argon (GMAW).

Prepared by the
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37831
operated by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
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MARTIN MARIETTA ENERGY SYSTEMS, INC. POST OFFICE BOX X OAK RIDGE, TENNESSEE 37831 <hr/> FABRICATION DEPARTMENT P & E DIVISION	ORNL WELDING PROCEDURE SPECIFICATION	WPS-1009
<p align="center">MANUAL GAS TUNGSTEN ARC (DC) AND SEMIAUTOMATIC GAS METAL ARC WELDING OF 6XXX ALUMINUM</p>		

PROCEDURE QUALIFICATION

SPECIFICATIONS ASME Code Section IX.

RECORDS PQR-1009-1 & -2.

BASE METAL-A

 GRADE OR ALLOY 6061 & 6063.
 SPECIFICATIONS ASME Code or Job Specs.
 P-NUMBER-GROUP P-23.
 FORM/THICKNESS Any. 0.187 - 2.0-in.
BASE METAL-B

 None.

FILLER METAL-A

 CLASSIFICATION ER4043.
 SPECIFICATIONS SFA-5.10 & ORNL Specs.
 F- & A-NUMBERS F-23.
 FORM OF FILLER Straight/spooled solid weld-rod.
 FILLER INSERT None.
 FILLER CONTROL P & E Procedure OA-12-F-3.
FILLER METAL-B

 Same.
 Same.
 Same.
 Spooled solid electrode.
 NA.
 Same.

PERFORMANCE QUALIFICATION

Determine that the welder is qualified and has welded to this WPS within 90 days.

JOINT AND GROOVE PREPARATION

 JOINT GEOMETRY JG-1009. JOINT DESIGN Job Specs.
 PRECAUTIONS Prevent contamination of joint and adjacent base metal from other metals (fixtures, tools, etc.).
 CUTTING DEFECTS File, grind or machine to produce smooth surfaces. Remove 0.06-in. metal from surfaces cut by PAC.
 SCALE AND OXIDE Remove within 1-in. of joint.
 FOREIGN MATERIAL Remove within 6-in. of joint.
 FILING Immediately before welding, file groove face and base metal within 0.25-in. of joint to expose bright new metal.

WELD JOINT ASSEMBLY

 FIXTURES Provide necessary clean fixtures to align and support parts during welding. Use temporary welds only where necessary.
 BACKING Gas. (Optional). RETAINERS None.
 PROTECTION Provide necessary shelter or screen for weld area to exclude foreign material and drafts that contaminate arc shielding.
 CLEANNESS EXAMINATION Immediately before welding examine groove face and adjacent base metal for foreign material.
 TACK WELDS Deposit short thin beads equally spaced along root of joint. Clean tack welds, examine, taper ends as necessary and remove defects.
 BACK GOUGING File, grind or machine the root of joint to remove defects.

WELDING POSITION
Flat position (1G).

PREPARED BY <u>W. A. Plunkett WAP</u>	WELDING TECHNOLOGIST	WPS-1009
APPROVED <u>D. R. Frizzell</u>	WELDING ENGINEER	Date <u>Oct. '84</u>
APPROVED <u>C. H. Woarke</u>	WELDING METALLURGIST	Rev. 0 Page 1 of 6

WELDING PROCESSES AND EQUIPMENT

GTAW PROCESS & CONTROL Gas tungsten arc welding, manual.

SHIELD GAS 99.995 (min) helium. **BACKING GAS** Helium (Optional). **TRAIL GAS** None.

CURRENT Direct, electrode negative (straight polarity).

CURRENT SOURCE Rectifier or generator (drooping V-A curve) with foot slope-control.

ARC STARTER High-frequency oscillator (touch start optional).

ELECTRODE SPEC AWS A5.12, Class EWh-2, tungsten.

GMAW PROCESS & CONTROL Gas metal arc welding (spray arc), semiautomatic.

SHIELD GAS 99.995 (min) argon. **BACKING GAS** None. **TRAIL GAS** None.

CURRENT Direct, electrode positive (reverse polarity).

CURRENT SOURCE Rectifier (constant potential V-A curve) listed on JWP.

WIRE FEEDER Suitable unit with electronic speed regulation and postflow timer listed on JWP.

GUN Listed on JWP.

PREHEAT AND INTERPASS TEMPERATURE

GTAW PREHEAT TEMP 60 - 200 F. **EQUIPMENT** Oxyacetylene torch or resistance heater.

GMAW PREHEAT TEMP 60 - 200 F. **INTERPASS TEMP** 300 F maximum.

TEMP CHECK Contact pyrometer or thermocouple.

WELDING OF JOINT

WELDING PARAMETERS Apply applicable Joint Welding Procedure.

TRAVEL Upward if weld axis is not level.

GTAW PROCESS

ELECTRODE Single.

DIMENSIONS Sketch-1.

WELD BEAD TYPE Stringer bead.

TRAVEL ANGLE Sketch-2.

TECHNIQUE Position torch. Start preflow; purge air from torch. Start arc at low current, when stable, upslope to welding current.

Feed welding rod at uniform rapid rate into leading edge of weld pool. Keep end of rod in shielding gas. Remove oxidized end of rod.

To stop a weld bead, fill weld pool, downslope current, when pool is at minimum size, break arc. Start postflow to minimize oxidation of electrode and weld bead.

GMAW PROCESS

ELECTRODE Single.

DIMENSIONS Sketch-3.

WELD BEAD TYPE Stringer bead and weave bead.

TRAVEL ANGLE Sketch-4.

TECHNIQUE Remove oxidized end of electrode. Start preflow; purge air from gun. Position gun; start arc.

Weave gun at uniform rate with dwell at each side of weld bead.

To stop a weld bead, fill weld pool, increase travel speed, break arc.

Maintain 10-sec (min) postflow.

CLEANING OF WELD BEADS

Brush, file or grind to remove oxide, spatter and other deposits from each weld bead and adjacent base metal.

PEENING

None.

DEFECTS

Before depositing each weld bead, examine groove and adjacent base metal for cracks, laminations and other defects. Report such defects.

Examine each bead and layer for abnormal surface and contour, incorrect size or reinforcement, cracks, pits, incomplete fusion, inadequate joint penetration, overlap, undercut, underfill, inclusions, oxide, etc.

Remove weld defects by filing, grinding or machining.

POSTWELD HEAT TREATMENT

None.

EXAMINATION

Job Specs.

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SKETCH-1 TUNGSTEN ELECTRODE DIMENSIONS

SKETCH-2 TRAVEL ANGLE (TA)

SKETCH-3 GUN DIMENSIONS

SKETCH-4 TRAVEL ANGLE (TA) - PLATE

SKETCH-5 TRAVEL ANGLE (TA) - CYL.

JOINT GEOMETRY (JG-1009)

GROOVE TYPE	DIMENSIONS					
	Thickness T (in.)	Bevel B (deg)		Root Face RF (in.)	Root Opening RO (in.)
<p>G-1 SINGLE-V</p>	0.375 to 1.0	37.5 ±2		0.010 ±0.005	0.0	
	1.0 to 2.0	37.5 ±2		0.010 ±0.005	0.0
<p>G-2 DOUBLE-V</p>						

M = Misalignment max: 0.1T for T to 0.2-in.
1/32-in. for T over 0.2-in.

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Current source:

GTAW. Gen. or Rect.

GMAW. Linde SVI-300.

JOINT WELDING PROCEDURE

Wire feeder: Aircomatic AHF-E or Linde SEH-3.

Gun:

Airco AH-35B

Linde ST-9 or equal

JOINT THICK- NESS T (in.)	BEAD & TYPR	PREHEAT INTERPASS TEMP (F) Min - Max	ROD, ELECTRODE DIAM FE ³ D (ipm)		TRAVEL (ipm)	PROCESS, CURRENT, SETTINGS										TORCH(T)/GUN(G)				
						CURRENT SOURCE SVI-300										(T) TUNG. DIAM (in.)	(T)(G) NOZZLE DIAM (in.)	GAS(cfhr)		
						GTAW dc(-) CURRENT		GMAW dc(+) CURRENT		SLOPE		VOLTAGE		INDUCT- ANCE				(T) (G)	(T) (G)	
						A±10% V±10%	A±10% V±10%	A±10% V±10%	A±10% V±10%	STEEP FLAT	HIGH LOW	HIGH LOW	HIGH LOW							
0.375	1-S	60 - 200	1/8			135	12									1/8	0.5	45		
	2-W	300	1/16	188				180	28		4.0	3.7			10		0.675		40	
	3-W	300	1/16	188				180	28		4.0	3.7			10		0.675		40	
1.0	1-S	60 - 200	1/8			170	13									1/8		45		
	2-W	300	1/16	216				210	30		4.4	5.8			10		0.675		45	
	3-W	300	1/16	216				210	30		4.4	5.8			10		0.675		45	
	4-W	300	1/16	216				210	30		4.4	5.8			10		0.675		45	
	5+W	300	1/16	216				210	30		4.4	5.8			10		0.675		45	
1.5	1-S	60 - 200	1/8			180	13										0.5	45		
	2-W	300	1/16	255				240	26		2.2	3.5			9.7		0.675		45	
to	3-W	300	1/16	255				240	26		2.2	3.5			9.7		0.675		45	
	4-W	300	1/16	255				240	26		2.2	3.5			9.7		0.675		45	
2.0	5+W	300	1/16	255				240	26		2.2	3.5			9.7		0.675		45

JOINT GEOMETRY (JG-1009)

SINGLE-V

WELD BEAD SEQUENCE

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Note:

S = Stringer bead.

W = Weave bead.