CBI

WELDING PROCEDURE SPECIFICATION

IDENTIFICATION	CONTRACT
LIGO-E950039-02-B	
WPS	
ER308L/REPAIR	930212

PRODUCT	LIGO BEAM TUBE MODULES	PAGE	1	OF	4
CUSTOMER	CALTECH	REV. NO.	2		
		BY	DMF	DATE	06/26/95

WORK THIS DOCUMENT WITH GENERAL WELD PROCEDURE SPEC. GWPS GTAW&GMAW

REFERENCE PROCEDURE QUALIFICATION RECORD			SPECIFIC CONTRACT	
NO.	POSITION QUALIFIED (QW-405)	THICKNESS QUALIFIED (QW-403)	POSITION (QW-405)	THICKNESS RANGE (QW-403)
10029	3G	1/16" to 1/4"	All	0.105" to 1/4"
4858	2G	1/16" to 1/2"		
6250	3G	1/16" to 5/8"		All size fillet welds

SPECIFIC CONTRACT WPS REQUIREMENTS

CODE EDITION AND ADDENDA ASME Section VIII & IX, 1992 Edition, 92 Add.

JOINTS (QW-402) SEE GENERAL WELDING TECHNIQUE PAGE 3

PREHEAT/INTERPASS TEMPERATURE (QW-406) SEE ATTACHED PAGE 2

BACKING MATERIAL (QW-402)
See page 2

POST WELD HEAT TREATMENT (QW-407)
PWHT REQUIRED No
IF PWHT IS REQUIRED, SEE APPROVED CONTRACT PWHT PROCEDURE FOR DETAILS AND EXTENT OF PWHT.

BASE MATERIAL (QW-403)

A240 Tp. 304L (ASME P-8, Gp. 1)

Any ASME P-8, Gp. 1 material may be welded together or to each other in any combination.

GAS (QW-408) COMPOSITION:

SHIELDING: See page 2
FLOW RATE:
BACK UP See Page 2
FLOW RATE:

ELECTRICAL CHARACTERISTICS (QW-409)
CURRENT: Direct Current
POLARITY: See Page 2
OTHER:
AMPERAGE AND VOLTAGE RANGE. SEE PAGE 3
VOLUME OF WELD METAL REQUIRED No
SEE ATTACHED PAGE N/A
MODE OF TRANSFER GMAW-Glob. or spray

FILLER MATERIAL (QW-404)

ASME SPECIFICATION NO: SFA 5.9
ASME CLASSIFICATION: ER308L *
ASME ANALYSIS NO: A-8
ASME GROUP NO: F-6
CONSUMABLE INSERT: N/A
SUPP. POWDER FILLER: N/A

TECHNIQUE (QW-410) / SPECIAL LIMITATIONS
SEE ATTACHED PAGE(S) 2
STRINGER OR WEAVE TECHNIQUE SEE PAGE 3
TYPE OF WELDING
MANUAL [X] MACHINE [ ]
SEMI-AUTOMATIC [ ] AUTOMATIC [ ]

FLUX (QW-404)
N/A

CUSTOMER APPROVAL

* ER308L in accordance with WMS-ER308L

REVIEWED	OB ENGR	DIST ENGR	WELDIN SERVICE HOUSTON	CORP QA	REG CONST QA	REG MFG QA			BY	DATE
					APPROVED			PREPARED	RWP	02/10/94
					LIGO		11/10/95	CHECKED	BGG	05/12/95
					M. Fellaliou		11/10/95	AUTHORIZED		

WL100 REV JUL 87<PC>

ELECTRICAL CHARACTERISTICS:

GMAW	GTAW
Direct Current	Direct Current
Electrode Positive	Electrode Negative
(Reverse Polarity)	(Straight Polarity)

SHIELDING GAS:

GMAW: 98% Argon - 2% O2

GTAW: 60% Argon - 40% Helium
or 100% Argon

LIMITATIONS:

1. This WPS is to be used for weld repairs only.
2. Pulsing current may be used for GTAW.
3. Use a single or multiple pass per side technique.
4. No single pass shall exceed 1/2" in thickness.
5. Use a single EWTh-2 (2% thoriated tungsten) electrode for GTAW.
6. Maintain a contact tip to work distance of 3/8" to 1" for GMAW.
7. Use gas cup nozzle sizes between 3/8" to 1" diameter. The gas cup nozzle shall cover the contact tip 1/8" minimum.
8. Only stainless steel brushes shall be used on stainless steel.
9. Only filler metal in accordance with WMS-ER308L shall be used.
10. An inert gas back purge shall be used on opposite side of welding. The oxygen content shall be less than 2.0%. See Special Procedures on page 3 for special exceptions.

INTERPASS TEMPERATURE:

The interpass temperature shall not exceed 350 F.

PREHEAT REQUIREMENTS (ASME P-8, Gp. 1):

No preheat is required except as an aid to remove moisture unless the ambient temperature falls below 0 F. When the ambient temperature falls below 0 F, a preheat of warm to the hand (approx. 100 F) is required within 3" of where the welding is started and maintained 3" ahead of the arc.

SPECIAL PROCEDURES:

1. GTAW may be used for all types of welded repairs except for repairs made to plates in excess of 1/4" thickness.

2. GMAW to be used only for weld repairs to the stiffener attachment welds.

3. For welded repairs requiring full thickness welding:

   a. Clean repair area by grinding or chipping large enough area to allow manipulation of the weld torch.

   b. Place repair jack on inside of tube with copper bar covering weld repair area.

   c. Apply pressure on jack to minimize shrinkage.

   d. Backing gas may be omitted.

   e. Weld using GTAW with ER308L in accordance with WMS-ER308L.

4. For welded repairs to the inside pass of the pump port:

   a. Use an autogenous GTAW pass on inside of port to obtain full fusion of land at repair area.

5. For welded repairs to the outside of tube while inside is at partial vacuum (approximately one atmosphere).

   a. An inert gas back purge is not applicable provided inside pressure is less than 35 Torr (equivalent to 1% Oxygen at one atmosphere).

   b. Current shall not exceed 85 amps for GTAW process.

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WELDING PROCEDURE SPECIFICATION

IDENTIFICATION	CONTRACT
WPS *ER308L/REPAIR*	*930212*

PRODUCT	*LIGO BEAM TUBE MODULES*	PAGE	*4*	OF	*4*
CUSTOMER	*CALTECH*	*REV. NO.*	*2*		
		BY	*DMF*	DATE	*06/26/95*

GENERAL WELDING TECHNIQUE

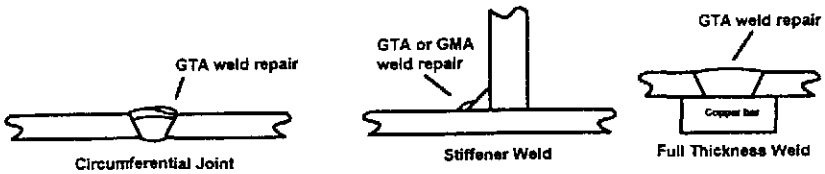
Operation Description	Beads Layer	Weld Proc.	Tungsten Diameter	Current (amps)	Voltage (Volts)	Travel (IPM)	B.O.R. Sec / 12"
*GTA weld with or without filler metal **	*As Reqd*	*GTA*	*1/16"* *3/32"* *1/8"* *5/32"* *3/16"*	*50-140* *50-220* *50-300* *50-400* *50-525*	*10-18* *10-18* *10-18* *12-18* *12-18*	*As Reqd*	

Filler Metal: ER308L in accordance with WMS-ER308L
Filler Metal Dia.: 1/16", 3/32", 1/8"
** Passes may be made with stringer or weave beads as required.*

JOINT DETAIL - See contract drawings for applicable joint details and dimensions.

Operation Description	Beads Layer	Weld Proc.	Electrode Size	Electrode Type	Current (amps)	Voltage (Volts)	Peak (amps)	
*Stringer Beads**	*As Reqd*	*GMA*	*.035*	*ER308L***	*130-260*	*21-28*		

** Vertical uphill welds and overhead welds may be deposited using a weave technique.*
*** ER308L in accordance with WMS-ER308L.*



Typical Weld Repairs (all positions)

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Contract

PROCEDURE QUALIFICATION RECORD

To A. S. M. E. Section IX
ESSENTIAL VARIABLES

No. 10029
Process GTAW
Manual [ ] Machine [X] Auto. [ ] Semiauto. [ ]
Material specification SA240 Type 304L together
ASME P No. 8, Gp. 1 To ASME P No. 8, Gp. 1
Thickness(if pipe, dia and wall thick) 0.11" to 1/8"
Filler metal group no. F F-6
Weld metal analysis no. A A-8
ASME specification no. SFA SFA 5.9
AWS specification no. A A 5.9

Flux or Atmosphere

Flux trade name	N/A
Inert gas composition	60% Argon - 40% Helium
Flow rate	20 - 45 cfh
Preheat temperature range	70°F - 350°F (IPT)
Postweld heat treatment	None Required

WELDING PROCEDURE

Single or multiple pass: Multiple Single or multiple arc: Single Position: 3G

Mode of transfer for GMAW: Spray [ ] Globular [ ] Pulsating [ ] Short Circuit [ ]
Filler Metal for GTAW or PAW: ER308L Filler metal diameter: 0.035"
Electrode: EWTh-2 Electrode diameter: 1/8"
Type of backing: None Required Welding current: Direct Current, Electrode Negative (Straight Polarity)
Consult WELDING VARIABLES for joint dimensions and welding current settings.

TEST RESULTS

Reduced Section Tensile Results

Specimen No.	Dimensions, in.		Area	Ultimate Total Load	Ultimate Unit Stress		Character of Failure and Location
	Width	Thickness	sq. in.	Kips	ksi	MPa	
11443-1	0.750	0.092	0.069	5.7	82.6	569.5	Ductile in weld metal
1443-2	0.750	0.097	0.073	6.0	82.2	566.7	Ductile in weld metal

Guided Bend Test

Type	Result	Type	Result
2 Transverse Face Bends	OK	2 Transverse Root Bends	OK

Welder's name: W. Kelly Brawner Social Security no.: 413-82-4060 Welder's symbol: WKB
Welder's name: Social Security no.: Welder's symbol:
Who by virtue of these tests meets welder performance requirements.

Work Order (Orig. WPS) No. H11443 Rev. 2

We certify that the statements in this record are correct and that the test weld was prepared, welded and tested in accordance with the requirements of Section IX of the ASME code.

Signed CBI

By _____ Date 1/24/94
Rick W. Prior

Remarks: Arcaloy (ER308L) by Alloy Rods

CBI

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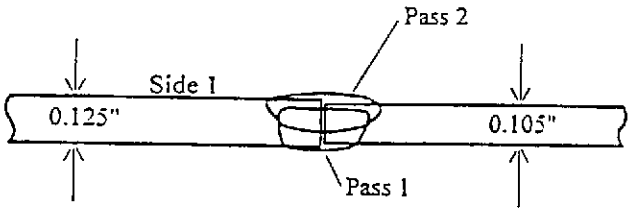
PROCEDURE QUALIFICATION RECORD

To A.S.M.E. Section IX

PART III WELDING VARIABLES



Maximum gap 0.010"
Plates fit on centerlines
All passes welded from Side 1
In Dwell is on the 1/8" side.

Side	1	1							
Pass number	1	2							
Filler wire	N/A	ER308L							
Wire diameter (inches)	N/A	0.035"							
Pulse mode	Pulsed	Sync							
Pulse width	50%	N/A							
Pulse frequency	3.0	3.0							
AVC response	–	–							
AVC mode	Samp	Cont							
Upslope time (sec)	2	2							
Downslope time (sec)	5	5							
Travel start delay (sec)	2	2							
Wire start delay (sec)	N/A	1							
Oscillation amp	N/A	0.15							
Track travel speed (ipm)	5.0	4.0							
Torch travel speed (ipm)	5.0	4.0							
Primary weld current (amps)	120	85							
Primary voltage (volts)	9.5	9.5							
Primary wire speed (ipm)	N/A	25							
Background current (amps)	85	60							
Background voltage (volts)	9.5	9.5							
Background wire (ipm)	N/A	10							
Out dwell time (x 0.1 sec)	N/A	2							
Excursion time (x 0.1 sec)	N/A	3							
In dwell time (x 0.1 sec)	N/A	3							
Primary time (%)	0.50	0.45							
Background time (%)	0.50	0.55							
Heat input (kJ/in)	11.7	7.4							
Energy density (MJ/in3)	N/A	1.5							

Qualification No. 10029

ate: 1/24/94

By _____
Rick W. Prior

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Contract

PROCEDURE QUALIFICATION RECORD

TO A.S.M.E. SECTION IX

ESSENTIAL VARIABLES

PQR No. 4858

Process GMAW/GTAW — GTAW Manual [X] Machine [ ] — GTAW Automatic [X] Semiautomatic [ ]

Material specification SA204 Type 304

ASME p. no. 8, Gp. 1 To ASME p. no. 8, Gp. 1

Thickness (if pipe, dia and wall thick) 1/4"

Filler metal group no. F. F-6

Weld metal analysis no. A. A-8

ASME specification no. SFA-5.9

AWS specification no. A-5.9

FLUX OR ATMOSPHERE

Flux trade name None Required

Inert gas composition *

Flow rate GMAW-40 CFH, GTAW-20CFH

Preheat temperature range 70°F to 350°F IPT

Postweld heat treatment None

WELDING PROCEDURE

Single or multiple pass Multiple — Single or multiple arc Single — Position 2G

Mode of transfer for GMAW: Spray [X] Globular [ ] Pulsating [ ] Short Circuit [ ]

Filler Metal for GTAW or PAW Not Required — Filler metal diameter Not Required

Electrode GMAW-ER308, GTAW-EWTh-2 — Electrode diameter GMAW-.035", GTAW-3/32"Ø

Type of backing None** — Welding current GTAW-Direct Current, Elec. Neg. (Straight Polarity)

Consult WELDING VARIABLES for joint dimensions and welding current settings.

GMAW-Direct Current, Elec. Pos. (Reverse Polarity)

TEST RESULTS

Reduced Section Tensile Results

Specimen No.	Dimensions in Width	Dimensions in Thickness	Area in 2	Ultimate Total Load Kips	Ultimate Unit Stress ksi	Ultimate Unit Stress MPa	Character of Failure and Location
H610R-1	1.498	0.222	0.332	29.5	88.9	612.9	Ductile in WM
H610R-2	1.502	0.220	0.330	29.1	88.2	608.1	Ductile in WM

Guided Bend Test

Type	Result	Type	Result
2 Transverse Face Bends	OK	2 Transverse Root Bends	OK

Welder's name Curtis Campbell — Social Security no. 403-36-4037 — Welder's Symbol CC

Who by virtue of these tests meets welder performance requirements.

Work Order (Orig. WPSI No. H610R - Rev. 0

We certify that the statements in this record are correct and that the test weld was prepared, welded and tested in accordance with the requirements of Section IX of the ASME code.

Signed CBI

By J. S. Lee J. S. Lee — Date 10/15/80

Remarks:

*GTAW - 100% Argon

GMAW - 98% Argon/2% Oxygen

**Temporary copper chill bar used.

Updated to new form, 8/28/87, JSL JSL

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PROCEDURE QUALIFICATION RECORD

TO A.S.M.E. SECTION IX

PART II ESSENTIAL VARIABLES

PQR No. 6250

Process GTAW — Manual [X] Machine [ ] Automatic [ ] Semiautomatic [ ] Date 3/25/83

Material specification SA240 Tp. 304

ASME p. no. P-8.Gp.1 To ASME p. no. P-8.Gp.1

Thickness (if pipe, dia and wall thick) 5/16"

Filler metal group no. F. F-6

Weld metal analysis no. A. A-8

ASME specification no. SFA - 5.9

AWS specification no. A - 5.9

FLUX OR ATMOSPHERE

Flux trade name None Required

Inert gas composition 100% Argon

Flow rate 30 CFH

Is backing strip used? No

Preheat temperature range 70°F - 350°F (IPT)

Postweld heat treatment None Required

WELDING PROCEDURE

Single or multiple pass Multiple — Single or multiple arc Single — Position 3G

Filler Metal ER308L* — Electrode diameter 3/32" 1/8"

Electrode EWTH-2** — Filler wire diameter

Type of backing Argon purge — Welding current Direct Current, Electrode Negative (Straight Polarity)

Consult PART III WELDING VARIABLES for joint dimensions and welding current settings.

TEST RESULTS

Reduced Section Tensile Results

Specimen No.	Dimensions in		Area in 2	Ultimate Total Load	Ultimate Unit Stress		Character of Failure and Location
	Width	Thickness		Kips	ksi	MPa	
H142X-1	1.502	0.287	0.431	36.6	84.9	585.4	Ductile in WM
H142X-2	1.499	0.270	0.405	34.6	85.4	588.8	Ductile in WM

Guided Bend Test

Type	Result	Type	Result
2 Transverse Face Bends	OK	2 Transverse Root Bends	OK

Welder's name Curtis Campbell — Social Security no. 403-36-4037 — Welder's Symbol CC

Who by virtue of these tests meets welder performance requirements.

Work Order (Orig. WPS) No. H142X — Rev. 0 — Date 3/2/83

We certify that the statements in this record are correct and that the test weld was prepared, welded and tested in accordance with the requirements of Section IX of the ASME code.

Signed CBI

By Robert G Walter — Date 3/25/83

Robert G. Walter for L.N. May

Remarks: *Arcaloy 308ELC by Alloy Rods

**2% Thoriated Tungsten

Updated to new form by RGW, 12/3/86

Printed in USA

WL 20 D REV NOV 83

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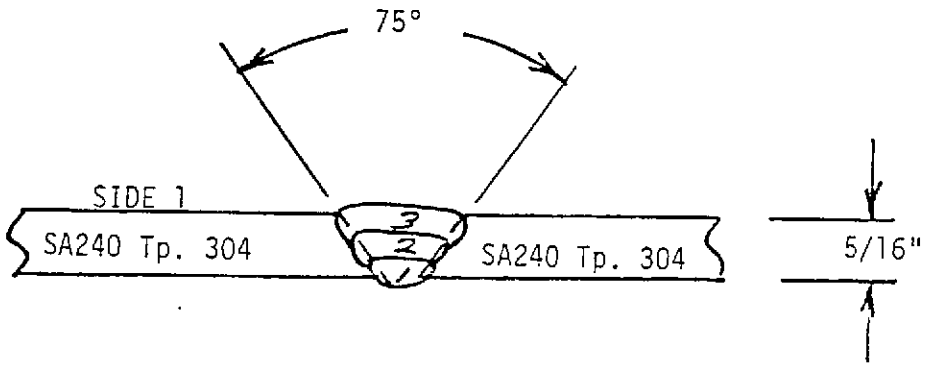
PROCEDURE QUALIFICATION RECORD

To A.S.M.E. Section IX

PART III WELDING VARIABLES



Argon purge
5-20 CFH

3G POSITION

1/8" GAP
0 LAND

Side	Pass	Filler Metal Type	Size Ø IN	Size Ø mm	Amps	Volts	Travel Speed in./min.	Travel Speed cm/min	Heat Input KJ/in	Heat Input KJ/cm	Remarks
1	1	ER308L	1/8	3.2	90	12	---	---	---	---	Uphill
1	2-3	ER308L	1/8	3.2	115	12	---	---	---	---	Uphill

Qualification No. 6250
Date: 3/25/83

BY Robert G. Walter
Robert G. Walter for L.N. May