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National Aeronautics and Space Administration

John C. Stennis Space Center Stennis Space Center, MS 39529-6000

COMPLIANCE IS MANDATORY

John C. Stennis Space Center ASME Procedure for Welding Nitronic 40 Stainless Steel Alloy

Original signed by

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Change/ Revision	Change Date	Originator/ Phone	Description
Basic	08.12.14	Doug Dike, Ext. 8-2803	Initial release, superseding SSC STD 34-045. Updated references in 3.0 and 5.0.
A	09.04.19	Doug Dike, Ext. 8-2803	 Five-year update. Minor administrative changes. Updated directorate titles on cover sheet as necessary. Updated references and acronyms. Section 5.0-b: Added, "and in accordance with ASME Boiler and Pressure Vessel Codes, Section IX, requirements." Section 8.0: Updated WPS, consolidating data from WPSs for: Nitronic 40/GTAW Nitronic 40/GTAW/I625 Nitronic 40/GTAW/I625/2 Updated WPS to Form SSC-937.

Document History Log

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1.0 PURPOSE

This John C. Stennis Space Center (SSC) standard (SSTD) outlines the qualified Gas Tungsten Arc Welding (GTAW) procedure for use in welding Nitronic 40 at SSC.

2.0 APPLICABILITY

This SSTD applies to all contractor and subcontractor personnel involved with the welding of Nitronic 40 at SSC.

3.0 REFERENCES and APPLICABLE DOCUMENTS

All references are assumed to be the latest version unless otherwise indicated.

- AMS 5561, Steel, Corrosion and Heat-Resistant, Welded and Drawn or Seamless and Drawn Tubing, 9.0Mn – 20Cr – 6.5Ni – 0.28N, High-Pressure Hydraulic
- AMS 5562, Steel, Corrosion and Heat Resistant, Seamless Tubing, 9.0Mn 20Cr 6.5Ni 0.28N, Solution Heat Treated
- AMS 5595, Steel, Corrosion Resistant, Sheet, Strip, and Plate, 9.0Mn 20Cr 6.5Ni 0.28N Solution Heat Treated
- AMS 5656, Steel, Corrosion Resistant, Bars, Wire, Forgings, Extrusions, and Rings, 9.0Mn 20Cr 6.5Ni 0.27N, Solution Heat Treated
- ASME Boiler and Pressure Vessel Code, Section II, Materials
- ASME Boiler and Pressure Vessel Code, Section IX, Welding, Brazing and Fusing Qualifications
- ASTM A182, Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
- ASTM A240, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
- ASTM A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
- ASTM A276, Standard Specification for Stainless Steel Bars and Shapes
- ASTM A312, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes

ASTM A314, Standard Specification for Stainless Steel Billets and Bars for Forging

- ASTM A336, Standard Specification for Alloy Steel Forgings for Pressure and High-Temperature Parts
- ASTM A473, Standard Specification for Stainless Steel Forgings
- ASTM A479, Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels
- ASTM A580, Standard Specification for Stainless Steel Wire

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- ASTM A666, Standard Specification for Annealed or Cold Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
- ASTM A813, Standard Specification for Single- or Double-Welded Austenitic Stainless Steel Pipe
- ASTM A814, Standard Specification for Cold-Worked Welded Austenitic Stainless Steel Pipe
- ASTM A943, Standard Specification for Spray-Formed Seamless Austenitic Stainless Steel Pipes
- ASTM A965, Standard Specification for Steel Forgings, Austenitic, for Pressure and High Temperature Parts
- ASTM A988, Standard Specification for Hot Isostatically-Pressed Stainless Steel Flanges, Fittings, Valves, and Parts for High Temperature Service
- AWS Welding Handbook, American Welding Society Welding Handbook

SPR 1440.1, SSC Records Management Program Requirements

SPR 8715.1, Safety and Health Program Requirements

SSTD-8070-0005-CONFIG, SSC Preparation, Review, Approval, and Release of SSC Standards

SSTD-8070-0013-WELD, Classes of Welding Inspection

SSTD-8070-0014-WELD, Standard for Qualifying Welders and Weld Procedures

4.0 **RESPONSIBILITIES**

- a. Users of this SSTD shall comply with its requirements, ensure use of the correct version of this SSTD and the documents it references, and inform the appropriate organization of needed changes in accordance with SSTD-8070-0005-CONFIG.
- b. Responsibilities for the use and control of this SSTD and for the review and approval of revisions or cancellation of this SSTD shall be as specified in SSTD-8070-0005-CONFIG and the applicable documents referenced therein.

5.0 **REQUIREMENTS AND PROCEDURES**

- a. This procedure shall be used for welding any Nitronic 40 stainless steel alloy (UNS S21900, S21903, and S21904) to one or more of the following:
 - 1. AMS 5561, 5562, 5595, 5656
 - 2. ASME SA-182, SA-240, SA-312, SA-479, SA-666, SA-813, SA-814, and SA-965
 - 3. ASTM A182, A240, A269, A276, A312, A314, A336, A473, A479, A580, A666, A813, A814, A943, A965, and A988.
- b. Items denoted as essential variables in the attached weld procedure specifications (WPS) shall not be altered when using the WPS. An alternate WPS may be used only if approved prior to use by the National Aeronautics and Space Administration (NASA)

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SSC Center Operations Directorate Project Management Division (PMD), the NASA SSC Engineering and Test Directorate (E&TD), NASA SSC Safety and Mission Assurance (S&MA) Office, and in accordance with ASME Boiler and Pressure Vessel Codes, Section IX, requirements.

- c. The attached Procedure Qualification Records (PQRs) No. 34-Nitronic 40/GTAW, No. 34-Nitronic 40/GTAW/I625, and No. 34-Nitronic 40/GTAW/I625/2 are PQRs for the original qualification of WPSs in this standard. When performing new qualifications, a new PQR should be filled out showing all pertinent data and results of the weld procedure qualification.
- d. The minimum service temperature for weldments produced under a WPS shall not be lower than the minimum test temperature of toughness tests (per QW-170) shown on the PQR or PQRs corresponding to the respective WPS.
- e. X-ray prints, test results and reports, and dye penetrant test reports must be traceable to individual welds.
- f. Welders shall be qualified in accordance with SSTD-8070-0014-WELD.
- g. Inspection methods for welds shall be in accordance with SSTD-8070-0013-WELD.
- g. All procedures shall be performed in compliance with applicable requirements in SPR 8715.1. If there is a conflict between this standard and the SPR, the SPR shall supersede this standard.

6.0 RECORDS AND FORMS

- a. Records required by the procedures of this SSTD shall be maintained in accordance with SPR 1440.1 and as specified in this SSTD.
- b. All records and forms are the latest version unless otherwise indicated.
- c. Forms may be obtained from the SSC Electronic Forms repository or from the NASA SSC Forms Management Officer. Quality Records are identified in the SSC Master Records Index.
- d. The original, signed WPSs, PQRs and Welder Performance Qualification (WPQ) forms (copies of which are provided in Attachments A-I of this SSTD) shall be maintained shall be maintained in Central Engineering Files (CEF).

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7.0 ACRONYMS AND ABBREVIATIONS

AMS	Alpha Magnetic Spectrometer
ASME	
	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
CEF	Central Engineering Files
E&TD	Engineering & Test Directorate
GTAW	Gas Tungsten Arc Welding
MIL	Military
NASA	National Aeronautics and Space Administration
PMD	Project Management Division
PQR	Procedure Qualification Record
S&MA	Safety & Mission Assurance
SSC	John C. Stennis Space Center
SSTD	John C. Stennis Space Center Standard
SPR	Stennis Procedural Requirements
WPQ	Welder Performance Qualification
WPS	Weld Procedure Specifications

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8.0 ATTACHMENTS

- Attachment A: WPS for Nitronic 40/GTAW, Nitronic 40/GTAW/I625; and Nitronic 40/GTAW/I625/2
- Attachment B: PQR Nitronic 40/GTAW
- Attachment C: WPQ Tests Nitronic 40/GTAW
- Attachment D: PQR Nitronic 40/GTAW/I625
- Attachment E: Suggested Format for Manufacturing Record of Welder of WPQ Nitronic 40/GTAW/I625
- Attachment F: PQR Nitronic 40/GTAW/I625/2
- Attachment G: Suggested Format for Manufacturing Record of Welder of WPQ Nitronic 40/GTAW/I625/2

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ATTACHMENT A: WELDING PROCEDURE SPECIFICATIONS (WPS)

Davidled To Company Name Company Name SSME Boiler and Pressure Vessel Code Sec IX Syncom Space Services (S3) Syncom Space Services (S3) Syncom Space Services (S3) Subject TAW, 34-045/GTAW, 1625, 34-045/GTAW, 1625/2 SSTD-8070-0037-WELD Sope Starting Startin	National Aerona Space Administ John C. Stennis Stennis Space	tration	ASME - WELDING	B PROCEDU	RE SPEC	FICATIONS	6 (WPS)	
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Supporting PGR(s) Reference Docs. SSTD-8070-0037-WELD Sorpe Joint SSTD-8070-0037-WELD Welding Nitronic 40 to Stainless steel Joint SSTD-8070-0037-WELD Asse MertALS P-no. 8 Grp-no. Itel Kerner Ype Austenitic SS P-no. 8 Grp-no. Itel Kerner Jacking None P-no. Grp-no. Itel Kerner Min.As-Welded Jaac. Min.M. Joint Jacking None P-no. Grp-no. Itel Kerner Complete Pen. Itel Kerner Min.M. N/A N/A Joint Spec type. See Note A. Filet Welds All N/A N/A N/A ILLER METALS Spec type. See Note B. 6 Itel Kerner Min.M. N/A TAW 5.9 See Note B. 6 Itel Kerner N/A N/A TAW 5.9 See Note B. 6 Itel Kerner N/A N/A TAW 5.9 See Note B.<	Qualified To		Company Name					
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Stennis	
Standard	

SSTD-8070-0037-WELD A Number Rev. Effective Date: September 4, 2019

Effective Date:September 4, 2019Review Date:September 4, 2024

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BJECT: ASME	Procedure for Weld	ding Nitronic 40 Stai	nless Steel Alloy
NASA Space John C	al Aeronautics and Administration 5. Stennis Space Center s Space Center, MS 39529-600		CEDURE SPECIFICATIONS (WPS
Welding Procedure Specificati 34-045 / GTAW	on Record Number	Date August 19, 2019	Revision Number C
Qualified To ASME Boiler and Pressure	e Vessel Code Sec IX	Company Name Syncom Space Services	(\$3)
BASE METALS			
Peening	Not allowed.		
Surface Preparation	See Notes G and H.		
Initial/Interpass Cleaning	See Notes G and H.		
Back Gouging Method	Thermal or Mechanical, if require	red. Grind 1.6 mm (1/16"), if therma	1.
POSTWELD HEAT TREATM	IENT		
Temperature	None		
Time and Temperature	None		
Other	None		
B. SFA 5.9, ASTM A58	3, S21900 to UNS S21904, S21903 0, TP XM-11, or ER 219. AWS No oved during welding the root pass.		mm (1/2") thick.
A. UNS S21904, S21903 B. SFA 5.9, ASTM A58 C. Tack welds to be rem D. High flow of shieldin E. Minimum 10 minutes	0, TP XM-11, or ER 219. AWS No oved during welding the root pass. g gas flow over molten puddle is r of back purge prior to welding.	equired to eliminate nitrogen absorp	
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A. UNS S21904, S21903 B. SFA 5.9, ASTM A58 C. Tack welds to be rem D. High flow of shieldin E. Minimum 10 minutes F. String or Weave bead	0, TP XM-11, or ER 219. AWS No oved during welding the root pass. g gas flow over molten puddle is r of back purge prior to welding. no more than three (3) times weld	o. (Class) ER 219 or TP XM-11. equired to eliminate nitrogen absorp wire diameter.	
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A. UNS S21904, S21903 B. SFA 5.9, ASTM A58 C. Tack welds to be rem D. High flow of shieldin E. Minimum 10 minutes F. String or Weave bead G. Wipe with cleaner or joint. H. Rework or repair Grin on Carbon Steel.	0, TP XM-11, or ER 219. AWS No oved during welding the root pass. g gas flow over molten puddle is r of back purge prior to welding. no more than three (3) times weld 1, 1, 1 Trichloroethane-moistened	o. (Class) ER 219 or TP XM-11. equired to eliminate nitrogen absorp wire diameter. , clean, lint-free rag then brush with brush. For grinding, use aluminum of Signature 2	tion from atmosphere. virgin SS brush 2" both sides of weld oxide grinding wheel not previously use Signature
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National Aeronautics and Space Administration John C. Stennis Space Center Stennis Space Center, MS 38	er	SME - WELDING	PROCEDURE	E SPECIF	FICATIONS	(WPS)	
Welding Procedure Specification Record Number		Date		Revision	Number		
34-045 / GTAW Qualified To		August 19, 2019 Company Name		С			
ASME Boiler and Pressure Vessel Code Sec IX		Syncom Space Serv	vices (S3)				
	Weld .	loint Designs					
	Atta	chment #1				_	
Single-V Groove	Single-B	evel Groove	Dou	ıble-V G	roove		
				\times			
Groove Angle: 50 to 75 deg Root Opening: 1/16 to 3/16 in. Root Face: 0 to 1/16 in. Misalignment: 1/16-in. max.	Groove Angle: 3 Root Opening: 1 Root Face: 0 to Misalignment: 1/	/16 to 3/16 in. 1/16 in.	Groove Ang Root Openi Root Face: Misalignme	0 to 1/16 to	o 3/16 in. In.		
Double-Bevel Groove	Single-J	Groove	Dou	ible-J G	roove		
				\geq]	
Groove Angle: 37.5 to 45 deg Root Opening: 1/16 to 3/16 in. Root Face: 0 to 1/16 in. Misalignment: 1/16-in. max.	Groove Angle: 37 Groove Radius: 3 Root Opening: 1/ Root Face: 0 to 1 Misalignment: 1/1	/8 in. 16 to 3/16 in. /16 in.	Groove Angl Groove Radi Root OpenIn Root Face: 0 Misalignmen	ius: 3/8 in. 1g: 1/16 to 1 to 1/16 in	3/16 in.		
Single-U Groove	Double-L	J Groove	Fillet	Weld T	or Lap		
		$\left\{ \right.$			Gap		
Groove Angle: 50 to 75 deg Groove Radius: 3/8 in. Root Opening: 1/16 to 3/16 in. Root Face: 0 to 1/16 in. Misalignment: 1/16-in. max.	Groove Angle: 50 Groove Radius: 3 Root Opening: 1/ Root Face: 0 to 1 Misalignment: 1/1	1/8 in. 16 to 3/16 in. /16 in.	t		1		

Lap

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Gap: 1/16-in. max. / Lap: 5 x t or 1 in. min.

SSC-937 (05/2019)

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Standard	Effective Date: September 4, 2019
	Review Date: September 4, 2024
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ATTACHMENT B: PQR NITRONIC 40/GTAW

Company Name Johnson Controls World Services Inc.	ons Used to Weld Test Coupon
Procedure Qualification Record No 34-Nitronic 40 / GTAW	Rev. A Date 5/22/99
WPS No. 34-045/GTAW Rev. A	
Welding Process(es) GTAW	
Types (Manual, Automatic, Semi-Auto) Manual	
JOINTS (QW-402)	-35 TO 40 DEG
25.4mm (1.00 ⁻) NITRONIC 40 3mm (0.125 ⁻)	CHAMFER W/ 0.125 R (TYP) (2507) (0.507) (0.507) (0.507) (0.094" TO 3.2mm (0.094" TO 0.125")
BASE METALS (QW-403)	(0.094" TO 0.125") POSTWELD HEAT TREATMENT (QW-407)
Material SpecUNS 21904 to UNS 21904	Temperature NOT APPLICABLE
Type or Grade Nitronic 40 to Nitronic 40 (XM-11 to XM-11)	Time
P-No. 8 to P-No. 8	Other
Thickness of Test Coupon 0,951" to 1.070"	
Diameter of Test Coupon 100mm nominal (104mm or 4,500"O.D.)	
Other	GAS (QW-408)
	Percent Composition
	Gas(es) (Mixture) Flow Rate
	Shielding ARGON 99.99% 0.566m3/h (20 to 35 CFH)
	and Backing
FILLER METALS (QW-404)	Trailing <u>N/A</u>
SFA Specification 5.9 or ASTM A580	
AWS Classification ER 219 Filler or Type XM-11 wire Metal F-No. 6 Weld Metal	ELECTRICAL CHARACTERISTICS (QW-409)
Analysis A-No. Size of Filler	Current DC Polarity DCEN (-)
Metal 2.3mm (3/32") & 3.1mm (1/8") Other	
	Amps. 60 - 120 volts 12 - 20 Tungsten Electrode Size 2.4mm (3/32*)
Deposited Weld Metal	Other
POSITION (QW-405)	TECHNIQUE (QW-410)
Position of Groove 6G	Travel Speed 127 - 203mm/min (5 - 8 i.p.m.)
Weld Progression (Uphill, Downhill) UPHILL	String or Weave Bead String Bead (3 times weld wire diameter
Other	Oscillation Not Applicable
	Multipass or Single Pass (per side) Multiple
PREHEAT (QW-406)	Single or Multiple Electrodes Single
Preheat Temp. 60° F Mininum	Other
Interpass Temp. 325° F Maximum	
all	

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			Tensile	Test (QW-150)				
Specimen No.	Width in.	Thickne in.		Area sq. in.	Ultimate Total Load Ib.	Ultimate Unit Stre psi	SS	naracter of Failure & Location
T 1	0.491	0.978	3	0.480	50,400	104,536	3	Base
T 2	0.496	0.996	3	0.494	51,900	103,382	2	Base
		1	Guided Ben	d Tests (QW-1)	50)	I		
	Type and Fig	ure No.		T	-	Result		
SIDE BEND QW	462.2 1					Satisfactory		
SIDE BEND QW	462.2 2					Satisfactory		
SIDE BEND QW	462.2 3					Satisfactory		
SIDE BEND QW	462.2 4					Satisfactory		
			Toughness	Tests (QW-17	0)			
Specimen	Notch	Notch	Test	Impact	Lateral	Exp.	Drop	Weight
No.	Location	Туре	Temp.	Values	% Shear	Mils	Break	No Break
08102.1 - weld 1	Weld	Charpy V	-100°F	32 ft-lbs	5	21		
08i02.1 - weld 2	Weld	Charpy V	-100°F	30	5	22		
08102.1 - weld 3	Weld	Charpy V	-100°F	32	5	19		
08102.1 - Haz. 1	HAZ	Charpy V	-100°F	145	5	27		
08101.1 - Haz. 2	HAZ	Charpy V	-100°F	33	25	85		
08102.1 - Haz. 3	HAZ	Charpy V	-100°F	30	5	20		
08102.1 - Base 1	Base	Charpy V	-100°F	152	30	86		
08102.1 - Base 2	Base	Charpy V	-100°F	160	40	89		
08102.1 - Base 3	Base	Charpy V	-100°F	166	40	84		
	Result - Sat	sfactory Yes,	No	D TEST (QW	Penetration in Yes, No	to Parent Meta	al	
Tests cond	Welder's Name	ECTION SPEC	CIALISTS, INC	Clock No	Macro-Res 2307 iry Test No. <u>P.(</u>	Stamp No.		P-01
We certify that the s	statements in thi	s record are c	orrect and that	the test welds	were prepared	, welded and te	ested in acc	ordance with
Date 5/22/99		Signe		ntrols World Se nufacturer) By	Burle	1-1		

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ATTACHMENT C: WPQ NITRONIC 40/GTAW

Welder Name Keith Bryant	Check No. 2307	Stamp No. 4
Using WPS No.	34-045/GTAW the above welder is qualified	Rev. A Date 5/22/99
Variable	Record Actual Values Used in Qualification	Qualification Range
Process	GTAW	GTAW
Process Type	GTAW	GTAW
Backing (metal, weldmetal, flux, etc. (QW-402)	N/A	N/A
Material Spec. (QW-403)	UNS 21904 to UNS 21094	P-No.8 Group 3 to P-No.8 Group 3
Thickness		0.4007.0.007
Groove	0.951" to 1.070"	0.188" to 2.00"
Filet	N/A	0.188" to 2.00"
Diameter Groove	4.5" O.D.	2.875" O.D. and larger
Fillet	N/A	2.875" O.D. and larger
Filler Metal (QW-404)		
Spec. No.	AWS (SFA) 5.9	SFA 5.9 or ASTM A580
Class	ER219	ER219 or TP XM-11
F-No.	6	6
Deposited Weld Metal Thickness	0.951" to 1.070"	12.7mm (0.50") min.
Groove X Fillet Position (QW-405)	6G	6G
Weld Progression	Upward	Upward
Gas Type (QW-408)	99.99% Argon	99.99% Argon
Backing Gas (QW-408)99.99% Argon	99% Argon	99% Argon
Electrical Characteristics (QW-409)	85 amps root; 90-115	
Current	amps remaining	60 - 120 Amps
Polarity	DCEN	DCEN
Guided Type and Fig No.	i Bend Test Results QW-462.	2(a), WQ-462.3(a), WQ-462.3(b) Result
Side Bend; Specimen 08/02.1-S1		Satisfactory
Side Bend; Specimen 08/02.1-S2		Satisfactory
Side Bend; Specimen 08/02.1-S3		Satisfactory
Side Bend; Specimen 08/02.1-S4		Satisfactory
one band, opennen court of		
Terr 4	Radiographic Test Result	ls (QW-304 & QW-305) proove welds by radiography
Radiographic Results Accept	allemanye dogilincarion or <u>c</u>	noove welds by indilography
Fil Fracture Test (Describe the location, nature and size	let Weld Test Results [See C e of any crack or tearing of the	
Length and Percent of Defects	inches	<u>%</u>
Macro Test-Fusion Appearance-Fillet Size (leg)in, X		
Test Conducted By Inspection Specialists, Inc. We certify that the statements in this record are corr	Labora	atory-Test No. P.O. SP139740 Specimen WPP-01 re prepared, welded and tested in accordance with the requirements of
Section IX of the ASME Code.		Organization Johnson Controls
		all.
Date 5/22/99		By purgung
(Detail of record of tests are illustrative only and may NOTE: Any essential variables in addition to those		e type and number of tests required by the Code.)

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ATTACHMENT D: PQR NITRONIC 40/GTAW/I625

	ons Used to Weld Test Coupon
Company Name Johnson Controls World Services Inc. Procedure Qualification Record No 34-Nitronic 40/GTAW//6	25 Rev. A Date 5/22/99
VPS No. 34-045/GTAW/625	
Nelding Process(es) GTAW	
Types (Manual, Automatic, Semi-Auto) Manual	
JOINTS (QW-402)	-35 TO 40 DEG
3mm (0,125")	NTRONIC 40 2 3mm TO 3.2mm (0.094" TO 0.125")
BASE METALS (QW-403)	POSTWELD HEAT TREATMENT (QW-407)
Material Spec. UNS 21904 to UNS 21904	Temperature NOT APPLICABLE
Type or Grade Nitronic 40 to Nitronic 40 (XM-11 to XM-11)	Time
P-No8to P-No8	Other
Thickness of Test Coupon 0.951" to 1.070"	
Diameter of Test Coupon_100mm nominal (104mm or 4.500"O.D.)	
	GAS (QVV-408)
	Percent Composition <u>Gas(es)</u> (Mixture) Flow Rate Shielding <u>ARGON</u> 99.99% 0.566m ³ /h (20 to 35 CFH) and Backing
	Percent Composition <u>Gas(es)</u> (Mixture) Flow Rate Shielding <u>ARGON</u> 99.99% 0.566m ³ /n (20 to 35 CFH)
SFA Specification 5.14 AWS Classification ERNiCrMo-3	Percent Composition Gas(es) (Mixture) Flow Rate Shielding ARGON 99.99% 0.566m ³ /h (20 to 35 CFH) and Backing
SFA Specification 5.14 AWS Classification ERNiCrMo-3	Percent Composition <u>Gas(es) (Mixture)</u> Flow Rate Shielding <u>ARGON 99.99% 0.566m³/h (20 to 35 CFH)</u> and Backing Trailing <u>N/A</u>
SFA Specification 5.14 AWS Classification ERNiCrMo-3 Metal F-No. 43 Analysis A-No. Size of Filler	Percent Composition <u>Gas(es) (Mixture) Flow Rate</u> Shielding <u>ARGON 99.99% 0.566m³/h (20 to 35 CFH)</u> and Backing Trailing <u>N/A</u> ELECTRICAL CHARACTERISTICS (QW-409) Current <u>DC</u> Polarity <u>DCEN (-)</u>
SFA Specification 5.14 AWS Classification ERNiCrMo-3 Metal F-No. 43 Weld Metal Analysis A-No. Size of Filler Metal 2.4mm (3/32") - 4.0mm (5/32") Other	Percent Composition Gas(es) (Mixture) Flow Rate Shielding ARGON 99.99% 0.566m³/h (20 to 35 CFH) and Backing Trailing N/A
SFA Specification 5.14 AWS Classification ERNiCrMo-3 Metal F-No. 43 Weld Metal Analysis A-No. Size of Filler Metal 2.4mm (3/32") - 4.0mm (5/32") Other	Percent Composition <u>Gas(es) (Mixture) Flow Rate</u> Shielding <u>ARGON 99.99% 0.566m³/h (20 to 35 CFH)</u> and Backing Trailing <u>N/A</u> ELECTRICAL CHARACTERISTICS (QW-409) Current <u>DC</u> Polarity <u>DCEN (-)</u>
SFA Specification 5.14 AWS Classification ERNiCrMo-3 Metal F-No. 43 Analysis A-No. Size of Filler Metal 2.4mm (3/32") - 4.0mm (5/32") Other Deposited Weld Metal Size of Filler	Percent Composition Gas(es) (Mixture) Flow Rate Shielding ARGON 99.99% 0.566m³/h (20 to 35 CFH) and Backing Trailing N/A
SFA Specification 5.14 AWS Classification ERNiCrMo-3 Metal F-No. 43 Analysis A-No. Size of Filler Metal 2.4mm (3/32") - 4.0mm (5/32") Other Deposited Weld Metal POSITION (QW-405) Position of Groove 6G	Percent Composition Gas(es) (Mixture) Flow Rate Shielding ARGON 99.99% 0.566m³/h (20 to 35 CFH) and Backing Trailing N/A
SFA Specification 5.14 AWS Classification ERNiCrMo-3 Metal F-No. 43 Analysis A-No. Size of Filler Metal 2.4mm (3/32") - 4.0mm (5/32") Other Deposited Weld Metal POSITION (QW-405) Position of Groove 6G Weld Progression (Uphill, Downhill) UPHILL	Percent Composition <u>Gas(es) (Mixture) Flow Rate</u> Shielding <u>ARGON 99.99% 0.566m³/h (20 to 35 CFH)</u> and Backing Trailing <u>N/A</u> ELECTRICAL CHARACTERISTICS (QW-409) Current <u>DC</u> Polarity <u>DCEN (-)</u> Amps. <u>60 - 140</u> volts <u>12 - 20</u> Tungsten Electrode Size <u>2.4mm (3/32")</u> Other TECHNIQUE (QW-410) Travel Speed <u>127 - 203mm/min (5 - 8 i.p.m.)</u> String or Weave Bead <u>String Bead (3 times weld wire diameter)</u>
SFA Specification 5.14 AWS Classification ERNiCrMo-3 Metal F-No. 43 Analysis A-No. Size of Filler Metal 2.4mm (3/32") - 4.0mm (5/32") Other Deposited Weld Metal POSITION (QW-405) Position of Groove 6G Weld Progression (Uphill, Downhill) UPHILL	Percent Composition Gas(es) (Mixture) Flow Rate Shielding ARGON 99.99% 0.566m³/h (20 to 35 CFH) and Backing Trailing N/A
SFA Specification 5.14 AWS Classification ERNiCrMo-3 Metal F-No. 43 Analysis A-No. Size of Filler Metal 2.4mm (3/32") - 4.0mm (5/32") Other Deposited Weld Metal POSITION (QW-405) Position of Groove 6G Weld Progression (Uphill, Downhill) UPHILL	Percent Composition <u>Gas(es) (Mixture) Flow Rate</u> Shielding <u>ARGON 99.99% 0.566m³/h (20 to 35 CFH)</u> and Backing Trailing <u>N/A</u> ELECTRICAL CHARACTERISTICS (QW-409) Current <u>DC</u> Polarity <u>DCEN (-)</u> Amps. <u>60 - 140</u> volts <u>12 - 20</u> Tungsten Electrode Size <u>2.4mm (3/32")</u> Other TECHNIQUE (QW-410) Travel Speed <u>127 - 203mm/min (5 - 8 i.p.m.)</u> String or Weave Bead <u>String Bead (3 times weld wire diameter)</u>
SFA Specification 5.14 AWS Classification ERNICrMo-3 Metal F-No. 43 Analysis A-No. Size of Filler Metal 2.4mm (3/32") - 4.0mm (5/32") Other Deposited Weld Metal POSITION (QW-405) Position of Groove 6G Weld Progression (Uphill, Downhill) UPHILL Other	Percent Composition Gas(es) (Mixture) Flow Rate Shielding ARGON 99.99% 0.566m³/h (20 to 35 CFH) and Backing Trailing N/A
SFA Specification 5.14 AWS Classification ERNICrMo-3 Metal F-No. 43 Weld Metal Analysis A-No. Size of Filler Metal 2.4mm (3/32") - 4.0mm (5/32") Other Deposited Weld Metal Deposited Weld Metal	Percent Composition Gas(es) (Mixture) Flow Rate Shielding ARGON 99.99% 0.566m³/h (20 to 35 CFH) and Backing Trailing N/A
Metal 2.4mm (3/32") - 4.0mm (5/32") Other Deposited Weld Metal	Percent Composition Gas(es) (Mixture) Flow Rate Shielding ARGON 99.99% 0.566m³/h (20 to 35 CFH) and Backing Trailing N/A

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QW-483 (Back)

No.	in.	Thickness in.	Area sq. in.	Total Load Ib.	Unit Stress psi	Failure & Location
T1	0.491	1.017	0.499	54,700	109,619	Base
Τ2	0.495	1.024	0.506	52,500	103,754	Weld

Guided Bend Tests (QW-160)				
Type and Figure No.	Result			
SIDE BEND QW 462.2 1	Satisfactory			
SIDE BEND QW 462.2 2	Satisfactory			
SIDE BEND QW 462.2 3	Satisfactory			
SIDE BEND QW 462.2 4	Satisfactory			

Specimen	Notch	Notch	Test	Impact	Lateral	Exp.	Drop	Weight
No.	Location	Туре	Temp.	Values	% Shear	Mils	Break	No Break
08102.3 - weld 1	Weld	Charpy V	-100°F	40 ft-lbs	85	14		
08102.3 - weid 2	Weld	Charpy V	-100°F	85	85	16		
08102.3 - weld 3	Weld	Charpy V	-100°F	39	85	13		
08102.3 - HAZ 1	HAZ	Charpy V	-100°F	74	40	16		
08102.3 - HAZ 2	HAZ	Charpy V	-100°F	44	85	15		
08102.3 - HAZ 3	HAZ	Charpy V	-100°F	50	85	20		
					-			
	-							

FILLET WELD TEST (QW-180) Result - Satisfactory_ Penetration into Parent Metal Yes, No Yes, No Type and Character of Failure_ Macro-Results Welder's Name Keith Bryant Clock No. 2307 Stamp No. 4 Tests conducted by: Inspection Specialists, Inc. Laboratory Test No. P.O. R1-149804 Sample WPP#3 per: ASME Section IX and ASTM A 370 We certify that the statements in this record are correct and that the test welds were prepared, welded and tested in accordance with the requirements of Section IX of the ASME Code. Signed Johnson Controls World Services Inc. (Manufacturer) By By Buybery Date 5/22/99

Responsible Office: NASA SSC Center Operations Directorate

SUBJECT: ASME Procedure for Welding Nitronic 40 Stainless Steel Alloy

ATTACHMENT E: SUGGESTED FORMAT FOR MANUFACTURING RECORD OF WELDER OF WPQ NITRONIC 40/GTAW/I625

Welder Name Keith Bryant	Check No. 2307	Stamp No. 4
Using WPS N		Rev. A Date 5/22/99
	the above welder is qualified f	or the following ranges.
Variable	Record Actual Values Used in Qualification	Qualification Range
Process	GTAW	GTAW
Process Type	GTAW	GTAW
Backing (metal,weldmetal,flux,etc. (QW-402)	N/A	N/A
Material Spec. (QW-403)	UNS 21904 to UNS 21904	P-No.8 Group No. 3 to P-No.8 Group No. 3
Thickness Groove	0.951" to 1.070"	0.188" to 2.00"
Fillet	N/A	0.198" to 2.00"
Diameter	4800	2 9751 O.D. and laures
Groove Fillet	4.5" O.D. N/A	2.875° O.D. and larger 2.875° O.D. and larger
Filler Metal (QW-404)	AWS (SFA) 5.14	SFA 5.14
Spec. No.	100 Jai A 9.14	or no. la
Class	ERNiCrMo-3	ERNIC/Mo-3
F-No.	43	43
Deposited Weld Metal Thickness Groove X Fillet	0.951" to 1.070"	12.7 mm (0.50") min.
Position (QW-405)	6G	6G
Weld Progression	Upward	Upward
Gas Type (QW-408)	99.99% Argon	99.99% Argon
Backing Gas (QW-408)99.99% Argon	99% Argon	99% Argon
Electrical Characteristics (QW-409) Current	120 amps root; 130-140 amps remaining	60 - 140 Amps
Polarity	DÇEN	DCEN
Guide Type and Fig No. Side Bend; Specimen 08102.3-S1	d Bend Test Results QW-462.2(a), WQ-462.3(a), WQ-462.3(b) Result Satisfactory
Side Bend; Specimen 08/02.3-S2		Satisfactory
Side Bend; Specimen 08/02.3-S3		Satisfactory
Side Bend; Specimen 08102.3-S4		Satisfactory
Radiographic Results Accept	Radiographic Test Results (alternative qualification of gra	ove welds by radiography
r Fracture Test (Describe the location, nature and siz	illet Weld Test Results [See QW te of any crack or tearing of the s	-462.4(0), QW-462.4(D)] specimen)
Length and Percent of Defects Macro TestFusion	inches	%
AppearanceFillet Size (leg)in, 3		
Test Conducted By Inspection Specialists, Inc.	Laborato	
	rect and that the test welds were	prepared, welded and tested in accordance with the requirements of
Section IX of the ASME Code.		
Section IX of the ASME Code.	0	rganization, Johnson Controls

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ATTACHMENT F: PQR NITRONIC 40/GTAW/I625/2

Company Name Johnson Controls World Services Inc.	
Procedure Qualification Record No 34-Nitronic 40/GTAW/1625	/2 Date09
WPS No 34-045/GTAW//6252	
Welding Process(es) GTAW	
Types (Manual, Automatic, Semi-Auto) Manual	
JOINTS (QW-402)	-35 TO 40 DEG
34 Bmm (1 37') MIN. 37 0mm (1 46') MAX. MITROPIIC 40 3mm (0 125') MAX.	CHAMFER W/ 0.155 R. (TPE) 14.5mm 10.031 10.094 TO 0.125 0.094 TO 0.125 10.094 TO 0.125 10.094 TO 0.125 10.094 TO 0.125 10.00
BASE METALS (QW-403)	POSTWELD HEAT TREATMENT (QW-407)
Material SpecUNS 21904 to UNS 21904	Temperature NOT APPLICABLE
Type or Grade Nitronic 40 to Nitronic 40 (XM-11 to XM-11)	Time
P-No. 8 to P-No. 8	Other
Thickness of Test Coupon 34.8mm (1.37") minimum to 37.0mm (1.46"	<u>ې </u>
maximum	
Diameter of Test Coupon 323.9mm (12.75") O.D.	
Other	GAS (QW-408)
	Percent Composition
	Gas(es) (Mixture) Flow Rate
	Shielding <u>ARGON</u> 99.99% 0.566m ³ /h (20 to 35 CFH) and Backing
FILLER METALS (QW-404)	Trailing N/ A
SFA Specification 5.14	
AWS Classification ERNiCrMo-3 Metal F-No. 43 Weld Metal	ELECTRICAL CHARACTERISTICS (QW-409)
Analysis A-No. Size of Filler	CurrentDC PolarityDCEN (-)
Metal 2.4mm (3/32") - 4.0mm (5/32") Other	Amps. 60 - 140 volts 12 - 20
Deposited Weld Metal	Tungsten Electrode Size 2.4mm (3/32")
	Other
POSITION (QW-405)	TECHNIQUE (QW-410)
Position of Groove 6G	Travel Speed <u>127 - 203mm/min (5 - 8 i.p.m.)</u>
Weld Progression (Uphill, Downhill) UPHILL	String or Weave Bead String Bead (3 times weld wire diamet
Other	Oscillation Not Applicable
	Multipass or Single Pass (per side) Multiple
	Single or Multiple Electrodor Single
	Single or Multiple Electrodes Single
PREHEAT (QW-406) Preheat Temp. 60° F. Minimum	Other
PREHEAT (QW-406) Preheat Temp. 60° F Minimum Interpass Temp. 325° F Maximum	Other

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QW-483 (Back)

		Ten	sile Test (QW-150)		
Specimen No.	Diameter in.	Area sq. in.	Ultimate Total Load Ib.	Ultimate Unit Stress psi	Character of Failure & Location
T 1C (Cap)	0.500	0.1963	16,125	82,100	Base
T 1R (Root)	0.354	0.0984	8,847	89,912	Base
T2C (Cap)	0.490	0.1886	16,423	87,100	Base
T2R (Root)	0.503	0.1987	17,546	88,300	Base

Guided Bend Tests (QW-160)					
Type and	Figure No.	Result			
QW 462.2	1	Satisfactory			
QW 462.2	2	Satisfactory			
QW 462.2	3	Satisfactory			
QW 462.2	4	Satisfactory			
	QW 462.2 QW 462.2 QW 462.2	Type and Figure No.			

Specimen	Notch	Notch	Test	Impact	Lateral	Exp.	Drop	Weight
No.	Location	Туре	Temp.	Values	% Shear	Mils	Break	No Break
08102.3 - weld 1 Cap	Weld	Charpy V	-320°F	79 ft-lbs	50	74		
08/02.3 - weld 2 Cap	Weld	Charpy V	-320°F	78 ft-lbs	50	64		
08102.3 - weld 3 Cap	Weld	Charpy V	-320°F	68 ft-lbs	40	62		
08102.3 - weld 1 Root	Weld	Charpy V	-320°F	36 ft-lbs	50	31		
08102.3 - weld 2 Root	Weld	Charpy V	-320°F	40 ft-lbs	50	36		
08102.3 - weld 3 Root	Weld	Charpy V	-320°F	43 ft-lbs	40	40		
08102.3 - HAZ 1 Pipe	HAZ	Charpy V	-320°F	33 ft-lbs	10	18		
08102.3 - HAZ 2 Pipe	HAZ	Charpy V	-320°F	42 ft-lbs	10	21		
08102.3 - HAZ 3 Pipe	HAZ	Charpy V	-320°F	42 ft-lbs	10	30		
08/02.3 - HAZ 1 Flange	HAZ	Charpy V	-320°F	30 ft-lbs	40	21		
08102.3 - HAZ 2 Flange	HAZ	Charpy V	-320°F	30 ft-lbs	30	21		
08102.3 - HAZ 3 Flange	HAZ	Charpy V	-320°F	40 ft-lbs	40	25		

	FILLET WELD	TEST (QV	V-180)			
Result - Satisfactory	Penet	ration into Pa	arent Met	al	- NJ	
	Yes, No		Yes, No	0		
	Type and Character of Failure		Mac	ro-Results		
Welder's Name_	Mark Corr	_Clock No	2394	St	amp No.	34
Tests conducted by:	Materials Technology, Inc.	Laboratory	Test No.	90522; P.O	No. L-R	2200125065
	per: ASME Sect	ion IX and A	STM A 37	70		
			01111110			
Ve certify that the statements in t		he test welds	were pre	epared, weld	led and t	ested in accordance with
Ve certify that the statements in t	his record are correct and that the the requirements of Sect Signed Johnson Cont	ne test welds tion IX of the rols World Se	were pre ASME Co	epared, weid ode.	ied and t	tested in accordance with
Ve certify that the statements in the statements of the Date 5/22/99	his record are correct and that the the requirements of Sect Signed Johnson Cont	he test welds ion IX of the	were pre ASME Co	epared, weid ode.	led and t	tested in accordance with

Cuided Band Tests (ON 460)

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			Tensile	Test (QW-150) Ultimate	Ultima		Character of	-1
Specimen No.	Diameter in.		in.	Total Load Ib.	Unit Stro psi		Failure & Location	_
								-1
								7
					1	L_		_1
T	ype and Figure	No	Guided Ben	d Tests (QW-16	Result			
	462.2 1			Test Not Per				
	462.2 2				Test Not Per			
	462.2 3				Test Not Per			
	462.2 4				Test Not Per			_
			Toughness	s Tests (QW-170	0)			
Specimen	Notch	Notch	Test	Impact	Lateral	Exp.	Drop	Weight
No.	Location	Туре	Temp.	Values	% Shear	Mils	Break	No Break
8102.3 - HAZ 1	HAZ	Charpy V	-320°F	44.5 ft-lbs	N/A	25		
8102.3 - HAZ 2	HAZ	Charpy V	-320°F	40.0 ft-lbs	N/A	25		
8102.3 - HAZ 3	HAZ	Charpy V	-320°F	40.0 ft-lbs	N/A	21		
					+			
	+				+			[
				+	+		+	
	_						1	
							+	L
			<u> </u>	+				
		L	L			L		L
Result - Satisfact		FI		D TEST (QW netration into Par				
ricourt Gationad		Yes,			Yes, No			
		Type and Char Mark Cort	acter of Failu	Clock No.	Macro-Re	sults Stamp No.	34	
	Welder's Name_ ts conducted by	Scientific Te	sting Laborat	ories_Laborator	ry Test No. 90			
		р	er ASME S	ection IX and AS	STM E 23			
Ve certify that the s	tatements in thi			t the test welds v ection IX of the A		, welded ar	d tested in a	ccordance wit
		Signed	Johnson Co	ontrols World Ser	vices Ipe	0		
				nufacturer)	Tal.	aber		

Stennis	SS]
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	Rev

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Responsible Office: NASA SSC Center Operations Directorate

SUBJECT: ASME Procedure for Welding Nitronic 40 Stainless Steel Alloy

ATTACHMENT G: SUGGESTED FORMAT FOR MANUFACTURING RECORD OF WELDER OF WPQ NITRONIC 40/GTAW/I625/2

Welder Name Mark Corr	Check No. 2394	Stamp No. 34
Using WPS No.	34-045/GTAW/I625/2 the above welder is qualified for	Rev. Basic Date 5/22/99 or the following ranges.
	Record Actual Values	
Variable	Used in Qualification	Qualification Range
Process	GTAW	GTAW
Process Type	GTAW	GTAW
Backing (metal,weldmetal,flux,etc. (QW-402)	N/A	N/A
Material Spec. (QW-403)	UNS 21904 to UNS 21904	UNS 21904 to UNS 21904
Thickness Groove	1.371" to 1.460"	0.625" to 2.920"
Fillet Diameter	N/A	0.625" to 2.920"
Groove	12.75* O.D.	2.875" and larger
Fillet	N/A	2.875" and larger
Filler Metal (QW-404) Spec. No.	AWS (SFA) 5.14	SFA 5.14
Class	ERNiCrMo-3	ERNiCrMo-3
F-No.	43	43
Deposited Weld Metal Thickness		
Groove X Fillet	1.371" to 1.460"	0.625" to 2.920"
Position (QW-405)	6G	6G
Weld Progression	Upward	Upward
Gas Type (QW-408)	99.99% Argon	99.99% Argon
Backing Gas (QW-408) 99.99% Argon	99% Argon	99% Argon
Electrical Characteristics (QW-409) Current	60-140 amps	60 - 140 Amps
Polarity	DCEN (-)	DCEN (-)
Guide Type and Fig No. Side Bend; Specimen 08102.3-S1	d Bend Test Results QW-462.2(0), WG-462.3(0), WG-462.3(0) Result Satisfactory
Side Bend; Specimen 08/02.3-S1		Satisfactory
Side Bend: Specimen 08102.3-S3		Satisfactory
Side Bend; Specimen 08/02.3-S4		Satisfactory
		Sansiaviory
Radiographic Results Accept	Radiographic Test Results (alternative qualification of gro Fillet Weld Test Results [See QW ze of any crack or tearing of the s	-462.4(a), QW-462.4(b)]
ength and Percent of Defects	inches	%
Macro TestFusion AppearanceFillet Size (leg)in.		
lest Conducted By Inspection Specialists, Inc.	rrect and that the test welds were	ry-Test No. P.O. R1-149804 Sample WPP#3 prepared, welded and tested in accordance with the requirements of ganizetime Johnson Controls
Date 5/22/99	By	
Detail of record of tests are illustrative only and ma		
NOTE: Any essential variables in addition to those		the any rest of the code.)
		he Order Dept., ASME, 345 E. 47 St., New York, N.Y. 10017
12/86) This form		THE STORT LIGHT, PROVIE, OND E. M. OL, NEW TURK, N.T. TUVI/