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Space Administration

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

**SSTD-8070-0036-WELD Rev. Basic  
SEPTEMBER 2014**

# COMPLIANCE IS MANDATORY

## **John C. Stennis Space Center ASME PROCEDURE FOR WELDING MONEL ALLOY (P-42) TO CARBON STEEL (P-1)**

### **Original signed by:**

<u>Scott Olive</u> NASA SSC Center Operations Design & Construction Project Management Division	<u>9-10-14</u> Date
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<u>Richard Harris</u> NASA SSC Center Operations Directorate Operations and Maintenance Division	<u>9-11-14</u> Date
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<u>Freddie Douglas</u> NASA SSC Safety & Mission Assurance	<u>9-16-14</u> Date
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### **Issued by**

<u>Issued CEF</u> Central Engineering Files	<u>                    </u> Date
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SUBJECT: ASME Procedure for Welding Monel Alloy (P-42) to Carbon Steel (P-1)		

## Document History Log

Change/ Revision	Change Date	Originator/ Phone	Description
Basic	09.10.2014	Doug Dike, Ext. 8-2803	Initial release, superseding SSC STD 34-042. <b><i>CEF Archive Information:</i></b> Part of Appendix B, Standards and Specifications Plan to Contract NAS13-400. References updated throughout document. Updated specifications in 5.0.b. Attachment A updated.

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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 Monel Alloy to Carbon Steel at SSC.

## 2.0 APPLICABILITY

This SSTD applies to all contractor and subcontractor personnel involved with the welding of Monel Alloy to Carbon Steel at SSC.

## 3.0 REFERENCES

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

ASME Boiler and Pressure Vessel Code, Section II, *Materials*

ASME Boiler and Pressure Vessel Code, Section IX, *Welding, Brazing and Fusing Qualifications*

ASME B31.3, *Process Piping*

ASTM A105, *Standard Specification for Carbon Steel Forgings for Piping Applications*

ASTM A106, *Standard Specification for Seamless Carbon Steel Pipe for High Temperature Service*

ASTM A234, *Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service*

ASTM B127, *Standard Specification for Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip*

ASTM B163, *Standard Specification for Seamless Nickel and Nickel Alloy Condenser and Heat Exchanger Tubes*

ASTM B164, *Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire*

ASTM B165, *Standard Specification for Nickel-Copper Alloy (UNS N04400) Seamless Pipe and Tube*

ASTM B366, *Standard Specification for Factory Made Wrought Nickel and Nickel Alloy Fittings*

ASTM B467, *Standard Specification for Welded Copper-Nickel Pipe*

ASTM B564, *Standard Specification for Nickel Alloy Forgings*

ASTM B725, *Standard Specification for Welded Nickel (UNS N02200/UNS N02201) and Nickel Copper Alloy (UNS N04400) Pipe*

ASTM B730, *Standard Specification for Welded Nickel (UNS N02200/UNS N02201) and Nickel Copper Alloy (UNS N04400) Tube*

AWS Welding Handbook

FED QQ-N-281, *Federal Specification: Nickel-Copper Alloy Bar, Rod, Plate, Sheet, Strip, Wire, Forgings, and Structural and Special Shaped Sections*

MIL-N-24106, *Nickel-Copper Alloy Bars, Rods and Forgings*

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MIL-T-1368, *Tube and Pipe, Nickel-Copper Alloy, Seamless and Welded*  
MIL-T-23520, *Tube and Pipe, Nickel-Copper Alloy, Seamless, Air Melted*  
SAE AMS 4544, *Sheet, Strip, and Plate, Corrosion-Resistant Alloy 67Ni-30Cu, Annealed.*  
SAE AMS 4574, *Nickel-Copper Alloy, Corrosion-Resistant, Tubing, Seamless 67Ni-31Cu Annealed.*  
SAE AMS 4575, *Nickel-Copper Alloy Tubing, Brazed, Corrosion-Resistant, 67Ni-31Cu, Annealed*  
SAE AMS 4576, *Nickel-Copper Alloy, Corrosion Resistant, Bars and Forgings 67Ni-30Cu.*  
SAE AMS 4730, *Nickel-Copper Alloy Wire, Corrosion-Resistant, 67Ni-31Cu Annealed.*  
SAE AMS 4731, *Nickel-Copper Alloy Wire and Ribbon, Corrosion-Resistant, 67Ni-31Cu, Annealed.*  
SPR 1440.1, *Records Management Program Requirements*  
SPR 8715.1, *Safety and Health Program Requirements*  
SSTD-8070-0013-WELD, *Classes of Welding Inspection*  
SSTD-8070-0014-WELD, *Qualifying Welders and Weld Procedures*  
SSTD-8070-0005-CONFIG, *SSC Preparation, Review, Approval, and Release of SSC Standards*

#### **4.0 RESPONSIBILITIES**

- a. Users of this SSTD shall comply with its requirements, ensure use of the correct version of this Standard and the documents it references, and inform the appropriate organization of needed changes in accordance with SSC Standard 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 Standard 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 UNS N04400 base metal (Monel 400) meeting one or more of the following specifications:
  - SAE AMS 4544, 4574, 4575, 4675, 4730, 4731
  - ASME SB127, SB163, SB164, SB165, SB564
  - ASTM B127, B163, B164, B165, B366, B564, B467, B725, B730
  - FED QQ-N-281
  - MIL-N-24106, MIL-T-1368, MIL-T-23520
- b. The carbon steel to be welded shall be a P-No.1, Group 2 material as listed in ASME Boiler and Pressure Vessel Code, Section IX, and with allowable stress equal to or

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higher than those of ASTM A105, A106 Grade C, or A234 Grade WPC materials per ASME B31.3.

- c. 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 NASA SSC Center Operations Design & Construction Project Management Division (PMD), the NASA SSC Center Operations Directorate Operations and Maintenance Division (OMD), the NASA SSC Engineering and Test Directorate (E&TD), and the NASA SSC Safety and Mission Assurance (S&MA) Office.
- d. The attached Procedure Qualification Records (PQR), No. 34-Monel/CSteel/GTAW, is a PQR for the original qualification of this WPS. When performing new qualifications, a new PQR should be filled out showing all pertinent data and results of the weld procedure qualification.
- 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.
- h. All procedures shall be performed in compliance with applicable requirements in SPR 8715.1. If ever there is a conflict between this standard and the SPR, the SPR shall superseded this standard.

## 6.0 RECORDS AND FORMS

Records and forms required by this standard shall be maintained in accordance with SPR 1440.1. All records and forms are assumed to be the latest edition unless otherwise indicated. 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.

The original, signed WPSs and PQRs (copies of which are provided in Attachments A and B of this SSTD) shall be maintained in CEF together with the original, signed hardcopy of this SSTD.

## 7.0 ACRONYMS AND ABBREVIATIONS

AMS	Alpha Magnetic Spectrometer
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
E&TD	Engineering & Test Directorate
GTAW	Gas Tungsten Arc Welding
MIL	Military
NASA	National Aeronautics and Space Administration

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OMD	Operations and Maintenance Division
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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## ATTACHMENT A: WELDING PROCEDURE SPECIFICATIONS (WPS)

### QW-482 SUGGESTED FORMAT FOR WELDING PROCEDURE SPECIFICATIONS (WPS) (See QW-200.1, Section IX, ASME Boiler and Pressure Vessel Code)

Company Name NASA, JOHN C. STENNIS SPACE CENTER By K.A. Broom  
Welding Procedure Specification No. 34-042 Date 7/15/1993 Supporting PCR No.(s) 34-Monel/CSteel/GTAW  
Revision No. 1 Date 8/19/13

Welding Process(es) GTAW Type(s) Manual  
(Automatic, Manual, Machine, or Semi-Automatic)

<b>JOINTS (QW-402)</b>		<b>Details</b>
Joint Design <u>Single/Double V Groove Single/Double U Groove All Fillets</u>	Two layers of buttering shall be supplied to the groove face of the carbon steel.	
Root Spacing _____	Buttering shall be applied with electrodes of ER Ni-Cu-7 and shall be done in the flat position.	
Backing: Yes _____ No <u>x</u>		
Backing Material (Type) <u>None</u>		
<small>(Refer to both backing and retainers)</small>		
<input type="checkbox"/> Metal <input type="checkbox"/> Nonfusing Metal	Figure 1 shows typical groove detail examples.	
<input type="checkbox"/> Nonmetallic <input type="checkbox"/> Other		
Sketches, Production Drawings, Weld Symbols, or Written Description should show the general arrangement of the parts to be welded. Where applicable, the details of weld groove may be specified.		
[At the option of the manufacturer, sketches may be attached to illustrate joint design, weld layers, and bead sequence (e.g., for notch toughness procedures, for multiple process procedures, etc.)]		

**\*BASE METALS (QW-403)**

P-No. 42 Group No. \_\_\_\_\_ to P-No. 1 Group No. 2

OR

Specification and type/grade or UNS Number UNS 04400

to Specification and type/grade or UNS Number SA-105 or SA-106 Grade C

OR

Chem. Analysis and Mech. Prop. Not Required

to Chem. Analysis and Mech. Prop. Not Required

Thickness Range:

Base Metal: Groove 4.8mm (0.188") to 14.7mm (0.58") Fillet ALL

Maximum Pass Thickness  $\leq 1/2$  inch (13 mm) (Yes)  (No)

Other Pipe Dia. Range: Groove, 25.4mm (1") and larger; Fillet, all. No pass greater than 12.7mm (1/2") thick.

*FILLER METALS (QW-404)	1	2
Spec. No. (SFA) _____	5.14	5.14
AWS No. (Class) _____	ER NiCu-7	ER NiCu-7
F-No. _____	42	42
A-No. _____		
Size of Filler Metals _____	2mm-3.2mm	2mm-3.2mm
Filler Metal Product Form _____		
Supplemental Filler Metal _____		
Weld Metal		2.4mm to 14.2mm
Thickness Range:		
Groove _____	1.6mm - 2.4mm	
Fillet _____		
Electrode-Flux (Class) _____	N/A	N/A
Flux Type _____	N/A	N/A
Flux Trade Name _____	N/A	N/A
Consumable Insert _____	N/A	N/A
Other _____		

\*Each base metal-filler metal combination should be recorded individually.

(03/08)

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**QW-482 (BACK)**

WPS No. 34-042 Rev. 0

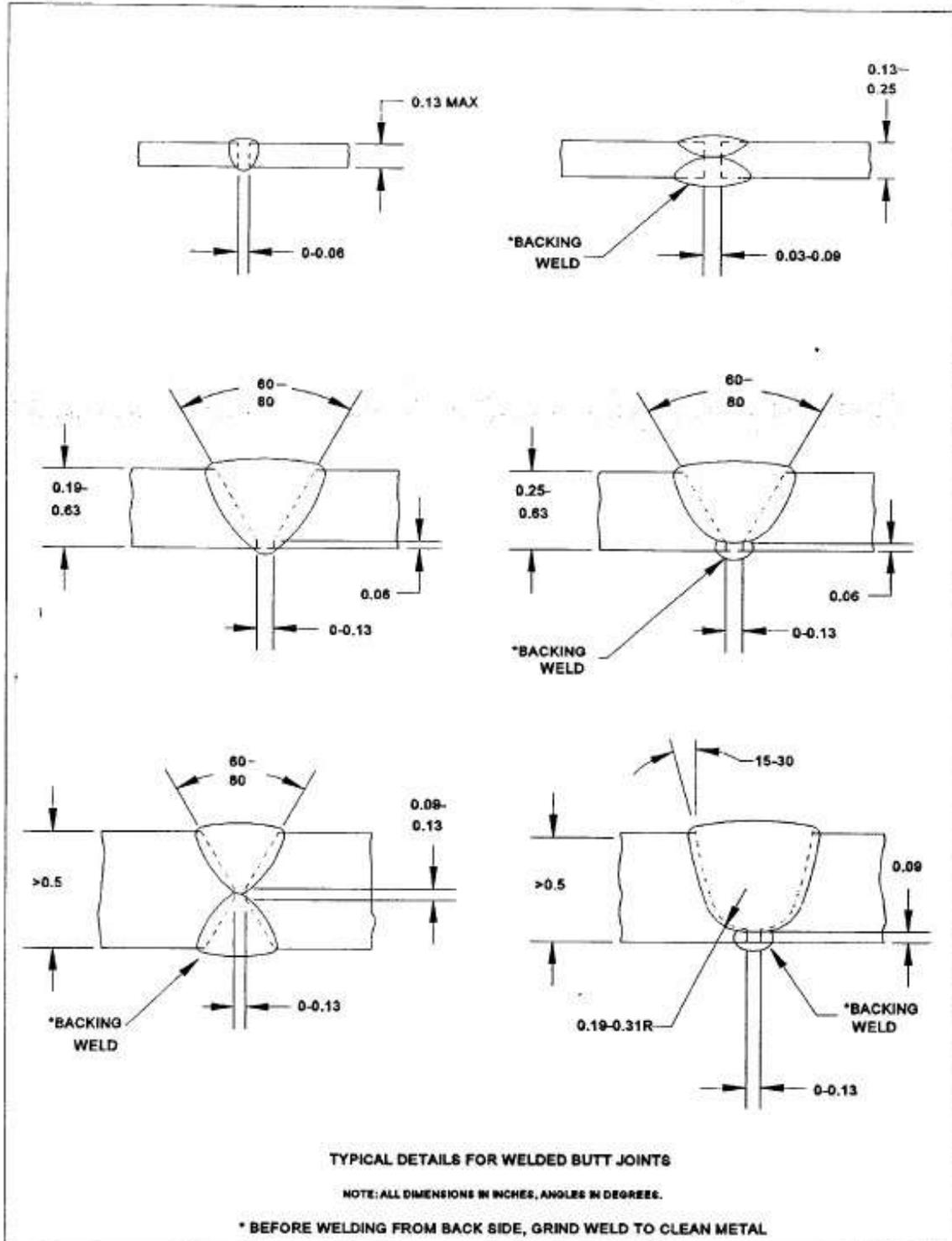
<p><b>CONDITIONS (QW-405)</b></p> Positions of Groove: ALL Welding Progression: Up <u>UP</u> Down _____ Positions of Fillet: ALL	<p><b>POST WELD HEAT TREATMENT (QW-407)</b></p> Temperature Range: N/A Time Range: N/A																																														
<p><b>PREHEAT (QW-406)</b></p> * Preheat Temp. Min: 60° F * Interpass Temp. Max: 200° F Preheat Maintenance: N/A <small>(Continuous or special heating where applicable should be recorded)</small>	<p><b>* GAS (QW-408)</b></p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th rowspan="2">Gas(es)</th> <th colspan="2">Percent Composition</th> </tr> <tr> <th>(Mixture) %</th> <th>Flow Rate CFH</th> </tr> </thead> <tbody> <tr> <td>Shielding</td> <td>Argon 99.99</td> <td>30-35</td> </tr> <tr> <td>Trailing</td> <td>None</td> <td>None</td> </tr> <tr> <td>Backing</td> <td>Argon 99.99</td> <td>10</td> </tr> </tbody> </table>	Gas(es)	Percent Composition		(Mixture) %	Flow Rate CFH	Shielding	Argon 99.99	30-35	Trailing	None	None	Backing	Argon 99.99	10																																
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Trailing	None	None																																													
Backing	Argon 99.99	10																																													
<p><b>ELECTRICAL CHARACTERISTICS (QW-409)</b></p> Current AC or DC: DC Polarity: DCEN (-) Amps (Range): 70-130 Volts (Range): 13-20 <small>(Amps and volts range should be recorded for each electrode size, position, and thickness, etc. This information may be listed in a tabular form similar to that shown below.)</small> Tungsten Electrode Size and Type: 2.4mm (3/32") TO 3.2mm (1/8") THORIATED EWTH-2 <small>(Pure Tungsten, 2% Thoriated, etc.)</small> Mode of Metal Transfer for GMAW: N/A <small>(Spray arc, short circuiting arc, etc.)</small> Electrode Wire feed speed range: N/A																																															
<p><b>TECHNIQUE (QW-410)</b></p> String or Weave Bead: String Bead Orifice or Gas Cup Size: *4 TO *8 Initial and Interpass Cleaning (Brushing, Grinding, etc.): w/virgin SS Brush 2" both sides of weld joint Method of Back Gouging: Thermal or Mechanical if required (Grind 1.6mm (1/16") if thermal) Oscillation: Oscillation not used with this procedure Contact Tube to Work Distance: None * Multiple or Single Pass (per side): Either - Maximum deposit per pass - 1/4" * Multiple or Single Electrodes: Single Travel Speed (Range): As required Peening: Peening not used with this procedure Other: *Apply two layers of buttering to the groove face of the carbon steel. Repair - Grind followed by brushing with SS brush Repair per this procedure or repair as directed by Engineer																																															
<table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <thead> <tr> <th rowspan="2">Weld Layer(s)</th> <th rowspan="2">Process</th> <th colspan="2">Filler Metal</th> <th colspan="2">Current</th> <th rowspan="2">Volt Range</th> <th rowspan="2">Travel Speed Range</th> <th rowspan="2">Other <small>(e.g., Remarks, Comments, Hot Wire Addition, Technique, Torch Angle)</small></th> </tr> <tr> <th>Class</th> <th>Dia.</th> <th>Type Polar.</th> <th>Amp Range</th> </tr> </thead> <tbody> <tr> <td>Root Pass</td> <td>GTAW</td> <td>ER NiCu-7</td> <td>1.6mm - 3.2mm (1/16 - 1/8")</td> <td>DCEN (-)</td> <td>70-130</td> <td>13-20</td> <td>76 - 127 mm/min (3-5 i.p.m.)</td> <td></td> </tr> <tr> <td>Fill</td> <td>GTAW</td> <td>ER NiCu-7</td> <td>1.6mm - 3.2mm (1/16 - 1/8")</td> <td>DCEN (-)</td> <td>70-130</td> <td>13-20</td> <td>76 - 127 mm/min (3-5 i.p.m.)</td> <td></td> </tr> <tr> <td>Cap</td> <td>GTAW</td> <td>ER NiCu-7</td> <td>1.6mm - 3.2mm (1/16 - 1/8")</td> <td>DCEN (-)</td> <td>70-130</td> <td>13-20</td> <td>76 - 127 mm/min (3-5 i.p.m.)</td> <td></td> </tr> </tbody> </table>								Weld Layer(s)	Process	Filler Metal		Current		Volt Range	Travel Speed Range	Other <small>(e.g., Remarks, Comments, Hot Wire Addition, Technique, Torch Angle)</small>	Class	Dia.	Type Polar.	Amp Range	Root Pass	GTAW	ER NiCu-7	1.6mm - 3.2mm (1/16 - 1/8")	DCEN (-)	70-130	13-20	76 - 127 mm/min (3-5 i.p.m.)		Fill	GTAW	ER NiCu-7	1.6mm - 3.2mm (1/16 - 1/8")	DCEN (-)	70-130	13-20	76 - 127 mm/min (3-5 i.p.m.)		Cap	GTAW	ER NiCu-7	1.6mm - 3.2mm (1/16 - 1/8")	DCEN (-)	70-130	13-20	76 - 127 mm/min (3-5 i.p.m.)	
Weld Layer(s)	Process	Filler Metal		Current		Volt Range	Travel Speed Range			Other <small>(e.g., Remarks, Comments, Hot Wire Addition, Technique, Torch Angle)</small>																																					
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Variable

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Figure 1



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### ATTACHMENT B: WELDING PROCEDURE QUALIFICATION RECORD (PQR)

**QW-483 SUGGESTED FORMAT FOR WELDING PROCEDURE QUALIFICATION RECORD (PQR)**

(See QW-201.2, Section IX, ASME Boiler and Pressure Vessel Code)  
Record Actual Conditions Used to Weld Test Coupon

Company Name Johnson Controls World Services Inc.

Procedure Qualification Record No. 34-MONEL/CSTEEL/GTAW Date 07-15-1993

WPS No. 34-042

Welding Process(es) GTAW

Types (Manual, Automatic, Semi-Auto) Manual

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JOINTS (QW-402)

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<p><b>BASE METALS (QW-403)</b></p> <p>Material Spec. <u>UNS N04400 to K03504 or K03501</u></p> <p>Type or Grade <u>Monel 400 to SA-105 or SA-106</u></p> <p>P-No. <u>42</u> to P-No. <u>1</u></p> <p>Thickness of Test Coupon <u>SCH 40 (.280")</u></p> <p>Diameter of Test Coupon <u>150 mm (6")</u></p>	<p><b>POSTWELD HEAT TREATMENT (QW-407)</b></p> <p>Temperature <u>NOT APPLICABLE</u></p> <p>Time _____</p> <p>Other _____</p>																
<p><b>FILLER METALS (QW-404)</b></p> <p>SFA Specification <u>SFA-5.14</u></p> <p>AWS Classification <u>ER NiCu-7</u></p> <p>Filler Metal F-No. <u>42</u></p> <p>Weld Metal Analysis A-No. <u>NiCu</u></p> <p>Size of Filler Metal <u>2.3mm (3/32") &amp; 3.1mm (1/8")</u></p> <p>Other _____</p> <p>Deposited Weld Metal _____</p>	<p><b>GAS (QW-408)</b></p> <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 30%;"></th> <th style="width: 30%;">Gas(es)</th> <th style="width: 20%;">(Mixture)</th> <th style="width: 20%;">Flow Rate</th> </tr> </thead> <tbody> <tr> <td>Shielding</td> <td>ARGON</td> <td>99.99%</td> <td>0.566m<sup>3</sup>/h (20C)</td> </tr> <tr> <td>Trailing</td> <td>N/A</td> <td></td> <td></td> </tr> <tr> <td>Backing</td> <td>ARGON</td> <td>99.99%</td> <td>0.991m<sup>3</sup>/h (35C)</td> </tr> </tbody> </table>		Gas(es)	(Mixture)	Flow Rate	Shielding	ARGON	99.99%	0.566m <sup>3</sup> /h (20C)	Trailing	N/A			Backing	ARGON	99.99%	0.991m <sup>3</sup> /h (35C)
	Gas(es)	(Mixture)	Flow Rate														
Shielding	ARGON	99.99%	0.566m <sup>3</sup> /h (20C)														
Trailing	N/A																
Backing	ARGON	99.99%	0.991m <sup>3</sup> /h (35C)														
<p><b>POSITION (QW-405)</b></p> <p>Position of Groove <u>6G</u></p> <p>Weld Progression (Uphill, Downhill) <u>UPHILL</u></p> <p>Other _____</p>	<p><b>ELECTRICAL CHARACTERISTICS (QW-409)</b></p> <p>Current <u>DC</u></p> <p>Polarity <u>DCEN (-)</u></p> <p>Amps. <u>100 - 138</u> volts <u>15 - 18</u></p> <p>Tungsten Electrode Size <u>2.4mm (3/32")</u></p> <p>Other _____</p>																
<p><b>PREHEAT (QW-406)</b></p> <p>Preheat Temp. <u>75° F</u></p> <p>Interpass Temp. <u>200° F MAX</u></p>	<p><b>TECHNIQUE (QW-410)</b></p> <p>Travel Speed <u>75 - 125 mm/min (3 - 5 i.p.m.)</u></p> <p>String or Weave Bead <u>String Bead</u></p> <p>Oscillation <u>Not Applicable</u></p> <p>Multipass or Single Pass (per side) <u>Multiple</u></p> <p>Single or Multiple Electrodes <u>Single</u></p> <p>Other <u>Applied two layers of buttering to the groove face of the carbon steel Applied with specific electrodes in the flat position.</u></p>																

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Responsible Office: NASA SSC Center Operations Directorate	
SUBJECT: ASME Procedure for Welding Monel Alloy (P-42) to Carbon Steel (P-1)	

**PQR No. 34-Monel/CSteel/GTAW**

**QW-483 (Back)**

**Tensile Test (QW-150)**

Specimen No.	Width in.	Thickness in.	Area in <sup>2</sup>	Ultimate Total Load lb	Ultimate Unit Stress psi	Character of Failure & Location
T 1	(0.497)	(0.277)	0.1377	10,300	74,800	BASE
T 2	(0.505)	(0.283)	0.1429	10,700	74,878	BASE

**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

**Toughness Tests (QW-170)**

Specimen No.	Notch Location	Notch Type	Test Temp.	Impact Values	Lateral Exp.		Drop Weight	
					% Shear	Mils	Break	No Break
U1A								

**FILLET WELD TEST (QW-180)**

Result - Satisfactory   N/A   Penetration into Parent Metal   Yes, No    
 Type and Character of Failure   Yes, No   Macro-Results   Yes, No    
 Welder's Name   BILL BUFKIN   Clock No.   2735   Stamp No.   W - 1    
 Tests conducted by:   MECHANICAL TEST LABORATORY   Laboratory Test No.   07F05.1 (.2)    
 per: \_\_\_\_\_

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  
(Manufacturer)

Date \_\_\_\_\_ By \_\_\_\_\_