

**SSTD-8070-0125-WELD Revision A**  
**February 2010**



National Aeronautics and  
Space Administration

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

# **John C. Stennis Space Center Standard WELD PROCEDURE FOR WELDING COPPER TUBE**

**Original signed by:**

Michael F. Killam for Robert Heitzman      02/03/10  
NASA SSC Center Operations Directorate      Date  
Operations & Maintenance Division

**Issued by:**

Issued CEF      02/05/10  
Central Engineering Files      Date



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	<i>Number</i>	<i>Rev.</i>
	Effective Date: February 9, 2010	
	Review Date: February 9, 2015	
Responsible Office: NASA Center Operations Directorate		
<b>SUBJECT: Welding Copper Tube</b>		

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## 1.0 PURPOSE

This John C. Stennis Standard (SSTD) specifies the procedure for Gas Tungsten Arc Welding (GTAW) of seamless copper tube P No. 31 at John C. Stennis Space Center (SSC).

## 2.0 APPLICABILITY

This SSTD applies to contractor and subcontractor personnel involved in the GTAW welding of seamless copper tube P No. 31.

## 3.0 REFERENCED DOCUMENTS

Referenced documents shall be the latest edition unless otherwise specified.

ASME Boiler and Pressure Vessel Code: Section II, Materials  
ASME Boiler and Pressure Vessel Code: Section IX, Welding and Brazing Qualifications  
ANSI/AWS A5.7M, *Copper and Copper-Alloy Welding Bare Rods and Electrodes*  
ASTM B-88, *Specification for Seamless Copper Water Tube*  
ANSI/AWS A5.12, *Specification for Tungsten and Oxide Dispersed Tungsten Electrodes for Arc Welding and Cutting*  
SCWI-8715-0002, *John C. Stennis Space Center Personal Protective Equipment*  
SPR 8715.1, *John C. Stennis Space Center Safety and Health Procedural Requirements*  
SSC Standard 34-002, *Introduction of Welding Standards*  
SSC Standard 34-004, *Classes of Welding Inspection*  
SPR 1440.1, *John C. Stennis Space Center Document Preparation, Numbering and Management*  
SSTD-8070-0014-WELD, *Qualifying Welders and Welding Procedures*

## 4.0 RESPONSIBILITIES

- a. It is the responsibility of SSC personnel performing the procedure specified herein to follow the requirements set by this SSC Standard.
- b. Responsibilities for the qualification of the welder and the performance of the welding procedure are defined in Section 5.0.

## 5.0 PROCEDURES

### 5.1 GENERAL

- a. All procedures shall be performed in compliance with applicable requirements in SPR 8715.1, SSC Safety and Health Procedural Requirements, and SCWI-8715-0002,

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Personal Protective Equipment. If ever there is a conflict between this standard and the SPR, the SPR shall take precedence.

- b. Welders shall be qualified in accordance with SSTD-8070-0014-WELD, *Qualifying Welders and Welding Procedures* and ASME Section IX.
- c. Inspection methods for the welds shall be in accordance with SSC Standard 34-004, *Classes of Welding Inspection*.

## 5.2 BASE MATERIAL

The base metal shall be seamless copper tube as per ASTM B-88, *Specification for Seamless Copper Water Tube*.

## 5.3 FILLER MATERIAL

The filler metal shall conform to ANSI/AWS A5.7M-2007, *Copper and Copper-Alloy Welding Bare Rods and Electrodes*.

## 5.4 SHIELDING GAS

The shielding gas shall be 99.9% argon gas (welding).

## 5.5 POSITION

The welding shall be in the 5G position – with the axis horizontal and fixed during welding.

## 5.6 ELECTRODE

The electrode shall be 2 percent thoriated tungsten as per ANSI/AWS A5.12, *Specification for Tungsten and Tungsten-Alloy Electrodes for Arc Welding and Cutting*.

## 5.7 PREPARATION OF BASE MATERIAL

- a. The area of the base metal to be welded shall be cleaned of any grease and dirt using a detergent.
- b. Rinse off the detergent with water.
- c. Remove oxides by either pickling the areas to be welded using an acid solution or abrasion clean with Scotch Brite pads or equivalent until a bright metal surface is obtained.

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- d. If acid is used then do a final rinse with water and dry.
- e. Prior to welding, the surface area is to have a final cleaning with an emery cloth.

## 5.8 JOINT DESIGN

Joint design shall be nominal “V” groove, as illustrated on the attached Welding Procedure Specification (WPS) form.

## 5.9 HEAT TREATMENT

No heat treatment is required.

## 5.10 PREHEAT

- a. Preheat shall be 350° F minimum.
- b. Interpass shall be 550° F maximum.

## 5.11 FINAL WELD TREATMENT

The complete area shall be smooth and free from undercutting in excess of 1/32” (inch), provided the minimum wall thickness is maintained.

## 5.12 INSPECTION

Dye-penetrant inspect final layers of all welds in accordance with approved procedures.

## 5.13 TESTING

Testing shall be per ASME Section IX.

## 5.14 POST HEAT

No post heat is required.

## 6.0 RECORDS AND FORMS

- a. Records and forms required by the procedures of this standard shall be maintained in accordance with SPR 1440.1. All forms are assumed to be the latest edition unless

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otherwise specified and may be obtained from the SSC Electronic Forms repository or from the NASA SSC Forms Management Officer.

- b. In accordance with SSC Standard 34-002, the original, signed WPS/PQR forms, and the corresponding Certificate of Analysis reports (copies of which are provided as attachments) shall be maintained, together with the original signed hard copy of this Standard, in Central Engineering Files (CEF).

## 7.0 ACRONYMS AND ABBREVIATIONS

ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
CEF	Central Engineering Files
°	Degrees
F	Fahrenheit
GTAW	Gas Tungsten Arc Welding
MSFC	Marshall Space Flight Center
NASA	National Aeronautics and Space Administration
PQR	Procedure Qualification Record
SCWI	John C. Stennis Space Center Work Instruction
SPR	Stennis Procedural Requirements
SSC	John C. Stennis Space Center
SSTD	John C. Stennis Space Center Technical Standard
WPS	Welding Procedure Specification





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### QW-482 (Back) WPS No. SSTD-8070-0125-WELD Rev. Basic

POSITIONS (QW-405) Position(s) of Groove <u>                    All                    </u> Welding Progression: Up <u>uphill</u> Down <u>                    </u> Position(s) of fillet <u>                    All                    </u>		POSTWELD HEAT TREATMENT (QW-407) Temperature Range <u>                    N/A                    </u> Time Range <u>                    N/A                    </u>																	
PREHEAT (QW-406) Preheat Temp. Min. <u>                    350°F                    </u> Interpass Temp. Max. <u>                    550°F                    </u> Preheat Maintenance <u>                    350°F                    </u> (Continuous or special heating where applicable should be recorded.)		GAS (QW-408) <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%;">Percent Composition (Mixture)</th> <th style="width: 20%;">Flow Rate</th> </tr> </thead> <tbody> <tr> <td>Shielding</td> <td><u>Argon</u></td> <td><u>99.9%</u></td> <td><u>up to 30 CFH</u></td> </tr> <tr> <td>Trailing</td> <td><u>Not Required</u></td> <td></td> <td></td> </tr> <tr> <td>Backing</td> <td><u>Argon</u></td> <td><u>99.9%</u></td> <td><u>up to 30 CFH</u></td> </tr> </tbody> </table>			Gas(es)	Percent Composition (Mixture)	Flow Rate	Shielding	<u>Argon</u>	<u>99.9%</u>	<u>up to 30 CFH</u>	Trailing	<u>Not Required</u>			Backing	<u>Argon</u>	<u>99.9%</u>	<u>up to 30 CFH</u>
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Backing	<u>Argon</u>	<u>99.9%</u>	<u>up to 30 CFH</u>																
ELECTRICAL CHARACTERISTICS (QW-409) Current AC or DC <u>                    DC                    </u> Polarity <u>straight</u> Amps (Range) <u>                    100-250                    </u> Volts (Range) <u>                    20-27                    </u>  (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.) Tungsten Electrode Size and type <u>                    3/32" or 1/8" 2% thoriated                    </u> <span style="margin-left: 300px;">(Pure Tungsten, 2% Thoriated, etc.)</span> Mode of Metal Transfer for GMAW <u>                    GTAW                    </u> <span style="margin-left: 300px;">(Spray arc, short circuiting arc, etc.)</span> Electrode Wire feed speed range <u>                    N/A                    </u>																			
TECHNIQUE (QW-410) String or Weave Bead <u>                    Stringer &amp; Weave                    </u> Orifice or Gas Cup Size <u>                    </u> Initial and Interpass Cleaning (Brushing, Grinding, etc.) <u>                    chemical clean, grinding, Scotch Brite, and wire brush(ss)                    </u>  Method of Back Gouging <u>                    N/A                    </u> Oscillation <u>                    Yes                    </u> Contact Tube to Work Distance <u>                    N/A                    </u> Multiple or Single (per side) <u>                    Multiple                    </u> Multiple or Single Electrodes <u>                    Single                    </u> Travel Speed (Range) <u>                    2 - 8 IPM                    </u> Peening <u>                    as required                    </u> Other <u>                    </u> <u>                    </u> <u>                    </u>																			
Weld Layer(s)	Process	Filler Metal		Current		Volt Range	Travel Speed Range	Other (e.g., Remarks, Comments, Hot Wire Addition, Technique, Torch Angle, Etc.)											
		Class	Dia.	Type Polar.	Amp. Range														
All	GTAW	ERCu	3/32" to 1/8"	DC straight	100-250	20-27	2-8 IPM	Forehand technique											

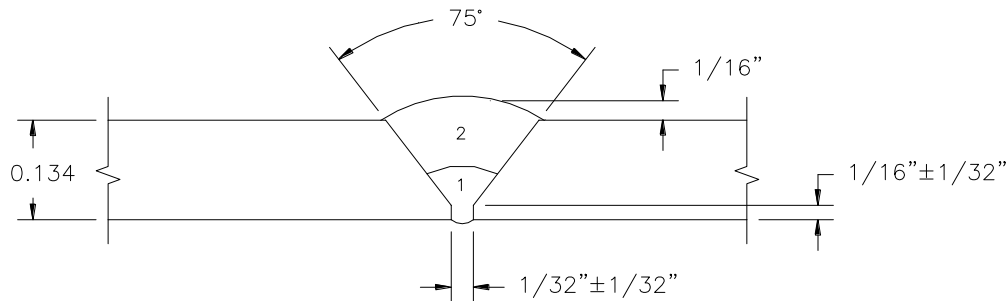
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**QW-483 SUGGESTED FORMAT FOR PROCEDURE QUALIFICATION RECORDS (PQR)**

(See QW-200.2, Section IX, ASME Boiler and Pressure Vessel Code) Record Actual Conditions used to Weld Test Coupon.

Company Name Mississippi Space Services  
 Procedure Qualification Record No. SSTD-8070-0125-WELD-BASIC Date 2/23/05  
 WPS No. SSTD-8070-0125-WELD  
 Welding Process(es) GTAW  
 Types (Manual, Automatic, Semi-Auto) Manual

## JOINTS (QW-402)



Groove Design of Test Coupon

(For combination qualifications, the deposited weld metal thickness shall be recorded for each filler metal or process used.)

## BASE METALS (QW-403)

Material Spec. ASTM B-88  
 Type or Grade \_\_\_\_\_  
 P-No. 31 to P-No. 31  
 Thickness of Test Coupon 0.134"  
 Diameter of Test Coupon 4" pipe  
 Other \_\_\_\_\_

## POSTWELD HEAT TREATMENT (QW-407)

Temperature N/A  
 Time N/A  
 Other \_\_\_\_\_

## GAS (QW-408)

	Percent Composition		
	Gas(es)	(Mixture)	Flow Rate
Shielding	<u>Argon</u>	<u>99.9%</u>	<u>up to 30 CFH</u>
Trailing	<u>Not Required</u>		
Backing	<u>Argon</u>	<u>99.9%</u>	<u>up to 30 CFH</u>

## FILLER METALS (QW-404)

SFA Specification 5.7 ERCU  
 AWS Classification 5.7 ERCU  
 Filler Metal F-No. 31  
 Weld Metal Analysis A-No. \_\_\_\_\_  
 Size of Filler Metal 3/32  
 Other \_\_\_\_\_  
 Weld Metal Thickness 0.134"

## ELECTRICAL CHARACTERISTICS (QW-409)

Current DC  
 Polarity straight  
 Amps. \_\_\_\_\_ Volts \_\_\_\_\_  
 Tungsten Electrode Size 3/32" or 1/8"  
 Other \_\_\_\_\_

## POSITION (QW-405)

Position of Groove 5G  
 Weld Progression (Uphill, Downhill) Uphill  
 Other \_\_\_\_\_

## TECHNIQUE (QW-410)

Travel Speed 2 to 8 IPM  
 String or Weave Bead string & weave  
 Oscillation N/A  
 Multipass or Single Pass (per side) Multipass  
 Single or Multiple Electrodes Single  
 Other \_\_\_\_\_

## PREHEAT (QW-406)

Preheat Temp. 350°F  
 Interpass Temp. 550°F  
 Other \_\_\_\_\_

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**QW-483 (Back) PQR No. SSTD-8070-0125-WELD-BASIC**  
Tensile Test (QW-150)

Specimen No.	Width	Thickness	Area	Ultimate Total Load lb.	Ultimate Unit Stress psi	Type of Failure & Location
T-1	0.751	0.086	0.065	2,230	34,308	Base
T-2	0.758	0.106	0.080	2,580	32,250	weld

Guided-Bend Tests (QW-160)

Type and Figure No.	Result
Face Bend FB-1 QW 462.3(A)	180° satisfactory
Face Bend FB-2 QW 462.3(A)	180° satisfactory
Root Bend RB-1 QW 462.3(A)	180° satisfactory
Root Bend RB-2 QW 462.3(A)	180° satisfactory

Toughness Tests (QW-170)

Specimen No.	Notch Location	Specimen Size	Test Temp.	Impact Values			Drop Weight Break (Y/N)
				Ft. lbs.	% Shear	Mils	

Fillet-Weld Test (QW-180)

Result – Satisfactory: Yes \_\_\_\_\_ No \_\_\_\_\_ Penetration into Parent Metal: Yes \_\_\_\_\_ No \_\_\_\_\_

Macro – Results \_\_\_\_\_

**Other Tests**

Type of Test \_\_\_\_\_

Deposit Analysis \_\_\_\_\_

Other \_\_\_\_\_

Welder's Name \_\_\_\_\_ Charles Hariel \_\_\_\_\_ Clock No. \_\_\_\_\_ Stamp No. \_\_\_\_\_ MSS-10 \_\_\_\_\_

Tests conducted by: \_\_\_\_\_ Tech Weld \_\_\_\_\_ Laboratory Test No. \_\_\_\_\_ 100-0205-2 \_\_\_\_\_

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.

Manufacturer Mississippi Space Services

Date 2/24/05

By Richard J. Hefner

(Detail of record of tests are illustrative only and may be modified to conform to the type and number of tests required by the Code.)

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P.O. Box 1900 PASCAGOULA, MS 39568-1900

OFFICE: 228-762-2890 FAX: 228-769-5219

**CERTIFICATE OF ANALYSIS**

Report No. **100-5B**  
Page **1 of 1**  
Date **2/23/05**  
Lab No. **100-0205-2**

Material	<b>B543</b>	Thickness	<b>.120"</b>	Dia.	<b>4.5" O.D.</b>	Ht/ID No.	<b>----</b>
Material	<b>B543</b>	Thickness	<b>.120"</b>	Dia.	<b>4.5" O.D.</b>	Ht/ID No.	<b>----</b>
Process	<b>GTAW</b>	Filler Metal	<b>ERCu</b>			Position	<b>----</b>
WPS	<b>----</b>			Welder	<b>----</b>	ID	<b>----</b>
From	<b>Mississippi Space Services</b>			PO	<b>68422</b>	Other	<b>----</b>
Test For	<b>Guided Bend &amp; Tension Test</b>					Test Date	<b>2/23/05</b>
Machine Model & Serial No.	<b>Tinus-Olsen Universal Tester #31193</b>						
Calibration Certified By	<b>Southern Calibration Service</b>					Date	<b>8/3/04</b>
Specification Followed	<b>ASTM E-74 and E-4</b>						

THIS CERTIFICATE MAY NOT BE ALTERED, DELETED FROM, PUBLISHED AND/OR USED EXCEPT IN FULL

**GUIDED BEND TEST**

Type	Figure No.	Results
Face Bend FB-1	QW 462.3(a)	180° Satisfactory
Face Bend FB-2	QW 462.3(a)	180° Satisfactory
Root Bend RB-1	QW 462.3(a)	180° Satisfactory
Root Bend RB-2	QW 462.3(a)	180° Satisfactory

**TENSION TEST**

Spec. No.	Width (in.)	Thickness (in.)	Area (in <sup>2</sup> )	Load at Fracture (lbs.)	Tensile Strength (psi)	Failure Location
T-1	0.751	0.086	0.065	2,230	34,308	Base
T-2	0.758	0.106	0.080	2,580	32,250	Weld

We certify that the statements in this record are correct and that the test samples were prepared and testing accordance with the requirements of Techweld PMT Procedure No. 1, ASTM E-8 and ASME Section IX 2001 Edition, 2003 Addenda.

Test materials will be discarded after thirty (30) days unless prior written notification is received.

Certified By

*James R. Blevins*  
**JAMES R. BLEVINS**  
990705e1  
CW1

Techweld, Inc.

Date **2/23/05**