National Aeronautics and
Space Administration

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

SSTD-8070-0137-WELD
Rev. B
OCTOBER 2024

COMPLIANCE IS MANDATORY

JOHN C. STENNIS SPACE CENTER FLUX CORED ARC WELDING OF CARBON STEEL FOR 1/8-INCH TO UNLIMITED PLATE THICKNESS

Approved in DDMS by:

Craig Chandler	10-30-2024
NASA SSC Center Operations Directorate Facilities Engineering Services	Date

Concurrence by:

Gina Ladner	10-30-2024
NASA SSC Center Operations Directorate Facilities Services	Date
Harry Ryan	10-9-2024
NASA SSC Engineering & Test Directorate	Date
Son Le	10-21-2024
NASA SSC Safety & Mission Assurance	Date

Issued by

ISSUED CEF	10-30-2024
Central Engineering Files	Date

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Document History Log

Status/Change/ Revision	Change Date	Originator/Phone	Description
Basic	04.01.2015	Doug Dike x8-2803	Initial release. 1.0 and 2.0: Revised to reflect that this standard applies to structural use only. 3.0: Updated references to include AWS D1.1 and AWS 5.36.
A	07/01/2019	Doug Dike Ext. 8-2803	Updated title and content to remove “P-No 1” references. Updated cover sheet approval/concurrence requirements per SSTD-8070-0005-CONFIG. Removed ASME references from document, as this procedure follows AWS requirements. Updated references and references. Minor administrative changes. 5.0-b: Added “in accordance with AWS D1.1. Updated WPS Form.
B	10/07/2024	Benny McGrath 8-2969	Five-year review. Updated directorate titles on cover sheet and throughout document. Updated references and acronyms. Section 8.1: Updated WPS Base Metals section, adding “1” in all P-no. cells; and adding “Carbon Steel/Note A” to Backing.

Table of Contents

1.0 PURPOSE

This John C. Stennis Space Center (SSC) standard (SSTD) provides for a qualified American Welding Society (AWS) weld procedure for Flux Cored Arc Welding (FCAW) of carbon steel (Group 1 or 2). This weld procedure is applicable to welding of carbon steel plate of 1/8-inch to unlimited thickness and pipe of nominal 24-inch diameter and larger with wall thickness of 1/8-inch and greater for structural use at SSC.

2.0 APPLICABILITY

a. This SSTD applies to all contractor and subcontractor personnel involved with the FCAW welding of (Group 1 or 2) carbon steel plate and pipe for structural use at SSC.

b. This SSTD is also valid for welding of (Group 1 or 2) carbon steel to (Group 1 or 2) carbon steel pipe, tube, fittings, or plate used in fluid services, provided that the produced welds are not fluid pressure boundary or pressure containing welds; e.g., carbon steel pipe supports or doubler plates welded to outer walls of carbon steel pipe and fittings being an allowed application of this standard.

3.0 REFERENCES AND APPLICABLE DOCUMENTS

Applicable documents shall be the latest version unless otherwise specified.

AWS D1.1, *Structural Welding Code - Steel*

AWS A5.20, *Specification for Carbon Steel Electrodes for Flux Cored Arc Welding*
AWS A5.29, *Specification for Low-Alloy Steel Electrodes for Flux Cored Arc Welding*
AWS 5.36, *Specification for Carbon and Low-Alloy Steel Flux Cored Electrodes for Flux Cored Arc Welding and Metal Cored Electrodes for Gas Metal Arc Welding*

SPR 1440.1, *SSC Records Management Program Requirements*

SPR 8715.1, *SSC Safety and Health Program Requirements*

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

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

SSTD-8070-0014-WELD, *Qualifying Welders and Welding Procedures*

4.0 RESPONSIBILITIES

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. All procedures shall be performed in compliance with applicable requirements in SPR 8715.1. If ever there is a conflict between this SSTD and the SPR, the SPR takes precedence.

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 NASA SSC Center Operations Directorate Facilities Engineering Services, the NASA SSC Engineering and Test Directorate (E&TD), the NASA SSC Safety and Mission Assurance (S&MA) Office, and in accordance with AWS D1.1.

c. The attached NASA-A36-FCAW(A) Procedure Qualification Record (PQR) is the PQR for the original WPSs in this SSTD. When performing new qualifications, a new, approved PQR shall be completed showing all pertinent data and results of the weld procedure qualification.

d. Welders shall be qualified in accordance with SSTD-8070-0014-WELD.

e. Inspection methods for welds shall be in accordance with SSTD-8070-0013-WELD.

f. Qualification tests shall be performed on test coupons welded with backing plates.

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 National Aeronautics and Space Administration (NASA) SSC Forms Management Officer. Quality Records are identified in the SSC Master Records Index.

d. The original, signed Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) (copies of which are provided in the attachments of this SSTD) and the accompanying Certificate(s) of Analysis validation test document shall be maintained in Central Engineering Files (CEF).

7.0 ACRONYMS AND ABBREVIATIONS

AWS	American Welding Society
CEF	Central Engineering Files
E&TD	Engineering and Test Directorate
FCAW	Flux Cored Arc Welding
NASA	National Aeronautics and Space Administration
PQR	Procedure Qualification Record
PQRD	Procedure Qualification Record Data
S&MA	Safety and Mission Assurance
SPR	John C. Stennis Space Center Procedural Requirement
SSC	John C. Stennis Space Center
SSTD	John C. Stennis Space Center Standard
WPS	Weld Procedure Specifications

8.0 ATTACHMENTS

8.1: WPS NASA-A36-FCAW
8.2: PQR NASA-A36-FCAW(A)
8.3: Certificate of Analysis

8.1: WPS NASA-A36-FCAW

National Aeronautics and Space Administration
John C. Stennis Space Center
Stennis Space Center, MS 39529-6000

AWS - AMERICAN WELDING SOCIETY (WPS)

Welding Procedure Specification Record Number: NASA-A36-FCAW-AWS	Date: September 26, 2024	Revision Number: B
Qualified To: AWS D1.1	Company Name: Syncom Space Services (S3)	
Supporting PQR(s): NASA-A36-FCAW (A)	Reference Docs.: SSTD-8070-0137-WELD	
Scope: FCAW Welding Group 1 or 2 Carbon Steel	Joint: Single V Groove	

BASE METALS

		P-no.	Grp-no.
Type	Carbon Steel	1	1or2
Welded To	Carbon Steel	1	1or2
Backing	Carbon Steel/Note A	1	1or2
Retainers	See Notes A and B.		
Notes	WPS# NASA-A36-FCAW See Attachment #1.		

THICKNESS RANGE QUALIFIED

	As-welded Min.	As-welded Max.	With PWHT Min.	With PWHT Max.
Complete Pen.	≥0.125"		N/A	N/A
Complete Pen. Impact Tested				
Impact Tested				
Fillet Welds	All		N/A	N/A

DIAMETER RANGE QUALIFIED

	As-welded Min.	As-welded Max.	With PWHT Min.	With PWHT Max.
Nominal Pipe Size	≥24"		N/A	N/A

FILLER METALS

Process	SFA	Classification	F-no.	A-no.	Chemical Analysis or Trade Name
FCAW		See Note D.			
Cons. Insert		N/A			
Flux		N/A			

THICKNESS RANGE QUALIFIED

As-welded Min.	As-welded Max.	With PWHT Min.	With PWHT Max.
≥0.125"		N/A	N/A

WELDING PROCEDURE

Welding Process	FCAW	FCAW	
Type	Semi-Automatic	Semi-Automatic	
Minimum preheat/interpass temperature (°F)	320°F (See Note E.)	320°F (See Note E.)	
Maximum interpass temperature (°F)	500°F	500°F	
Tungsten Size	N/A	N/A	
Tungsten Type	N/A	N/A	
Filler Metal Size (in.)	0.045 - 0.052	0.045 - 0.052	
Layer Number	Root	2 - Cap	
Position of Groove	(See Note G.)	(See Note G.)	
Weld Progression	N/A	N/A	
Current/Polarity	DCEP (See Note F.)	DCEP (See Note F.)	
Amperes	N/A	N/A	
Volts	24.5 - 30	24.5 - 30	
Travel Speed (in./min)	5 - 12 ipm	8 - 20 ipm	
Maximum Heat Input (kj/in)	N/A	N/A	
DC Pulsing Current	N/A	N/A	
Shielding: Gas Type	Argon / CO2 - 75% / 25%	Argon / CO2 - 75% / 25%	
Flow Rate (cfh)	30 - 60 CFH	30 - 60 CFH	
Trailing: Gas Type	N/A	N/A	
Flow Rate (cfh)			
Backing: Gas Type	N/A	N/A	
Flow Rate (cfh)			
String or Weave	String or (Weave, ≤ 5/8")	String or (Weave, ≤ 5/8")	
Orifice/Gas Cup Size	3/8" - 3/4"	3/8" - 3/4"	
Multi/Single Pass per Side	Multiple (See Note C.)	Multiple (See Note C.)	
Weld Deposit Chemistry			
Notes	Contact Tube to Work Distance - 1/2" to 1". Single Electrode.		

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National Aeronautics and Space Administration
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AWS - AMERICAN WELDING SOCIETY (WPS)

Welding Procedure Specification Record Number	Date	Revision Number
NASA-A36-FCAW-AWS	September 26, 2024	B
Qualified To	**Company Name**	
AWS D1.1	Syncom Space Services (S3)	

BASE METALS

Peening	Not allowed.
Surface Preparation	Joint Prep - Flame cut and light grinding on surfaces to be welded.
Initial/Interpass Cleaning	Grinding, Power Brush
Back Gouging Method	None

POSTWELD HEAT TREATMENT

Temperature	None
Time and Temperature	None
Other	None

NOTES

A. AWS D1.1, Table 3.1, Groups I and II (Refer to both backing and retainers.)
B. Any Group I to any Group I; any Group II to any Group I; any Group II to any Group II.
C. Maximum Pass Thickness: ≤ 1/2" (13mm)
D. AWS No. A5.20, A5.29 or A5.36 (Class) E71T1
E. Maintain 320°F for 2 1/2 hours. Continuous or special heating, where applicable, should be recorded. Immediately after final pass is completed, slow cool to ambient temperature.
F. Power Supply; CV (Constant Voltage)
G. Welded in flat position 1G or 1F (Fillet) weld only.

Signature 1

Engineer Name	Signature
Skip Wright	S E Wright
Date: 10-07-24	

Signature 2

Quality Name	Signature
Richard Ladner	Richard Ladner
Date: 10-7-24	

Signature 3

Customer Reviewer Name	Signature
Benjamin McGrath	B McG
Date: 10-07-24	

Signature 4

Customer Name	Signature
Date:	

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SUBJECT: Flux Cored Arc Welding of Carbon Steel for 1/8-inch to Unlimited Plate Thickness

National Aeronautics and Space Administration
John C. Stennis Space Center
Stennis Space Center, MS 39529-6000

AWS - AMERICAN WELDING SOCIETY (WPS)

Welding Procedure Specification Record Number	Date	Revision Number
NASA-A36-FCAW-AWS	September 26, 2024	B
Qualified To: AWS D1.1	Company Name: Syncom Space Services (S3)	

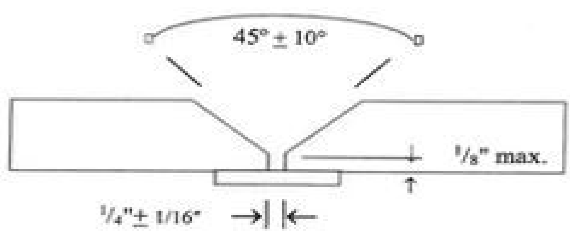
INSPECTION SPECIALISTS, INC.

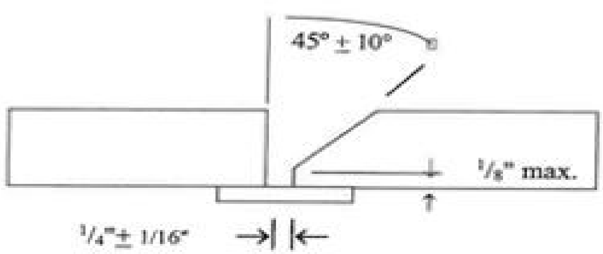
WPS# NASA-A36-FCAW
ATTACHMENT # 1

Note # 1 AWS D1.1 Any Group I to Any Group I
Any Group II to Any Group I
Any Group II to Any Group II

Joint Detail

Note: Maximum plate misalignment is ± ¼"





TRAVIS G MOORE
CWI 99041251
QC1 EXP. 4/1/2020

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8.2: PQR NASA-A36-FCAW(A)

SUGGESTED FORMAT FOR PROCEDURE QUALIFICATION RECORDS (PQR)
(SEE AWS D1.1)
Record Actual Variables used to Weld Test Coupon

INSPECTION SPECIALISTS, INC.
MECHANICAL TESTING LABORATORY DIVISION

WELDING PROCEDURE SPECIFICATION (WPS) Yes ☐
PREQUALIFIED ____ **QUALIFIED BY TESTING** ____
or PROCEDURE QUALIFICATION RECORD (PQR) Yes ☒

AWS D1.1:2010 STRUCTURAL WELDING CODE

Identification # NASA-A36-FCAW (A)
Revision 0 Date 2/3/14 By ISI
Company Name Jacobs Technology
Authorized by Travis G. Moore Date 2/3/14
Welding Process(es) FCAW
Type - Manual ☐ Semi-Automatic ☒
Supporting WPS No.(s) NASA-A36-FCAW
Machine ☐ Automatic ☐

JOINT DESIGN USED
Type Single-V-Groove
Single ☒ Double Weld ☐
Backing Yes ☒ No ☐
Backing Material A-36
Root Opening 1/4" Root Face Dimension 1/8"
Groove Angle 45° Radius (J-U) N/A
Back Gouging: Yes ☐ No ☒ Method N/A

POSITION
Position of Groove 1G Fillet N/A
Vertical Progression: Up ☐ Down ☐

ELECTRICAL CHARACTERISTICS
Transfer Mode (GMAW) Short-Circuiting ☐
Globular ☒ Spray ☐
Current: AC ☐ DCEP ☒ DCEN ☐ Pulsed ☐
Other Power Source : CV

BASE METALS
Material Spec. ASTM A36 HT.#S7-04729
Type or Grade N/A
Thickness Groove 1.250" Fillet N/A
Diameter (Pipe) N/A

TECHNIQUE
Stringer or Weave Bead Stringer
Multi-pass or Single Pass (per side) Multiple
Number of Electrodes single
Electrode Spacing Longitudinal N/A
Lateral N/A
Angle N/A

FILLER METALS
AWS Specification 5.20
AWS Classification E71T-1M

SHIELDING
Flux N/A
Gas Argon/Co2
Composition 75%/25%
Electrode-Flux (Class) N/A
Flow Rate 40 CFH
Gas Cup Size 3/4"

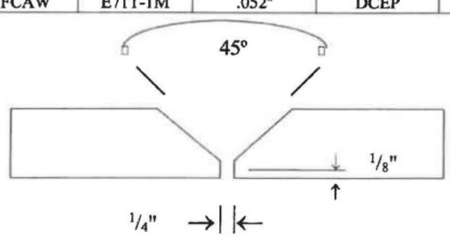
Contact Tube to Work Distance ¾"
Peening None
Inter-pass Cleaning Grinding, Brushing

PREHEAT
Preheat Temp., Min. 320° F
Inter-pass Temp., Min. 320° F Max. 442° F

POSTWELD HEAT TREATMENT
Temp. N/A
Time N/A

WELDING PROCEDURE

Pass or Weld Layer(s)	Process	Filler Metals Class	Filler Metals Diam.	Current Type & Polarity	Current Wire Feed Speed IPM	Volts	Travel Speed	Notes
1-Cap	FCAW	E71T-1M	.052"	DCEP	155-275	24.5-30	8-15 IPM	**See Attachment for test recorded weld passes.**



TRAVIS G MOORE
CWI 99041251
QCI EXP. 4/1/2020

No misalignment was present.

PROCEDURE QUALIFICATION RECORD (PQR) # NASA-A36-FCAW (A)
TEST RESULTS

Revised 2/25/2015

TENSILE TEST

Specimen No.	Width	Thickness	Area	Ultimate Tensile Load. lb	Ultimate Unit Stress. psi	Character of Failure and Location
7319.90(.1) T-1	0.751″	1.211″	0.9095″	71,028	78,096	Base
7319.90(.1) T-2	0.752″	1.205″	0.9062″	70,835	78,167	Base

GUIDED BEND TEST

Specimen No.	Type of Bend	Result	Remarks
7319.90(.1)	Side Bend	Acceptable	
7319.90(.1)	Side Bend	Acceptable	
7319.90(.1)	Side Bend	Acceptable	
7319.90(.1)	Side Bend	Acceptable	

VISUAL INSPECTION

Appearance: Acceptable
Undercut: None
Piping Porosity: None
Convexity: Acceptable
Test Date: 1/31/14
Witnessed By: Travis G. Moore

Radiographic, Magnetic & Visual Examination

RT Report No. 86835 Result Acceptable
MT Report No. 11500 Result Acceptable
VT Report No. 12998 Result Acceptable

FILLET WELD TEST RESULTS

Minimum size multiple pass Macro-etch
1. N/A 3. N/A
2. N/A

Maximum size single pass Macro-etch
1. N/A 3. N/A
2. N/A

Other Tests

All-Weld-Metal Tension Test
Tensile Strength, psi: N/A
Yield Point/Strength, psi: N/A
Elongation in 2 in., %: N/A
Laboratory Test No.: N/A

Welder's Name: Casey Deschamp Soc. Sec. No.: 2778 Stamp No.: JT-43

Tests Conducted By: Inspection Specialists, Inc. - MTL Div.

Test Number: 7319.90(.1)

AWS Travis G Moore CWI 99041251 QC1 EXP. 4/1/2014

Per: Travis G Moore Travis G Moore

We, the undersigned, 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 4, Part B of ANSI/AWS D1.1 (2010) Structural Welding Code-Steel.
year

Signed: Jacobs
Manufacturer or Contractor

By: Benjamin A. McLeod

Title: NDT - LvIII / CWI

Date: 2-13-14

8.3: Certificate of Analysis

INSPECTION SPECIALISTS, INC.

MECHANICAL TESTING LABORATORY DIVISION

CERTIFICATE OF ANALYSIS

Client: Jacobs Technology Job No: 7319.90

Client Representative: Benny McGrath Purchase Order:

Test Specification: AWS D1.1

Sample Identification: One (1) 1.250″ Plate WPS # NASA-A36-FCAW PQR # NASA-A36-FCAW (A)
Welder: Casey Deschamp Stamp "JT-43" ASTM A- 36

The above referenced sample was prepared and tested in accordance with the welding procedure qualification requirements of AWS D1.1. Two (2) tensile test specimens and four (4) guided bend test specimens were prepared and tested. Prior to mechanical testing the samples was x-rayed. The results of these tests are reported herein.

TENSILE TEST

SPECIMEN ID	WIDTH INCHES	THICKNESS INCHES	AREA SQ. IN.	ULTIMATE LOAD POUNDS	TENSILE STRENGTH PSI	NATURE OF FRACTURE
7319.90(.1) T-1	0.731″	1.211″	0.9095″	71,028	78,096	Base
7319.90(.1) T-2	0.752″	1.205″	0.9062″	70,835	78,167	Base

GUIDED BEND TEST

SPECIMEN ID	TYPE TEST	TEST RESULT
7319.90(.1) S1	Side Bend	Acceptable
7319.90(.1) S2	Side Bend	Acceptable
7319.90(.1) S3	Side Bend	Acceptable
7319.90(.1) S4	Side Bend	Acceptable

RADIOGRAPHIC EXAMINATION: Acceptable (Report # 86835)
MAGNETIC *EXAMINATION:* Acceptable (Report # 11500)
VISUAL *EXAMINATION:* Acceptable (Report # 12998)

The tests expressed herein meet or exceed the requirements of AWS D1.1

CERTIFIED BY: Travis G Moore CWI 99041251 QC1 EXP. 4/1/2014

Travis G. Moore, Lab Manager Date: February 3, 2014 Certificate No: 1 of 1

ALL TEST SPECIMENS, SAMPLES, DROPS, ETC. WILL BE DISCARDED THIRTY (30) DAYS AFTER TESTING UNLESS OTHERWISE INSTRUCTED IN WRITING.