COMPLIANCE IS MANDATORY

JOHN C. STENNIS SPACE CENTER
ASME AND AWS PROCEDURES
FOR SMAW AND FCAW OF STRUCTURAL STEELS (P-NO. 1, GROUP 1 OR 2)

Approved by:

Approved in DDMS by Scott Olive 7-1-2019
NASA SSC Center Operations Date
Design & Construction Project
Management Division

Concurrence by:

Approved in DDMS by Gina Ladner 7-17-2019
NASA SSC Center Operations Directorate Date
Operations and Maintenance Division

Approved in DDMS by Bartt Hebert 7-15-2019
NASA SSC Engineering & Test Directorate Date

Approved in DDMS by Son Le 7-15-2019
NASA SSC Safety & Mission Assurance Date

Issued by

ISSUED CEF 7-17-2019
Central Engineering Files Date

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**Document History Log**

<table>
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<th>Originator/Phone</th>
<th>Description</th>
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<td>07/05/2014</td>
<td>Doug Dike Ext. 8-2803</td>
<td>Initial release.</td>
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<td>07/01/2019</td>
<td>Doug Dike Ext. 8-2803</td>
<td>Modified title to read: ASME and AWS Procedures for SMAW and FCAW of Structural Steels (P-No. 1, Group 1 or 2. “ASTM A572, High Strength, Low Alloy Columbium-Vanadium” was deleted. Deleted specific references to A572 throughout document. Updated cover sheet approval/concurrence requirements per SSTD-8070-0005-CONFIG. Updated references and references. 5.0-a: Amended to read, “These ASME and AWS (structural steel) procedures shall be used for welding steels by the SMAW and FCAW processes.” 5.0-b: Added “and in accordance with ASME Section IX and AWS D1.1 requirements.” Minor administrative changes. Updated WPS forms.</td>
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1.0 PURPOSE

This John C. Stennis Space Center (SSC) standard (SSTD) outlines the qualified Shielded Metal Arc Welding (SMAW) and Flux-Cored Arc Welding (FCAW) procedures for use in welding carbon steels.

2.0 APPLICABILITY

This SSTD applies to all contractor and subcontractor personnel involved with the welding of steels in accordance with American Society of Mechanical Engineers (ASME) and American Welding Society (AWS) requirements.

3.0 REFERENCES

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

ASME Boiler and Pressure Vessel Codes, Section IX, *Welding and Brazing Qualifications*
AWS D1.1, *Structural Welding Code - Steel*
SPR 1440.1, *SSC Records Management 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, *Qualifying Welders and Welding 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. These ASME and AWS (structural steel) procedures shall be used for welding steels by the SMAW and FCAW processes.

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 Project Management Division (PMD), the NASA SSC Engineering and Test Directorate
(E&TD), the NASA SSC Safety and Mission Assurance (S&MA) Office, and in accordance with ASME Section IX and AWS D1.1 requirements.

c. The attached Procedure Qualification Record (PQR), and Welder Performance Qualification (WPQ) are the PQRs and WPQs for the original WPSs in this SSTD. When performing new qualifications, a new, approved PQR and WPQ 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.

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 WPSs, PQRs and WPQs (copies of which are provided in the attachments of this SSTD) and the accompanying Certificate(s) of Analysis validation test documents shall be maintained in Central Engineering Files (CEF).

7.0 ACRONYMS AND ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>ASME</td>
<td>American Society of Mechanical Engineers</td>
</tr>
<tr>
<td>ASTM</td>
<td>American Society for Testing and Materials</td>
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<td>AWS</td>
<td>American Welding Society</td>
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<tr>
<td>CEF</td>
<td>Central Engineering Files</td>
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<tr>
<td>E&amp;TD</td>
<td>Engineering &amp; Test Directorate</td>
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<td>National Aeronautics and Space Administration</td>
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<td>PMD</td>
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<td>PQR</td>
<td>Procedure Qualification Record</td>
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<td>S&amp;MA</td>
<td>Safety &amp; Mission Assurance</td>
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<td>SMAW</td>
<td>Shielded Metal Arc Welding</td>
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<td>Welder Performance Qualification</td>
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<td>WPS</td>
<td>Weld Procedure Specifications</td>
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RELEASED - Printed documents may be obsolete; validate prior to use.
8.0 ATTACHMENTS

WPS/PQR/Certificates of Analysis*

SMAW
8.1: WPS - ASME NASA-A572-SMAW
8.2: WPS - AWS NASA-A572-SMAW
8.3: PQR NASA-A572-SMAW-PQR
8.4: Certificate of Analysis Report No. 6990.90 (April 24, 2013)

FCAW
8.5: WPS – ASME NASA-A572-FCAW
8.6: WPS – AWS NASA-A572-FCAW
8.7: PQR NASA-A572-FCAW-PQR
8.8: Certificate of Analysis Report No. 6987.90 (April 24, 2013)
8.1: Weld Procedure Specification (ASME WPS)-SMAW

**SMAW**

- **Type:** SMAW
- **Classification:** E6010, E7018
- **Chemical Analysis or Trade Name:**
  - SMAW: Note B.
  - SMAW: Note B.

**FILLER METALS**

- **Nominal Pipe Size:** N/A
- **MINIMUM THICKNESS RANGE QUALIFIED**
  - With PWHT:
    - As-welded: Min. 0.1875", Max. 0.250"
    - Complete Pen.: Min. 0.1875", Max. 0.250"
    - Complete Pen.: Min. 0.1875", Max. 0.250"
    - Impact Tested: N/A
    - Impact Tested: N/A
    - Fillet Welds: N/A

**WELDING PROCEDURE**

- **Welding Process:** SMAW - E5010, SMAW - E7018
- **Type:** Manual
- **Minimum preheat/interpass temperature (°F):**
  - SMAW: 320°F (See Note C.)
  - SMAW: 320°F (See Note C.)
- **Maximum interpass temperature (°F):**
  - SMAW: 600°F
  - SMAW: 600°F
- **Tungsten Size:** N/A
- **Tungsten Type:** N/A
- **Filter Metal Size (in.):** 3/32" - 1/8" (SMAW), 3/32" - 3/16" (SMAW)
- **Layer Number:** Root and Hot Pass
- **Position of Groove:** All
- **Weld Progression:** N/A
- **Current/Polarity:** DCEP
- **Amperes:** 50 - 150
- **Vols:** 20 - 30
- **Travel Speed (in./min):** 3 - 14 in/min
- **Maximum Heat Input (bpy):** N/A
- **DC Pulses Current:** N/A
- **Shielding:** Gas Type
  - Flow Rate (cc): N/A
- **Trailing:** Gas Type
  - Flow Rate (cc): N/A
- **Back Up:** Gas Type
  - Flow Rate (cc): N/A
- **Stringer or Weave:** String or Weave
- **Orifice Gas Cup Size:** N/A
- **Multi/Single Pass per Side:** Multiple
- **Weld Deposit Chemistry:** N/A

**Notes:**

- **SCT-937 (05/2019)**
### SUBJECT: ASME and AWS Procedures for SMAW and FCAW of Structural Steels (P-No. 1, Group 1 or 2)

#### ASME - WELDING PROCEDURE SPECIFICATIONS (WPS)

<table>
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<tr>
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<tr>
<td>NASA-A572-SMAW-ASME</td>
<td>June 1, 2019</td>
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#### BASE METALS

- **Peening**: Not allowed.
- **Surface Preparation**: See Note D.
- **Initial/Interpass Cleaning**: See Note D.
- **Back Gouging Method**: None

#### POSTWELD HEAT TREATMENT

- **Temperature**: None
- **Time and Temperature**: None
- **Other**: None

#### NOTES

- **A. Groove Thickness Range**: 0.1875" - 8.00"
  - **Maximum Pass Thickness**: <1/2"
- **B. Filler Metal Product Form**: Low Hydrogen
- **C. Preheat Maintenance**: 330°F - 460°F.
- **D. Remove all contamination and water from surface. Remove all slag on weld and adjacent base metal using steel brushes.**

---

**Signature 1**

- **Engineer Name**: Doug Dike
- **Date**: June 1, 2019

**Signature 2**

- **Quality Name**: George Smith
- **Date**: June 1, 2019

---

**Signature 3**

- **Customer Reviewer Name**: Benjamin McGrath
- **Date**: June 1, 2019

**Signature 4**

- **Customer Name**: Your Name
- **Date**: Your Date
Responsible Office: NASA SSC Center Operations Directorate

SUBJECT: ASME and AWS Procedures for SMAW and FCAW of Structural Steels (P-No. 1, Group 1 or 2)

ASME - WELDING PROCEDURE SPECIFICATIONS (WPS)

Welding Procedure Specification Record Number
NASA-A572-SMAW-ASME

Date
June 1, 2019

Revision Number
A

Qualified To
ASME Boiler and Pressure Vessel Code

Company Name
Syncrom Space Services (S3)

Weld Joint Designs

Attachment #1

Single-V Groove

Single-Bevel Groove

Double-V Groove

Double-Bevel Groove

Single-J Groove

Double-J Groove

Single-U Groove

Double-U Groove

Fillet Weld T or Lap

Gap: 1/16-in. max. / Lap: 5 x t or 1 in. min.
8.2: Weld Procedure Specification (AWS WPS)-SMAW

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<td>NASA-A572-SMAW-AWS</td>
<td>June 1, 2019</td>
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**Qualified To**
- AWS D1.1

**Supporting PQ(s)**
- NASA-A572-SMAW-PQR

**Scope**
- Welding P-1 to P-1 Group 1 or 2
- Joint: Single V Groove, Single Bevel Groove

### BASE METALS

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<th>Type</th>
<th>P-no.</th>
<th>Grp-no. 1 or 2</th>
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<tr>
<td>Welded To</td>
<td>P-no.</td>
<td>Grp-no. 1 or 2</td>
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<tr>
<td>Backing</td>
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<tr>
<td>Retainers</td>
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<td>Notes</td>
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**FILLER METALS**

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<td>E6010</td>
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<td>Flux</td>
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**WELDING PROCEDURE**

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<td>Maximum interpass temperature (°F)</td>
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<tr>
<td>Tungsten Size</td>
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<tr>
<td>Tungsten Type</td>
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<td>Filler Metal Size (in.)</td>
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<td>Layer Number</td>
<td>Root and Hot Pass</td>
<td>Fill</td>
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<tr>
<td>Position of Groove</td>
<td>(See Note E.)</td>
<td>(See Note E.)</td>
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<tr>
<td>Weld Progression</td>
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<tr>
<td>Current/Polarity</td>
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**DC Pulsing Current**

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<td>Sting or Weave</td>
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<tr>
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**Notes**

SSC-537A (05/2019)
# SUBJECT: ASME and AWS Procedures for SMAW and FCAW of Structural Steels (P-No. 1, Group 1 or 2)

| National Aeronautics and Space Administration  
| John C. Stennis Space Center  
| Stennis Space Center, MS 39529-6000 |
| AWS - AMERICAN WELDING SOCIETY (WPS) |

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<th>Revision Number</th>
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<td>NASA-A572-SMAW-AWS</td>
<td>June 1, 2019</td>
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<thead>
<tr>
<th>Qualified To</th>
<th>Company Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>AWS D1.1</td>
<td>Syncom Space Services (S3)</td>
</tr>
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</table>

### BASE METALS
- Peening: Not allowed.
- Surface Preparation: See Note D.
- Initial/Interpass Cleaning: See Note D.
- Back Gouging Method: None

### POSTWELD HEAT TREATMENT
- Temperature: None
- Time and Temperature: None
- Other: None

### NOTES
- A. Groove Thickness Range: ≥0.125"  
  Maximum Pass Thickness: ≤1/2"
- B. Filler Metal Product Form: Low Hydrogen
- C. Preheat Maintenance: 330°F - 460°F.
- D. Remove all contamination and water from surface. Remove all slag on weld and adjacent base metal using steel brushes.
- E. Welded in the flat position 1G or 1F (Fillet) weld only.

### Signature

**Signature 1**  
**Engineer Name:** Doug Dike  
**Date:** June 1, 2019

**Signature 2**  
**Quality Name:** George Smith  
**Date:** June 1, 2019

**Signature 3**  
**Customer Reviewer Name:** Benjamin McGrath  
**Date:** June 1, 2019

**Signature 4**

**Customer Name**

**Date**
Responsible Office: NASA SSC Center Operations Directorate

SUBJECT: ASME and AWS Procedures for SMAW and FCAW of Structural Steels (P-No. 1, Group 1 or 2)
## SUBJECT: ASME and AWS Procedures for SMAW and FCAW of Structural Steels (P-No. 1, Group 1 or 2)

### 8.3: Weld Procedure Qualification Record (PQR)-SMAW

**PROCEDURE QUALIFICATION RECORD (PQR)**
(See QW-200.2, Section IX, ASME Boiler and Pressure Vessel Code)

**Base Metals (QW-403)**
- Material Spec.: ASTM A572
- Type or Grade: 50
- P-No. to P-No.: N/A
- Thickness of Test Coupon: 1.500"  
- Diameter of Test Coupon: N/A

**Filler Metals (QW-404)**
- AWS Classification: E6010, E7018
- Filler Metal F-No.: 3, 4
- Weld Metal Analysis A-No.: 1, 1
- Size of Filler Metal: 1/8", 1/8"
- Deposited Weld Metal: 0.250" - 1.250"

**Joint (QW-402)**
- Joint Design: 75°
- Thickness: 1 1/2" Thick

**Preheat (QW-406)**
- Preheat Temp.: 350°F Min.
- Interpass Temp.: 330°F - 460°F

**Position (QW-405)**
- Position of Groove: 1G
- Weld Progression (Uphill, Downhill): N/A

**Postweld Heat Treatment (QW-407)**
- Temperature: N/A
- Other: N/A

**Gas (QW-408)**
- Shielding: N/A
- Traveling: N/A
- Backing: N/A

**Electrical Characteristics (QW-409)**
- Current: DC
- Polarity: EP
- Amps: 2800 (S) 2800 (K)
- Volts: 30 VDC
- Tungsten Electrode Size: N/A

**Technique (QW-410)**
- Travel Speed: 4-14 IPM
- String or Weave Bead: String
- Oscillation: 1 1/2 times the rod diameter
- Multipass or Single Pass (per side): Multi-pass
- Single or Multiple Electrodes: Single

**Procedure Qualification Record No.: NASA-A572-SMAW-PQR**
Date: 4/24/13
WPS No.: NASA-A572-SMAW
Welding Process: SMAW

**Groove Design of Test Coupon**
(For combination qualifications, the deposited weld metal thickness shall be recorded for each filter metal or process used.)

**Company Name:** Jacobs Technology

**Effective Date:** July 1, 2019

**Review Date:** July 1, 2024

**Responsible Office:** NASA SSC Center Operations Directorate

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*RELEASED - Printed documents may be obsolete; validate prior to use.*
Responsible Office: NASA SSC Center Operations Directorate

SUBJECT: ASME and AWS Procedures for SMAW and FCAW of Structural Steels (P-No. 1, Group 1 or 2)

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<tr>
<th>Specimen No.</th>
<th>Width</th>
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<th>Ultimate Unit Stress</th>
<th>Type of Failure &amp; Location</th>
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Guided-Bend Tests (QW-160)

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Toughness Tests (QW-170)

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<th>Test Temp.</th>
<th>Impact Values</th>
<th>Lateral Exp.</th>
<th>Drop Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Fillet-Weld Test (QW-180)

<table>
<thead>
<tr>
<th>Result – Satisfactory: Yes</th>
<th>N/A</th>
<th>No</th>
<th>N/A</th>
<th>Penetration into Parent Metal: Yes</th>
<th>N/A</th>
<th>No</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macro – Results</td>
<td>N/A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Other Tests

<table>
<thead>
<tr>
<th>Type of Test</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deposit Analysis</td>
<td>N/A</td>
</tr>
<tr>
<td>Other</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Welder's Name: Robert Jones
Soc. Sec. No.:
Stamp No. 52

Tests conducted by: Inspection Specialists, Inc. - MTL Div.
Laboratory Test No. 6990.90

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: Jacobs Technology

Date: April 24, 2013

By: [Signature]

April 24, 2013

[Signature]
8.4: Certificate of Analysis

![Certificate of Analysis]

**CERTIFICATE OF ANALYSIS**

Client: Jacobs Technology

Job No: 6900.90

Client Representative: Benny McGrath

Purchase Order: 

Test Specification: ASME Section IX

Sample Identification: One (1) - 1.500" Plate Procedure Qualification WPS # NASA-A572-SMAW

Welder: Robert Jones

The above referenced sample was prepared and tested in accordance with the welding procedure qualification requirements of ASME Section IX. Two (2) tensile test specimens and four (4) guided bend test specimens were prepared and tested. The results of these tests are reported herein.

**TENSILE TEST**

<table>
<thead>
<tr>
<th>SPECIMEN ID</th>
<th>WIDTH, INCHES</th>
<th>THICKNESS, INCHES</th>
<th>AREA, SQ. IN.</th>
<th>ULTIMATE LOAD, POUNDS</th>
<th>TENSILE STRENGTH, PSI</th>
<th>NATURE OF FRACTURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>6900.90 -T1</td>
<td>0.751&quot;</td>
<td>1.474&quot;</td>
<td>1.107&quot;</td>
<td>93,747</td>
<td>84,686</td>
<td>Weld</td>
</tr>
<tr>
<td>6900.90 -T2</td>
<td>0.744&quot;</td>
<td>1.467&quot;</td>
<td>1.0914&quot;</td>
<td>93,797</td>
<td>85,942</td>
<td>Weld</td>
</tr>
</tbody>
</table>

**GUIDED BEND TEST**

<table>
<thead>
<tr>
<th>SPECIMEN ID</th>
<th>TYPE TEST</th>
<th>TEST RESULT</th>
</tr>
</thead>
<tbody>
<tr>
<td>6900.90 -S1</td>
<td>Side Bend</td>
<td>Acceptable</td>
</tr>
<tr>
<td>6900.90 -S2</td>
<td>Side Bend</td>
<td>Acceptable</td>
</tr>
<tr>
<td>6900.90 -S3</td>
<td>Side Bend</td>
<td>Acceptable</td>
</tr>
<tr>
<td>6900.90 -S4</td>
<td>Side Bend</td>
<td>Acceptable</td>
</tr>
</tbody>
</table>

The tests expressed herein meet or exceed the requirements of ASME Section IX.

CERTIFIED BY:

![Certification Signature]

Date: April 24, 2013
Certificate No: 1 of 1

Travis G. Moore, Lab Manager

ALL TEST SPECIMENS, SAMPLES, ROSES, ETC. WILL BE DISCARDED THIRTY (30) DAYS AFTER TESTING UNLESS OTHERWISE INSTRUCTED IN WRITING.
8.5: Weld Procedure Specification (ASME WPS)-FCAW

**Welding Procedure Specification Record Number**

<table>
<thead>
<tr>
<th>Number</th>
<th>Rev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSTD-8070-0135-WELD</td>
<td>A</td>
</tr>
</tbody>
</table>

**Effective Date:** July 1, 2019

**Review Date:** July 1, 2024

**Responsible Office:** NASA SSC Center Operations Directorate

**SUBJECT:** ASME and AWS Procedures for SMAW and FCAW of Structural Steels (P-No. 1, Group 1 or 2)

### 8.5: Weld Procedure Specification (ASME WPS)-FCAW

**ASME - WELDING PROCEDURE SPECIFICATIONS (WPS)**

<table>
<thead>
<tr>
<th>Welding Procedure Specification Record Number</th>
<th>Date</th>
<th>Revision Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>NASA-A572-FCAW-ASME</td>
<td>June 1, 2019</td>
<td>A</td>
</tr>
</tbody>
</table>

**Qualified To**

- ASME Boiler and Pressure Vessel Code

**SupportingPOR(s)**

- NASA-A572-FCAW-PQR

**Slope**

- Single V Groove, Single Bevel Groove

**BASE METALS**

- Type
- P-no. 1
- Grp-no. 1 or 2
  - Complete Pen.
  - Impact Tested

**THICKNESS RANGE QUALIFIED**

<table>
<thead>
<tr>
<th>Min.</th>
<th>Max.</th>
<th>Min. With PWHT</th>
<th>Max. With PWHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1875&quot;</td>
<td>8.00&quot;</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

**FILLER METALS**

- Process
  - SMAW
    - SFA: 5.1
    - Classification: E6010
    - F-no.: 3
    - A-no.: 1
    - Note B.
    - Chemical Analysis or Trade Name: Note B.
    - Min. As-welded: 0.1875"
    - Max. As-welded: 500"
    - Min. With PWHT: N/A
    - Max. With PWHT: N/A

- FCAW
  - SFA: 5.36
  - Classification: E71T-1
  - F-no.: 6
  - A-no.: 1
  - Note B.
  - Chemical Analysis or Trade Name: Note B.
  - Min. As-welded: 0.035" - 0.055"
  - Max. As-welded: 500"
  - Min. With PWHT: N/A
  - Max. With PWHT: N/A

**WELDING PROCEDURE**

- Welding Process
  - SMAW A5.1
    - Type: Manual / Semi-Automatic
    - Minimum preheat/interpass temperature (°F): 350°F
    - Maximum interpass temperature (°F): 500°F
    - Tungsten Size: N/A
    - Tungsten Type: N/A
    - Filter Metal Size (in.): 3/32" - 3/16"
    - Layer Number: Root and Hot Pass
    - Position of Groove: All
    - Weld Penetration: N/A
    - Current/Polarity: DCEP
    - Amperes: 50 - 150
    - Vols: 23 - 32
    - Travel Speed (in./min): 3 - 14 ipm
    - Maximum Heat Input (kJ/cm)
    - DC Pulsing Current: N/A
    - Shielding: Argon / CO2 - 75% / 25%
    - Flow Rate (cfh): 30 - 50 CFH
    - Trailing: N/A
    - Flow Rate (cfh): N/A
    - Backing: N/A
    - Flow Rate (cfh): N/A
    - String or Weave: String or Weave
    - Orifice/Gas Cup Size: N/A
    - Multi/Single Pass per Side: Multiple
    - Weld Deposit Chemistry: N/A

**Notes:** See Note C.
Responsible Office: NASA SSC Center Operations Directorate

SUBJECT: ASME and AWS Procedures for SMAW and FCAW of Structural Steels (P-No. 1, Group 1 or 2)

| National Aeronautics and Space Administration John C. Stennis Space Center Stennis Space Center, MS 38629-6000 | ASME - WELDING PROCEDURE SPECIFICATIONS (WPS) |
|-----------------------------------------------------------------------------------------------------------------|
| Welding Procedure Specification Record Number | Date | Revision Number |
| NASA-A572-FCAW-ASME | June 1, 2019 | A |
| Qualified To ASME Boiler and Pressure Vessel Code | Company Name | Syncom Space Services (S3) |

**BASE METALS**

- Peening: Not allowed.
- Surface Preparation: See Note D.
- Initial/Interpass Cleaning: See Note D.
- Back Gouging Method: None

**POSTWELD HEAT TREATMENT**

- Temperature: None
- Time and Temperature: None
- Other: None

**NOTES**

A. Groove Thickness Range: 0.1875" - 8.00"

   Maximum Pass Thickness: ≤1/2"

B. Filler Metal Product Form: Low Hydrogen

C. Technique: Contact Tube to Work Distance: 3/4" Max and single electrodes.

D. Remove all contamination and water from surface. Remove all slag on weld and adjacent base metal.

<table>
<thead>
<tr>
<th>Signature 1</th>
<th>Signature 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineer Name: Doug Dike</td>
<td>Quality Name: George Smith</td>
</tr>
<tr>
<td>Date: June 1, 2019</td>
<td>Date: June 1, 2019</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Signature 3</th>
<th>Signature 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer Reviewer Name: Benjamin McGrath</td>
<td>Customer Name</td>
</tr>
<tr>
<td>Date: June 1, 2019</td>
<td>Date</td>
</tr>
</tbody>
</table>

SSC-937 (05/2019)
SUBJECT: ASME and AWS Procedures for SMAW and FCAW of Structural Steels (P-No. 1, Group 1 or 2)
8.6: Weld Procedure Specification (AWS WPS)-FCAW

<table>
<thead>
<tr>
<th>Welding Procedure Specification Record Number</th>
<th>Date</th>
<th>Revision Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>NASA-A572-FCAW-AWS</td>
<td>June 1, 2019</td>
<td>A</td>
</tr>
</tbody>
</table>

**Qualified To**
AWS D1.1

**Supporting PQR(s)**
NASA-A572-FCAW-PQR

**Scope**
Welding P-1 to P-1 Group 1 or 2

**BASE METALS**

<table>
<thead>
<tr>
<th>Type</th>
<th>Grp-no. 1 or 2</th>
<th>P-no.</th>
<th>Backing</th>
<th>Retainers</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Welded To</td>
<td>P-no.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Backing</td>
<td>None.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**FILLER METALS**

<table>
<thead>
<tr>
<th>Process</th>
<th>SFA</th>
<th>Classification</th>
<th>F-no.</th>
<th>A-no.</th>
<th>Chemical Analysis or Trade Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMAW</td>
<td>5.1</td>
<td>E6010</td>
<td>3</td>
<td>1</td>
<td>Note B.</td>
</tr>
<tr>
<td>FCAW</td>
<td>5.36</td>
<td>E71T-1</td>
<td>6</td>
<td>1</td>
<td>Note B.</td>
</tr>
</tbody>
</table>

**WELDING PROCEDURE**

<table>
<thead>
<tr>
<th>Type</th>
<th>Manual / Semi-Automatic</th>
<th>Manual / Semi-Automatic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum preheat/interpass temperature (°F)</td>
<td>350°F</td>
<td>350°F</td>
</tr>
<tr>
<td>Maximum interpass temperature (°F)</td>
<td>500°F</td>
<td>500°F</td>
</tr>
<tr>
<td>Tungsten Size</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Tungsten Type</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Filter Metal Size (in.)</td>
<td>3/32&quot; - 3/16&quot;</td>
<td>0.035&quot; - 0.055&quot;</td>
</tr>
<tr>
<td>Layer Number</td>
<td>Root and Hot Pass</td>
<td>Fill</td>
</tr>
<tr>
<td>Position of Groove</td>
<td>(See Note E.)</td>
<td>(See Note E.)</td>
</tr>
<tr>
<td>Weld Progression</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Current/Polarity</td>
<td>DCEP</td>
<td>DCEP</td>
</tr>
<tr>
<td>Amps</td>
<td>50 - 150</td>
<td>180 - 275</td>
</tr>
<tr>
<td>Volts</td>
<td>23 - 32</td>
<td>26 - 30</td>
</tr>
<tr>
<td>Travel Speed (in/min)</td>
<td>3 - 14 ipm</td>
<td>4 - 14 ipm</td>
</tr>
<tr>
<td>Maximum Heat Input (kW)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DC Pulsing Current</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shielding: Gas Type</td>
<td>N/A</td>
<td>Argon / CO2 - 75% - 25%</td>
</tr>
<tr>
<td>Flow Rate (c+h)</td>
<td></td>
<td>30 - 50 CFH</td>
</tr>
<tr>
<td>Trailing: Gas Type</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Flow Rate (c+h)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Backing: Gas Type</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Flow Rate (c+h)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>String or Weave</td>
<td>String or Weave</td>
<td>String or Weave</td>
</tr>
<tr>
<td>Orifice/Gas Cup Size</td>
<td>N/A</td>
<td>1/4&quot; to 1/2&quot; (FCAW CO2)</td>
</tr>
<tr>
<td>Multi/Single Pass per Side</td>
<td>Multiple</td>
<td>Multiple</td>
</tr>
</tbody>
</table>

**Notes**
See Note C.
## SUBJECT:
ASME and AWS Procedures for SMAW and FCAW of Structural Steels (P-No. 1, Group 1 or 2)

### AWS - AMERICAN WELDING SOCIETY (WPS)

<table>
<thead>
<tr>
<th>Welding Procedure Specification Record Number</th>
<th>Date</th>
<th>Revision Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>NASA-A572-FCAW-AWS</td>
<td>June 1, 2019</td>
<td>A</td>
</tr>
</tbody>
</table>

**BASE METALS**
- Peening: Not allowed.
- Surface Preparation: See Note D.
- Initial/Interpass Cleaning: See Note D.
- Back Gouging Method: None

**POSTWELD HEAT TREATMENT**
- Temperature: None
- Time and Temperature: None
- Other: None

**NOTES**
A. Groove Thickness Range: \( \geq 0.125" \)
   - Maximum Pass Thickness: \( \leq 1/2" \)
B. Filler Metal Product Form: Low Hydrogen
C. Technique: Contact Tube to Work Distance 3/4" Max and single electrodes.
D. Remove all contamination and water from surface. Remove all slag on weld and adjacent base metal.
E. Welded in the flat position 1G or 1F (Filler) weld only.

### Signature 1
- **Engineer Name:** Doug Dike
- **Date:** June 1, 2019

### Signature 2
- **Quality Name:** George Smith
- **Date:** June 1, 2019

### Signature 3
- **Customer Reviewer Name:** Benjamin McCrath
- **Date:** June 1, 2019

### Signature 4
- **Customer Name:**
- **Date:**

---

**RELEASED - Printed documents may be obsolete; validate prior to use.**
8.7: Weld Procedure Qualification Record (PQR)-FCAW

---

### Weld Procedure Qualification Record (PQR)

See QW-200.2, Section IX, ASME Boiler and Pressure Vessel Code

Record actual conditions used to weld test coupon.

---

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Jacobs Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procedure Qualification Record No.</td>
<td>NASA-A572-FCAW-PQR</td>
</tr>
<tr>
<td>WPS No.</td>
<td>NASA-A572-FCAW</td>
</tr>
<tr>
<td>Welding Processes</td>
<td>SMAW / FCAW</td>
</tr>
</tbody>
</table>

---

#### 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 A572
- Type or Grade: 50
- P-No. to P-No.: 1.500*
- Diameter of Test Coupon: N/A
- Other: 1 ½" thick

**POSTWELD HEAT TREATMENT (QW-407)**

- Temperature: N/A
- Other: N/A

**GAS (QW-408)**

- Shielding: Argon/C02
- Percent Composition (Mixtures): 75%/25%
- Flow Rate: 20-60 CFH
- Other: N/A

**ELECTRICAL CHARACTERISTICS (QW-409)**

- Current: DC
- Polarity: EP
- Amps: SMAW/E (810 FCAW130-200)
- Volts: N/A
- Tungsten Electrode Size: N/A
- Other: N/A

**TECHNIQUE (QW-410)**

- Travel Speed: 4-11 IPM
- String or Weave Bead: String
- Oscillation: 1 ½ times the root diameter
- Multi-pass or Single Pass (per side): Multi-pass
- Single or Multiple Electrodes: Single
- Other: N/A

---

**POSITION (QW-405)**

- Position of Groove: 1G
- Weld Progression (Uphill, Downhill): N/A

---

**PREHEAT (QW-406)**

- Preheat Temp.: 350°F Min.
- Inter-pass Temp.: 350°F - 500°F

---

**Note:** Test weld was produced when dual classification was permitted.

**Deposited Weld Metal:**

- P-No.: 1.250*  1.250*

---

**FILLER METALS (QW-404)**

- SFA Specification: A5.1  A5.20 / A5.36
- AWS Classification: E6010  E7/T1-1
- Filler Metal F-No.: 3  6
- Weld Metal Analysis A-No.: 1  1
- Size of Filler Metal: 1/4"  .045"
- Other: N/A

---

**Other:**

- N/A
### Tensile Test (QW-150)

<table>
<thead>
<tr>
<th>Specimen No.</th>
<th>Width</th>
<th>Thickness</th>
<th>Area</th>
<th>Ultimate Total Load</th>
<th>Ultimate Unit Stress</th>
<th>Type of Failure &amp; Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>6987.90-T1</td>
<td>0.754&quot;</td>
<td>1.495&quot;</td>
<td>1.1272&quot;</td>
<td>98,632</td>
<td>87,602</td>
<td>Weld</td>
</tr>
<tr>
<td>6987.90-T2</td>
<td>0.750&quot;</td>
<td>1.495&quot;</td>
<td>1.1175&quot;</td>
<td>96,368</td>
<td>86,235</td>
<td>Weld</td>
</tr>
</tbody>
</table>

### Guided-Bend Tests (QW-160)

<table>
<thead>
<tr>
<th>Type and Figure No.</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>6987.90-S1</td>
<td>Acceptable</td>
</tr>
<tr>
<td>6987.90-S2</td>
<td>Acceptable</td>
</tr>
<tr>
<td>6987.90-S3</td>
<td>Acceptable</td>
</tr>
<tr>
<td>6987.90-S4</td>
<td>Acceptable</td>
</tr>
</tbody>
</table>

### Toughness Tests (QW-170)

<table>
<thead>
<tr>
<th>Specimen No.</th>
<th>Notch Location</th>
<th>Notch Type</th>
<th>Test Temp.</th>
<th>Impact Values</th>
<th>Lateral Exp.</th>
<th>Drop Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### Fillet-Weld Test (QW-189)

<table>
<thead>
<tr>
<th>Test Result</th>
<th>N/A</th>
<th>No</th>
<th>N/A</th>
<th>Yes</th>
<th>N/A</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macro Results</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
</tbody>
</table>

### Other Tests

<table>
<thead>
<tr>
<th>Type of Test</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deposit Analysis</td>
<td>N/A</td>
</tr>
<tr>
<td>Other</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Welder's Name: Jackie Ladner
Soc. Sec. No.: 44
Stamp No.: 44
Tests conducted by: Inspection Specialists, Inc. - MTL Div.
Laboratory Test No.: 6987.90
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: Jacobs Technology
Date: April 24, 2013
By: [Signatures]
8.8: Certificate of Analysis

**CERTIFICATE OF ANALYSIS**

**Client:** Jacobs Technology  
**Job No.:** 6987.90

**Client Representative:** Benny McGrath  
**Purchase Order:**

**Test Specification:** ASME Section IX

**Sample Identification:** One (1) – 1.500" Plate  
Procedure Qualification WPS # NASA-A572-FCAW

**Welder:** Jackie Ladner

The above referenced sample was prepared and tested in accordance with the welding procedure qualification requirements of ASME Section IX. Two (2) tensile test specimens and four (4) guided bend test specimens were prepared and tested. The results of these tests are reported herein.

**TENSILE TEST**

<table>
<thead>
<tr>
<th>SPECIMEN ID</th>
<th>WIDTH INCHES</th>
<th>THICKNESS INCHES</th>
<th>AREA SQ. IN.</th>
<th>ULTIMATE LOAD POUNDS</th>
<th>TENSILE STRENGTH PSI</th>
<th>NATURE OF FRACTURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>6987.90-T1</td>
<td>0.754&quot;</td>
<td>1.490&quot;</td>
<td>1.1272&quot;</td>
<td>98,632</td>
<td>87,502</td>
<td>Weld</td>
</tr>
<tr>
<td>6987.90-T2</td>
<td>0.750&quot;</td>
<td>1.490&quot;</td>
<td>1.1175&quot;</td>
<td>96,368</td>
<td>86,235</td>
<td>Weld</td>
</tr>
</tbody>
</table>

**GUIDED BEND TEST**

<table>
<thead>
<tr>
<th>SPECIMEN ID</th>
<th>TYPE TEST</th>
<th>TEST RESULT</th>
</tr>
</thead>
<tbody>
<tr>
<td>6987.90-S1</td>
<td>Side Bend</td>
<td>Acceptable</td>
</tr>
<tr>
<td>6987.90-S2</td>
<td>Side Bend</td>
<td>Acceptable</td>
</tr>
<tr>
<td>6987.90-S3</td>
<td>Side Bend</td>
<td>Acceptable</td>
</tr>
<tr>
<td>6987.90-S4</td>
<td>Side Bend</td>
<td>Acceptable</td>
</tr>
</tbody>
</table>

The tests expressed herein meet or exceed the requirements of ASME Section IX.

**CERTIFIED BY:**

Travis G. Moore, Est Manager  
Date: April 24, 2013  
Certificate No: 1 of 1

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