

Supplement SENSE Level I— Entry Welder Training Performance Testing Procedures



Supplement SENSE Level I— Entry Welder Training Performance Testing Procedures

1st Edition

Prepared by the
American Welding Society (AWS) Education Committee—Task Group on SENSE Standards

Under the Direction of the
AWS Education Committee

Approved by the
AWS Board of Directors

Abstract

The goal of this supplement is to improve welder training by using and teaching the application of AWS Standard Welding Procedure Specifications (SWPSs) related to the SENSE Level I—Entry Welder workmanship and performance qualification tests. This supplement provides a recommended Workmanship or Welder Performance Qualification Technique Sheet and accompanying SWPS (where available) for Level I workmanship and welder performance qualification tests. SENSE workmanship and welder qualification tests are part of the completion requirements for trainees who seek to achieve AWS SENSE Entry Welder credential. These procedures are provided for educational use only. They shall not be used by employers for welder performance qualification tests nor for production welding.



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Foreword

This foreword is not part of this standard but is included for informational purposes only.

The AWS Schools Excelling through National Skill Standards Education (SENSE) program began in 1993 with the award of a grant by the U.S. Department of Education to develop a series of voluntary standards to promote consistency and quality in welding education on a national basis. The development of these national skill standards involved a survey of the welding industry, skilled trades, and the welding education community, to arrive at a consensus on welder skills and competencies required by industry. The result of this survey was an occupational task analysis. This task analysis formed the basis for the development of the SENSE specifications and guidelines.

AWS QC10, *Specification for Qualification and Certification of SENSE Level I—Entry Welders*, establishes the minimum requirements for trainees to receive an AWS SENSE training certificate for full or partial completion of the Level I—Entry Welder program. It also specifies the requirements for a training organization to register trainees in the AWS SENSE Certificate Database as full or partial program completers.

AWS EG2.0, *Guide for the Training of Welding Personnel: SENSE Level I—Entry Welders*, provides guidelines for the implementation of an entry-level welder training program that complies with the national SENSE standards for welding education as specified in AWS QC10. AWS EG2.0 is intended to support the development or selection of a SENSE-based curriculum focused on best practices and tailored to the needs of local employers.

AWS EG2.0 Supplement, *Supplement SENSE Level I—Entry Welder Training Performance Testing Procedures*, provides a Welder Performance Qualification Technique Sheet and accompanying AWS Standard Welding Procedure Specification (SWPS) (where available) for each SENSE Level I workmanship and welder performance qualification test. These technique sheets and SWPSs are intended to provide trainees with practice in using SWPSs to complete the workmanship and performance qualification tests included in the course of study. The SWPSs contained in this supplement are for educational use only, and shall not be used by employers for welder performance qualification tests nor for production welding.

Comments and suggestions for the improvement of this specification are welcome. They should be sent to the Director, AWS Education Committee, American Welding Society, 8669 NW 36 St, # 130, Miami, FL 33166.

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Supplement SENSE Level I—Entry Welder Training Performance Testing Procedures

1. General Provisions

1.1 Scope. EG2.0 Supplement, *Supplement SENSE Level I—Entry Welder Training Performance Testing Procedures*, provides a Welder Performance Qualification Technique Sheet and accompanying AWS Standard Welding Procedure Specification (where available) for each SENSE Level I workmanship and welder performance qualification test. These technique sheets and SWPSs are intended to provide trainees with practice in using SWPSs to complete the workmanship and performance qualification tests included in the course of study.

Welding Procedure Specifications (WPSs) and Standard Welding Procedure Specifications (SWPSs) are commonly used in industry to produce quality welds that are repeatable by properly trained welders. Welding educators who take advantage of this supplement to teach trainees how to interpret and use WPSs and SWPSs will be enhancing the employability of their graduates.

The SWPSs contained in this supplement are for educational use only, and shall not be used by employers for welder performance qualification tests nor for production welding.

1.2 Safety Precautions. Safety and health issues and concerns are beyond the scope of this supplement and therefore are not fully addressed herein. It is the responsibility of the training organization and the welding educator to establish and enforce appropriate safety and health practices. Safety and health information is available from other sources, including, but not limited to:

- (1) ANSI Z49.1, *Safety in Welding, Cutting, and Allied Processes*
- (2) The Occupational Health and Safety Administration (OSHA)
- (2) Manufacturer's safety literature on equipment and materials
- (4) Other applicable federal, state, and local regulations

2. Reference Documents

Unless specified, the latest approved revision applies.

ANSI Z49.1, *Safety in Welding, Cutting, and Allied Processes*

AWS A3.0M/A3.0, *Standard Welding Terms and Definitions, Including Terms for Adhesive Bonding, Brazing, Soldering, Thermal Cutting, and Thermal Spraying*

AWS B2, *Standard Welding Procedure Specifications (SWPSs)*

AWS B2.1/B2.1M, *Specification for Welding Procedures and Performance Qualification*

AWS B4.0, *Standard Methods for Mechanical Testing of Welds*

AWS EG2.0, *Guide for the Training of Welding Personnel: SENSE Level I—Entry Welders*

AWS QC10, *Specification for Qualification and Certification of SENSE Level I—Entry Welders*



3. Definitions

Terms used in this supplement are defined in AWS A3.0M/A3.0, *Standard Welding Terms and Definitions*. The following terms are not found in AWS A3.0, *Standard Welding Terms and Definitions*, or are modified for the purposes of this standard:

standard welding procedure specification (SWPS). A welding procedure specification qualified according to the requirements of AWS B2.1, approved by AWS, and made available for production welding by companies or individuals other than those performing the qualification test.

welder performance qualification technique sheet (WPQTS). A document similar to a welding procedure specification written for the sole purpose of communicating requirements for workmanship and welder performance qualification tests.

welder performance qualification test. A standard plate or pipe welder performance test per the requirements of AWS B2.1 or other national or international standard or company specification. These tests are typically visually examined for surface acceptance criteria, and either mechanically tested or radiographically examined to verify soundness.

welding procedure specification (WPS). A document providing the required welding variables for a specific application to assure repeatability by properly trained welders and welding operators.

workmanship qualification test. A welding performance test made to the prescribed SWPS or WPS that requires visual examination only.

4. Welder Training Performance Testing Procedures

Annex A, Table A.1 provides a summary of the Level I Workmanship and Welder Performance Qualification tests from AWS QC10. Annex B lists all the SWPS references that are recommended for these tests.

To aid in training, Welder Performance Qualification Technique Sheets (WPQTSs) for each test in Table A.1 are based on the preferred parameters from each respective SWPS.

Annex C provides the WPQTS and relevant SWPS data for each test in Table A.1. The SWPS are clearly marked for “educational use only,” as SWPSs are sold to industry where every company must purchase their own copy to license the procedure from AWS for commercial use.

Educators are recommended to use these procedures for training to teach SWPS use and better prepare trainees who seek to become an AWS Certified Welder.

5. Performance Testing Guidelines

5.1 Identification. The trainee should be assigned an identifying letter, symbol, or number coded for managing traceability of their performance qualification tests.

5.2 Safety Equipment. The trainee should use personal safety equipment applicable for the welding process. The safety requirements of the training program facility should conform to the requirements on ANSI Z49.1, and should be followed by the trainee.

5.3 Material and Equipment Check. The welding power supply (set-up), base materials, filler metal and fluxes/gases as applicable should be checked against the WPQTSs by the instructor before the trainee starts a performance qualification test.

5.4 Fit-Up. The trainee shall assemble the performance test assembly per instructions of the applicable drawing specified in Table A.1, and in accordance with the WPQTS.

5.5 Assembly Control. The instructor should witness placing of each test assembly in the specified welding position, and should mark the test assembly or secure it such that it remains in the specified position until welding has been completed.

5.6 Positioning. All cleaning, grinding and chipping of slag, or other in-process operations should be performed with the test assembly in the specified welding position. Evidence of removal of the test assembly or movement from the original location, except by accidental means (subject to concurrence from the instructor) should be cause for a test termination, and retest.

5.7 Testing Methods and Acceptance Criteria. The test methods and acceptance criteria should meet the requirements of AWS QC10, Clause 8.

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Annex A (Informative)

Level I Welding Performance Qualification Matrix

This annex is not part of this standard but is included for informational purposes only.

Table A.1
Recommended SWPSs for SENSE Level I
Workmanship and Welder Performance Qualification Tests

Test	Drawing AWS EDU No.	Process	Workmanship/ Performance	Material	Position	Test Thickness (in.)	SWPS ^a	SWPS Qual. Thickness (in.)
1	3	GMAW-S	Workmanship	Steel	Multiple	10 ga.–14 ga.	B2.1-1-004	10 ga.–18 ga.
2	2	GMAW-Spray	Workmanship	Steel	1G, 2F	0.375	B2.1-1-235	1/8–1.5
3	1	FCAW-G	Workmanship	Steel	Multiple	0.375	B2.1-1-019 or B2.1-1-020	1/8–1.5
4	1	FCAW-S	Workmanship	Steel	Multiple	0.375	B2.1-1-027 or B2.1-1-018	1/8–1/2 or 1.5
5	3	GTAW	Workmanship	Steel	Multiple	10 ga.–14 ga.	B2.1-1-008	10 ga.–18 ga.
6	4	GTAW	Workmanship	Stainless	Multiple	10 ga.–14 ga.	B2.1-8-009	10 ga.–18 ga.
7	5	GTAW	Workmanship	Aluminum	1G, 2F	10 ga.–14 ga.	B2.1-22-015	10 ga.–18 ga.
8	6	SMAW	Performance	Steel	2G	0.375	B2.1-1-016	1/8–1.5
9	6	SMAW	Performance	Steel	3G	0.375	B2.1-1-016	1/8–1.5

^a Any applicable qualified WPS may be used in lieu of the recommended SWPS (AWS D1.1 prequalified, company furnished, etc.).

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Annex B (Informative)

Standard Welding Procedure Specifications for Level I Welding Performance Qualification Tests

This annex is not part of this standard but is included for informational purposes only.

B.1 Scope

SENSE Level I workmanship and welder performance qualification tests must be conducted using AWS B2 SWPSs or alternative WPSs, as described in AWS QC10, *Specification for Qualification and Certification of SENSE Level I—Entry Welders*. AWS SWPSs are used by industry under purchased license. They are provided in AWS EG2.0 Supplement, *Supplement SENSE Level I—Entry Welder Training Performance Testing Procedures*, for educational use only, and shall not be used by employers for welder performance qualification tests nor for production welding.

Table B.1 shows which SWPS is recommended (based on availability) for the workmanship and welder performance qualification tests included in SENSE Level I—Entry Level. Additional SWPSs may be recommended in the future for use in the EG2.0 Supplement as they are qualified by the AWS B2 Committee.

Training organizations have the option to use other WPSs that are qualified to AWS D1 Structural Welding Codes, or other national or international standards. It is the responsibility of the training organization to specify the SWPSs, alternate WPSs, and governing standard(s) that are suitable for course of study.

Table B.1
Recommended SWPSs for SENSE Level I Tests

Test	Process/Material	SWPS	Drawing AWS EDU-
1	GMAW-S/Steel	B2.1-1-004	3
2	GMAW (Spray)/Steel	B2.1-1-235	2
3	FCAW-G/Steel	B2.1-1-019 or B2.1-1-020	1
4	FCAW-S/Steel	B2.1-1-027 or B2.1-1-018	1
5	GTAW/Steel	B2.1-1-008	3
6	GTAW/Stainless	B2.1-8-009	4
7	GTAW/Aluminum	B2.1-22-015	5
8	SMAW/Steel	B2.1-1-016	6
9	SMAW/Steel	B2.1-1-016	6

B.2 SWPS Reference Documents

Unless specified, the latest approved revision of the SWPS applies for the recommended SENSE Level I workmanship or welding performance qualification test.

Test No.	AWS SWPS	Title
Test 1	B2.1-1-004	<i>Standard Welding Procedure Specification (SWPS) for Gas Metal Arc Welding (Short Circuiting Transfer Mode) of Carbon Steel (M-1, Group 1), 18 through 10 gauge, As-Welded Condition, with or without Backing</i>
Test 2	B2.1-1-235	<i>Standard Welding Procedure Specification (SWPS) for Argon plus 2% Oxygen Shielded Gas Metal Arc Welding (Spray Transfer Mode) of Carbon Steel (M-1/P-1/S-1, Groups 1 and 2), 1/8 through 1-1/2 inch Thick, ER70S-3, Flat Position Only, As-Welded or PWHT Condition, Primarily Pipe Applications</i>
Test 3	B2.1-1-019	<i>Standard Welding Procedure Specification (SWPS) for CO₂ Shielded Flux Cored Arc Welding of Carbon Steel (M-1/P-1, Group 1 or 2), 1/8 through 1-1/2 inch Thick, E70T-1 and E71T-1, As-Welded Condition; or B2.1-1-020, Standard Welding Procedure Specification (SWPS) for 75% Ar/25% CO₂ Shielded Flux Cored Arc Welding of Carbon Steel (M-1/P-1, Group 1 or 2), 1/8 through 1-1/2 inch Thick, E70T-1 and E71T-1, As-Welded or PWHT Condition</i>
Test 4	B2.1-1-027	<i>Standard Welding Procedure Specification (SWPS) for Self-Shielded Flux Cored Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), 1/8 through 1/2 inch Thick, E71T-11, As-Welded Condition; or B2.1-1-018, Standard Welding Procedure Specification (SWPS) for Self-Shielded Flux Cored Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), 1/8 through 1-1/2 inch Thick, E71T-8, As-Welded Condition</i>
Test 5	B2.1-1-008	<i>Standard Welding Procedure Specification (SWPS) for Gas Tungsten Arc Welding of Carbon Steel (M-1/P-1 or S-1), 18 through 10 gauge, As-Welded Condition, with or without Backing</i>
Test 6	B2.1-8-009	<i>Standard Welding Procedure Specification (SWPS) for Gas Tungsten Arc Welding of Austenitic Stainless Steel (M-8/P-8 or S-8), 18 through 10 gauge, As-Welded Condition, with or without Backing</i>
Test 7	B2.1-22-015	<i>Standard Welding Procedure Specification (SWPS) for Gas Tungsten Arc Welding of Aluminum (M-22/P-22 or S-22), 18 through 10 gauge, As-Welded Condition, with or without Backing</i>
Test 8 & 9	B2.1-1-016	<i>Standard Welding Procedure Specification (SWPS) for Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), 1/8 through 1-1/2 inch Thick, E7018, As-Welded or PWHT Condition</i>

Annex C (Informative)

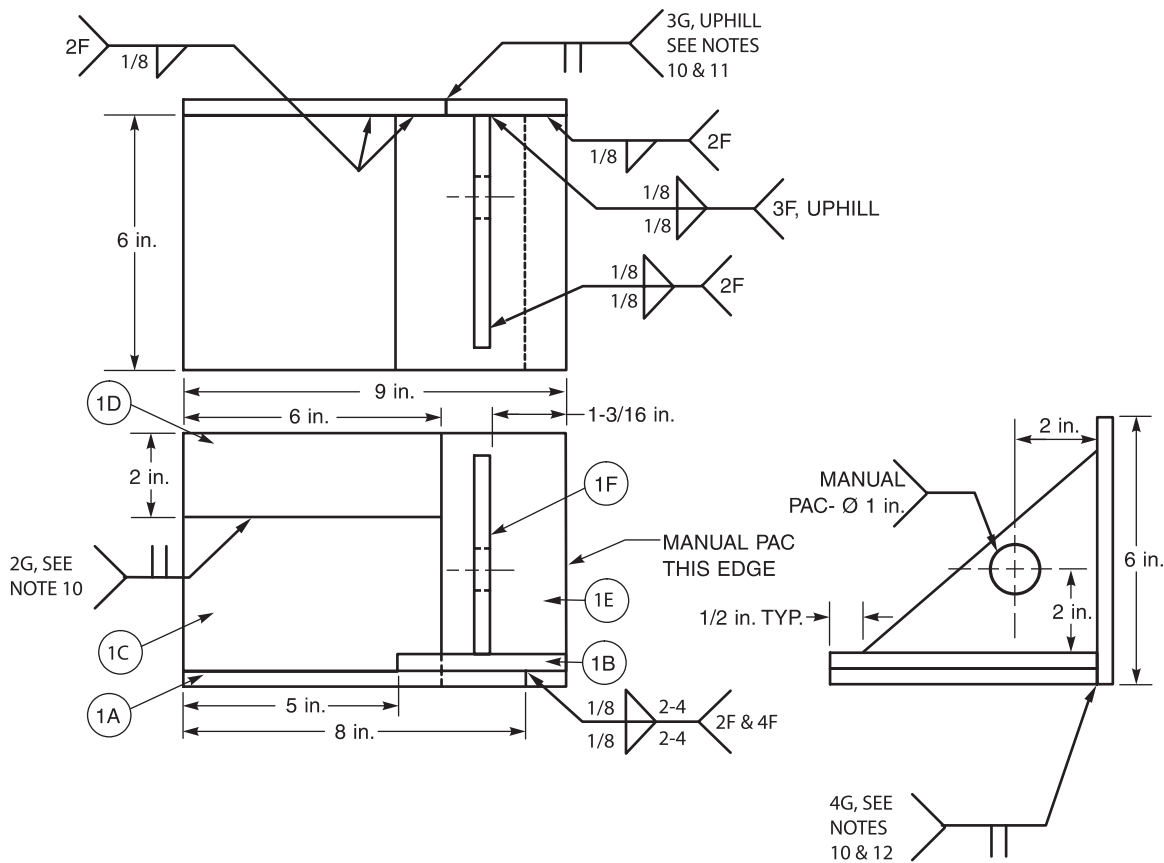
Level I Welder Training Performance Testing Procedures

This annex is not part of this standard but is included for informational purposes only.

C.1 Scope

This annex provides a recommended Welder Performance Qualification Technique Sheet and accompanying AWS SWPS standard data (based on SWPS availability) for each performance test listed in Table A.1.

	SENSE PROGRAM WORKMANSHIP PERFORMANCE QUALIFICATION TECHNIQUE SHEET	SENSE TEST No: Level I - Entry Welder, Test 1	
		REVISION No: 1	DATE: 5/15/2015
		SUPPORTING SWPS No: AWS B2.1-1-004	
MATERIAL: ASTM A569 (or equivalent M-1 steel) ¹		Joint Details: See Drawing AWS EDU-3	
PRODUCT FORM: Sheet Steel			
THICKNESS: 10 Gage and 14 Gage			
POSITION: Multiple	PROGRESSION: Uphill		
MIN. PREHEAT / MAX INTERPASS TEMP: 50°F /NA			
CLEANING: Wire Brush, Grind as Required			
BACKING: None			
BACKGOUGING: None			
COUPON: 10 to 14 gauge per drawing			
VARIABLE	14 Gage	10 Gage	
Process	GMAW-S	GMAW-S	
Process Type	Semiautomatic	Semiautomatic	
Filler Classification	ER70S-6	ER70S-6	
Filler Size (in.) ¹	0.035	0.035	
Consumable Insert	None	None	
Tungsten Electrode Classification	NA	NA	
Tungsten Electrode Size (in.)	NA	NA	
Penetration Enhancing Flux	None	None	
Current/Polarity	DCEP	DCEP	
Current Range (Amps)	80 - 112	100 - 140	
Transfer Mode (GMAW & FCAW)	Short Circuiting	Short Circuiting	
Voltage Range	16 - 19	18 - 20	
Wire Feed Speed (IPM)	NA	NA	
Contact Tube to Work (in.)	1/2 (Nominal)	1/2 (Nominal)	
Bead Width (Stringer or Weave)	Stringer	Stringer	
Travel Speed (IPM)	NA	NA	
Torch Shielding Gas Composition	Argon + 25% CO ₂	Argon + 25% CO ₂	
Torch Shielding Gas Flow Rate (cfh)	20-40 ft ³ /h	20-40 ft ³ /h	
Shielding Gas Cup Size	1/2 in. ID minimum	1/2 in. ID minimum	
Root Shielding Gas Composition	NA	NA	
Root Shielding Gas Flow Rate (cfh)	NA	NA	
Deposit Thickness (in.)	Per drawing		
Gage Nominal Thickness (T)	0.074 in.	0.134 in.	
Qualification Standard	AWS QC10, <i>Specification for Qualification and Certification of SENSE Level I—Entry Welders</i>		
Acceptance Criteria:	Visual Inspection per: AWS QC-10, Table 8.1		
NOTES: 1. Base Metal Groupings (M Numbers) per AWS B2.1			



- NOTES:
1. All dimensions U.S. Customary Units unless otherwise specified.
 2. 10 ga.-14 ga. thickness carbon steel. Optional choice of thickness within range specified.
 3. The welder shall prepare a bill of materials in U.S. Customary Units prior to cutting.
 4. The welder shall convert the above bill of materials to S.I. Metric Units of measure.
 5. All parts may be mechanically cut or machine PAC unless specified manual PAC.
 6. All welds GMAW-S (Short Circuiting Transfer) or GTAW as applicable.
 7. Fit and tack entire assembly on bench before attaching to positioning arm.
 8. All welding to be done in position according to welding symbol.
 9. Employ boxing technique where applicable.
 10. Melt through not required.
 11. Weld joints parts 1C and 1D to 1E.
 12. Weld joints parts 1C and 1E to 1A.

ID	QTY	SIZE	METRIC CONVERSION	 <u>American Welding Society</u>		
				Entry Welder Performance Qualification		
				GMAW-S, GTAW Carbon Steel		
				DATE:	SCALE:	DWG #: AWS EDU-3
				DR BY:	Tolerances: (Unless otherwise specified) DRAWING NOT TO SCALE Fractions: $\pm 1/16"$ Angles: $+10^\circ, -5^\circ$	
				APP BY:		

Standard Welding Procedure Specification (SWPS)

Gas Metal Arc Welding (Short Circuiting Transfer Mode) of Carbon Steel (M-1, Group 1), 18 through 10 Gauge, in the As-Welded Condition, with or without Backing

Welding Research Council—Supporting PQR Numbers: 092A, 093A,
094A, 095A, 096B, 097A, 098A, 099A, 100A, 101A, 102B, and 103A

Requirements for Application of SWPSs

Scope. The data to support this Standard Welding Procedure Specification (SWPS) have been derived from the above listed Procedure Qualification Records (PQRs) which were reviewed and validated under the auspices of the Welding Research Council. This SWPS is not valid using conditions and variables outside the ranges listed. The American Welding Society considers that this SWPS presents information for producing an acceptable weld using the conditions and variables listed. The user needs a significant knowledge of welding and accepts full responsibility for the performance of the weld and for providing the engineering capability, qualified personnel, and proper equipment to implement this SWPS.

Application. This SWPS is to be used only as permitted by the applicable fabrication document(s) [such as code, specification, or contract document(s)]. The fabrication document(s) should specify the engineering requirements such as design, need for heat treatment, fabricating tolerances, quality control, and examination and tests applicable to the end product.

User's Responsibility. A SWPS does not replace or substitute for fabrication codes, specifications, contract requirements, or capability and judgment

on the part of the user. A SWPS is to be used only as permitted by the applicable fabrication code, specification, or contract document.

The ability to produce production welds having properties suitable for the application depends upon supplementing the SWPS with appropriate performance qualification tests and sound engineering judgment. The user is responsible for the quality and performance of the final product in accordance with the provisions of the fabrication document(s).

Supplementary Instructions. To adapt this SWPS to a specific application, a user may issue supplementary instructions. Such instructions may consist of tighter fit-up tolerances, higher minimum preheat temperature or any other instructions necessary to produce a weldment that meets the requirements of the fabrication document(s). These instructions shall not be less restrictive than provided in the SWPS.

Safety. Safety precautions shall conform to the latest edition of ANSI Z49.1, *Safety in Welding, Cutting, and Allied Processes*, published by the American Welding Society.

This specification may involve hazardous materials, operations, and equipment. The specification does not purport to address all of the safety problems associated with its use. It is the responsibility of the user to establish appropriate safety and health practices. The user should determine the applicability of any regulatory limitations prior to use.

Standard Welding Procedure Specification (SWPS)

LIMITATIONS

This procedure is not qualified for Notch Toughness or PWHT applications.

WELDING PROCESSES

Welding Process:	GMAW-S (Gas Metal Arc Welding)
Method of Application:	Semiautomatic
Mode of Metal Transfer:	Short Circuiting Transfer Mode

BASE METALS

Base Metal: ¹	Carbon Steel, M-1, Group 1 to M-1, Group 1
Thickness Range: ²	Groove Weld: 18 ga. (0.0478 in.) through 10 ga. (0.1345 in.) Fillet Weld: 18 ga. (0.0478 in.) through 10 ga. (0.1345 in.)
Coating:	Uncoated

FILLER METALS

Filler Metal Specification: ¹	AWS A5.18
A-Number or Chemical Composition:	A Number None, ER70S-6
F-Number:	F Number 6
Classification:	ER70S-6
Supplementary Filler Metal:	Not permitted
Supplementary Powder:	Not permitted
Deposit Thickness Range:	Groove Weld: Sheet metal thickness plus reinforcement, maximum Fillet Weld Leg: Sheet metal thickness, minimum
Maximum Bead Thickness:	Sheet metal thickness plus reinforcement

JOINT DESIGNS

Joint Designs:	See Figure 1
Backing:	Optional
Backing Material:	Carbon Steel, M-1. Nonmetallic or nonfusing metal retainers are not permitted.

POSITIONS

Welding Positions:	All
Vertical Progression:	Uphill or Downhill

¹ M numbers for base metal and F and A numbers for filler metal and weld metal, respectively, are as detailed in AWS B2.1.

² See the applicable ASTM Specification for base metal thickness tolerances.

Standard Welding Procedure Specification (SWPS)

GAS

Torch Shielding Gas: 75% Argon, 25% Carbon Dioxide or AWS A5.32, Class SG-AC-25
Flow Rate: 20 to 40 ft³/h
Gas Nozzle Size: 1/2 in. diameter minimum (I.D.)
Root Shielding Gas: None
Trailing Gas: None

PREHEAT AND INTERPASS TEMPERATURE

Preheat Temperature: 50°F minimum, 120°F maximum
Interpass Temperature: No maximum
Preheat Maintenance: Continuous or special heating not required

POST WELD HEAT TREATMENT

Postweld Heat-Treatment: None (not qualified for PWHT)

ELECTRICAL CHARACTERISTICS

Base Metal	Filler Metal		Amperes		Voltage	Current
	Classification	Dia. (in.)	Groove	Fillet	Volts	Type/Polarity
18 ga.	ER70S-6	0.035	60/85	70/90	15/17	DCEP (Reverse)
17 ga.	ER70S-6	0.035	65/92	76/93	15/17	DCEP (Reverse)
16 ga.	ER70S-6	0.035	70/99	81/96	15/17	DCEP (Reverse)
15 ga.	ER70S-6	0.035	75/105	87/100	16/19	DCEP (Reverse)
14 ga.	ER70S-6	0.035	80/112	92/105	16/19	DCEP (Reverse)
13 ga.	ER70S-6	0.035	85/118	98/108	16/19	DCEP (Reverse)
12 ga.	ER70S-6	0.035	90/127	103/112	18/20	DCEP (Reverse)
11 ga.	ER70S-6	0.035	95/132	109/116	18/20	DCEP (Reverse)
10 ga.	ER70S-6	0.035	100/140	115/120	18/20	DCEP (Reverse)

Pulsing Current: Not Permitted
Contact Tube to Work Distance: 1/2 inch nominal
Mode of Metal Transfer: Short Circuiting Transfer Mode

TECHNIQUE

Weave or Stringer Beads: Stringer or weave
Peening: No
Initial Cleaning: Mechanical or chemical, joint shall be dry prior to welding
Interpass Cleaning: Mechanical only
Single or Multiple Electrodes: Single
Single or Multiple Pass: Either
Backgouging: Not required, mechanical or thermal if used
Repair: Defects in welds shall be removed by mechanical or thermal methods. The repair cavity may differ in contour and dimension from a normal joint preparation and may present different restraint conditions.

Standard Welding Procedure Specification (SWPS)

COMPANY NAME _____

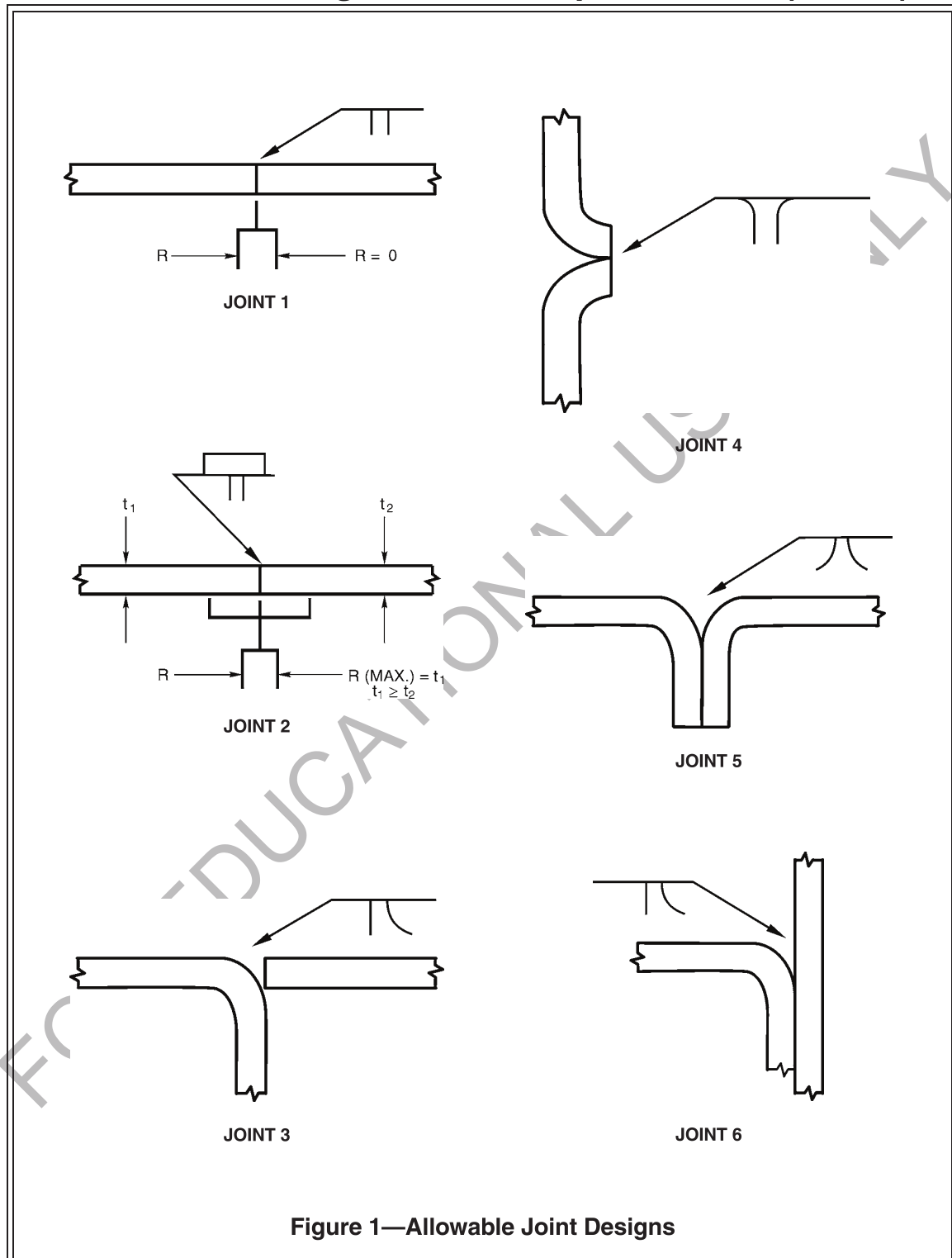
In the name of the Company stated above, I accept full responsibility for the application of this SWPS for use with:

_____ Dated _____
Fabrication Document(s): (Such as Code, Specification, or Contract Document)

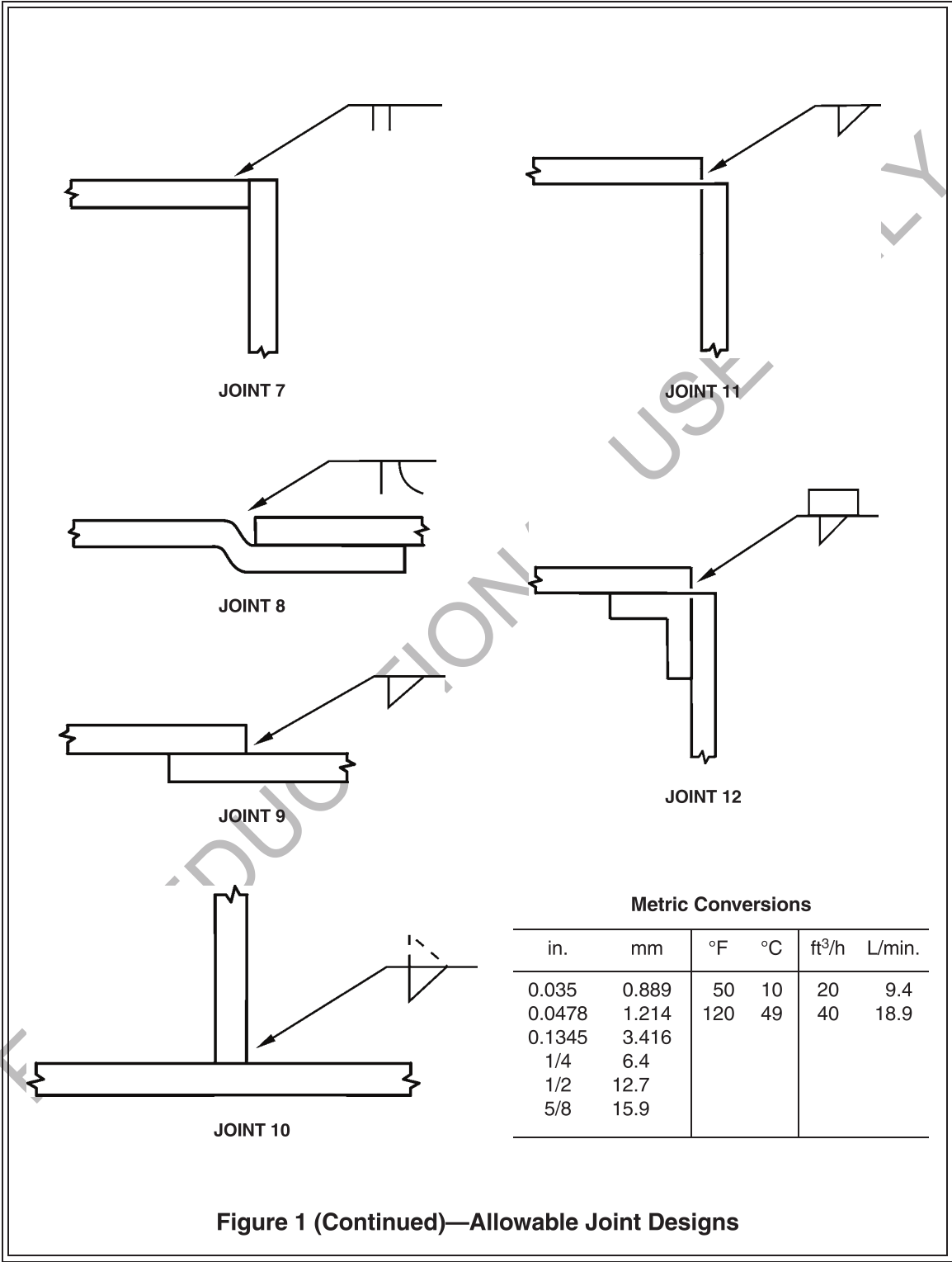
Date _____ Approved By _____ Title _____

FOR EDUCATIONAL USE ONLY

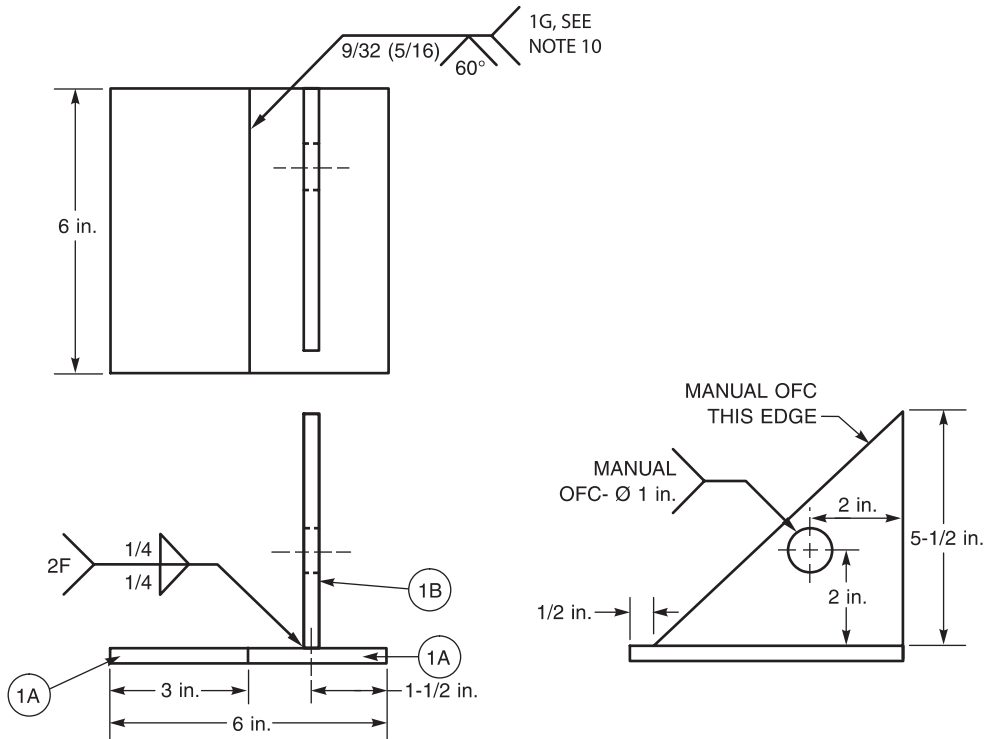
Standard Welding Procedure Specification (SWPS)



Standard Welding Procedure Specification (SWPS)



	SENSE PROGRAM WORKMANSHIP PERFORMANCE QUALIFICATION TECHNIQUE SHEET		SENSE TEST No: Level I - Entry Welder, Test 2		
			REVISION No: 1	DATE: 5/15/2015	
			SUPPORTING SWPS No: AWS B2.1-1-235		
MATERIAL: ASTM A36			Joint Details: See Drawing AWS EDU-2		
PRODUCT FORM: Plate					
DIAMETER: NA	THICKNESS: 3/8"				
POSITION: 1G, 2F	PROGRESSION: NA				
MIN. PREHEAT / MAX INTERPASS TEMP: 50°F / NA					
CLEANING: Wire Brush, Grind as Required					
BACKING: None					
BACKGOUGING: None					
COUPON: Per Drawing					
VARIABLE		Root and Balance (0.035 Electrode)	Root and Balance (0.045 Electrode)	Root and Balance (1/16 Electrode)	
Process		GMAW	GMAW	GMAW	
Process Type		Semiautomatic	Semiautomatic	Semiautomatic	
Electrode/Filler Classification		ER 70S-3	ER 70S-3	ER 70S-3	
Electrode/Filler Size (in.) ²		0.035	0.045	1/16	
Consumable Insert		NA	NA	NA	
Tungsten Electrode Classification		NA	NA	NA	
Penetration Enhancing Flux		NA	NA	NA	
Current/Polarity		DCEP	DCEP	DCEP	
Current Range (Amps)		{ 0.035 Electrode { 0.045 Electrode { 1/16 Electrode	180 - 280 NA NA	NA 210 - 350 NA	NA NA 250 - 400
Transfer Mode (GMAW & FCAW)		Spray	Spray	Spray	
Voltage Range		24 - 28	24 - 29	26 - 30	
Wire Feed Speed (IPM)		330 - 500	200 - 450	220 - 420	
Contact Tube to Work (in.)		3/4 ± 1/4	1 ± 1/4	1 ± 1/4	
Bead Width (Stringer or Weave)		Either	Either	Either	
Travel Speed (IPM)		NA	NA	NA	
Torch Shielding Gas Composition		Argon + 2% Oxygen	Argon + 2% Oxygen	Argon + 2% Oxygen	
Torch Shielding Gas Flow Rate (cfh)		20 to 40 ft ³ /h	20 to 40 ft ³ /h	20 to 40 ft ³ /h	
Shielding Gas Cup Size		1/2 in. ID Minimum	1/2 in. ID Minimum	1/2 in. ID Minimum	
Root Shielding Gas Composition		NA	NA	NA	
Root Shielding Gas Flow Rate (cfh)		NA	NA	NA	
Deposit Thickness (in.)		Per Drawing			
Qualification Standard		AWS QC10, <i>Specification for Qualification and Certification of SENSE Level I—Entry Welders</i>			
Acceptance Criteria:		Visual Inspection per: AWS QC-10, Table 8.1			
NOTES: 1. Electrode Size - Welder's choice					



- NOTES:
- 1. All dimensions U.S. Customary Units unless otherwise specified.
 - 2. 3/8 in. thickness carbon steel.
 - 3. The welder shall prepare a bill of materials in U.S. Customary Units of measure prior to cutting.
 - 4. The welder shall convert the above bill of materials to S.I. Metric Units of measure.
 - 5. All parts may be mechanically cut or machine OFC unless specified manual OFC.
 - 6. All welds GMAW Spray Transfer.
 - 7. Fit and tack entire assembly on bench before welding.
 - 8. All welding to be done in position according to welding symbol.
 - 9. Employ boxing technique where applicable.
 - 10. Melt through not required.

ID	QTY	SIZE	METRIC CONVERSION	 American Welding Society		
				Entry Welder Performance Qualification		
				GMAW Spray Transfer, Carbon Steel		
				DATE:	SCALE:	DWG #: AWS EDU-2
				DR BY:	Tolerances: (Unless otherwise specified) DRAWING NOT TO SCALE Fractions: ± 1/16" Angles: +10°, -5°	
				APP BY:		

Standard Welding Procedure Specification (SWPS)

**Argon plus 2% Oxygen Shielded Gas Metal Arc Welding
(Spray Transfer Mode) of Carbon Steel (M-1/P-1/S-1,
Groups 1 and 2), 1/8 through 1-1/2 inch Thick,
ER70S-3, Flat Position Only, As-Welded or
PWHT Condition, Primarily Pipe Applications**

**Welding Research Council¹—Supporting PQR Numbers:
200853, 200854, 200864, 200865**

Requirements for Application of Standard SWPSs

Scope. The data to support this Standard Welding Procedure Specification (SWPS) has been derived from the above listed Procedure Qualification Records (PQRs) which were reviewed and validated under the auspices of the Welding Research Council. This SWPS is not valid using conditions and variables outside the ranges listed. The American Welding Society considers that this SWPS presents information for producing an acceptable weld using the conditions and variables listed. The user needs a significant knowledge of welding and accepts full responsibility for the performance of the weld and for providing the engineering capability, qualified personnel, and proper equipment to implement this SWPS.

Application. This SWPS is to be used only as permitted by AWS B2.1, *Specification for Procedure and Performance Qualification*, and the applicable fabrication document(s) [such as code, specification, or contract document(s)]. The fabrication document(s) should specify the engineering requirements such as design, need for heat treatment, fabricating tolerances, quality control, and examination and tests applicable to the end product.

User's Responsibility. An SWPS does not replace or substitute fabrication codes, specifications, con-

tract requirements, or capability and judgment on the part of the user. An SWPS is to be used only as permitted by the applicable fabrication code, specification, or contract document.

The ability to produce production welds having properties suitable for the application depends upon supplementing the SWPS with appropriate performance qualification tests and sound engineering judgment. The user is responsible for the quality and performance of the final product in accordance with the provisions of the fabrication document(s).

Supplementary Instructions. To adapt this SWPS to a specific application, a user may issue supplementary instructions. Such instructions may consist of tighter fit-up tolerances, higher minimum preheat temperature, or any other instructions necessary to produce a weldment that meets the requirements of the fabrication document(s). These instructions shall not be less restrictive than provided in the SWPS.

Safety. Safety precautions shall conform to the latest edition of ANSI Z49.1, *Safety in Welding, Cutting, and Allied Processes*, published by the American Welding Society.

This specification may involve hazardous materials, operations, and equipment. The specification does not purport to address all of the safety problems associated with its use. It is the responsibility of the user to establish appropriate safety and health practices. The user should determine the applicability of any regulatory limitations prior to use.

¹Welding Research Council, P.O. Box 201547, Shaker Heights, OH 44120.



Standard Welding Procedure Specification (SWPS)

LIMITATIONS

This procedure is not qualified for Notch Toughness applications.
A Constant Voltage (Constant Potential) Power Source is required.

WELDING PROCESSES

Welding Processes: GMAW (Gas Metal Arc Welding—Spray Transfer Mode)
Method of Application: Semiautomatic
Mode of Metal Transfer: Spray Transfer Mode

BASE METALS

Base Metal²: Carbon Steel, M-1, P-1, or S-1, Groups 1 or 2
Thickness Range: 1/8 in. through 1-1/2 in. for groove welds, 1/8 in. minimum for fillet welds
Pipe Diameter: 2-7/8 in. OD and over
Coating: Uncoated

FILLER METALS

Filler Metal Specification²: AWS A5.18
A Number: A Number 1
F Number: F Number 6
Classification: ER70S-3
Supplementary Filler Metal: Not Permitted
Supplementary Powder: Not Permitted
Deposit Thickness Range: 1-1/2 in. maximum plus reinforcement for groove welds
1/8 in. through 1-1/2 in. fillet weld size for fillet welds

JOINT DESIGNS

Joint Designs: See Figure 1
Backing: Required unless backgouged and back welded
Backing Material: Carbon Steel, M-1, P-1, S-1 Group 1, 2, or 3 or weld metal of similar chemical analysis. Nonmetallic or nonfusing metal retainers are not permitted.

POSITIONS

Permitted Positions: Groove Welds—Flat Position,
Fillet Welds—Flat and Horizontal Position
Vertical Progression: Not Applicable

PREHEAT AND INTERPASS TEMPERATURE

Preheat Temperature³: 50°F Minimum
Interpass Temperature³: 50°F Minimum, 500°F Maximum
Preheat Maintenance: During welding, after welding is completed, preheat maintenance prior to any Post Weld Heat Treatment is not required

² M, P, and S numbers for base metal and F and A numbers for filler metal and weld metal, respectively, are as detailed in AWS B2.1, *Specification for Welding Procedure and Performance Qualification*, and ASME Boiler and Pressure Vessel Code, Section IX.

³ Preheat and interpass temperatures must be sufficient to prevent crack formation. Temperatures above the minimum shown may be required for highly restrained welds or by the fabrication document(s).

Standard Welding Procedure Specification (SWPS)

GAS

Torch Shielding Gas: Welding Grade: Argon plus 2% Oxygen or AWS A5.32, Class SG-AO-2.
Flow Rate: 20 to 40 ft³/h
Backing/Root Shielding Gas: Not required
Trailing Gas: None
Torch Gas Nozzle Size: 1/2 in. ID minimum

ELECTRICAL CHARACTERISTICS

Electrode			Current			Wire Feed Speed
Classification	Stage	Diameter (in.)	Volts	Amperes	Polarity	(ipm)
ER70S-3	Root or Fill	0.035	24–28	180–280	DCEP (Reverse)	330–500
ER70S-3	Root or Fill	0.045	24–29	210–350	DCEP (Reverse)	200–450
ER70S-3	Root or Fill	1/16	26–30	250–400	DCEP (Reverse)	220–420

Pulsing Current: Not permitted
Contact Tube to Work Distance: 3/4 in. to 1-1/4 in.

POSTWELD HEAT TREATMENT

Postweld Heat Treatment: Welds may either be as-welded or postweld heat treated at 1100 to 1200°F. If heat treated, the heat treatment time shall be 1 hour per inch of thickness (15 minutes minimum) unless otherwise noted in the fabrication documents.

TECHNIQUE

Weave or Stringer Bead: Either
Peening: Not permitted
Initial Cleaning: Chemical or mechanical; joint shall be dry prior to welding
Interpass Cleaning: Mechanical only
Backgouging: Mechanical or thermal when used
Single or Multiple Passes: Either
Maximum Bead Thickness: 1/4 in.
Repair: Defects in welds shall be removed by mechanical or thermal methods. The repair cavity may differ in contour and dimension from a normal joint preparation and may present different restraint conditions. Repair of base metal defects shall be in accordance with the requirements of the fabrication document(s).

COMPANY NAME _____

In the name of the Company stated above, I accept full responsibility for the application of this Standard WPS for use with:

_____ Dated _____
 Fabrication Document(s): (Such as Code, Specification, or Contract Document)

Date _____ Approved by _____ Title _____

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Standard Welding Procedure Specification (SWPS)

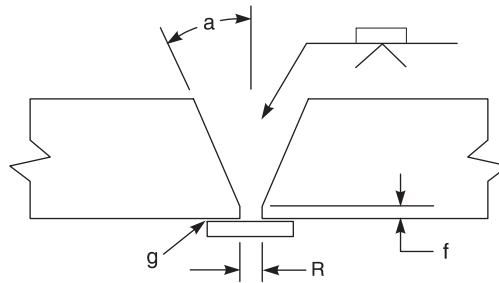
Metric Conversions

in.	mm	°F	°C	ft ³ /h	L/min	ipm	mm/s
1/32	0.8	50	10	5	2.4	200	84
0.035	0.9	500	260	10	5.0	320	134
0.045	1.1	1100	595	15	7.1	330	139
1/16	1.6	1200	650	25	11.8	420	176
3/32	2.4					450	189
1/8	3.2					500	210
3/16	4.8						
1/4	6.4						
3/8	9.6						
3/4	19.0						
1-1/2	38.0						

Standard Welding Procedure Specification (SWPS)

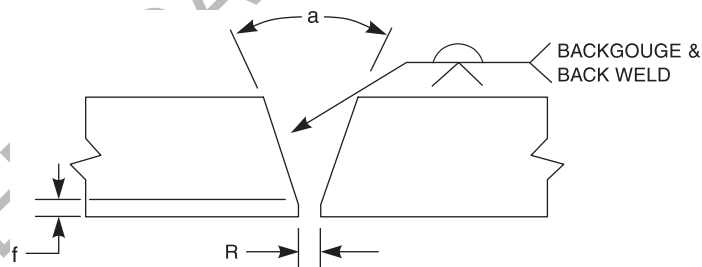
FILLET WELDS: All Joints

GROOVE WELDS: For pipe and tubular products, see Joints 1 and 2. In addition, joints having groove designs resulting from end preparations conforming with ASME B16.25, *Butt Welding Ends*, and prequalified joint details for complete and partial joint penetration groove welded joints permitted by AWS D1.1, *Structural Welding Code—Steel*, are also allowable for application with this SWPS.



$a = 30^\circ, +10^\circ, -0^\circ$
 $f = 1/16 \text{ in.} \pm 1/32 \text{ in.}$
 $g = 1/16 \text{ in. MAX.}$
 $R = 3/16 \text{ in.} \pm 1/16 \text{ in.}$
 I.D. MISMATCH = $1/16 \text{ in. MAX.}$

JOINT 1

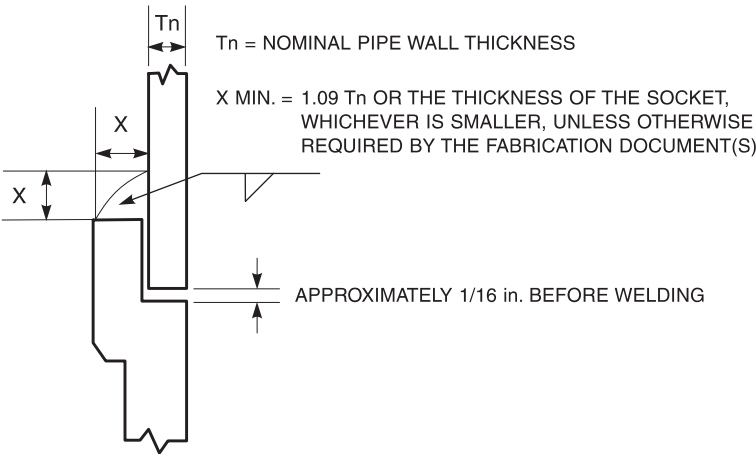


$a = 60^\circ \text{ MIN.}$
 $R = 1/8 \text{ in.,} +1/16 -1/8$
 $f = \text{NOT LIMITED}$

JOINT 2

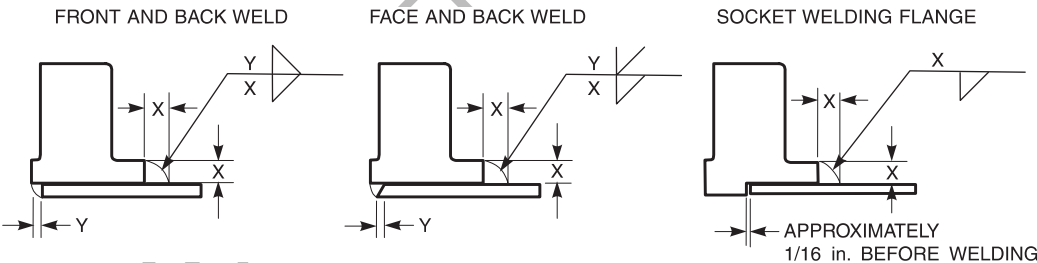
Figure 1—Allowable Joint Designs

Standard Welding Procedure Specification (SWPS)



RECOMMENDED WELDING DIMENSIONS FOR SOCKET WELDING COMPONENTS OTHER THAN FLANGES

JOINT 3



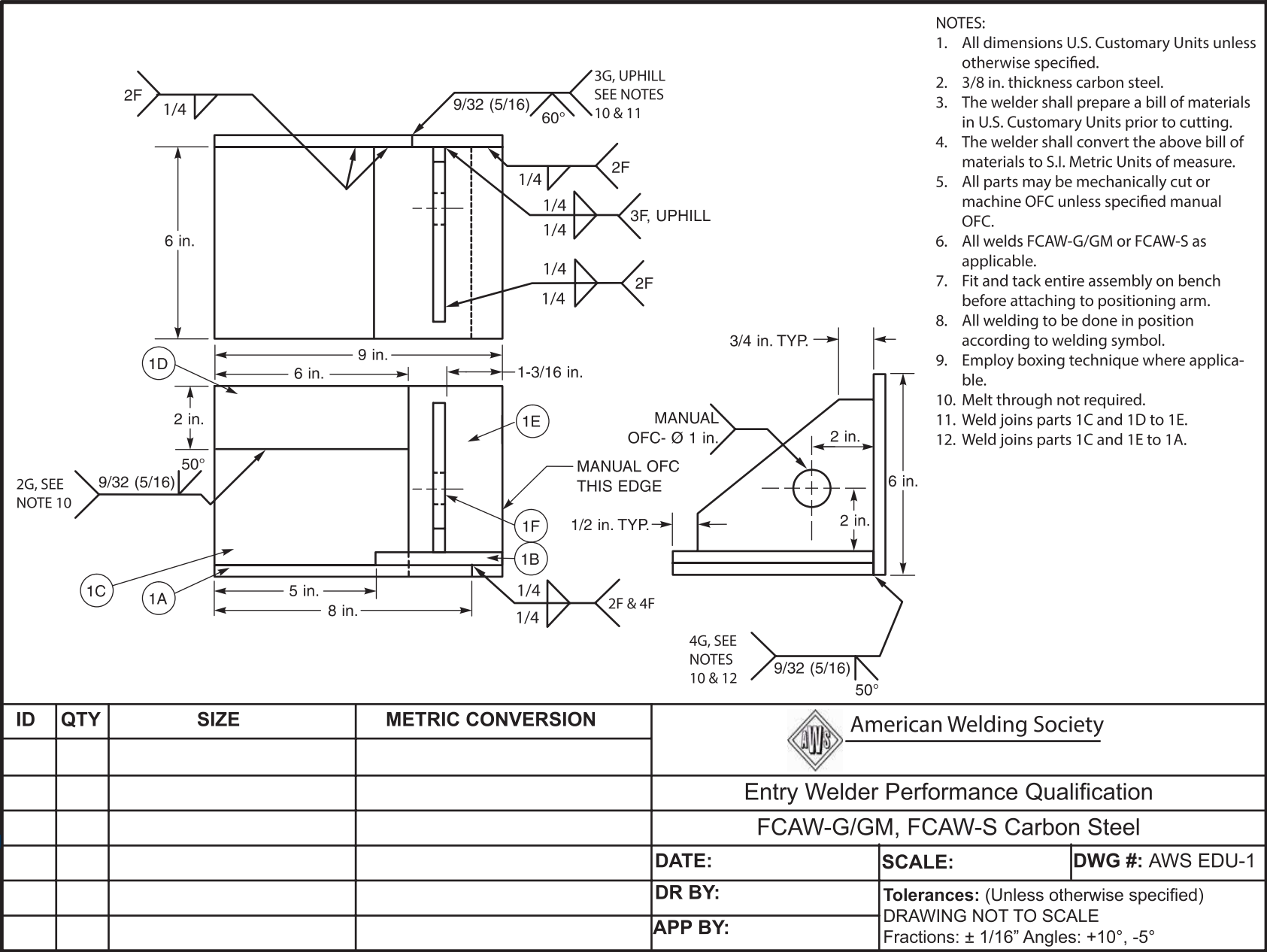
$X_{min} = 1.4 T_n$ OR THE THICKNESS OF THE HUB, WHICHEVER IS SMALLER, UNLESS OTHERWISE REQUIRED BY THE FABRICATION DOCUMENT(S)
 $Y_{min} = T_n$ OR $1/4$ in., WHICHEVER IS SMALLER, UNLESS OTHERWISE REQUIRED BY THE FABRICATION DOCUMENT(S)
 T_n = NOMINAL PIPE WALL THICKNESS

RECOMMENDED WELDING DIMENSIONS FOR FLANGES

JOINT 4

Figure 1 (Continued)—Allowable Joint Designs

	SENSE PROGRAM WORKMANSHIP PERFORMANCE QUALIFICATION TECHNIQUE SHEET		SENSE TEST No: Level I - Entry Welder, Test 3 (A)	
			REVISION No: 1	DATE: 5/15/2015
			SUPPORTING SWPS No: AWS B2.1-1-019	
MATERIAL: ASTM A36			Joint Details: See Drawing AWS EDU-1	
PRODUCT FORM: Plate				
DIAMETER: NA	THICKNESS: 3/8 in.			
POSITION: 3G & 4G	PROGRESSION: Uphill			
MIN. PREHEAT / MAX INTERPASS TEMP: 50°F / NA				
CLEANING: Wire Brush, Grind as Required				
BACKING: Carbon Steel Backing Strip ¹				
BACKGOUGING: None				
COUPON: Per drawing				
VARIABLE		Root and Balance (0.045 Electrode)	Root and Balance (0.052 Electrode)	Root and Balance (1/16 Electrode)
Process		FCAW-G	FCAW-G	FCAW-G
Process Type		Semiautomatic	Semiautomatic	Semiautomatic
Electrode/Filler Classification		E71T-1M	E71T-1M	E71T-1M
Electrode/Filler Size (in.) ²		0.045	0.052	1/16
Consumable Insert		NA	NA	NA
Tungsten Electrode Classification		NA	NA	NA
Penetration Enhancing Flux		NA	NA	NA
Current/Polarity		DCEP	DCEP	DCEP
Current Range (Amps)		180 - 280	190 - 300	210 - 350
Transfer Mode (GMAW & FCAW)		Globular	Globular	Globular
Voltage Range		24 - 28	24-29	24-29
Wire Feed Speed (ipm)		230 - 440	250-500 / 150-450	250-500 / 150-450
Contact Tube to Work (in.)		1 ± 1/4	1 ± 1/4	1 ± 1/4
Bead Width (Stringer or Weave)		Either	Either	Either
Travel Speed (IPM)		NA	NA	NA
Torch Shielding Gas Composition		CO ₂	CO ₂	25% CO ₂
Torch Shielding Gas Flow Rate (cfh)		20 to 40 ft ³ /h	20 to 40 ft ³ /h	20 to 40 ft ³ /h
Shielding Gas Cup Size		1/2 in. ID Minimum	1/2 in. ID Minimum	1/2 in. ID Minimum
Root Shielding Gas Composition		NA	NA	NA
Root Shielding Gas Flow Rate (cfh)		NA	NA	NA
Deposit Thickness (in.)		Per drawing	Per drawing	Per drawing
Qualification Standard		AWS QC10, <i>Specification for Qualification and Certification of SENSE Level I—Entry Welders</i>		
Acceptance Criteria:		Visual Inspection per: AWS QC-10, Table 8.1		
NOTES: 1. The backing thickness shall be 1/4" min. to 3/8" max; backing width shall be one inch minimum. 2. Electrode Size - Welder's choice				



Standard Welding Procedure Specification (SWPS)

CO₂ Shielded Flux Cored Arc Welding of Carbon Steel (M-1/P-1, Group 1 or 2), 1/8 through 1-1/2 inch Thick, E70T-1 and E71T-1, As-Welded Condition

Welding Research Council—Supporting PQR Numbers:

003066, 003067, 007008, 007010, 007012, 103030, 103031, 103032,
103033, 103034, 106001, 106002, 200292, 200430, 200763, 200764,
200765, 200767, 200768, 200769, 200770, 200773, 200774, 200775,
200776, 200780, 200781, 200782, 200783, 200784, 200785

Requirements for Application of SWPSs

Scope. The data to support this Standard Welding Procedure Specification (SWPS) have been derived from the above listed Procedure Qualification Records (PQRs) which were reviewed and validated under the auspices of the Welding Research Council. This SWPS is not valid using conditions and variables outside the ranges listed. The American Welding Society considers that this SWPS presents information for producing an acceptable weld using the conditions and variables listed. The user needs a significant knowledge of welding and accepts full responsibility for the performance of the weld and for providing the engineering capability, qualified personnel, and proper equipment to implement this SWPS.

Application. This SWPS is to be used only as permitted by the applicable fabrication document [such as code, specification, or contract document(s)]. The fabrication document should specify the engineering requirements such as design, need for heat treatment, fabricating tolerances, quality control, and examination and tests applicable to the end product.

User's Responsibility. An SWPS does not replace or substitute for fabrication codes, specifications, contract requirements, or capability and judgment on

the part of the user. An SWPS is to be used only as permitted by the applicable fabrication code, specification, or contract document.

The ability to produce production welds having properties suitable for the application depends upon supplementing the SWPS with appropriate performance qualification tests and sound engineering judgment. The user is responsible for the quality and performance of the final product in accordance with the provisions of the fabrication document.

Supplementary Instructions. To adapt this SWPS to a specific application, a user may issue supplementary instructions. Such instructions may consist of tighter fit-up tolerances, higher minimum preheat temperature, or any other instructions necessary to produce a weldment that meets the requirements of the fabrication document. These instructions shall not be less restrictive than provided in the SWPS.

Safety. Safety precautions shall conform to the latest edition of ANSI Z49.1, *Safety in Welding, Cutting, and Allied Processes*, published by the American Welding Society.

This specification may involve hazardous materials, operations, and equipment. The specification does not purport to address all of the safety problems associated with its use. It is the responsibility of the user to establish appropriate safety and health practices. The user should determine the applicability of any regulatory limitations prior to use.