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MILITARY STANDARD

ARC WELDING PROCEDURES FOR CONSTRUCTIONAL STEELS

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DEPARTMENT OF DEFENSE
WASHINGTON, DC 20360

Arc Welding Procedures for Constructional Steels

MIL-STD-1261C(MR)

1. This Military Standard is approved for use by the U.S. Army Materials Technology Laboratory, Watertown, MA, Department of the Army, and is available for use by all Departments and Agencies of the Department of Defense.

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Director, U.S. Army Materials Technology Laboratory, ATTN: SLCMT-MEE Watertown, MA 02172-0001 by using the Standarization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

FOREWORD

1. This standard prescribes the classification and welding processes employed in arc welding procedures for constructional steels. Classes of arc welding procedures are designated for constructional steels utilized in specific design applications.

2. The document has been revised to cover the current state-of-the-art by including additional welding processes with referenced matching filler metal to reflect current industry practices.

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TABLES

1. SCOPE

1.1 Scope. This standard covers the classification of metal-arc welding of constructional steels and the procedures required for documentation before production welding.

1.2 Classification.

1.2.1 Welding procedures. The metal-arc welding procedures are classified as follows:

Class 1 - Constructional steels, readily weldable, for low stressed joints.

Class 2 - Constructional steels, readily weldable for highly stressed joints.

Class 3 - Constructional steels requiring special welding procedures, excluding corrosion resistant steels (see 3.6).

NOTE: Classification of weldments shall be in accordance with the design agency.

1.2.2 Welding process. The welding processes are classified as follows:

(a) Shielded metal arc (SMAW) - manual
(b) Gas tungsten arc (GTAW) - manual or automatic
(c) Gas metal arc (GMAW) - semi-automatic or automatic
(d) Submerged arc (SAW) - semi-automatic or automatic
(e) Flux cored arc (FCAW) - semi-automatic or automatic
(f) Plasma arc (PAW) - manual or automatic
(g) Stud arc (SW) - manual or semi-automatic
(h) Electrogas (EGW) - automatic

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this standard to the extent specified herein. Unless otherwise specified, the issues of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation.

SPECIFICATIONS

FEDERAL

QQ-E-450 - Electrode, Welding, Covered, Mild Steel

MILITARY

MIL-R-5632	- Rod and Wire, Steel, Welding (For Aircraft Applications)
MIL-W-8611	- Welding, Metal-Arc and Gas, Steels, and Corrosion and Heat Resistant Alloys; Process For
MIL-E-8697	- Electrode, Welding, Covered, Low Hydrogen, Heat-Treatable Steel
MIL-E-18193	- Electrode, Welding, Carbon Steel and Alloy Steel Bare, Coiled
MIL-E-19933	- Electrodes and Rods - Welding Bare, Chromium and Chromium - Nickel Steels
MIL-E-22200/1	- Electrode, Welding, Mineral Covered, Iron-Powder, Low-Hydrogen, Medium and High Tensile Steel, as Welded or Stress-Relieved Weld Application
MIL-E-22200/2	- Electrode, Welding, Covered (Austenitic Chromium-Nickel Steel for Corrosive and High Temperature Services)
MIL-E-22200/6	- Electrode, Welding, Mineral-Covered, Low Hydrogen, Medium and High Tensile Steel.
MIL-E-22200/7	- Electrode, Welding, Covered, Molybdenum Alloy Steel Application
MIL-E-22200/8	- Electrodes, Welding, Covered, Low-Hydrogen, and Iron-Powder Low-Hydrogen, Chromium-Molybdenum Alloy Steel and Corrosion Resisting Steel
MIL-E-22200/10	- Electrodes, Welding, Mineral Covered, Iron Powder, Low-Hydrogen Medium, High Tensile and Higher Strength Low Alloy Steels
MIL-E-23765/1	- Electrodes and Rods-Welding, Bare, Solid, and Alloy Cored, Ordinary Strength and Low Alloy Steel
MIL-E-23765/2	- Electrode and Rods - Welding, Bare, Solid, or Alloyed Cored; Low Alloy Steel
MIL-E-24403/1	- Electrodes-Welding, Flux Cored, Ordinary Strength & Low Alloy Steel
MIL-E-24403/2	- Electrode-Welding, Flux Cored, Low Alloy Steel
MIL-M-47230	- Magnetic Particle Inspection, Soundness Requirements for Materials, Parts, and Weldments

STANDARDS

MILITARY

DOD-STD-100	- Engineering Drawing Practices
MIL-STD-410	- Nondestructive Testing Personnel Qualification and - Certification (Eddy Current, Liquid Penetrant, Magnetic Particle, Radiographic and Ultrasonic)
MIL-STD-453	- Inspection Radiographic
MIL-STD-1264	- Radiographic Inspection for Soundness of Welds in Steel by Comparison to Graded ASTM-E 390 Reference Radiographs
MIL-STD-1265	- Radiographic Inspection, Classification & Soundness Requirements For Steel Castings
MIL-STD-1595	- Qualification of Aircraft, Missile and Aerospace Fusion Welders
MIL-STD-1949	- Inspection, Magnetic Particle
MIL-STD-6866	- Inspection, Penetrant Method of

(Copies of specifications, standards, handbooks, drawings, publications, and other Government documents required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

2.2 Other publications. The following document(s) form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted shall be those listed in the issue of the DODISS specified in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS shall be the issue of the nongovernment documents which is current on the date of the solicitation.

AMERICAN WELDING SOCIETY

AWS A2.4	- Symbols for Welding and Nondestructive Examination
AWS A3.0	- Welding Terms and Definitions
AWS A5.1	- Mild Steel Covered Arc Welding Electrodes
AWS A5.5	- Low Alloy Steel Covered Arc Welding Electrodes
AWS A5.9	- Welding Electrodes Rods, Corrosion Resisting Chromium and Chromium Nickel Steel Bare and Composite Metal Cored and Stranded
AWS A5.17	- Carbon Steel Electrodes and Fluxes for Submerged Arc Welding
AWS A5.18	- Carbon Steel Filler Metals for Gas Shielded Arc Welding
AWS A5.20	- Carbon Steel Electrodes for Flux Cored Arc Welding
AWS A5.23	- Low Alloy Steel Electrodes and Fluxes for Submerged Arc Welding
AWS A5.26	- Consumables Used for Electrogas Welding of Carbon and High Strength Low Alloy Steel
AWS A5.28	- Low Alloy Steel Filler Metals for Gas Shielded Arc Welding
AWS A5.29	- Low Alloy Steel Electrodes for Flux Cored Arc Welding
AWS D1.1	- Structural Welding Code: Steel
AWS Handbook	- Volume I, 7th Edition, Chapter 5, Testing for Evaluation of Welded Joints

(Application for copies should be addressed to the American Welding Society, 550 Northwest LeJeune Road, P. O. Box 351040, Miami, FL 33135.)

ASTM

ASTM E8 - Tension Testing of Metallic Materials
ASTM E164 - Ultrasonic Contact Examination of Weldments

(Application for copies should be addressed to the ASTM, 1916 Race Street, Philadelphia, PA 19103.)

3. DEFINITIONS

3.1 Contractor manufacturer. The term "contractor" as used in this standard is defined as the organization having a direct contract with one Government agency. The term "manufacturer" is defined as the organization actually performing the operations covered by this standard. The contractor may or may not be the manufacturer.

3.2 Welding symbols. Symbols for welding shall be as specified in AWS A2.4.

3.3 Readily weldable steels. Readily weldable steels are those with a maximum carbon equivalent of 0.40 weight percent for plain carbon steel grades. This value may be increased for low alloy steels to 0.45 weight percent provided the carbon content does not exceed 0.22 weight percent and phosphorus and sulfur do not exceed 0.06 weight percent each and thickness does not exceed 0.75 inch (19 mm).

3.4 Steels requiring special process controls. All steels which do not fall within the limits defined in 3.3 as applicable.

3.5 Carbon Equivalent. Carbon equivalent (CE) is determined from the following formula:

$$CE = C + \frac{Mn}{6} + \frac{Mo}{4} + \frac{Cr}{5} + \frac{Ni + Cu}{15} + \frac{P}{3}$$

Note: Elements represent a weight percent.

When phosphorous does not exceed 0.06 weight percent, the value "P" may be omitted.

3.6 Corrosion resistant steels. Corrosion resistant steels are those containing more than 4 percent by weight of chromium and less than 50 percent by weight of nickel.

3.7 Weld crack. A weld crack is a linear rupture resulting from excessive localized stress. They may occur in the weld metal, fusion zone or heat affected zone.

3.8 Porosity. Porosity is defined as rounded cavities, free from solid material, which result from gas entrapment during solidification.

3.9 Overlap. Overlap is the protrusion of weld metal beyond the bond at the toe of the weld.

3.10 Slag inclusion. A slag inclusion is a nonmetallic solid material entrapped in or on the weld metal, or between the weld metal and base metal.

3.11 Undercut. Undercut is a groove melted into the base material adjacent to the toe of the weld and left unfilled by weld material.

3.12 Welding terms. AWS A3.0 shall be used to define all other welding terms not defined herein.

4. GENERAL REQUIREMENTS

4.1 Welding procedures. The contractor shall prepare or have the manufacturer prepare detailed welding procedures which delineate all proposed procedures, methods and techniques applicable to the welding requirements of the contract. The welding procedures shall include the factors in table I and shall include orthogonal, isometric, or other suitable drawing types in accordance with DOD-STD-100. The drawings shall delineate a cross section of each joint, the location of each joint, and other information necessary to identify the joint and welding requirements. Changes in any of the elements in table I shall be incorporated into revised welding procedures. The proposed welding procedures and revised welding procedures shall be accepted by the Government (see 5.1.1 and 5.2.1) or the procuring activity (see 5.3.1) prior to the contractor commencing welding or revising welding operations.

TABLE I. Factors and changes in joint welding procedures.

Joint welding procedure	Joint welding procedure to be revised and reviewed when factor is changed	
1. Shielding medium type and flow rate	YES.	
2. Manual, semi-automatic or automatic wire feed rate	YES.	When changing from one to another.
3. Travel speed, machine only	YES.	When there is a change in travel speed outside the accepted range.
4. Base metal, type, grade, class and range of composition	YES.	For changes which increase the carbon equivalent (see 3.4) above the accepted maximum.
5. Thickness of base metal	YES.	For changes outside the accepted range.
6. Heat treated condition	YES.	For changes which alter the hardness above or below the specified hardness.
7. Joint type:		
a. Bevel angle or groove angle	YES.	For changes which exceed the accepted limits.
b. Root face	YES.	For changes which exceed the accepted limits.
c. Root opening	YES.	For changes which exceed the accepted limits.

TABLE I Factors and changes in joint welding procedures.(Continued)

Joint welding procedure	Joint welding procedure to be revised and reviewed when factor is changed	
d. Groove radius	YES.	For changes which exceed the accepted limits.
8. Method and material for backing of root passes	YES.	
9. Joint preparation:		
a. Preparation of base metal for welding	YES.	For change to thermal method of preparation.
b. Preparation of root for welding second side. (Joint welded from both sides.)	YES.	For change to thermal method of preparation.
10. Position of welding	YES.	When accepted limits of position are exceeded.
11. Base metal temperature:		
a. Temperature at start of welding	YES.	
b. Interpass temperature	YES.	
12. Filler metal:		
a. Brand	YES.	Unless the new brand is accepted for the same type, and class under the applicable MIL QPL or AWS filler metal specification
b. Type and class	YES.	
c. Size	YES.	For increase of electrode size.
13. Welding energy:		
a. Arc current	YES.	When the limits established in the recorded joint welding procedure are exceeded.
b. Arc voltage	YES.	When the limits established in the recorded joint welding procedure are exceeded.

TABLE I Factors and changes in joint welding procedures.(Continued)

Joint welding procedure	Joint welding procedure to be revised and reviewed when factor is changed
c. Source of power, A.C. or D.C., and polarity if D.C. is used	YES. Except when acceptance granted for A.C.-D.C. electrode or shielded metal-arc welding.
14. Weld metal deposition. Sequence and approximate number of passes.	YES. When major changes are made.
15. Mechanical treatment (such as straightening, peening, burnishing, presetting, cold-drawing, spinning, etc)	YES. A change from accepted mechanical treatment which affects the required properties of the weldment.
16. Post-weld heat treatment	YES. Any change from accepted heat treatment procedure which affects the required properties of the weldment changes such as: a. Exceeding temperature limits. b. Change of time at temperature. c. Change of heating or cooling rate. d. Change of cooling medium. e. Change of heating medium. f. Change of sequence of heat treatment operations including time interval for stress relief.
17 Welding process	YES. When changing from one process to another.
18 Nonconsumable electrode:	
a. Size	YES.
b. Type or Class	YES.
c. Specification number	YES.

NOTE: See 4.1.1 for heat input controls.

4.1.1 Heat input controls. For steels requiring heat-input controls, the heat input, expressed in joules per inch (per mm) (see 6.2), shall be recorded and made part of the welding procedure for each different welding condition see 4.1. The information will be compiled to clearly show the joint description, welding symbol, specific type of metal and its thickness, amperage, voltage, travel speed, welding process, preheat temperature, interpass temperature, filler wire identification plus diameter and resulting heat input. The maximum heat input recommended by the manufacturer of the material for each different welding condition shall also be shown. Where unequal thicknesses or different compositions are brought together into a weld joint, the selection of heat input shall be based on the lower maximum.

4.1.2 Repair welding procedures. When repair of defective weldments is necessary and not prohibited by the contract or order, the contractor shall prepare repair welding procedures detailing the factors listed in table II in addition to the information required in 4.1 and when applicable 4.1.1. The contractor shall submit repair welding procedures for acceptance to the Government (see 5.1.1 and 5.2.1) or the procuring activity (see 5.3.1) prior to the contractor commencing repair welding.

TABLE II. Factors for repair welding.

(a) Method to be used (grinding or other) for removal of defects.
(b) Method of inspection used to ensure removal of defects.
(c) Contour of cavity prior to welding, such as minimum root dimensions and included angle.

4.2 Qualifications.

4.2.1 Qualifications for welders and welding equipment operators. For Class 1 welds the contractor or manufacturer shall be responsible for assuring welders and welder equipment operators meet the minimum acceptance criteria as established by the approved workmanship specimens when following the recorded welding procedure. For Class 2 and 3 welds the contractor or manufacturer shall be responsible for qualifying all welders and equipment operators in accordance with AWS D1.1 or MIL-STD-1595 as applicable. Records of all welders and welding equipment operators as illustrated in AWS D1.1 or MIL-STD-1595 as applicable shall be maintained by the manufacturer or contractor and shall be made available upon the government's request for review for conformance to all requirements specified. The Government reserves the right to have welders and welder equipment operators recertified when it is deemed necessary to assure conformance to this standard.

4.2.2 Welding procedure qualifications.

4.2.2.1 Welding procedure qualifications for weldments other than aerospace ground support equipment. Unless otherwise specified, the manufacturer or contractor shall maintain a record as illustrated in AWS D1.1 of all weldment qualification tests, using the manufacturers or contractors recorded welding procedure in accordance with 4.1, which shall be made available upon the government's request for review for conformance to all requirements specified. The welding procedures shall be qualified per evaluation of the workmanship specimens in accordance with 4.6.

4.2.2.2 Welding procedure qualifications for weldments of aerospace ground support equipment. When required by drawings or the procuring activity, welding procedure qualifications for weldments of aerospace ground support equipment or similar equipment shall be in accordance with 4.2.2.1 and performed only by welders or welding equipment operators qualified in accordance with MIL-STD-1595.

4.3 Production weldments.

4.3.1 Production weldments for weldments other than aerospace ground support equipment or other similar equipment. Welders and welding equipment operators qualified in accordance with 4.2.1 shall perform production weldments for weldments other than aerospace ground support equipment or other similar equipment.

4.3.2 Production weldments for weldments of aerospace ground support equipment or other similar equipment. When required by drawings or the procuring activity, production weldments for aerospace ground support equipment or other similar equipment shall be performed only by welders or welding equipment operators qualified in accordance with MIL-STD-1595.

4.4 Welding process. Unless otherwise specified by the contract or order, drawing or detail specification, the welding process (see 1.2.2) shall be selected at the option of the contractor or manufacturer.

4.5 Qualifications of nondestructive testing inspection (NDTI) personnel. Personnel shall be qualified in accordance with MIL-STD-410. The contractor shall be responsible for determining the capability of their inspection personnel for performing visual inspection, in order to evaluate welds in accordance with the visual criteria established in this specification.

4.6 Evaluation of workmanship specimens. Workmanship specimens shall be evaluated for proper weld profile, surface quality, freedom from lack of penetration and fusion, and minimum effective throat (See 5.1.5 through 5.1.6.2), according to drawings or standards agreed upon in the contract. Nondestructive testing is also applicable to the extent specified in the contract.

5. DETAIL REQUIREMENTS

5.1 Class 1. Readily weldable steel, for low stressed joints.

5.1.1 Welding procedures. Joint welding procedures shall be prepared in accordance with 4.1 and when applicable 4.1.1. Prior to production, the Government reserves the right to review for acceptance the procedures together with drawings prepared in accordance with DoD-STD-100. Subsequent to initial production, the government shall be notified of any changes to the factors listed in table I for acceptance.

5.1.1.1 Repair welding procedures. When repair welding is required (see 4.1.2).

5.1.2 Filler metal. Unless otherwise specified in the contract or order, drawing, or detail specification, the filler metal shall conform to QQ-E-450, MIL-E-18193, MIL-E-22200/1, MIL-E-22200/10, MIL-E-23765/1, MIL-E-23765/2, MIL-E-24403/1, MIL-E-24403/2, AWS A5.1, AWS A5.17, AWS A5.18, AWS A5.20, AWS A5.23, AWS A5.26, AWS A5.28, AWS A5.29 or AWS A5.5. If the filler metal for the process selected is not available from the above specifications, the filler metal shall be a commercial filler metal approved by the procuring activity. Selected filler metal shall have a yield strength equal to or greater than the lowest yield strength base metal being welded.

5.1.3 Mechanical properties. When mechanical properties requirements are specified by the procuring activity, weld metal or joints shall meet the mechanical properties requirements shown in the contract or order, drawing, or detail material specification. Unless otherwise specified, the material shall be tested in accordance with the applicable methods of either ASTM E8 or the American Welding Society Handbook, seventh edition (Chapter 5, Volume 1).

5.1.4 Soundness. When required, the determination of soundness of weldments shall be made by magnetic particle, dye penetrant, radiographic or ultrasonic inspection methods. Personnel shall be qualified in accordance with MIL-STD-410.

5.1.4.1 Magnetic particle inspection. When magnetic particle inspection is specified in the contract or order, drawing, or detailed specification, weld joints shall be subject to magnetic particle inspection in accordance with MIL-STD-1949.

5.1.4.1.1 Magnetic particle inspection criteria. Unless otherwise specified, acceptance criteria shall be in accordance with MIL-M-47230.

5.1.4.2 Radiographic inspection. When radiographic inspection is specified in the contract or order, drawing or detailed specification, weld joints shall be subject to radiographic inspection in accordance with MIL-STD-1264, MIL-STD-1265 and MIL-STD-453. The contractor shall prepare and submit to the procuring activity for review and approval, prior to production, a position drawing or drawings for each weldment in accordance with DOD-STD-100. Drawings shall consist of symbols in accordance with AWS A2.4, as required to indicate weld joints to be radiographed and include in detail, the factors in table III.

5.1.4.3 Dye penetrant inspection. When dye penetrant inspection is specified in the contract or order, drawing, or detailed specification, weld joints shall be subject to dye penetrant inspection in accordance with MIL-STD-6866.

5.1.4.4 Ultrasonic inspection. When ultrasonic inspection is specified in the contract or order, drawing or detailed specification, weld joints shall be subject to ultrasonic inspection in accordance with ASTM E164. For the development of Level III drawings only, the contractor or manufacturer shall prepare and submit to the procuring activity for review and approval, prior to production, a position drawing or drawings for each weldment in accordance with DOD-STD-100. Drawings shall consist of symbols in accordance with AWS A2.4, as required to indicate weld joints to be ultrasonically inspected and include, in detail, the factors in table IV.

5.1.5 Workmanship. Unless otherwise specified, the contractor or manufacturer, prior to production, shall prepare workmanship specimens using the established welding procedures (see 4.1 through 4.1.1). The specimens may be actual parts or samples simulating all welding conditions and shall represent the minimum acceptable weld quality level and cleaning used in production. If the production weldment is to be welded under rigid restraint, the workmanship specimen shall be equally restrained. Specimens shall be identified by part number and joint configuration. Workmanship specimens prepared to represent multi-pass welds shall be prepared in such a manner as to have exposed at least 1-1/2 inch (3.8 cm) of each pass. All workmanship specimens shall be cross sectioned and etched and shall be attached to the workmanship sample. The workmanship specimens shall be approved by the Government. Workmanship specimens shall be protected from damage and environmental deterioration and maintained in the immediate fabrication area.

5.1.6 Examination. Workmanship specimens and product weldments shall be visually examined in accordance to 5.1.6.1 and examined dimensionally in accordance to 5.1.6.2.

5.1.6.1 Visual. Visual examination of weldments for discontinuities and their permissable acceptance limits shall be in accordance with table V.

5.1.6.2 Dimensional. Fillet and groove weld acceptable dimensions shall be in accordance with table VI. Fillet welds shall be measured using fillet weld gages.

TABLE III. Factors for radiographic inspection.

(a)	Thickness of plate through which radiographs are taken
(b)	Location of film
(c)	Position of film
(d)	Direction of radiation (see note)
(e)	Frequency of examination for joints and weldments
(f)	Soundness of each joint, in accordance with MIL-STD-1264

NOTE: Film size and direction of radiation may be varied provided the necessary coverage is obtained.

TABLE IV. Factors for ultrasonic inspection.

(a)	Thickness of plate through which ultrasonics are taken
(b)	Method used
(c)	Technique used
(d)	Scanning
(e)	Mode of transmission
(f)	Type and size of transducer
(g)	Frequency of examination for joints and welds

TABLE V. Visual Inspection.

Discontinuity	Condition	Acceptance Criteria
a. Weld cracks	------	None allowed.
b. Slag inclusions	------	None allowed.
c. Porosity	------	1. Maximum pore size shall be 1/16 inch (1.6 mm) in diameter. 2. There shall be no more than six pores for any twelve inch (30.5 cm) length of weld. For small weldments with continuous welds less than twelve inches (30.5 cm)in length, there shall be proportionately less pores allowed (example: a maximum of three pores for six inches (15.25 cm) of weld).
d. Overlap	------	The overlap condition shall not exceed 10% of the total weld length.
e. Undercut	1. Base materials 0.25 inch and less in thickness	a. The maximum depth of undercut shall be no greater than 10% of the material thickness which has the undercut. The extent of the undercut shall not exceed 10% of weld length provided the weld seam meets minimum size. b. Maximum width of an undercut shall not exceed twice the depth. c. Melting of base metal on edges of material is not considered to be undercut. It is acceptable provided: (1) Weld seam meets the minimum size. (2) Melting does not exceed 10% thickness for 10% of weld length. (3) Melting of corners is not considered to be undercut. Melting shall not exceed 25% of material thickness.

TABLE V. Visual Inspection. (Continued)

Discontinuity	Condition	Acceptance Criteria
	2. Base materials greater than 0.25 inch (6.35 mm) in thickness	a. Maximum depth of undercut shall be 1/32 inches (0.8 mm). b. Undercut must have a width no less than twice the depth, i.e., the undercut condition shall not create a notch in the undercut member. c. The length of undercut shall not exceed two inches (5 cm) cumulative in any continuous 24 inch (61 cm) length of weld. For continuous welds less than 24 (61 cm) inches in length, the maximum cumula- tive length shall be in direct proportion to this limit or one inch (2.54 cm), whichever is greater. (Example: for an eight inch (20.3 cm) continuous length of weld, maximum cumulative allowable undercut length is one inch)(2.54 cm). d. Melting of base metal on edges of material is not considered to be undercut. It is acceptable provided: (1) Weld seam meets the minimum size. (2) Melting does not exceed 10% thickness for 10% of weld length. (3) Melting of corners is not con- sidered to be undercut. Melting shall not exceed 25% of material thickness.

TABLE VI. Weld dimensions.

Type of weld	Weld dimensions	Acceptance Criteria
Fillet	less than 0.25 inch (6.35 mm)	The weld dimension is the minimum as specified on the drawing symbol.
Fillet	0.25 inch (6.35 mm) and greater	The weld may be undersize by 1/16 inch (1.6 mm) for a maximum length. of 10% of the continuous weld length.
Groove	Any dimension	No underfill is allowed.

5.2 Class 2. Readily weldable steels, for highly stressed joints.

5.2.1 Welding procedures. See 5.1.1.

5.2.1.1 Repair welding procedures. When repair welding is required (see 4.1.2).

5.2.2 Filler metal. Unless otherwise specified in the contract or order, drawing, or detailed specification, the filler metal shall conform to QQ-E-450, MIL-E-18193, MIL-E-22200/10, MIL-E-23765/1, MIL-E-23765/2, MIL-E-24403/1, MIL-E-24403/2, AWS A5.1, AWS A5.17, AWS A5.18, AWS A5.20, AWS A5.23, AWS A5.26, AWS A5.28, AWS A5.29 or AWS A5.5). If the filler metal for the process selected is not available from the above specifications, the filler metal shall be a commercial filler metal approved by the procuring activity. Selected filler metal shall have a yield strength equal to or greater than the lowest yield strength base metal being welded. When pre-heat or post-heat treatments are required, the selected filler metal shall, after heat treatment, produce a yield strength equal to or greater than the lowest yield strength base metal and shall meet the impact requirements of lowest base metal in the applicable specification.

5.2.3 Mechanical properties. When mechanical properties requirements are specified by the procuring activity, weld metal or joints shall meet the mechanical properties requirements in accordance with 5.1.3.

5.2.4 Soundness. When specified in the contract or order, drawing or detailed specification, soundness of weldment shall be determined in accordance with 5.1.4. after all mechanical treatments and heat treatments.

5.2.5 Post-weld mechanical treatments. All weldments subjected to straightening and forming after welding shall require inspection of welded joints in straightened areas by magnetic particle (see 5.1.4.1), radiographic (see 5.1.4.2), dye penetrant (see 5.1.4.3) or ultrasonic (see 5.1.4.4) inspection methods. Less than 100% inspection of the joints may be permitted, when a statistical quality control system has been established by the contractor and approved by the procuring activity.

5.2.5.1 Post-weld heat treatments. All weldments given a post-heat treatment shall require inspection in the same manner as weldments that have been given mechanical treatments (see 5.2.5).

5.2.6 Workmanship. Workmanship shall be in accordance with 5.1.5.

5.2.7 Examination. Workmanship specimens and product weldments shall be visually and dimensionally examined in accordance with 5.1.6.1 and 5.1.6.2.

5.3 Class 3. Steels requiring special welding procedure controls.

5.3.1 Welding procedures. Welding procedures shall be in accordance with 4.1, and when applicable 4.1.1. Prior to production, the procuring activity shall review the procedures together with drawings prepared in accordance with DOD-STD-100 for acceptance. Subsequent to initial production, the procuring activity shall be notified of any changes to the factors listed in table I for acceptance.

5.3.1.1 Repair welding procedures. When repair welding is required (see 4.1.2).

5.3.2 Filler metal. Unless otherwise specified, filler metal shall conform to MIL-R-5632, MIL-E-8697, MIL-E-22200/7, MIL-E-22200/6, MIL-E-18193, MIL-E-22200/1, MIL-E-23765/1, MIL-E-23765/2, MIL-E-24403/1, MIL-E-24403/2, AWS A5.1, AWS A5.17, AWS A5.18, AWS A5.20, AWS A5.23, AWS A5.26, AWS A5.28, AWS A5.29 or AWS A5.5. If filler metal for the process elected is not available in the above specifications, the filler metal shall be a commercial filler metal approved by the procuring activity. Filler metal, for the process specified, shall be selected on the following basis.

(1) For the base metal in the as-welded condition:

(a) Base metal of 60,000 psi (413.7 MPa) yield strength or greater, the lowest yield strength of the filler metal shall meet, but not exceed by more than 15,000 psi (103.4 MPa) the lowest yield strength of the base metal being welded.

(b) Base metals less than 60,000 psi (413.7 MPa) yield strength, the filler metal shall have a yield strength of at least 50,000 psi (344.7 MPa), i.e., filler metal for SMAW will have a yield strength of 50,000 psi (344.7 MPa) as per AWS A5.1

(c) When a combination of base metals are used, one of 60,000 psi (413.7 MPa) yield strength or greater and one less than 60,000 psi (413.7 MPa) yield strength, the filler metal shall be at least 50,000 psi (344.7 MPa) yield strength.

(2) When weldments in the above strength categories are post-heat treated, selected filler metal, after heat treatment, shall produce a yield strength at least equal to or greater than the lowest yield strength base metal and shall meet impact requirements of the lowest base metal in the applicable specification when specified in the drawing or applicable base metal specification.

NOTE: Austenitic electrodes should be used only when approved or specified by the procuring activity in the contract or order or on the applicable drawings. In such a case, (1) and (2) above are not applicable. When use of austenitic electrodes is permitted, filler metals shall conform to MIL-E-22200/2, MIL-E-22200/8, MIL-E-19933, AWS A5.9 or other specification approved by the procuring activity. Use of austenitic electrodes for weldments which require post heat-treatment is not recommended.

5.3.3 Mechanical properties. When mechanical properties requirements are specified by the procuring activity, weld metal or joints shall meet the mechanical properties requirements in accordance with 5.2.3.

5.3.4 Soundness. When specified in the contract or order, drawings or detailed specifications, requirements for soundness shall be in accordance with 5.1.4 after all mechanical treatments and heat treatments.

5.3.5 Post-weld mechanical treatments. All weldments subjected to straightening and forming after welding shall require inspection of welded joints in straightened areas in accordance with 5.2.5.

5.3.5.1 Post-weld heat treatments. All welds given a post-weld heat treatment shall require inspection in the same manner as weldments that have been given mechanical treatments (see 5.3.5.).

5.3.6 Workmanship. Unless otherwise specified, the contractor or manufacturer shall prepare workmanship specimens using the established welding procedures prior to production (see 4.1 through 4.1.1). The specimens may be actual parts or samples simulating all welding conditions and shall represent the minimum acceptable weld quality level and cleaning used in production. If the production weldment is to be welded under rigid restraint, the workmanship specimen shall be equally restrained. Specimens shall be identified by part number and joint configuration. Workmanship specimens prepared to represent multi-pass welds shall be prepared in such a manner as to have exposed at least 1-1/2 inch (3.8 cm) of each pass. Workmanship specimens shall be cross sectioned and etched to show the number of passes and shall be attached to the workmanship sample. Unless otherwise specified, the procuring activity shall approve the workmanship specimens. Workmanship specimens shall be protected from damage and environmental deterioration and maintained in the immediate fabrication area.

5.3.7 Examination. Workmanship specimens and product weldments shall be visually and dimensionally examined in accordance with 5.1.6.1 and 5.1.6.2.

6. NOTES

6.1 Intended use.

6.1.1 Class 1. Examples of weldments for which this procedure is intended are as follows: attachments, brackets, fenders, heaters, ducts, safety shield, ammunition boxes, boiler casings, air vents and most types of sheet metal assemblies.

6.1.2 Class 2. Examples of weldments for which this procedure is intended are as follows: highly stressed carriage and vehicle components and assemblies, leakproof containers, pressure tight vessels, buildings and bridges when constructed of readily weldable steel as defined in 3.3.

6.1.3 Class 3. This procedure is intended for use when fabricating weldments by metal-arc welding when the design and service requirements are such as to require the use of constructional steels as defined in 3.4, when corrosion resistance is not required.

NOTE: Classification of weldments shall be in accordance with the design agency.

6.2 Heat input calculation. Heat input is calculated as follows:

$$\text{Joules per inch (per mm)} = \frac{\text{Amperes x arc volts x 60}}{\text{travel speed (inches per minute) (mm per minute)}}$$

6.3 Contract data requirements. When this standard is used in an acquisition which incorporates a DD Form 1423, Contract Data Requirements List (CDRL), the data requirements identified below shall be developed as specified by an approved Data Item Description (DD Form 1664) and delivered in accordance with the approved CDRL incorporated into the contract. When the provisions of DAR 7-104.9 (n) (2) are invoked and the DD Form 1423 is not used, the data specified below shall be delivered by the contractor in accordance with the contract or purchase order requirements. Deliverable data required by this standard is cited in the following paragraphs.

Paragraph Nos.	Data Requirement Title	Applicable DID No.
4.1, and 4.1.2 5.1.4.1, 5.1.4.2, 5.1.4.3 and 5.1.4.4	Drawings, Engineering And Associated Lists	DI-E-7031
4.1, 4.1.1, 4.1.2, 5.1.1 and 5.1.5	Welding And Repair Welding Procedures	DI-T-1920
5.1.4.1, 5.1.4.2 5.1.4.3 and 5.1.4.4	Weldment Inspection	DI-T-1921

(Copies of data item descriptions related to this specification, and identified in section 6 will be approved and listed as such in DOD 5010.12L, Vol. 11, AMSDL. Copies of data item descriptions required by the contractors in connection with specific acquisition functions should be obtained from the Naval Publications and Forms Center or as directed by the contracting officer.)

6.4 Subject term (keyword) listing.

Metal-arc Welding
Constructional steels
Low stressed joints
Highly stressed joints
Welding process

6.5 Changes from previous issue. The margins of this standard are marked with a single verticle line to indicate where changes from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations.

Custodian:
Army - MR

Review interest:
Army - AR, AT, ME, MI
DLA - DH

Preparing activity:
Army - MR

Project THJM-A241

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