

MIL-W-52574A(ME)
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SUPERSEDING
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MILITARY SPECIFICATION

WELDING PROCESS AND WELDING PROCEDURE REQUIREMENTS

FOR MANUFACTURE OF EQUIPMENT UTILIZING STEELS

This specification is approved for use by the Mobility Equipment Research and Development Command, Department of the Army, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers welding requirements for the manufacture of construction and other mechanical equipment to performance-type military specifications, and the procedures required for documentation prior to production welding.

1.2 Classification.

1.2.1 Welding processes. The types of welding processes are classified as follows:

- Type I - Shielded metal-arc welding.
- Type II - Gas tungsten-arc (manual or machine) welding.
- Type III - Gas metal-arc (manual or machine) welding.
- Type IV - Submerged-arc (manual or machine) welding.
- Type V - Plasma-arc (manual or machine) welding.
- Type VI - Flux cored arc (manual or machine) welding.

1.2.2 Welding procedures. The classes of welding procedures are classified as follows:

- Class 1 - Readily weldable steels for low stressed joints (see 6.3.2).
- Class 2 - Readily weldable steels for highly stressed joints (see 6.3.3).
- Class 3 - Steels requiring special welding procedures (see 6.3.4).

FSC 3431

MIL-W-52574A(ME)

1.3 Applicability. This specification, when referenced in the end item specification, contract, or order, shall apply to all steel welding required at either the contractor's or manufacturer's facility (see 6.3.1).

2. APPLICABLE DOCUMENTS

2.1 Issues of documents. The following documents of the issue in effect on date of invitation for bids or request for proposal form a part of this specification to the extent specified herein.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

Boiler and Pressure Vessel Code, Section IX, Welding Qualifications.

(Application for copies should be addressed to the American Society of Mechanical Engineers, 345 East 47th Street, New York, NY 10017.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- E 109 - Dry Powder Magnetic Particle Inspection.
- E 138 - Wet Magnetic Particle Inspection.
- E 164 - Ultrasonic Contact Inspection of Weldments.
- E 390 - Reference Radiographs for Steel Fusion Welds.

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

AMERICAN WELDING SOCIETY (AWS)

- A2.0 - Standard Welding Symbols.
- A2.2 - Nondestructive Testing Symbols.
- D1.1 - Structural Welding Code, Section 5, Qualification.

(Application for copies should be addressed to the American Welding Society, 2501 North West Seventh Street, Miami, FL 33125.)

(Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

MIL-W-52574A(ME)

3. REQUIREMENTS

3.1 Material.

3.1.1 Weld filler metals. Weld filler metals shall develop the full design strength for the loading imposed on the joint. Where different class steels are welded to each other, filler metal having the strength of the lower strength steel shall be used, provided the filler metal and procedure are compatible with the higher strength steel.

3.2 Welding process. Unless otherwise specified in the end item specification, the welding process (see 1.2.1) shall be selected at the option of the contractor or manufacturer.

3.2.1 Process identification. At the time the end item first article model(s) is furnished for examination, the contractor shall furnish to the Government, in the form of sketches or outline drawings (dimensions not required), identification of Class 2 and Class 3 steels used in the fabrication of the end item and the recommended welding repair procedures for accomplishing repair of such steels by the Government. Identification shall include class of steel with ASTM designation and grade, and location by part or assembly. The recommended procedures shall include, but shall not be limited to, the following:

- (a) Type of weld filler metal to be used for repair of each different type of steel by the shielded metal arc (coated electrode) process, the flux cored arc welding process, and the gas metal-arc process including:
 - (1) Type and class of metal electrode.
 - (2) Size (diameter) of metal electrode.
 - (3) Shielding medium for gas shielded arc welding.
- (b) Material handling safeguard for coated metal electrodes to prevent contamination and moisture absorption, including the treatment of coated metal electrodes after exposure to contamination and moisture absorption.
- (c) Preparation of base metal for welding. Method to be used, grinding or other. Preparation of root for welding second side when thickness of material necessitates that joint be welded from both sides.

MIL-W-52574A(ME)

- (d) Base metal temperature:
 - (1) Minimum and maximum temperature of base metal at start of welding.
 - (2) Minimum and maximum preheat temperatures of base metal at start of welding.
 - (3) Minimum and maximum interpass temperature during welding.
- (e) Moisture content of shielding medium for gas metal-arc welding.
- (f) Rate of flow of shielding medium for gas metal-arc welding.
- (g) Maximum heat input during welding.
- (h) The minimum ambient temperature at which welding should be done.
- (i) Post weld heat-treatment (stress-relieving) requirements.

3.3 Required procedures.

3.3.1 Welding procedures. Prior to the production fabrication of any weldment including attachments, the contractor shall prepare or shall have the manufacturer prepare an outline drawing showing the location of each joint and the joint welding procedures to cover all welding, including a general outline for the repair of base material and welded joints. This information shall be prepared in duplicate and the cover sheet shall be signed "approved" by the manufacturer and by the contractor. Each joint welding procedure shall contain a reference to the location of the joint as shown on the outline drawing, a typical cross section sketch of the joint, and shall include the factors listed in Table I. Changes in any of the factors shall be reflected in the recorded joint welding procedures. Signed copies of the joint welding procedures shall be retained by the contractor or manufacturer during the life of the contract and shall be made available upon request by the Government.

MIL-W-52574A(ME)

TABLE I. Factors and changes in joint welding procedures.

<u>Joint welding procedure.</u>	<u>Joint welding procedure to be revised and reviewed when factor is changed.</u>
1. Shielding medium type.	Yes.
2. Manual, semi-automatic or automatic.	Yes. When changing from one to another.
3. Travel speed, machine only.	Yes. When there is a change in travel speed outside the approved range.
4. Base material, type, grade, class, and range of composition.	Yes.
5. Thickness of base material.	Yes.
6. Heat-treated condition.	Yes.
7. Joint type:	
(a) Bevel angle or groove angle.	Yes.
(b) Root face.	Yes.
(c) Root opening.	Yes.
(d) Groove radius.	Yes.
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.
11. Base metal temperature:	
(a) Temperature at start of welding.	Yes.
(b) Interpass during welding.	Yes.
12. Filler metal:	
(a) Brand.	Yes. Unless the new brand is approved for the same type and class under the applicable Military Qualified Products List.
(b) Type and class.	Yes.
(c) Size.	Yes. For increase of electrode size.

MIL-W-52574A(ME)

TABLE I. Factors and changes in joint welding procedures. - Continued

<u>Joint welding procedure.</u>	<u>Joint welding procedure to be revised and reviewed when factor is changed.</u>
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.
(c) Source of power, a.c. or d.c., and polarity if d.c. is used.	Yes. Except when a.c.-d.c. electrode approved on 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, etc.).	Yes. A change from approved mechanical treatment which affects the required properties of the weldment.
16. Post heat-treatment.	Yes. Any change from approved 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.

Note: For steels requiring heat-input controls, the heat input expressed in joules per inch shall be recorded and made part of the welding procedure for each different welding condition. The information will be compiled to clearly show the joint description, welding symbol, specific type of material and its thickness, amperage, voltage, travel speed, welding process, and filler wire identification, plus diameter and resulting heat input. The maximum

MIL-W-52574A(ME)

heat input recommended by the manufacturer of the material for each different welding condition shall 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. Heat-input is calculated as follows:

$$\text{Energy Input} = \frac{\text{amperes} \times \text{arc volts} \times 60}{\text{travel speed (inches per minute)}} = \text{Joules per inch}$$

or

$$\text{Energy Input} = \frac{\text{amperes} \times \text{arc volts} \times 60}{\text{travel speed (centimeters per minute)}} = \text{Joules per centimeter}$$

3.3.2 Welding practices. The surfaces of parts to be welded shall be free from paint, grease, scale which can be removed by chipping and wire brushing, and other foreign matter. When multiple passes of weld metal are required, each pass shall be thoroughly cleaned before making another pass. All welded parts and assemblies shall be free from cracks and other imperfections that may reduce the effectiveness of the part or assembly. All weldments shall be free from slag, flux, weld spatter, and other impurities detrimental to the strength and soundness of the weld. Work shall be positioned for flat welding whenever practicable. Butt-type joints having members of equal thickness shall be aligned within 10 percent of the thickness of the members involved. Weldments shall be free from overlaps. The quality of production weldments shall be equal to or better than those shown by the weld joint specimens (see 3.4).

3.3.3 Weldment repair procedure. Prior to the production fabrication of any weldment including attachments, the contractor shall prepare, or shall have the manufacturer prepare, a weldment repair procedure for the repair of defective welds and defects in base materials. The responsibility for preparing and signing the weldment repair procedure will be the same as specified in 3.3.1. The repair procedures shall include, but shall not be limited to, the following:

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

MIL-W-52574A(ME)

3.4 Workmanship specimens. The contractor or manufacturer shall prepare workmanship specimens representing each typical weld joint encountered on the end item to be manufactured. The specimens shall be prepared using the approved welding procedures (see 3.3.1). The specimens shall be free of cracks and other injurious defects and shall represent acceptable weld appearance and cleaning procedure to be used in production. Specimens prepared to represent multi-pass welds shall be prepared in such a manner as to have exposed at least 1.5 inches of each pass. Specimens of actual production parts shall be cross-sectioned and etched to show the number of passes. The quality level of specimens using actual parts shall be determined by the contractor as the minimum required to insure that the end item will meet the test requirements of the applicable end item specification.

3.5 Mechanical characteristics and weld soundness.

3.5.1 Mechanical characteristics. Mechanical characteristics of all welds shall be such that weldments will transmit stress, without failure or permanent deformation, when the end item being produced, is subjected to any test specified in the end item specification.

3.5.2 Weld soundness. Weld joints of Class 1, Class 2, and Class 3 steels shall be visually inspected for soundness. Furthermore, weld joints of Class 2 and Class 3 steels shall be subjected to a nondestructive test for soundness. Joints requiring nondestructive tests shall be identified on the welding procedure outline drawing (see 3.3.1) in accordance with the nondestructive testing symbol requirements of AWS A2.2. The frequency of nondestructive testing shall also be indicated on the welding procedure drawing.

3.5.2.1 Radiographic inspection. Where radiographic methods are used to determine type and severity levels of discontinuities which affect soundness of weldments, the contractor or manufacturer shall indicate acceptable levels of soundness in accordance with graded reference radiographs of ASTM E 390.

3.5.2.2 Magnetic particle inspection. Where magnetic particle inspection methods are used to detect discontinuities affecting soundness of weldments, the contractor or manufacturer shall indicate acceptance standards for weldments when inspected in accordance with ASTM E 109 or ASTM E 138.

MIL-W-52574A(ME)

3.5.2.3 Ultrasonic inspection. Where ultrasonic inspection methods are used to detect discontinuities affecting soundness of weldments, the contractor or the manufacturer shall indicate acceptance standards for weldments when inspected in accordance with ASTM E 164. Data developed in accordance with 3.5.2.1, 3.5.2.2, and 3.5.2.3 shall be prepared in duplicate and the cover sheet shall be signed "approved" by the contractor and the manufacturer. Signed copies of this joint inspection data shall be retained by the contractor or manufacturer during the life of the contract and shall be made available upon request by the Government.

3.6 Welder and welding operator certification. Before assigning any welder to manual welding work covered by this specification, the contractor shall provide a contracting officer with certification that the welder has passed qualification tests as prescribed by either of the following listed codes for the type of welding operations to be performed and that such qualification is effective as defined by the particular code:

AWS D1.1, Structural Welding Code, Section 5, Qualification.
ASME Boiler and Pressure Vessel Code, Section IX, Welding Qualifications.

Contractors who make only flat or horizontal welds need not qualify welders for "all position welding". Subject to approval by the Government, the contractor's standard welder qualification may be substituted in lieu of the above codes provided that the contractor's procedure is equivalent to the above codes. The contractor shall be responsible for determining that automatic welding equipment operators are capable of producing quality welds in accordance with the contractor's or manufacturer's recorded welding procedure (see 3.3.1).

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

MIL-W-52574A(ME)

4.2 Inspection.

4.2.1 Class 1 steels.

4.2.1.1 Welding procedures. Joint welding procedures shall be prepared as specified in 3.3.1. The procedures shall be retained by the contractor or manufacturer and shall be made available upon request by the Government.

4.2.1.2 Workmanship specimens. Workmanship specimens shall be prepared as specified in 3.4.

4.2.1.3 Inspection. Weldments shall be visually inspected for conformance with 3.3.2 and 3.5.1; and visually inspected for soundness (see 3.5.2).

4.2.2 Class 2 and Class 3 steels.

4.2.2.1 Welding procedures. Joint welding procedures shall be prepared as specified in 3.3.1. The joint procedures shall be retained by the contractor or manufacturer and shall be made available upon request by the Government.

4.2.2.2 Workmanship specimens. Workmanship specimens shall be prepared as specified in 3.4.

4.2.2.3 Inspection. Weldments shall be visually inspected for conformance to 3.3.2, 3.5.1, and 3.5.2. Prior to production fabrication of any weldment, the contractor or manufacturer shall identify the joints requiring inspection as specified in 3.5.2, and determine the inspection medium (magnetic particle, ultrasonic, or radiographic) necessary to determine the soundness of production welds. All weldments subjected to straightening and forming after welding shall require inspection of welded joints in the straightened areas. The contractor shall develop or have the manufacturer develop, as applicable, the information shown in Table II. This information shall be retained by the contractor or manufacturer during the life of the contract and shall be made available upon request by the Government. The Government reserves the right to require changes to the inspection procedures where such changes are deemed necessary to assure supplies and services conform to prescribed requirements.

MIL-W-52574A(ME)

TABLE II. Weldment inspection factors.

Inspection type			Inspection factors
Radio-graphic	Magnetic particle	Ultra-sonic	
X	X	X	Location of joints in weldments to be inspected (symbols in accordance with AWS A2.0).
X	X	X	Joint type (symbols in accordance with AWS A2.0):
X	X	X	Frequency of inspection for joints and weldments.
X		X	Thickness of plate through which tests were made.
X			Location of film.
X			Position of film.
X	X	X	Soundness standard for each joint.
	X		Inspection medium, wet or dry.
	X		Type of current, a.c. or d.c.
	X		Amount of current.
	X		Magnetizing technique, direct or indirect.
	X		Sequence of operations, continuous or residual.
	X		Geometric and material description of prods.
		X	Testing frequency.
		X	Size of transducer.
		X	Shape of transducer, (flat, concave, etc.).
		X	Nominal frequency of transducer.
		X	Angle of beam used.
		X	Couplant used.
		X	Size, location and concentration of indications which are to be considered acceptable.

MIL-W-52574A(ME)

5. PACKAGING (Not applicable to this specification.)

6. NOTES

6.1 Intended use. This specification is intended for use in controlling the welding of steels used in the manufacture of equipment to performance-type military specifications, and to require identification of steel classes used in the manufacture of equipment to facilitate field repairs of damaged equipment by the military.

6.2 Ordering data. Procurement documents should specify the following:

(a) Title, number, and date of this specification.

6.3 Definition of terms.

6.3.1 Contractor, manufacturer. The term "contractor" as used in this specification is defined as the organization having a direct contact with the Government. The term "manufacturer" is defined as the organization actually performing the operations covered by this specification. The contractor may or may not be the manufacturer; hence, when "contractor" or "manufacturer" is used, it designates them as separate parties or as one and the same when "or both" is used.

6.3.2 Class 1 steels. Examples of Class 1 readily weldable steels for low stressed joints are steels conforming to ASTM A 36, A 108, A 575, and A 576 with 0.25% carbon, maximum.

6.3.3 Class 2 steel. Example of Class 2 readily weldable steel for highly stressed joints is steel conforming to the requirements of ASTM A 441.

6.3.4 Class 3 steels. Examples of Class 3 steels requiring special welding procedures are steels conforming to the requirements of ASTM A 148, A 440, and A 514.

6.4 Classification changes. Changes in classification of the welding procedures and welding processes between this revision of the specification and the previous edition are as follows:

MIL-W-52574A(ME)

<u>Old Designation</u>	<u>New Designation</u>
Type 1	Class 1
Type 2	Class 2
Type 3	Class 3
Process (a)	Type I
Process (b)	Type II
Process (c)	Type III
Process (d)	Type IV
-	Type V
-	Type VI

Custodian:
Army - ME

Preparing activity:
Army - ME

User activity:
Army - WC

Project 3431-A126

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions - Reverse Side)

1. DOCUMENT NUMBER		2. DOCUMENT TITLE	
3a. NAME OF SUBMITTING ORGANIZATION		4. TYPE OF ORGANIZATION (Mark one)	
b. ADDRESS (Street, City, State, ZIP Code)		<input type="checkbox"/> VENDOR	
		<input type="checkbox"/> USER	
		<input type="checkbox"/> MANUFACTURER	
		<input type="checkbox"/> OTHER (Specify): _____	
5. PROBLEM AREAS			
a. Paragraph Number and Wording:			
b. Recommended Wording:			
c. Reason/Rationale for Recommendation:			
6. REMARKS			
7a. NAME OF SUBMITTER (Last, First, MI) - Optional		b. WORK TELEPHONE NUMBER (Include Area Code) - Optional	
c. MAILING ADDRESS (Street, City, State, ZIP Code) - Optional		8. DATE OF SUBMISSION (YYMMDD)	

(TO DETACH THIS FORM, CUT ALONG THIS LINE.)