

**MIL-STD-1943(MR)**  
**5 February 1985**

---

SUPERSEDING  
MIL-W-13773A(MR)  
6 October 1965  
AMENDMENT -2  
8 September 1972

**MILITARY STANDARD**

**WELDING REPAIR OF STEEL CASTINGS  
(OTHER THAN ARMOR) METAL-ARC, MANUAL**



MIL-STD-1943(MR)

Welding Repair of Steel Castings (Other Than Armor), Metal-ARC, Manual

MIL-STD-1943(MR)

1. This Military Standard is approved for use by the Army Materials and Mechanics Research Center, 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, US Army Materials and Mechanics Research Center, ATTN: DRXMR-SMS, Watertown, MA 02172 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

MIL-STD-1943(MR)

FORWORD

1. This standard is intended to prescribe the repair welding requirements for all types of steel castings, (excluding armor castings). Repair welding of armor castings is covered under MIL-STD-1941.

## CONTENTS

Par graph	Page	
1.0	Scope .....	1
1.1	Scope .....	1
2.0	Referenced documents .....	2
3.0	Definitions .....	3
4.0	General requirements .....	4
4.1	Preparation of welding procedures and drawings .....	4
4.2	Welders or welding operator .....	4
4.3	Workmanship .....	4
4.4	Metric units .....	4
5.0	Detailed requirements .....	5
5.1	Recorded welding procedure .....	5
5.1.1	Critical factors .....	5
5.1.2	Qualification of personnel for casting repair welding . . . . .	5
5.2	Material .....	5
5.2.1	Castings .....	5
5.2.2	Filler metal .....	5
5.3	Preparation for repair welding .....	5
5.3.1	Method of removal of defects prior to welding .....	5
5.3.2	Cavity condition .....	6
5.4	Temperature conditions .....	6
5.4.1	Preheating .....	6
5.4.2	Interpass temperature .....	6
5.4.3	Post heating .....	6
5.5	Repair weld procedure .....	6
5.6	Machinability of repaired areas .....	6
5.7	Physical properties of repaired areas .....	6
5.8	Non-destructive inspection requirements .....	6
5.8.1	Radiographic requirements .....	6
5.8.2	Magnetic particle requirements .....	6
5.9	Inspection of repaired castings .....	7
5.9.1	Radiographic inspection .....	7
5.9.2	Visual examination .....	7
5.9.3	Tests .....	7
Appendix	Contract Data Requirements .....	8

MIL-STD-1943(MR)

1.0 SCOPE

1.1 Scope. This standard covers the requirements for manual-arc welding for the repair of readily weldable steel castings, in connection with production or maintenance in field or at storage areas. This does not cover the repair welding of armor castings.

MIL-STD-1943(MR)

2.0 APPLICABLE DOCUMENTS

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

SPECIFICATIONS

Military

- DOD-D-1000 - Drawings, Engineering and Associated Lists
- MIL-I-6868 - Inspection Process, Magnetic Particle

STANDARDS

- DOD-STD-100 - Engineering Drawing Practices
- 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.

(Copies of specifications, standards, and drawings required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer).

2.2 Other publications. The following documents form a part of this standard to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) STANDARDS

A-488 Steel Castings, Welding, Qualifications of Procedures and Personnel

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

## MIL-STD-1943(MR)

## 3.0 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 Welding terms and definitions shall be as specified in AWS A3.0.

3.3 Readily weldable steels. Readily weldable steels are those with a maximum carbon equivalent or 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 or 3.6, as applicable.

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

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

Note: Elements represent a weight percent.

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

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

3.7 Recorded repair welding procedures. A written statement, including drawing(s) showing the location and extent (length, width, depth) of the defects, and weld parameter(s), material(s) employed to repair defect(s).

3.8 Qualified welding procedure. A welding procedure is considered being qualified when both the welding procedure and a sample of a repair welded casting having been approved by the government contracting officer or his designated agents.

## MIL-STD-1943(MR)

## 4.0 GENERAL REQUIREMENTS

4.1 Preparation of welding procedures and drawings. The recorded welding procedure shall be prepared by the contractor or manufacturer and shall have drawings and isometric perspectives of areas to be prepared as described in the Contract Data Requirements Appendix.

4.2 Welders or welding operator. The contractor shall be responsible for determining the qualification of the welders or the welding operators to perform welding satisfactorily, as prescribed in the contractor's or the manufacturer's approved welding procedure. Unless otherwise specified in the contract as a minimum for ascertaining qualification, the welders shall perform the tests specified in ASTM A 488.

4.3 Workmanship. Repair welds shall be free from porosity, shrinkage, slag, cracks, and comply with the quality of the originally specified item. The appearance and soundness of the repair weld shall be equal to or better than that of the approved preproduction casting.

4.4 Metric units. When metric dimensions are required, units for inch may be converted to the metric equivalent by multiplying by the following conversion factor:

<u>English</u>	<u>Multiply by</u>	<u>Equals</u>	<u>Metric SI Units</u>
inch	25.40	=	Millimeters (mm)

## MIL-STD-1943(MR)

## 5.0 DETAILED REQUIREMENTS

5.1 Recorded repair welding procedure. Prior to the repair of any casting, the contractor shall prepare the recorded welding procedures required for restoring the defective casting and submit same to procuring agency's contracting officer for appropriate engineering office approval as described in the Contract Data Requirements Appendix. Once approved a copy of the approved weld procedure together with a sample casting repaired per that procedure shall be presented to the Product Assurance Office (designated by contracting office) for approval. The repair procedure shall be considered qualified when notified by the contracting officer or his designated agents.

5.1.1 Critical factors. The recorded welding procedure shall include the following critical factors for weld repair:

- (a) Chemical analysis of the casting
- (b) Material specification
- (c) Sketch of defect and drawing showing location (including dimensions)
- (d) Defect removal-cavity preparation (method used)
- (e) In spection of repair cavity (method to insure removal of defect)
- (f) Base metal-type and heat-treated condition
- (g) Filler metal: Size & Type (specification - AWS designation)
- (h) Flux or gas & gas flow rate
- (i) Position of weld
- (j) Arc-voltage and current range
- (k) Minimum pre-heat temperature
- (l) Maximum interpass temperature
- (m) Post-heat treatment
- (n) Inspection of completed weld (method)

5.1.2 Qualification of personnel for casting repair welding. The manufacturer or contractor shall determine the extent of welder training needed to repair casting per the qualified weld procedure.

5.2 Material.

5.2.1 Castings. The repaired castings shall be capable of meeting the requirements of the casting specification.

5.2.2 Filler metal. Unless otherwise specified in the contract or order, the yield strength of the deposited weld metal shall be equal to or greater than the yield strength of the base metal. When the weldment is to be heat treated, the deposited weld metal shall meet the minimum yield strength of the base metal after heat treatment.

5.3 Preparation for repair welding.

5.3.1 Method of removal of defects prior to welding. All defective portions of a casting shall be removed as specified in the contractor's qualified welding procedure. A melting process such as arc cutting or flame cutting shall be permitted only upon specified approval of the contracting officer.

## MIL-STD-1943(MR)

5.3.2 Cavity condition. The cavity formed by removal of a defect shall conform to the shape and dimensions prescribed in the contractor's qualified welding procedure. It shall also be free of any foreign material that may adversely affect the quality of the weld deposit.

5.4 Temperature conditions.

5.4.1 Preheating. When preheating is permitted, it shall be performed in accordance with the conditions prescribed in the contractor's qualified welding procedure. No repair welding shall be carried out when the temperature of the casting is lower than 60°F.

5.4.2 Interpass Temperature. When the contractor's qualified welding procedure specifies that a casting or any area thereon is to be preheated, the casting or area thus specified shall not be permitted to cool below the initial preheat temperature until all welding has been completed, unless otherwise permitted by the contracting officer. The interpass temperature of castings repair-welded after final heat treatment, shall be not more than 400°F below the last temperature employed in that treatment.

5.4.3 Post heating. When post heating is permitted, it shall be carried out in accordance with the contractor's qualified welding procedure.

5.5 Repair weld procedure. Welding repair on production castings shall be performed in accordance with the contractor's approved qualified welding procedure. Peening of weld-metal deposits shall be permitted only upon approval of the contracting officer. When permitted, the peening shall be carried out in accordance with the contractor's qualified welding procedure. Unless otherwise specified, the surface of repair welds shall be finished off so as to simulate the original casting surface. All slag and weld spatter shall be removed.

5.6 Machinability of repaired areas. Unless otherwise specified, repair-welding procedures that will adversely affect machinability shall not be permitted in areas to be machined.

5.7 Physical properties of repaired areas. Unless otherwise specified in the contract or order, the physical properties requirements of the repair welds and all areas affected by the welding shall conform to the requirements specified on the casting drawing.

5.8 Non-destructive inspection requirements.

5.8.1 Radiographic requirements. Repair welds shall meet the radiographic requirements specified for the casting. If no requirements for repair welds are specified in the casting specification, drawing, or contract, the welds shall meet the requirements of Grade III of MIL-STD-1264, providing radiographic requirements are specified for the castings being repaired.

5.8.2 Magnetic particle requirements. Repair shall meet the magnetic particle requirements specified for the casting. If no soundness requirements are specified in the casting specification drawing or contract the repair welds shall be free of cracks when inspected per MIL-I-6868.

MIL-STD-1943 (MR)

5.9 Inspection of repaired castings.

5.9.1 Radiographic inspection. Radiographic inspection shall be carried out in accordance with MIL-STD-453 to determine compliance with 5.8.1.

5.9.2 Visual examination. All repair welds shall be subjected to visual examination for compliance with the workmanship requirementf of 4.3.

5.9.3 Tests. When specified on the drawing or in the contract or order, the contractor shall prepare and submit a weld repair sample for test to determine the applicability of the repair welding procedure to be employed in production.

Custodian:  
Army - MR

Preparing activity

Army - MR

User activities:  
Army, AT, ME, MI

Project No. THJM-A223

## MIL-STD-1943(MR)

## APPENDIX

## 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".

<u>Paragraph No.</u>	<u>Data Requirements Title</u>	<u>Applicable DID No.</u>
4.1	Drawings, Engineering and Associated Lists	DI-E-7031
5.1	Request for Repair Welding Approval for Forgings or Castings	DI-P-1637