



Designation: A488/A488M – 07

# Standard Practice for Steel Castings, Welding, Qualifications of Procedures and Personnel<sup>1</sup>

This standard is issued under the fixed designation A488/A488M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reappraisal. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

*This standard has been approved for use by agencies of the Department of Defense.*

## 1. Scope\*

1.1 This practice covers the qualification of procedures, welders, and operators for the fabrication and repair of steel castings by electric arc welding.

1.1.1 Qualifications of a procedure and either or both the operator or welder under Section IX of the **ASME Boiler and Pressure Vessel Code** shall automatically qualify the procedure and either or both the operator or welder under this practice. P-number designations in the ASME grouping of base metals for qualification may be different than the category numbers listed in **Table 1**. Refer to **Appendix X1** for a comparison of ASTM category numbers with the corresponding ASME P-Number designations.

1.2 Each manufacturer or contractor is responsible for the welding done by his organization and shall conduct the tests required to qualify his welding procedures, welders, and operators.

1.3 Each manufacturer or contractor shall maintain a record of welding procedure qualification tests (**Fig. 1**), welder or operator performance qualification tests (**Fig. 2**), and welding procedure specification (**Fig. 3**), which shall be made available to the purchaser's representative on request.

1.4 The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system must be used independently of the other. Combining values from the two systems may result in nonconformance with this practice.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

<sup>1</sup> This practice is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.18 on Castings.

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## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

- A27/A27M Specification for Steel Castings, Carbon, for General Application
- A128/A128M Specification for Steel Castings, Austenitic Manganese
- A148/A148M Specification for Steel Castings, High Strength, for Structural Purposes
- A216/A216M Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
- A217/A217M Specification for Steel Castings, Martensitic Stainless and Alloy, for Pressure-Containing Parts, Suitable for High-Temperature Service
- A351/A351M Specification for Castings, Austenitic, for Pressure-Containing Parts
- A352/A352M Specification for Steel Castings, Ferritic and Martensitic, for Pressure-Containing Parts, Suitable for Low-Temperature Service
- A356/A356M Specification for Steel Castings, Carbon, Low Alloy, and Stainless Steel, Heavy-Walled for Steam Turbines
- A370 Test Methods and Definitions for Mechanical Testing of Steel Products
- A389/A389M Specification for Steel Castings, Alloy, Specially Heat-Treated, for Pressure-Containing Parts, Suitable for High-Temperature Service
- A447/A447M Specification for Steel Castings, Chromium-Nickel-Iron Alloy (25-12 Class), for High-Temperature Service
- A487/A487M Specification for Steel Castings Suitable for Pressure Service
- A494/A494M Specification for Castings, Nickel and Nickel Alloy

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

\*A Summary of Changes section appears at the end of this standard.



TABLE 1 Categories of Base Materials

Category Number	Material Description	ASTM Specification	Grades
1	Carbon steel (carbon less than 0.35 %, tensile strength less than or equal to 70 ksi [480 MPa]).	A27/A27M  A216/A216M A352/A352M A356/A356M A732/A732M A757/A757M A958	all grades  WCA, WCB LCB, LCA 1 1A, 2A A1Q SC 1020, SC 1025, SC 1030, SC 1040, SC 1045, CLASSES 65/35, 70/36
2	Carbon steel (tensile strength greater than 70 ksi [480 MPa]). Carbon-manganese steel (tensile strength equal to or greater than 70 ksi but less than 90 ksi [620 MPa]).	A148/A148M  A216/A216M A352/A352M A732/A732M A757/A757M A958	80-40  WCC LCC 2Q, 3A A2Q SC 1030, SC 1040, SC 1045, CLASSES 80/40, 80/50
3	Carbon and carbon-manganese steel (tensile strength equal to or greater than 90 ksi [620 MPa]).	A732/A732M  A958	3Q, 4A, 4Q, 5N  SC 1045, CLASSES 90/60, 105/85, 115/95
4	Low-alloy steel (annealed, normalized, or normalized and tempered. Tensile strength less than 85 ksi [585 MPa]).	A148/A148M  A217/A217M A352/A352M A356/A356M A389/A389M A487/A487M A757/A757M A958	80-50  WC1, WC4, WC5, WC6, WC9 LC1, LC2, LC3, LC4 2, 5, 6, 8 C23, C24 11A, 12A, 16A B2N, B3N, B4N SC 4130, SC 4140, SC 8620, SC 8625, SC 8630, CLASSES 65/35, 70/36, 80/40, 80/50
5	Low-alloy steel (annealed, normalized, or normalized and tempered. Tensile strength equal to or greater than 85 ksi [585 MPa]).	A148/A148M A217/A217M A356/A356M A487/A487M A732/A732M A757/A757M A958	90-60, 105-85 C5, C12, C12A, WC11 9, 10, 12 1A, 1C, 2A, 2C, 4A, 4C, 6A, 8A, 9A, 9C, 10A, 13A 6N, 15A D1N1, D1N2, D1N3, E2N1, E2N2, E2N3 SC 4340, CLASSES 90/60, 105/85
6	Low-alloy steel (quenched and tempered)	A148/A148M  A352/A352M A487/A487M  A732/A732M A757/A757M  A958	90-60, 105-85, 115-95, 130-115, 135-125, 150-135, 160-145, 165-150, 165-150L, 210-180, 210-180L, 260-210, 260-210L LC2-1, LC1, LC2, LC3, LC4, LC9 1B, 1C, 2B, 2C, 4B, 4C, 4D, 4E, 6B, 7A, 8B, 8C, 9A, 9B, 9C, 9D, 9E, 10B, 11B, 12B, 13B, 14A 7Q, 8Q, 9Q, 10Q, 11Q, 12Q, 13Q, 14Q B2Q, B3Q, B4Q, C1Q, D1Q1, D1Q2, D1Q3, E1Q, E2Q1, E2Q2, E2Q3 SC 4140, SC 4130, SC 4340, SC 8620, SC 8625, SC 8630, CLASSES 115/95, 130/115, 135/125, 150/ 135, 160/145, 165/150, 210/180
7	Ferritic stainless steel	A743/A743M	CB-30, CC-50
8	Martensitic stainless steel	A217/A217M A352/A352M A356/A356M A487/A487M  A743/A743M A757/A757M	CA-15 CA6NM CA6NM CA15-A, CA15-B, CA15-C, CA15-D, CA15M-A, CA6NM-A, CA6NM-B CA-15, CA-15M, CA6NM, CA-40, CA6N, CB6 E3N
9	Low-carbon austenitic stainless steel (carbon equal to or less than 0.03 %)	A351/A351M  A743/A743M  A744/A744M	CF-3, CF-3A, CF-3M, CF-3MA, CF-3MN, CK-3MCUN, CG3M, CN3MN CF-3, CF-3M, CF-3MN, CK-3MCUN, CN-3M, CG3M, CN3MN CF-3, CF-3M, CK-3MCUN, CG3M, CN3MN
10	Unstabilized austenitic stainless steel (carbon greater than 0.03 %)	A351/A351M	CE-8MN, CF-8, CF-8A, CF-8M, CF-10, CF-10M, CG-8M, CH-8, CH-10, CH-20, CG6MMN,

Category Number	Material Description	ASTM Specification	Grades
			CF10S1MNN, CE20N
		<b>A447/A447M</b>	Type I
		<b>A743/A743M</b>	CF-8, CG-12, CF-20, CF-8M, CF-16F, CF10SMNN, CH-20, CG-8M, CE-30, CG6MMN, CH10, CF16Fa
		<b>A744/A744M</b>	CF-8, CF-8M, CG-8M
11	Stabilized austenitic stainless steel	<b>A351/A351M</b>	CF-8C, CF-10MC, CK-20, HK-30, HK-40, HT-30, CN-7M, CT-15C
		<b>A447/A447M</b>	Type II
		<b>A743/A743M</b>	CF-8C, CN-7M, CN-7MS, CK-20
		<b>A744/A744M</b>	CF-8C, CN-7M, CN-7MS
12	Duplex (austenitic-ferritic) stainless steel	<b>A351/A351M</b>	CD3MWCuN, CD-4MCU
		<b>A872/A872M</b>	J93183, J93550
		<b>A890/A890M</b>	1A, 1B, 2A, 3A, 4A, 5A, 6A
		<b>A995/A995M</b>	1B, 2A, 3A, 4A, 5A, 6A
13	Precipitation-hardened austenitic stainless steel	<b>A747/A747M</b>	CB7CU-1, CB7CU-2
14	Nickel-base alloys	<b>A494/A494M</b>	CW-12MW, CY-40 Class 1, CY-40 Class 2, CZ-100, M-35-1, M-35-2, M-30C, N-12MV, N-7M, CW-6M, CW-2M, CW-6MC, CX-2MW, CU5MCUC
		<b>A990</b>	CW2M
15	Steel Castings, Austenitic Manganese	<b>A128/A128M</b>	A, B-1, B-2, B-3, B-4, C, D, E-1, E-2, F

**A732/A732M** Specification for Castings, Investment, Carbon and Low Alloy Steel for General Application, and Cobalt Alloy for High Strength at Elevated Temperatures

**A743/A743M** Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application

**A744/A744M** Specification for Castings, Iron-Chromium-Nickel, Corrosion Resistant, for Severe Service

**A747/A747M** Specification for Steel Castings, Stainless, Precipitation Hardening

**A757/A757M** Specification for Steel Castings, Ferritic and Martensitic, for Pressure-Containing and Other Applications, for Low-Temperature Service

**A872/A872M** Specification for Centrifugally Cast Ferritic/Austenitic Stainless Steel Pipe for Corrosive Environments

**A890/A890M** Specification for Castings, Iron-Chromium-Nickel-Molybdenum Corrosion-Resistant, Duplex (Austenitic/Ferritic) for General Application

**A958** Specification for Steel Castings, Carbon and Alloy, with Tensile Requirements, Chemical Requirements Similar to Standard Wrought Grades

**A990** Specification for Castings, Iron-Nickel-Chromium and Nickel Alloys, Specially Controlled for Pressure Retaining Parts for Corrosive Service

**A995/A995M** Specification for Castings, Austenitic-Ferritic (Duplex) Stainless Steel, for Pressure-Containing Parts

2.2 *American Society of Mechanical Engineers*.<sup>3</sup>

**ASME** Boiler and Pressure Vessel Code, Section IX

2.3 *American Welding Society*.<sup>4</sup>

ANSI/AWS 3.0 Definitions for Welding and Cutting

### 3. Terminology

3.1 *Definitions*—Definitions of terms relating to welding shall be in agreement with the definitions of the American Welding Society, ANSI/AWS A3.0.

### 4. Weld Orientation

4.1 *Orientation*—The orientation of welds with respect to horizontal and vertical planes of reference are classified into four positions, namely, flat, horizontal, vertical, and overhead as shown in Fig. 4. Test material shall be oriented as shown in Fig. 4; however, an angular deviation of  $\pm 15^\circ$  from the specified horizontal and vertical planes is permitted during welding.

4.2 *Flat Position* (Fig. 4(a))—This position covers plate in a horizontal plane with the weld metal deposited from above, or pipe or a cylindrical casting with its axis horizontal and rolled during welding so that the weld metal is deposited from above.

4.3 *Horizontal Position* (Fig. 4(b))—This position covers plate in a vertical plane with the axis of the weld horizontal, or pipe or a cylindrical casting with its axis vertical and the axis of the weld horizontal.

4.4 *Vertical Position* (Fig. 4(c))—In this position, the plate is in a vertical plane with the axis of the weld vertical.

4.5 *Overhead Position* (Fig. 4(d))—In this position, the plate is in a horizontal plane with the weld metal deposited from underneath.

4.6 *Horizontal Fixed Position* (Fig. 4(e))—In this position, the pipe or cylindrical casting has its axis horizontal and the welding groove in a vertical plane. Welding shall be done without rotating the pipe or casting so that the weld metal is deposited from the flat, vertical, and overhead position.

4.7 *Qualification*—Qualification in the horizontal, vertical, or overhead position shall qualify also for the flat position.

<sup>3</sup> Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990, <http://www.asme.org>.

<sup>4</sup> Available from American Welding Society (AWS), 550 NW LeJeune Rd., Miami, FL 33126, <http://www.aws.org>.



RECOMMENDED FORM FOR MANUFACTURER'S RECORD OF WELDING PROCEDURE QUALIFICATION TESTS

Procedure No. \_\_\_\_\_ Date: \_\_\_\_\_ Welding Process: \_\_\_\_\_  
 Material Specification: \_\_\_\_\_ to \_\_\_\_\_ of category No. \_\_\_\_\_ to category No. \_\_\_\_\_  
 Plate Thickness: \_\_\_\_\_ Thickness Range Qualified \_\_\_\_\_  
 Filler Metal F Group No. \_\_\_\_\_ Weld Deposit A-Group No.: \_\_\_\_\_  
 Flux Designation: \_\_\_\_\_ Gas Composition: \_\_\_\_\_  
 Gas Flow Rate: \_\_\_\_\_ Backing Strip, if any: \_\_\_\_\_  
 Preheat Temperature Range: \_\_\_\_\_ Single or Multiple Pass: \_\_\_\_\_  
 Position of Groove: \_\_\_\_\_ Filler Wire Diameter: \_\_\_\_\_  
 Trade Name: \_\_\_\_\_ Type of Backing: \_\_\_\_\_  
 Forehand or Backhand: \_\_\_\_\_ Amps: \_\_\_\_\_ Volts \_\_\_\_\_ Inches/min: \_\_\_\_\_  
 Postheat Temperature \_\_\_\_\_ Time at Temperature \_\_\_\_\_

TENSION TEST RESULTS

Specimen No.	Width	Dimensions Thickness	Area	Ultimate Total Load, lb	Ultimate Unit Stress, psi	Nature of Failure and Location

GUIDED BEND TEST RESULTS

Specimen No.	Results	Specimen No.	Results

Welder's Name: \_\_\_\_\_ Clock No. \_\_\_\_\_ Stamp No. \_\_\_\_\_

Who by virtue of these tests meets the welder performance qualification.

Test Conducted By: \_\_\_\_\_ Test No. \_\_\_\_\_  
per \_\_\_\_\_

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of ASTM Standard \_\_\_\_\_

Signed: \_\_\_\_\_  
Manufacturer or Contractor

Date: \_\_\_\_\_

FIG. 1 Report Form 1

ASTM A488/A488M-07

<https://standards.iteh.ai/catalog/standards/sist/fcd60bcf-31d9-4aae-971c-fa23ed368e1a/astm-a488-a488m-07>



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## RECOMMENDED FORM FOR MANUFACTURER'S OR CONTRACTOR'S RECORD OF WELDER OR OPERATOR PERFORMANCE QUALIFICATION TESTS

Welder or Operator's Name: Stamp No. \_\_\_\_\_  
 Clock No. \_\_\_\_\_ Welding Process: \_\_\_\_\_  
 Position: \_\_\_\_\_  
 In accordance with Procedure No. \_\_\_\_\_  
 Material Specification: \_\_\_\_\_ to \_\_\_\_\_ of category No. \_\_\_\_\_ to category No. \_\_\_\_\_  
 Plate Thickness: \_\_\_\_\_ Range of Thickness Qualified: \_\_\_\_\_  
 Filler Metal Specification No. \_\_\_\_\_ Group No. F. \_\_\_\_\_  
 Filler Metal A-Group No. \_\_\_\_\_ Filler Metal Diameter \_\_\_\_\_  
 Trade Name: \_\_\_\_\_ Flux Designation or Gas Analysis: \_\_\_\_\_  
 Was Backing Strip Used? \_\_\_\_\_

### GUIDED BEND TEST RESULTS

Specimen No.	Results	Specimen No.	Results

Test Conducted By: \_\_\_\_\_ Laboratory Test No. \_\_\_\_\_  
 per \_\_\_\_\_

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with ASTM Standard \_\_\_\_\_.

Signed: \_\_\_\_\_  
 Manufacturer or Contractor

Date: \_\_\_\_\_

FIG. 2 Report Form 2

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REPORT FORM 3

RECOMMENDED FORM FOR WELDING PROCEDURE SPECIFICATION

1. Title

Welding of<sup>A</sup> \_\_\_\_\_ steel castings.

<sup>A</sup> Indicate general material description, such as carbon, Cr-Mo, 12 Cr, etc.

2. Specification No. \_\_\_\_\_ Rev. \_\_\_\_\_

Date \_\_\_\_\_

3. Scope

3.1 Procedure Specification No. \_\_\_\_\_ covers the welding of<sup>A</sup> \_\_\_\_\_ steel castings using the<sup>B</sup> \_\_\_\_\_ welding process.

<sup>A</sup> Indicate general material description in the Title.

<sup>B</sup> Indicate specific welding process, such as shielded metal arc, etc.

4. Base Material

4.1 The base material shall conform to the specification for<sup>A</sup> \_\_\_\_\_ which is found in materials category number<sup>B</sup> \_\_\_\_\_.

<sup>A</sup> Insert reference to ASTM designation or indicate chemical analysis and physical properties.

<sup>B</sup> Indicate category number from Table 1.

4.2 Base material shall be in the<sup>A</sup> \_\_\_\_\_ heat treated condition before welding.

<sup>A</sup> Indicate heat treatment before welding.

5. Filler Metal

5.1 The filler metal shall conform to ANSI/AWS Specification<sup>A</sup> \_\_\_\_\_ which is found in weld metal analysis group A \_\_\_\_\_<sup>B</sup>.

<sup>A</sup> Indicate appropriate American Welding Society specification number and filler metal classification (e.g., A5.1 E7018).

<sup>B</sup> Indicate A Number from Table 4.

5.2 Flux for submerged arc welding shall conform to the following nominal composition:<sup>A</sup> \_\_\_\_\_.

<sup>A</sup> Indicate chemical composition or trade designation.

5.3 Shielding gas for gas shielded arc welding shall conform to the following nominal composition:<sup>A</sup> \_\_\_\_\_.

<sup>A</sup> Indicate the single gas or proportional parts of mixed gases and flow rates.

6. Preparation of Base Material

6.1 Metal removal shall be performed by<sup>A</sup> \_\_\_\_\_.

<sup>A</sup> Indicate method of metal removal, such as chipping, grinding, carbon arc cutting, frame cutting, etc. Also indicate whether preheat is required during metal removal.

6.2 Configuration of the weld preparation for partial penetration welds shall conform to the following geometry:<sup>A</sup> \_\_\_\_\_.

<sup>A</sup> Indicate minimum root radius and minimum side wall angle.

6.3 Configuration of the weld preparation for full penetration welds shall conform to the following geometry:<sup>A</sup> \_\_\_\_\_.

<sup>A</sup> Indicate minimum side wall angle.

6.4 Backing plates shall be used for welding full penetration welds.

Backing plates shall be made from<sup>A</sup> \_\_\_\_\_ steel and shall fit the back of the cavity with a minimum gap of<sup>B</sup> \_\_\_\_\_.

<sup>A</sup> Indicate material of backing plate.

<sup>B</sup> Indicate dimension of maximum gap.

6.5 Surfaces of the weld preparation shall be cleaned of all oil, grease, dirt, scale, slag, shot blasting grit, or any foreign material which may be harmful to the quality of the weld. Surfaces of backing plates when used shall also meet the same cleanliness requirements.

6.6 All surfaces of the weld preparation shall be inspected as follows:<sup>A</sup> \_\_\_\_\_.

<sup>A</sup> Indicate type of inspection.

7. Preheat

7.1 Preheat and interpass temperature shall be maintained in the range from<sup>A</sup> \_\_\_\_\_ to<sup>B</sup> \_\_\_\_\_ during \_\_\_\_\_<sup>C</sup>.

<sup>A</sup> Indicate minimum temperature.

<sup>B</sup> Indicate maximum temperature.

<sup>C</sup> Indicate if preheat maintenance is during welding or until postweld heat treatment is performed.

7.2 Preheat for tack welding of backing plates is the same as required for welding.

7.3 Minimum temperature before applying heat shall be<sup>A</sup> \_\_\_\_\_.

<sup>A</sup> Indicate temperature.

7.4 Local preheating to the temperatures indicated may be performed so that the heated area completely surrounds the weld preparation for a minimum distance of<sup>A</sup> \_\_\_\_\_ in any direction.

<sup>A</sup> Indicate minimum distance for local preheating.

8. Welding Position

8.1 Welds shall be made in the<sup>A</sup> \_\_\_\_\_ position.

<sup>A</sup> Indicate position or positions in which the welding will be performed. See Fig. 4.

9. Electrical Characteristics

9.1 The current used shall be \_\_\_\_\_<sup>A</sup>. The base material shall be attached to the \_\_\_\_\_<sup>B</sup> welding electrode lead.

<sup>A</sup> Indicate whether direct or alternating current. If direct, state whether non-pulsed or pulsed. If pulsed, state frequency.

<sup>B</sup> Indicate whether electrode positive (EP) or electrode negative (EN) output terminal of power supply is used.

Electrode Wire Diameter <sup>A</sup>	Amperage <sup>A</sup>	Range <sup>A</sup>	Voltage <sup>A</sup>
_____	_____	_____	_____
_____	_____	_____	_____

<sup>A</sup> Indicate for each diameter of electrode, the amperage, the range of amperage permitted, and the voltage requirements. For welding processes using wire, indicate wire diameter, wire feed speed, and current requirements.

9.2 Electrodes subject to moisture absorption must be stored and handled to maintain dryness according to the following:<sup>A</sup> \_\_\_\_\_.

<sup>A</sup> Where applicable, indicate electrode care instructions.

10. Welding Details

10.1 The width of any pass of welding shall not exceed<sup>A</sup> \_\_\_\_\_ times the size of the filler metal used.

<sup>A</sup> Indicate the number for controlling the maximum width.

10.2 Craters shall be properly filled before each interruption of the arc.

10.3 Slag or flux shall be removed on any bead before depositing the next successive bead.

10.4 Interpass inspection shall be performed according to the following:<sup>A</sup> \_\_\_\_\_.

<sup>A</sup> Indicate degree of interpass inspection required.

10.5 Peening shall be performed according to the following:<sup>A</sup> \_\_\_\_\_.

<sup>A</sup> Indicate the degree of peening required. Indicate any limits on peening first and last layers.

11. Post-Weld Heat Treatment

11.1 Post-weld heat treatment shall consist of the following:<sup>A</sup> \_\_\_\_\_.

<sup>A</sup> Indicate the heating and cooking rates, holding temperatures and times.

12. Inspection

12.1 Inspection of the completed weld shall be performed according to the following:<sup>A</sup> \_\_\_\_\_.

<sup>A</sup> Indicate degree of inspection.

FIG. 3 Report Form 3