

Designation: A488/A488M - 18 A488/A488M -  $18^{61}$ 

## 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 reapproval. A superscript epsilon  $(\varepsilon)$  indicates an editorial change since the last revision or reapproval.

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

ε<sup>1</sup> NOTE—Grade designations in Table 1 and Table X1.1 were corrected editorially in January 2020.

### 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 SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the standard.
  - 1.4.1 SI Units—Within the text, the SI units are shown in brackets.
- 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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.
- 1.6 This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

### 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

A297/A297M Specification for Steel Castings, Iron-Chromium and Iron-Chromium-Nickel, Heat Resistant, for General Application

<sup>&</sup>lt;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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<sup>&</sup>lt;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.



## **TABLE 1 Categories of Base Materials**

Category Number	Material Description	ASTM Specification	Grades
1	Carbon steel (carbon less than	A27/A27M	All grades
•	0.35 %, tensile strength less than	712777127101	7 iii gradoo
	or equal to 70 ksi [485 MPa])		
	than or equal to 70 ksi [485 MPa])	A216/A216M	WCA, WCB
	than or equal to 70 KSI [400 WFa])		
		<u>A216/A216M</u>	WCA, WCB
		A352/A352M	LCB, LCA
		A356/A356M	1
		A732/A732M	1A, 2A
		A757/A757M	A1Q
		A958/A958M	SC 1020, SC 1025, SC 1030, CLASSES 65/35,
			70/36
2—	Carbon steel (tensile strength	A148/A148M	<del>80-40</del>
_	greater than 70 ksi [485 MPa]).	A140/A140W	00-40
2	Carbon steel (tensile strength	A140/A140M	90.40
2		A148/A148M	80-40
	greater than 70 ksi [485 MPa])		
	Carbon-manganese steel (tensile	<del>A216/A216M</del>	<del>WCC</del>
	strength equal to or greater than		
	<del>70 ksi [485 MPa]).</del>		
		A016/A016M	WCC
	Carbon-manganese steel (tensile	A216/A216M	WCC
	strength equal to or greater than		
	70 ksi [485 MPa]) but less than 90		
	ksi [620 MPa])		
	but less than 90 ksi [620 MPa]).	A352/A352M	LCC
	Dat 1000 than ou har [UZU IVII ajj.		
		A352/A352M	LCC
		A732/A732M	2Q, 3A
		A757/A757M	A2Q
		A958/A958M	SC 1030, SC 1040, SC 1045, CLASSES 80/40,
		A930/A930W	
			80/50
3	Carbon and carbon-manganese	A732/A732M	3Q, 4A, 4Q, 5N
	steel (tensile strength equal to or		
	greater than 90 ksi [620 MPa])		
	greater than 90 ksi [620 MPa]).	A958/A958M	SC 1045, CLASSES 90/60, 105/85, 115/95
	THUT Styl Stal	A958/A958M	SC 1045, CLASSES 90/60, 105/85, 115/95
		A956/A956W	SC 1045, CLASSES 90/60, 105/65, 115/95
4	l	A 1 40 / A 1 40 M	00.50
-4	Low-alloy steel (annealed,	A148/A148M	<del>80-50</del>
	normalized, or normalized and		
	tempered.		
_4	Low-alloy steel (annealed,	<u>A148/A148M</u>	80-50
	normalized, or normalized and		
	tempered ASTIVIAGE	A047/A047M	WO4 WO4 WO5 WOO WOO
	Tensile strength less than 85 ksi	<del>A217/A217M</del> 6-aa4d-	WC1, WC4, WC5, WC6, WC9
	[585 MPa]).		
		A O 1 7 / A O 1 7 N /	WC1, WC4, WC5, WC6, WC9
	Tensile strength less than 85 ksi	A217/A217M	
	Tensile strength less than 85 ksi [585 MPa])	A217/A217W	
		A352/A352M	LC1, LC2, LC3, LC4
		A352/A352M	
		A352/A352M A356/A356M	2, 5, 6, 8
		A352/A352M A356/A356M A389/A389M	2, 5, 6, 8 C23, C24
		A352/A352M A356/A356M	2, 5, 6, 8
		A352/A352M A356/A356M A389/A389M A487/A487M	2, 5, 6, 8 C23, C24 11A, 12A, 16A
		A352/A352M A356/A356M A389/A389M A487/A487M A757/A757M	2, 5, 6, 8 C23, C24 11A, 12A, 16A B2N, B3N, B4N
		A352/A352M A356/A356M A389/A389M A487/A487M	2, 5, 6, 8 C23, C24 11A, 12A, 16A B2N, B3N, B4N SC 4130, SC 4140, SC 8620, SC 8625, SC 8630,
		A352/A352M A356/A356M A389/A389M A487/A487M A757/A757M	2, 5, 6, 8 C23, C24 11A, 12A, 16A B2N, B3N, B4N
<del>-5</del>	[585 MPa])	A352/A352M A356/A356M A389/A389M A487/A487M A757/A757M A958/A958M	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
<del>-5</del>	[585 MPa]) Low-alloy-steel (annealed,	A352/A352M A356/A356M A389/A389M A487/A487M A757/A757M	2, 5, 6, 8 C23, C24 11A, 12A, 16A B2N, B3N, B4N SC 4130, SC 4140, SC 8620, SC 8625, SC 8630,
<del>-5</del>	Low-alloy steel (annealed, normalized, or normalized and	A352/A352M A356/A356M A389/A389M A487/A487M A757/A757M A958/A958M	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
	Low-alloy-steel (annealed, normalized, or normalized and tempered:	A352/A352M A356/A356M A389/A389M A487/A487M A757/A757M A958/A958M	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 90-60, 105-85
<del>-5 -</del> <u>5 -</u>	Low-alloy-steel (annealed, normalized, or normalized and tempered. Low-alloy steel (annealed,	A352/A352M A356/A356M A389/A389M A487/A487M A757/A757M A958/A958M	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
	Low-alloy-steel (annealed, normalized, or normalized and tempered:	A352/A352M A356/A356M A389/A389M A487/A487M A757/A757M A958/A958M	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 90-60, 105-85
	Low-alloy steel (annealed, normalized, or normalized and tempered. Low-alloy steel (annealed, normalized, or normalized and	A352/A352M A356/A356M A389/A389M A487/A487M A757/A757M A958/A958M	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 90-60, 105-85
	Low-alloy steel (annealed; normalized, or normalized and tempered. Low-alloy steel (annealed, normalized, or normalized and tempered	A352/A352M A356/A356M A389/A389M A487/A487M A757/A757M A958/A958M A148/A148M	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 90-60, 105-85
	Low-alloy steel (annealed, normalized, or normalized and tempered: Low-alloy steel (annealed, normalized, or normalized and tempered Tensile strength equal to or greater	A352/A352M A356/A356M A389/A389M A487/A487M A757/A757M A958/A958M	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 90-60, 105-85
	Low-alloy steel (annealed; normalized, or normalized and tempered. Low-alloy steel (annealed, normalized, or normalized and tempered	A352/A352M A356/A356M A389/A389M A487/A487M A757/A757M A958/A958M A148/A148M	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 90-60, 105-85
	Low-alloy steel (annealed, normalized, or normalized and tempered. Low-alloy steel (annealed, normalized, or normalized and tempered Tensile strength equal to or greater than 85 ksi [585-MPa]).	A352/A352M A356/A356M A389/A389M A487/A487M A757/A757M A958/A958M A148/A148M A148/A148M	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 90-60, 105-85
	Low-alloy-steel (annealed, normalized, or normalized and tempered: Low-alloy-steel (annealed, normalized, or normalized and tempered Tensile strength equal to or greater than 85 ksi [585-MPa]). Tensile strength equal to or greater	A352/A352M A356/A356M A389/A389M A487/A487M A757/A757M A958/A958M A148/A148M	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 90-60, 105-85  90-60, 105-85 C5, C12, C12A, WC11
	Low-alloy steel (annealed, normalized, or normalized and tempered. Low-alloy steel (annealed, normalized, or normalized and tempered Tensile strength equal to or greater than 85 ksi [585-MPa]).	A352/A352M A356/A356M A389/A389M A487/A487M A757/A757M A958/A958M A148/A148M A148/A148M A217/A217M	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 90-60, 105-85  G5, C12, C12A, WC11 C5, C12, C12A, WC11
	Low-alloy-steel (annealed, normalized, or normalized and tempered: Low-alloy-steel (annealed, normalized, or normalized and tempered Tensile strength equal to or greater than 85 ksi [585-MPa]). Tensile strength equal to or greater	A352/A352M A356/A356M A389/A389M A487/A487M A757/A757M A958/A958M A148/A148M A148/A148M A217/A217M A217/A217M A356/A356M	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 90-60, 105-85  G5, C12, C12A, WC11 9, 10, 12
	Low-alloy-steel (annealed, normalized, or normalized and tempered: Low-alloy-steel (annealed, normalized, or normalized and tempered Tensile strength equal to or greater than 85 ksi [585-MPa]). Tensile strength equal to or greater	A352/A352M A356/A356M A389/A389M A487/A487M A757/A757M A958/A958M A148/A148M A148/A148M A217/A217M	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 90-60, 105-85  G5, C12, C12A, WC11 C5, C12, C12A, WC11
	Low-alloy-steel (annealed, normalized, or normalized and tempered: Low-alloy-steel (annealed, normalized, or normalized and tempered Tensile strength equal to or greater than 85 ksi [585-MPa]). Tensile strength equal to or greater	A352/A352M A356/A356M A389/A389M A487/A487M A757/A757M A958/A958M A148/A148M A148/A148M A217/A217M A217/A217M A356/A356M	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 90-60, 105-85  90-60, 105-85  C5, C12, C12A, WC11 9, 10, 12 1A, 1C, 2A, 2C, 4A, 4C, 6A, 8A, 9A, 9C, 10A,
	Low-alloy-steel (annealed, normalized, or normalized and tempered: Low-alloy-steel (annealed, normalized, or normalized and tempered Tensile strength equal to or greater than 85 ksi [585-MPa]). Tensile strength equal to or greater	A352/A352M A356/A356M A389/A389M A487/A487M A757/A757M A958/A958M A148/A148M A148/A148M A217/A217M A217/A217M A356/A356M A487/A487M	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 90-60, 105-85  90-60, 105-85  C5, C12, C12A, WC11 9, 10, 12 1A, 1C, 2A, 2C, 4A, 4C, 6A, 8A, 9A, 9C, 10A, 13A
	Low-alloy-steel (annealed, normalized, or normalized and tempered: Low-alloy-steel (annealed, normalized, or normalized and tempered Tensile strength equal to or greater than 85 ksi [585-MPa]). Tensile strength equal to or greater	A352/A352M A356/A356M A389/A389M A487/A487M A757/A757M A958/A958M A148/A148M A148/A148M A217/A217M A217/A217M A356/A356M A487/A487M A732/A732M	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 90-60, 105-85  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
	Low-alloy-steel (annealed, normalized, or normalized and tempered: Low-alloy-steel (annealed, normalized, or normalized and tempered Tensile strength equal to or greater than 85 ksi [585-MPa]). Tensile strength equal to or greater	A352/A352M A356/A356M A389/A389M A487/A487M A757/A757M A958/A958M A148/A148M A148/A148M A217/A217M A217/A217M A356/A356M A487/A487M	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 90-60, 105-85  90-60, 105-85  C5, C12, C12A, WC11 9, 10, 12 1A, 1C, 2A, 2C, 4A, 4C, 6A, 8A, 9A, 9C, 10A, 13A
	Low-alloy-steel (annealed, normalized, or normalized and tempered: Low-alloy-steel (annealed, normalized, or normalized and tempered Tensile strength equal to or greater than 85 ksi [585-MPa]). Tensile strength equal to or greater	A352/A352M A356/A356M A389/A389M A487/A487M A757/A757M A958/A958M A148/A148M A148/A148M A217/A217M A217/A217M A356/A356M A487/A487M A732/A732M	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 90-60, 105-85  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
	Low-alloy-steel (annealed, normalized, or normalized and tempered: Low-alloy-steel (annealed, normalized, or normalized and tempered Tensile strength equal to or greater than 85 ksi [585-MPa]). Tensile strength equal to or greater	A352/A352M A356/A356M A389/A389M A487/A487M A757/A757M A958/A958M A148/A148M A148/A148M A217/A217M A217/A217M A356/A356M A487/A487M A732/A732M A757/A757M	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  90-60, 105-85  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
5	Low-alloy steel (annealed, normalized, or normalized and tempered. Low-alloy steel (annealed, normalized, or normalized and tempered Tensile strength equal to or greater than 85 ksi [585 MPa]) Tensile strength equal to or greater than 85 ksi [585 MPa])	A352/A352M A356/A356M A389/A389M A487/A487M A757/A757M A958/A958M A148/A148M A148/A148M A217/A217M A217/A217M A356/A356M A487/A487M A732/A732M A757/A757M A958/A958M	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 90-60, 105-85  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
	Low-alloy steel (annealed, normalized, or normalized and tempered. Low-alloy steel (annealed, normalized, or normalized and tempered Tensile strength equal to or greater than 85 ksi [585 MPa]). Tensile strength equal to or greater than 85 ksi [585 MPa])	A352/A352M A356/A356M A389/A389M A487/A487M A757/A757M A958/A958M A148/A148M A148/A148M A217/A217M A217/A217M A356/A356M A487/A487M A732/A732M A757/A757M	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 90-60, 105-85  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  90-60, 105-85, 115-95, 130-115, 135-125,
5	Low-alloy steel (annealed, normalized, or normalized and tempered. Low-alloy steel (annealed, normalized, or normalized and tempered Tensile strength equal to or greater than 85 ksi [585 MPa]) Tensile strength equal to or greater than 85 ksi [585 MPa])	A352/A352M A356/A356M A389/A389M A487/A487M A757/A757M A958/A958M A148/A148M A148/A148M A217/A217M A217/A217M A356/A356M A487/A487M A732/A732M A757/A757M A958/A958M	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 90-60, 105-85  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

## TABLE 1 Continued

Category Number	Material Description	ASTM Specification	Grades
		A352/A352M A487/A487M	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
		A732/A732M A757/A757M	7Q, 8Q, 9Q, 10Q, 11Q, 12Q, 13Q, 14Q B2Q, B3Q, B4Q, C1Q, D1Q1, D1Q2, D1Q3, E1Q, E2Q1, E2Q2, E2Q3
		A958/A958M	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
<del>7</del> 7	Ferritic stainless steel Ferritic stainless steel	A743/A743M A743/A743M	<del>CB 30, CC 50</del> <u>CB30†, CC50†</u>
<del>-8</del> <u>8</u>	Martensitic stainless steel Martensitic stainless steel	A217/A217M A217/A217M A352/A352M A356/A356M A487/A487M	CA-15 CA15† CA6NM CA6NM CA15-A, CA15-B, CA15-C, CA15-D, CA15M-A, CA6NM-A, CA6NM-B
		A743/A743M A743/A743M A757/A757M	CA-15, CA-15M, CA6NM, CA-40, CA6N, CB6 CA15†, CA15M†, CA6NM, CA40†, CA6N, CB6 E3N
<del>-9</del>	Low-carbon austenitic stainless steel (carbon equal to or less than	A351/A351M	CF-3, CF-3A, CF-3M, CF-3MA, CF-3MN, CK-3MCUN, CG3M, CN3MN
9	0.03 %)  Low-carbon austenitic stainless  steel (carbon equal to or less than  0.03 %)	A351/A351M	CF3†, CF3A†, CF3M†, CF3MA†, CF3MN†, CK3MCUN†, CG3M, CN3MN
	(Inttps://sta	411UA1US.	CE 2 CE 2M CE 2MN CK 2MCLIN CN 2M
		A743/A743M A743/A743M	CF-3, CF-3M, CF-3MN, CK-3MCUN, CN-3M, CG3M, CN3MN CF3†, CF3M†, CF3MN†, CK3MCUN†, CN3M†, CG3M, CN3MN
		A744/A744M A744/A744M	CF-3, CF-3M, CK-3MCUN, CG3M, CN3MN CF3†, CF3M†, CK3MCUN†, CG3M, CN3MN
<del>10</del>	Unstabilized austenitic stainless steel (carbon greater than 0.03 %)	<del>A351/A351M</del>	GF-8, GF-8A, GF-8M, GF-10, GF-10M, GG-8M, GH-8, GH-10, GH-20, GG6MMN, GF10SMNN, GE20N
<u>10</u>	Unstabilized austenitic stainless steel (carbon greater than 0.03 %)	<u>A351/A351M</u>	<u>CF8†, CF8A†, CF8M†, CF10†, CF10M†, CG8M†,</u> <u>CH8†, CH10†, CH20†, CG6MMN, CF10SMNN,</u> <u>CE20N</u>
		A447/A447M <del>A743/A743M</del>	— Type I <del>CF-8, CG-12, CF-20, CF-8M, CF-16F,</del> <del>CF-10SMN, CH-20, CG-8M, CE-30, CG6MMN,</del>
		<u>A743/A743M</u>	CH10, CF16Fa CF8†, CG12†, CF20†, CF8M†, CF16F†, CF10SMNN, CH20†, CG8M†, CE30†, CG6MMN, CH10, CF16Fa
		<del>A744/A744M</del> A744/A744M	CF 8, CF 8M, CG 8M CF8†, CF8M†, CG8M†
11	Stabilized austenitic stainless steel	A297/A297M <del>A351/A351M</del>	HG10MNM <del>CF-8C, CF-10MC, CK-20, HK-30, HK-40, HT-30,</del> CN-7M, CT-15C
		A351/A351M	<del>CN-7M, CT-15C</del> CF8C†, CF10MC†, CK20†, HK30†, HK40†, <u>HT30†, CN7M†, CT15C†</u>
		A447/A447M <del>A743/A743M</del>	Type II <del>CF-8C, CN-7M, CN-7MS, CK-20</del>
		<u>A743/A743M</u> <del>A744/A744M</del>	<u>CF8C†, CN7M†, CN7MS†, CK20†</u> <del>CF-8C, CN-7M, CN-7MS</del>



### TABLE 1 Continued

Category Number	Material Description	ASTM Specification	Grades
12	Duplex (austenitic-ferritic) stainless steel	A872/A872M	J93183, J93550
		A890/A890M	1A, 1B, 2A, 3A, 4A, 5A, 6A
		A995/A995M	1B, 2A, 3A, 4A, 5A, 6A
13	Precipitation-hardened austenitic stainless steel	A747/A747M	CB7CU-1, CB7CU-2
14—	Nickel-base alloys	A494/A494M	CW-12MW, CY-40 Class 1, CY-40 Class 2, CZ-100, M-35-1, M-35-2, M-30C, N-12MY, N-7M, CW-6M, CW-2M, CW-6MC, CX-2MW, CU5MCUC
<u>14</u>	Nickel-base alloys	<u>A494/A494M</u>	CW12MW†, CY40† Class 1, CY40† Class 2, CZ100†, M35-1†, M35-2†, M30C†, N12MV†, N7M†, CW6M†, CW2M†, CW6MC† CX2MW†, CU5MCUC
		A990/A990M	CW2M
<del>15 -</del>	Steel Castings, Austenitic Manga- nese	A128/A128M	A, B-1, B-2, B-3, B-4, C, D, E-1, E-2, F
15	Steel castings, austenitic manga- nese	A128/A128M	A, B-1, B-2, B-3, B-4, C, D, E-1, E-2, F

†Editorially corrected.

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

A732/A732M Specification for Castings, Investment, Carbon and Low Alloy Steel for General Application, and Cobalt Alloy for High Strength at Elevated Temperatures ASTM A488/A488M-18e1

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/A958M Specification for Steel Castings, Carbon and Alloy, with Tensile Requirements, Chemical Requirements Similar to Standard Wrought Grades

A990/A990M 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. Any casting definitions not referenced in AWS are listed herein.

<sup>&</sup>lt;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>&</sup>lt;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:				
		of category No		egory No		
Plate Thickness:	Thick	ness Range Qualified —				
		Weld Deposit A-Group				
		Composition:				
		ng Strip, if any:				
Preheat Temperature F	Range:	Single or Multiple	Pass:			
Position of Groove:	Fille	er Wire Diameter:	. 455.			
		Backing:				
Forehand or Backhand	,pc c  •	Amps: Volt	S	Inches/min:		
Postheat Temperature		Time at Temperature _				
rostricat remperature		Time at Temperature =				
		TENS	SION TEST RI	ESULTS		
				Ultimate Total	Ultimate Unit	Nature of Failure
Specimen No.	Width	Dimensions Thickness	Area	Load, Ib	Stress, psi	and Location
,					· · · · · · · · · · · · · · · · · · ·	
		GUIDE	D BEND TES	T RESULTS		
Specimen No.		Results		Specimen No.		Results
Welder's Name		Clock No Star	mn No			
		ts the welder performan	•			
		Test No.				
•		rest No.	Stan	dards		
per We certify that the sta	atements in	this record are correct a	and that the	test welds were prepare	ed welded and te	ested in accordance
		tandard			ea, welded, and te	Stea in accordance
Signed:						
Jigited. ——			ıfacturer or C	`ontractor	7	
Date:		Dooring		Praviaw		
Date:						

FIG. 1 Report Form 1

<u>AS IM A488/A488M-18e1</u>

https://standards.iteh.ai/catalog/standards/sist/bacaf34f-570d-4886-aa4d-aaac4bc9885a/astm-a488-a488m-18e



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

Velder or Opeator's Name: Stamp No								
Clock No Welding Process								
Position:								
In accordance with Procedure No								
Material Specification: to	— of category No. — to cat	egory No						
Plate Thickness: Range of								
Filler Metal Specification No. ———	Group No. F							
Trade Name: Flux Design	ation or Gas Analysis:							
Was Backing Strip Used?								
	GUIDED BENI	) TEST RESULTS						
Specimen No.	Results	Specimen No.	Results					
per								
	record are correct and that the	test welds were prepared, welded, an	nd tested in accordance with ASTM					
Standard								
Signed:								
	Manufacture	er or Contractor						
Date:								

FIG. 2 Report Form 2

# iTeh Standards (https://standards.iteh.ai) Document Preview

ASTM A488/A488M-18e1

https://standards.iteh.ai/catalog/standards/sist/bacaf34f-570d-4886-aa4d-aaac4bc9885a/astm-a488-a488m-18e1



## REPORT FORM 3

### RECOMMENDED FORM FOR WELDING PROCEDURE SPECIFICATION

Welding of A steel castings.  A Indicate parenal material description, such as carbon, Cr-Mo, 12 Cr, etc.  2. Specification No	1. Title	7. Preheat
2. Specification No	Welding of <sup>A</sup> steel castings.	7.1 Preheat and interpass temperature shall be maintained in the range
2. Specification No	A Indicate general material description, such as carbon, Cr-Mo, 12 Cr, etc.	from $A$ to $B$ during $C$ .
So Scope 3. I Procedure Specification No covers the welding of ^		
3. Stope 3. 1 Procedure Specification No covers the welding of ^ steel castings using the ^ welding process. 4 Indicate penetial material description in the Title. 5 Indicate specific welding process, such as shielded metal arc, etc. 4. Base Material 4.1 The base material shall be norm to the specification for ^	· — — — — — — — — — — — — — — — — — — —	
s. 1. Procedure Specification No. overs the welding of "steel castings using the" welding process.  * Indicate general material description in the Title.  * Base Material  * In The base material shall conform to the specification for "which is found in materials category number"  * In the same material shall conform to the specification for "hinser reference to ASTM designation or indicate chemical analysis and physical properties.  * Productate beginning to the stream of the same as required for welding.  * Productate positions of the weld preparation for Table 1.  * Stream the same and the same designation of the same as the same as required for welding.  * Filler Metal  * S. The filler metal shall conform to ANSI/AWS Specification of "hinding the same shell and the same designation.  * Indicate appropriate American Welding Sociely specification number and filler metal classification (e.g., A5.1 E7018).  * Indicate designation or trade designation.  * S. Shielding gas for gas shielded are welding shall conform to the following nominal composition:  * Indicate chemical composition or trade designation.  * S. Shielding gas for gas shielded are welding shall conform to the following nominal composition:  * Indicate chemical composition or trade designation.  * S. Shielding gas for gas shielded are welding shall conform to the following as material welds.  * Properation of Base Material  * Metal removal.  * A metal removal.  * A configuration of the weld preparation for partial penetration welds shall conform to the following geometry.*  * Indicate where district and the voltage requirements.  * S. Configuration of the weld preparation for full penetration welds shall conform to the following geometry.*  * Indicate where diameter of electrode, the amperage, the range of americal and processes under the category with a minimum side wall angle.  * S. Configuration of the weld preparation for full penetration welds.  * S. Surfaces shall be made from a seel and shall fit the back of the category with a minimum side w		
steel castings using the welding process.  A indicate specific welding process, such as shielded metal are, etc.  A Base Material  4.1 The base material shall conform to the specification for a which is found in materials category number?  A Insert reference to ASTM designation or indicate chemical analysis and physical properties.  I indicate category number from Table 1.  4.2 Base material shall be in the a stream theorem to the specification for a many direction.  A Insert reference to ASTM designation or indicate chemical analysis and physical properties.  I indicate category number from Table 1.  4.2 Base material shall be in the a stream theorem welding.  5. Filler Metal  5. The little metal shall conform to ANSI/AWS Specification a stream to the specification of a stream to the specification of a stream to the stream theorem welding.  5. Filler metal a shall conform to ANSI/AWS Specification number and number and siller metal classification (e.g., AS.1 E7018).  5. Filler metal composition: A stream the stream theorem welds and composition: A stream theorem welds and composition: A stream the stream theorem welds and composition: A stream the stream theorem welds and the		
A Indicate general material description in the Title.  4. Base Material  4.1 The base material shall conform to the specification for which is found in materials category number?  4.1 Insert reference to ASTM designation or indicate chemical analysis and physical properties.  5 indicate category number from Table 1.  4.2 Base material shall be in the file selection of the welding.  5. Filler Metal  5. The filler metal designation or indicate chemical number and filler metal category number from Table 2.  5. Filler Metal  5. The filler metal shall conform to ANSI/AWS Specification for methods in weld metal analysis group A filler metal category number from Table 3.  5. Filler Metal  5. Filler Metal  5. Filler Metal  5. Filler Metal  5. Filler submerged are welding.  5. Filler designation of a selection of the following nominal composition.  4 Indicate hemical composition or trade designation.  5. Shielding gas for gas shielded are welding shall conform to the following nominal composition.  5. Shielding gas for gas shielded are welding shall conform to the following nominal composition.  5. Preparation of Base Material  6. Preparation of Base Material  7 Indicate themical composition or trade designation.  6. Preparation of Base Material  6. Configuration of the weld preparation or partial penetration welds shall conform to the following generator.  A Indicate minimum soft and is required during metal revoval.  A Indicate minimum soft and is required during metal revoval.  A Indicate minimum soft and is required during metal revoval.  A Indicate minimum soft and is required during metal revoval.  A Indicate information of the weld preparation or partial penetration welds shall composition.  A Indicate minimum soft and is required during metal revoval.  A Indicate information of the weld preparation or position is required during metal revoval.  A Indicate minimum soft and the veltage requirements. For welding processes using the revolution of the weld preparation shall be cleaned of all oil, grease, in the case		·
4. Base Material 4.1 The base material shall conform to the specification for		
4. The base material shall conform to the specification for which is found in materials category number?  A insert reference to ASTM designation or indicate chemical analysis and physical properties.  A indicate tadegory number from Table 1.  4. 2 Base material shall be in the hall heat treated condition before wolding.  A indicate heat treatment before welding.  A indicate heat treatment before welding.  5. Filler Metal  5. 1 The filler metal shall conform to ANSI/AWS Specification hall in weld metal analysis group A		
4.1 The base material shall conform to the specification for described in materials category number for a hybriscal properties.  9 Indicate category number from Table 1.  4.2 Base material shall be in the described in the described in material category number from Table 1.  5.2 Filter Metal  5. The filter metal shall conform to ANSI/AWS Specification described in the stream of the specification of the spe		
which is found in materials category number?  Insert reference to ASTM designation or indicate chemical analysis and physical properties.  Indicate category number from Table 1.  4.2 Base material shall be in the heat treated condition before welding.  In the file reate last and palysis group A		·
Ansert reference to ASTM designation or indicate chemical analysis and physical properties.  Bindicate category number from Table 1.  2 Base material shall be in the heat treated condition before welding.  5. Filter Metal  5. 11 The filter metal shall conform to ANSI/AWS Specification which is found in weld metal analysis group A e.  5. Filter Metal  5. 11 The filter metal shall conform to ANSI/AWS Specification number and filter metal classification (e.g., A.5.1 E7018).  Bindicate appropriate American Welding Society specification number and filter metal classification (e.g., A.5.1 E7018).  Bindicate A Number from Table 4.  5. 2 Flux for submerged are welding shall conform to the following nominal composition.  A Indicate chemical composition or trade designation.  5. 3 Shielding gas for gas shielded are welding shall conform to the following nominal composition:  A Indicate the single gas or proportional parts of mixed gases and flow rates.  6. Preparation of Base Material  6. I Metal removal shall be performed by A		7.4 Local preheating to the temperatures indicated may be performed
physical properties.  **Indicate actaegory number from Table 1.  **4. Base material shall be in the **	which is found in materials category number <sup>B</sup>	so that the heated area completely surrounds the weld preparation for a
A Base material shall be in the 4 heat treated condition before welding.  5. Filer Metal  5. Filer Metal  5. The filter metal shall conform to ANSIAWS Specification 4 which is found in weld metal analysis group A 6.  5. The filter metal shall conform to ANSIAWS Specification 1 which is found in weld metal analysis group A 7.  6. Indicate appropriate American Welding Society specification number and "Indicate appropriate American Welding Society specification number and "Indicate assification (e.g., A.5.1 E7018).  7. Indicate A Number from Table 4.  5. Filter to submerged are welding shall conform to the following nominal composition.  7. Indicate chemical composition or trade designation.  5. Shielding gas for gas shielded are welding shall conform to the following nominal composition.  7. Indicate the single gas or proportional parts of mixed gases and flow rates.  6. Preparation of Base Material  6. It welds removal shall be performed by 4 1 performed by 4 1 performed welds shall be 1 performed by 4 1 performed welds whether preheat is required during metal removal.  6. Configuration of the weld preparation for full penetration welds shall conform to the following geometry.  7. Indicate minimum root radius and minimum side wall angle.  8. Section of the weld preparation for full penetration welds shall conform to the following geometry.  8. Indicate material of backing plate shall be used for welding full penetration welds shall conform to the following geometry.  8. Indicate dimension of maximum gap.  8. Section of the weld preparation	A Insert reference to ASTM designation or indicate chemical analysis and	minimum distance of <sup>A</sup> in any direction.
4.2 Base material shall be in the heat treated condition before welding.  5. Fillor Motal  5.1 The filler metal shall conform to ANSI/AWS Specification shall be performed. See Fig. 4.  5.1 The filler metal shall conform to ANSI/AWS Specification g.  6. Indicate A Number from Table 4.  5.2 Flux for submerged arc welding shall conform to the following nominal composition: shall be performed by shall removal.  6. Preparation of Base Material  6. 1 Metal removal shall be performed by shall conform to the following nominal composition: shall be performed by shall be performed b	physical properties.	<sup>A</sup> Indicate minimum distance for local preheating.
4.2 Base material shall be in the heat treated condition before welding.  5. Fillor Motal  5.1 The filler metal shall conform to ANSI/AWS Specification should be performed. See	B Indicate category number from Table 1.	8. Welding Position
"A Indicate heat treatment before welding.  5. Filler Metal  5. Filler Metal shall conform to ANSI/AWS Specification^		
A indicate heat treatment before welding.  5. Filler Metal  5. The filler metal shall conform to ANSI/AWS specification A which is found in weld metal analysis group A B.  A indicate appropriate American Welding Society specification number and filler metal classification (e.g., 45.1 E7018).  By indicate A Number from Table 4.  5.2 Flux for submerged arc welding shall conform to the following nominal composition: A indicate chemical composition: A 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 A indicate method of metal removal, such as chipping, grinding, carbon arc cutting, frame cutting, frame cutting, frame cutting, error cutting, frame cutting, error will be performed by A indicate memoral of more following geometry:  A indicate method of metal removal, such as chipping, grinding, carbon arc cutting, frame cutting, error cutting, frame cutting, error will be performed by A indicate minimum more radius and minimum side wall angle.  6.2 Configuration of the weld preparation for partial penetration welds shall conform to the following geometry:  A indicate minimum more radius and minimum side wall angle.  6.3 Configuration of the weld preparation for full penetration welds. Sacking plates shall be made from a steel and shall fit the back of the cavity with a minimum gap of B.  A indicate mention of maximum gap.  6.5 Surfaces of the weld preparation shall be cleaned of all oil, grease, dirf, 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:  A indicate the return that the surfaces of the weld preparation shall be inspected as follows:  A indicate the return that the surfaces of the weld preparation shall be inspected as follows:  A indicate the performed according to the following:  A indicate		
5. Filter Metal  5. 11 The filter metal shall conform to ANS/AWS Specification <sup>A</sup> A indicate appropriate American Welding Society specification number and filter metal classification (e.g., 45.1 E7018).  Bindicate A Number from Table 4.  S.2 Flux for submerged are welding shall conform to the following nominal composition.  A indicate chemical composition or trade designation.  S.3 Shielding gas for gas shielded are welding shall conform to the following nominal composition:  A indicate the single gas or proportional parts of mixed gases and flow rates.  B. Preparation of Base Material  6.1 Metal removal shall be performed by <sup>A</sup> A indicate method of metal removal, such as chipping, grinding, carbon are cutting, frame cutting, etc. As lo 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.  A 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.  A indicate minimum side wall angle.  6.4 Backing plates shall be used for welding full penetration welds.  Backing plates shall be made from steel and shall fit the back of the cavity with a minimum 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.  A indicate the remainal of power supply is used.  Electrode  Wire  Diameter.  A Indicate thereited copositive (EP) or electrode positive (EP) or electrode or amperage permitted, and the vollage requirements.  Flanciate whether direct or alternating current. If direct, state whether noneautication particle		
5.1 The filler metal shall conform to ANSI/AWS Specification A which is found in weld metal analysis group A B A Indicate appropriate American Welding Society specification number and filler metal classification (e.g., 45.1 E7018).  5.2 Flux for submerged arc welding shall conform to the following nominal composition:  A Indicate chemical composition or trade designation.  5.3 Shielding gas for gas shielded arc welding shall conform to the following nominal composition:  A 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 A 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:  A 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:  A Indicate minimum side wall angle.  6.4 Backing plates shall be used for welding full penetration welds.  Backing plates shall be used for welding full penetration welds.  Backing plates shall be used for welding full penetration welds.  Backing plates shall be weld breparation 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 shall be made from A indicate material of backing plate.  A Indicate threatment shall be performed according to the following:  A Indicate threatment shall be performed according to the following:  A Indicate threatment shall be performed according to the following:  A Indicate threatment shall be performed according to the following:  A Indicate the number for controlling the maximum widh.  A Indicate the number for controlling the maximum widh.  A Indicate the number for controlling the maximum wid		
which is found in weld metal analysis group A		
A Indicate appropriate American Welding Society specification number and filler metal classification (e.g., A.S. 1 E7018).  A Indicate A Number from Table 4.  5.2 Flux for submerged are welding shall conform to the following nominal composition:  A Indicate chemical composition or trade designation.  5.3 Shielding gas for gas shielded are welding shall conform to the following nominal composition:  A 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  A Indicate method of metal removal, such as chipping, grinding, carbon are cutting, frame cutting and incomposition of the weld preparation for partial penetration welds shall conform to the following geometry:  A 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:  A Indicate method of metal removal, such as chipping, grinding, carbon are cutting, frame cutting, frame cutting, etc. Also indicate whether relectrode positive (EP) or electrode negative (EN) output terminal of power supply is used.  Electrode  Wire  Diameter*  A Indicate whether electrode positive (EP) or electrode negative (EN) output terminal of power supply is used.  Electrode  Wire  A Indicate whether electrode positive (EP) or electrode negative (EN) output terminal of power supply is used.  Electrode  Wire  A Indicate de whether electrode positive (EP) or electrode negative (EN) output terminal of power supply is used.  Electrode  Wire  A Indicate designation of Base Material  A Indicate the single gas or proportional parts of mixed gases and flow rates.  A Indicate the subject gase and shall electrode are indicated whether preparation shall be c		
filler metal classification (e.g., A5.1 E7018).  # Indicate A Number from Table 4.  5.2 Flux for submerged are welding shall conform to the following nominal composition:  * Indicate chemical composition or trade designation.  5.3 Shielding gas for gas shielded are welding shall conform to the following nominal composition:  * 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 * Indicate method of metal removal, such as chipping, grinding, carbon are cutting, frame cutting, frame cutting, carbon are 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:  * 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:  * Indicate method of metal removal, such as chipping, grinding, carbon are cutting, frame cutting, frame cutting, frame with the weld preparation for partial penetration welds shall conform to the following geometry:  * Indicate method of metal removal, such as chipping, grinding, carbon are cutting, frame removal.  6.2 Configuration of the weld preparation for partial penetration welds shall conform to the following geometry:  * Indicate method of metal removal, such as chipping, grinding, carbon are cutting, frame frame cutting, frame frame cutting, frame frame cutting, fr		
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<ul> <li>12. Inspection</li> <li>12.1 Inspection of the completed weld shall be performed according to the following:<sup>A</sup></li> </ul>	<sup>A</sup> Indicate type of inspection.	<sup>A</sup> Indicate the heating and cooking rates, holding temperatures and times.
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the following: <sup>A</sup>		·

FIG. 3 Report Form 3



3.2 production welding—any welding carried out during manufacturing before final delivery to the customer. Production welding is part of the casting production process. Most castings will receive some welding as part of the process of producing a casting to customer requirements.

### 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 positions.
- 4.7 Qualification—Qualification in the horizontal, vertical, or overhead position shall qualify also for the flat position. Qualification in the horizontal fixed position, or in the horizontal and vertical and overhead positions, shall qualify for all positions.

### 5. Preparation of Test Plate

- 5.1 Procedure qualification testing shall be performed on cast or wrought material having the same category number as the casting being welded. Test material shall be subjected to the same heat treatment before and after welding as will be applied to the casting. If the castings are not to be postweld heat treated, then the test material is not to be postweld heat treated. Test plate material for performance qualification testing is covered in 12.2.
  - 5.2 The dimensions of the test plate shall be such as to provide the required number of test specimens.
- 5.3 The test joint shall be welded using the type of welding groove proposed in the welding procedure. The dimensions of the welding groove are not essential variables of the welding procedure.
  - 5.4 The thickness of the test plate shall depend on the range of thickness to be qualified as shown in Tables 2 and 3.
  - 5.5 The joint preparation shown in Fig. 5 shall qualify the supplier for all welding on steel castings.
- 5.6 Where pipe or a cylindrical casting is used for qualification, it is recommended that a minimum nominal diameter of 5 in. [125 mm] and a minimum thickness of 3/8 in. [10 mm] be used.

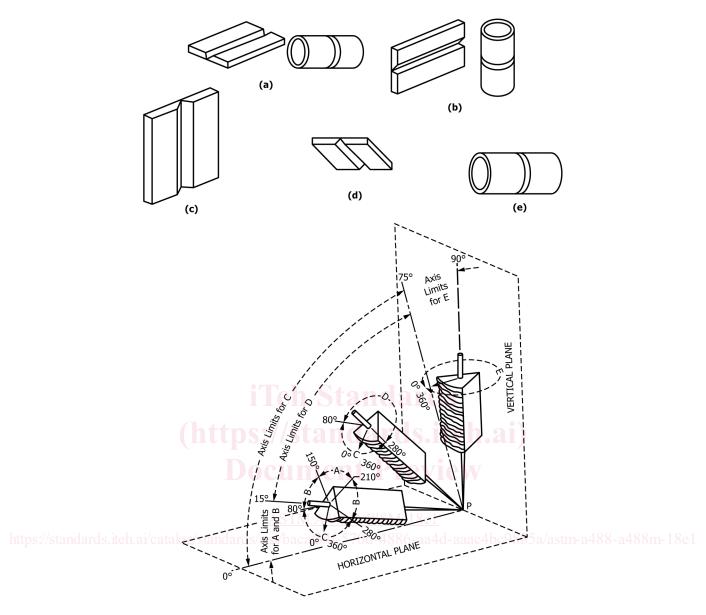
### 6. Types of Tests

- 6.1 Four types of tests are used in the qualification procedure as follows:
- 6.1.1 Tension Test—Tests in direct tension are used in the procedure qualification to measure the strength of groove-weld joints.
- 6.1.2 Bend Test—Guided bend tests are used in the procedure and performance qualification tests to check the degree of soundness and ductility of groove-weld joints.
- 6.1.3 *Charpy Impact Test*—Charpy V-notch impact test specimens are used in the procedure qualification to determine the impact strength of weld metal deposited in groove-type joints.
- 6.1.4 *Radiographic Test*—Radiographic examination in accordance with 12.6 of a length of weld may be used to prove the ability of operators and welders to make sound welds.

#### 7. Tension Test

- 7.1 Specimens—Tension tests shall be in accordance with the requirements of 7.1.1 or 7.1.2.
- 7.1.1 All thicknesses of plate may be tested using reduced-section specimens in accordance with the requirements of Fig. 6. All thicknesses of pipe or cylindrical castings having an outside diameter greater than 3 in. [75 mm] may be tested using reduced-section specimens in accordance with the requirements of Fig. 7.
  - 7.1.1.1 A single specimen of full-plate or full-pipe thickness shall be used for thicknesses up to and including 1 in. [25 mm].
  - 7.1.1.2 For plate or pipe thicknesses greater than 1 in. [25 mm], single or multiple specimens may be used.
- 7.1.1.3 When multiple specimens are used, each set shall represent a single required tension test. Collectively, all of the specimens required to represent the full thickness of the weld at one location shall comprise a set.





**Tabulation of Positions of Groove Welds** 

Position	Diagram Reference	Inclination of Axis, °	Rotation of Face,°
Flat	А	0 to 15	150 to 210
Horizontal	В	0 to 15	80 to 150 210 to 280
Overhead	С	0 to 80	0 to 80 280 to 360
	<del></del>	<del>15 to 80</del> <del>80 to 90</del>	<del>-80 to 280</del> <del> 0 to 360</del>
Vertical		15 to 80 80 to 90	80 to 280 0 to 360

 $\ \, \text{Note 1---}(a) \,\, \text{Flat Position; } (b) \,\, \text{Horizontal Position; } (c) \,\, \text{Vertical Position; } (d) \,\, \text{Overhead Position; } (e) \,\, \text{Horizontal Fixed Position.}$ 

FIG. 4 Orientation of Welds

TABLE 2 Type and Number of Test Specimens and Range of Thicknesses Qualified - (Procedure)

Thickness, t, of Test Plate or Pipe as	Range of Thick Qualified		٦	Type and Number	er of Tests Require	$d^B$
Welded, in. [mm]	min, in. [mm]	max	Reduced Section Tension	Side Bend	Face Bend	Root Bend
1/16 to 3/8 [1.6 to 9.5], incl	1/16 [1.6]	2t <sup>C</sup>	2		2	2
Over 3/8 [9.5], under 3/4 [19.0]	3/16 [4.8]	2 <i>t</i>	2		2	2
3/4 [19.0] to under 11/2 [38.1]	3/16 [4.8]	2 <i>t</i>	2	4		
1½ [38.1] and over	3/16 [4.8]	8 [203]	2	4		

<sup>&</sup>lt;sup>A</sup> For repair welding, the minimum thickness requirements do not apply.

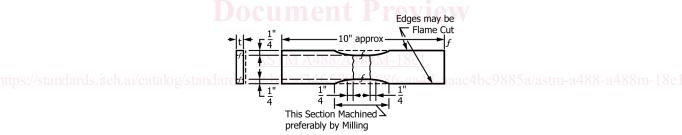
TABLE 3 Type and Number of Test Specimens and Thickness Limits Qualified - (Performance)

Thickness, t, of Test Plate or Pipe as	Thickness Qualified	Туре	and Number of Tests Requ	uired <sup>A</sup>
Welded, in. [mm]	mickiess Qualified	Side Bend	Face Bend	Root Bend
Up to % [9.5], incl	2t		1	1
Over 3/8 [9.5], under 3/4 [19.0] <sup>B</sup>	2t		1	1
Over % [9.5], under ¾ [19.0] <sup>B</sup>	2t	2		
3/4 [19.0], and over	max to be welded	2		

A A total of four specimens are required to qualify for Position 1(e) of Fig. 4. Refer to Fig. 17 and Fig. 18.

<sup>&</sup>lt;sup>B</sup> Either the face- and root-bend tests or the side-bend tests may be used for thicknesses from % to ¾ in. [9.5 to 19.0 mm].





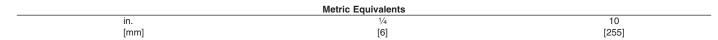


FIG. 6 Reduced-Section Tension Specimen for Plate

- 7.1.1.4 When multiple specimens are necessary, the entire thickness shall be mechanically cut into a minimum number of approximately equal strips of a size that can be tested in the available equipment. Each specimen shall be tested and meet the requirements of 7.1.4.
  - 7.1.2 Turned specimens, in accordance with the requirements of Fig. 8, may be used for tension tests.
- 7.1.2.1 For thicknesses up to and including 1 in. [25 mm], a single turned specimen may be used, which shall be a specimen of the largest diameter possible for the test coupon thickness.
- 7.1.2.2 For thicknesses greater than 1 in. [25 mm], multiple specimens shall be cut through the full thickness of the weld with their centers parallel to the metal surface and not over 1 in. [25 mm] apart. The centers of the specimens adjacent to the metal surfaces shall not exceed 5/8 in. [16 mm] from the surface.
- 7.1.2.3 When multiple specimens are used, each set shall represent a single required tension test. Collectively, all of the specimens required to represent the full thickness of the weld at one location shall comprise a set. Each specimen shall be tested and meet the requirements of 7.1.4.
  - 7.1.3 The weld shall be in the center of the reduced section.

<sup>&</sup>lt;sup>B</sup> Either the face- and root-bend tests or the side-bend tests may be used for thicknesses from % to ¾ in. [9.5 to 19.0 mm].

<sup>&</sup>lt;sup>C</sup> The maximum thickness qualified with pipe smaller than 5 in. [127 mm] is two times the thickness of the pipe but not more than ¾ in. [19.0 mm].