AEROSPACE MATERIAL SPECIFICATION

AMS5368™	REV. E

Issued 1961-01
Revised 2018-08
Reaffirmed 2023-11

Superseding AMS5368D

Steel, Corrosion-Resistant, Investment Castings 15Cr - 4.0Ni - 2.3Mo - 0.09N Solution Heat Treated (Composition similar to UNS J92001)

RATIONALE

AMS5368E revises chemical analysis standards (3.1), updates the default NDT acceptance requirement (3.7.4.1), prohibits unauthorized exceptions (3.8), updates reports (4.5.5), and results from a Five-Year Review and update of this specification.

AMS5368E has been reaffirmed to comply with the SAE Five-Year Review policy.

1. SCOPE

1.1 Form

This specification covers a corrosion-resistant steel in the form of investment castings.

1.2 Application

These castings have been used typically for parts requiring good corrosion resistance up to 850 °F (454 °C), but usage is not limited to such applications.

2. APPLICABLE DOCUMENTS

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the reference document has been cancelled and no superseding document has been specified, the last published issue of that document shall apply.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
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Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

For more information on this standard, visit
https://www.sae.org/standards/content/AMS5368E/

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AMS2175 Castings, Classification and Inspection of

AMS2248 Chemical Check Analysis Limits, Corrosion and Heat-Resistant Steels and Alloys, Maraging and Other Highly Alloyed Steels, and Iron Alloys

AMS2360 Room Temperature Tensile Properties of Castings

AMS2694 In-Process Welding of Castings

AMS2700 Passivation of Corrosion Resistant Steels

AMS2750 Pyrometry

AMS2804 Identification, Castings

AMS-H-6875 Heat Treatment of Steel Raw Materials

ARP1917 Clarification of Terms Used in Aerospace Metals Specifications

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM A751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products

ASTM E8/E8M Tension Testing of Metallic Materials

ASTM E18 Rockwell Hardness Hardness of Metallic Materials

ASTM E1417/E1417M Liquid Penetrant Testing

ASTM E1444/E1444M Magnetic Particle Testing

ASTM E1742/E1742M Radiographic Examination

3. TECHNICAL REQUIREMENTS

3.1 Composition

Shall conform to the percentages by weight shown in Table 1, determined by wet chemical methods in accordance with ASTM A751, by spectrochemical methods, or by other analytical methods acceptable to the purchaser (see 8.2.1 and 8.2.2).

Table 1 - Composition

Element	Min	Max
Carbon	0.08	0.15
Manganese	0.40	1.10
Silicon	--	0.75
Phosphorus	--	0.04
Sulfur	--	0.03
Chromium	14.50	15.50
Nickel	3.50	4.50
Molybdenum	2.00	2.60
Nitrogen	0.05	0.13
Carbon + Nitrogen	0.15	0.25
Iron	remainder	

3.1.1 The producer may test for any element not otherwise listed in Table 1 and include this analysis in the report of 4.5. Limits of acceptability may be specified by the purchaser (see 8.2.3).

3.1.2 Check Analysis

Composition variations shall meet the applicable requirements of AMS2248.

3.2 Melting Practice

Castings and specimens shall be poured at casting the producer's facility either from a melt (see 8.2.4) of a master heat, or directly from a master heat (see 3.4.2 and 8.2.5).

3.2.1 Revert (gates, sprues, risers, and rejected castings) may be used only in the preparation of master heats; revert shall not be remelted directly without refining for pouring of castings. Melting of revert creates a new master heat.

3.2.2 Portions of two or more qualified master heats (see 3.4.2) may be melted together and poured into castings using a procedure authorized by the purchaser (see 8.2.6).

3.2.3 If melts (see 8.2.4) are modified by replenishment (see 8.2.7), the producer shall have a written procedure acceptable to the purchaser which defines the controls, test, and traceability criteria for both castings and separately cast specimens. Control factors of 4.4.2.2 shall apply.

3.3 Condition

Unless otherwise specified, castings shall be delivered in the solution heat treated condition (see 8.6).

3.4 Test Specimens

Specimens shall be either separately cast, integrally cast (see 8.2.8), or machined from a casting, and shall conform to 3.2.

3.4.1 If specimens are separately cast, the producer shall have a written procedure acceptable to the purchaser. Control factors of 4.4.2.2 shall apply.

3.4.2 Each master heat shall be qualified by evaluation of chemical and tensile specimens.

3.4.2.1 If replenishments are made at remelt as in 3.2.3, frequency of sampling and testing used by the producer for qualification to 3.4.2 shall be acceptable to the purchaser.

3.4.2.2 Tensile tests of 3.4.2 are not required if these tests are conducted using integrally cast specimens (4.3.3.2) or specimens machined from casting (4.3.3.3).

3.4.3 Chemical Analysis Specimens

Shall be of any convenient size and shape.

3.4.4 Tensile Specimens

Shall be of standard proportions in accordance with ASTM E8/E8M (see 8.3) with 0.250-inch (6.35-mm) diameter at the reduced parallel gage section.

3.4.4.1 Separately cast and integrally cast specimens may be either cast to size, and/or cast oversize and subsequently machined to 0.250-inch (6.35-mm) diameter.

3.4.4.2 When integrally cast specimens and/or specimens machined from casting are specified, specimen size and location shall be agreed upon by the purchaser and the producer (see 8.2.9 and 8.6).

3.5 Heat Treatment

To produce the condition in castings for delivery, solution heat treat in accordance with AMS-H-6875 except as specified in 3.5.1, to conform to the room temperature tensile properties of 3.6.1 and the hardness of 3.6.2. Pyrometry shall be in accordance with AMS2750.

3.5.1 Production Castings and Specimens

3.5.1.1 Solution Heat Treatment

Heat to a temperature within the range of 1875 to 1925 °F (1024 to 1052 °C), hold at the selected temperature within ±25 °F (±14 °C) for not less than 1 h/in (25 mm) of maximum section thickness, and cool rapidly to room temperature.

3.5.2 Response to Heat Treatment

After heat treatment in accordance with 3.5.1, specimens shall be heat treated as follows for subsequent testing to demonstrate response to heat treatment:

3.5.2.1 Austenite Condition

Heat to a temperature within the range of 1750 to 1825 °F (954 to 996 °C), hold at the selected temperature within ±25 °F (±14 °C) for not less than 1 h/in (25 mm) of maximum section thickness, and cool rapidly to room temperature.

3.5.2.2 Sub-Zero Cool

Cool to below -100 °F (-73 °C) or lower, hold at temperature for not less than 3 hours, and warm to room temperature.

3.5.2.3 Temper

Heat to 850 °F ± 25 °F (454 °C ± 14 °C), hold at heat for not less than 3 hours, and cool in air.

3.5.3 For 3.5.1.1 and 3.5.2.1, section thicknesses over 1 inch (25 mm) shall either be quenched in water or oil or gas-fan cooled.

3.5.4 Tensile specimens used for master heat qualification may be heat treated separately from castings.

3.6 Properties

Conformance shall be based upon testing of separately cast specimens unless the purchaser specifies integrally cast specimens or specimens machined from casting. Properties for integrally cast specimens and specimens machined from casting shall be as specified by the purchaser (see 8.6).

3.6.1 Room Temperature Tensile Properties After Response to Heat Treatment

After heat treating as in 3.5.2, shall be as shown in Table 2, determined on separately cast specimens in accordance with ASTM E8/E8M (see 8.3). Properties other than those listed may be defined as specified in AMS2360.

3.6.1.1 Separately Cast Specimens

Shall be as shown in Table 2.

Table 2 - Minimum tensile properties

Property	Value
Tensile Strength	200 ksi (1379 MPa)
Yield Strength at 0.2% Offset	150 ksi (1034 MPa)
Elongation in 4D	8%

3.6.2 Hardness

Shall be as follows, determined in accordance with ASTM E18:

3.6.2.1 Castings

Castings, heat treated to the condition of 3.5.1.1, shall have a hardness not higher than 39 HRC.

3.6.2.2 Castings and Representative Specimens

Castings and representative specimens, heat treated to the condition of 3.5.2, shall have hardness not lower than 40 HRC.

3.7 Quality

3.7.1 Castings, as received by the purchaser, shall be uniform in quality and condition, sound, and free from foreign materials and from imperfections detrimental to usage of the castings. Castings shall be free of cracks, laps, hot tears, and cold shuts, and free of scale and other process-induced surface contamination which would obscure defects.

3.7.1.1 Unless otherwise specified, castings shall be sufficiently cleaned such that, after passivation by the purchaser, the castings shall meet the corrosion test requirement of AMS2700.

3.7.2 Castings shall be produced under radiographic control. This control shall consist of radiographic examination of each casting part number until foundry manufacturing controls in accordance with 4.4.2 have been established. Additional radiography shall be conducted in accordance with the frequency of inspection specified by the purchaser, or as necessary to ensure continued maintenance of internal quality.

3.7.2.1 Radiographic inspection shall be conducted in accordance with ASTM E1742/E1742M or other method specified by the purchaser.

3.7.3 When specified, additional nondestructive testing shall be performed as follows:

3.7.3.1 Fluorescent penetrant inspection in accordance with ASTM E1417/E1417M or other method specified by the purchaser.

3.7.3.2 Magnetic particle inspection in accordance with ASTM E1444/E1444M or other method specified by the purchaser.

3.7.4 Acceptance standards for radiographic, fluorescent penetrant, magnetic particle, visual, and other inspection methods shall be as agreed upon by the purchaser and the producer (see 8.2.9). AMS2175 may be used to specify acceptance standards (casting grade) and frequency of inspection (casting class).

3.7.4.1 When acceptance standards are not specified, the following applies: Castings shall meet Grade C of AMS2175 and radiographic indications of gas holes, sand spots, and inclusions shall be cause for rejection when closer to the edge than twice their maximum dimension.

3.7.5 Castings shall not be peened, plugged, impregnated, or welded unless authorized by the purchaser.

3.7.5.1 When authorized by the purchaser, welding in accordance with AMS2694 or other welding program acceptable to the purchaser may be used.

3.8 Any exceptions shall be authorized by the purchaser and reported as in 4.5.5.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The producer of castings shall supply all samples for the producer's tests and shall be responsible for the performance of all required tests. The purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the castings conform to specified requirements.

4.2 Classification of Tests

4.2.1 Acceptance Tests

Composition (3.1), room temperature tensile properties after processing for response to heat treatment (3.6.1), hardness of castings (3.6.2.1), hardness of representative specimens after processing for response to heat treatment (3.6.2.2), and the applicable requirements of quality (3.7) are acceptance tests and shall be performed as specified in 4.3.

4.2.2 Periodic Tests

Corrosion resistance (3.7.1.1) and radiographic soundness (3.7.2) are periodic tests and shall be performed at a frequency selected by the producer unless a frequency of testing is specified by the purchaser.

4.2.3 Preproduction Tests

All technical requirements are preproduction tests and shall be performed on sample castings (4.3.2), when a change in control factors occurs (4.4.2.2), and when the purchaser deems confirmatory testing to be required.

4.3 Sampling and Testing

The minimum testing performed by the producer shall be in accordance with the following:

4.3.1 One chemical analysis specimen or a casting from each master heat shall be tested for conformance with Table 1; if 3.4.2.1 applies, test frequency shall be acceptable to the purchaser.

4.3.2 One preproduction casting in accordance with 4.4 shall be tested to requirements of the casting drawing and to all technical requirements.

4.3.2.1 Dimensional inspection sample quantity shall be as specified by the purchaser.

4.3.3 Tensile property tests shall be conducted to determine conformance with 3.6.1. Sampling and test frequency is dependent upon the type and origin of specimen specified by the purchaser (see 3.4.4 and 3.6) or selected by the producer (see 4.3.3.4). When 3.4.2.1 applies, specimen source and test frequency shall be acceptable to the purchaser.

4.3.3.1 For separately cast specimens in the solution, austenite condition, sub-zero cool, and temper condition of 3.5.2, one specimen from each master heat shall be tested for conformance to 3.6.1.

4.3.3.2 For integrally cast specimens in the solution, austenite condition, sub-zero cool, and temper condition of 3.5.2, two specimens from each lot (see 8.2.10) shall be randomly selected and tested for conformance with properties specified by the purchaser (see 8.6).

4.3.3.3 For specimens machined from casting, one casting shall be randomly selected from each lot and tested in the solution, austenite condition, sub-zero cool, and temper condition of 3.5.2 at each location shown on the engineering drawing to 3.6.1 for conformance with properties specified by the purchaser (see 8.6).

4.3.3.3.1 When size and location of specimens are not shown, two specimens shall be tested, one from the thickest section and one from the thinnest section. Once established under 4.4.2.2, test locations may be changed only as agreed upon by the purchaser and the producer.

4.3.3.4 When acceptable to the purchaser, specimens machined from casting may be used in lieu of both separately cast and integrally cast specimens, and integrally cast specimens may be used in lieu of separately cast specimens. In each case, the resultant properties must conform to requirements specified by the purchaser (see 8.6).

4.3.3.4.1 When specimens are selected for test as in 4.3.3.4 from an origin other than that specified by the purchaser, the producer shall include in the report of 4.5 a description of the source of the specimen that was tested.

4.3.3.5 When casting size, section thickness, gating method, or other factors do not permit conformance with 4.3.3.2 or 4.3.3.3, sampling and testing shall be agreed upon by the purchaser and the producer.

4.3.4 Castings shall be inspected in accordance with 3.7 to the methods, frequency, and acceptance standards specified by the purchaser.

4.3.5 Casting shall be inspected for hardness to determine conformance with 3.6.2.1.

4.3.5.1 Unless otherwise specified by the purchaser, one casting from each lot shall be hardness tested to determine conformance with 3.6.2.1.

4.3.5.1.1 In event of failure, the entire lot shall be 100% inspected or re-heat treated in accordance with 4.6.2.

4.4 Approval

4.4.1 Sample casting(s) from new or reworked master patterns produced under the casting procedure of 4.4.2 shall be approved by the purchaser before castings for production use are supplied, unless such approval be waived by the purchaser.

4.4.2 For each casting part number, the producer shall establish parameters for process control factors that will consistently produce castings and test specimens meeting the requirements of the casting drawing and this specification. These parameters shall constitute the approved casting procedure and shall be used for production of subsequent castings and test specimens. If necessary to make any change to these parameters, the producer shall submit a statement of the proposed change for the purchaser reapproval. When requested, the producer shall also submit test specimens, sample castings, or both to the purchaser for reapproval.

4.4.2.1 Production castings produced prior to receipt of the purchaser's approval shall be at the producer's risk.

4.4.2.2 Control factors for producing castings and separately cast specimens include, but are not limited to, the following factors. Suppliers procedures shall identify tolerances, ranges, and/or control limits, as applicable. Control factors for separately cast specimens must generally represent, but need not be identical to, those factors used for castings (see 3.2.3 and 3.4.1):

Composition of ceramic cores, if used
Arrangement and number of patterns in the mold (including integrally cast specimens, if applicable)
Size, shape, and location of gates and risers
Mold refractory formulation
Grain refinement methods, if applicable
Mold back-up material (weight, thickness, or number of dips)
Type of furnace, atmosphere, and charge for melting
Mold preheat and metal pouring temperatures
Fluxing or deoxidation procedure
Replenishment procedure, if applicable
Time molten metal is in furnace

Solidification and cooling procedures
Cleaning operations (mechanical and chemical)
Heat treatment
Straightening
Final inspection methods
Location and size of integrally cast specimens and specimens machined from casting, if applicable

4.4.2.2.1 Any of the control factors for which parameters are considered proprietary by the producer may be assigned a code designation. Each variation in such parameters shall be assigned a modified code designation.

4.4.2.2.1.1 Unless otherwise agreed upon by the purchaser and the producer, the purchaser shall be entitled to review proprietary control factor details and coding at the producer's facility.

4.5 Reports

The producer of castings shall furnish with each shipment a certification document declaring that castings have been processed, tested, and inspected as specified and that the results of the inspections and tests conform to requirements.

4.5.1 Unless otherwise specified, the producer shall furnish test report(s) showing the results of tests and inspections conducted in accordance with 4.2 and 4.3.

4.5.1.1 Chemical analysis determinations, property test data, and the results of any retests conducted shall be expressed numerically to reflect actual quantitative test values.

4.5.1.2 Hardness test readings may be expressed as single values or as a range of values exhibited by results obtained from the sample size.

4.5.1.3 Inspection and preproduction results shall be reported at the frequency specified by, and in a format acceptable to the purchaser.

4.5.1.4 Nonconformances shall be documented and approved by the purchaser in accordance with the purchaser's material review requirements.

4.5.2 The statement of conformity and test report(s) shall include or be traceable to the purchase order number, master heat identification, heat treat/lot number, AMS5368E, part number, quantity, and, when required (see 5.1.2), the list of individual serial numbers or serial number range.

4.5.2.1 If 4.3.3.4.1 applies, the mechanical property test report shall denote the source of the specimens that were tested.

4.5.3 Test reports for acceptance testing of 4.2 shall be as follows:

4.5.3.1 For Each Master Heat

Composition (see 4.3.1)
Tensile properties (see 4.3.3.1)

4.5.3.2 For Each Lot

Inspection results (see 4.3.4)
Tensile properties, when specified (see 4.3.3.2 and 4.3.3.3)
Hardness of castings (see 4.3.5)