



AEROSPACE MATERIAL SPECIFICATION

AMS5360™**REV. G**

Issued 1947-09
Revised 2018-08
Reaffirmed 2023-11

Superseding AMS5360F

Steel, Corrosion and Heat-Resistant, Investment Castings

17Cr - 13Ni - 1.9Mo

Solution Heat Treated

(Composition similar to UNS J92951)

RATIONALE

AMS5360G 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.

AMS5360G has been reaffirmed to comply with the SAE Five-Year Review policy.

1. SCOPE

1.1 Form

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

1.2 Application

These castings have been used typically for parts requiring oxidation resistance up to 1600 °F (871 °C) but usage is not limited to such applications. At elevated temperatures, strength of this material is slightly higher than, and oxidation resistance is similar to, that of UNS J92500 (CF-3) and J92600 (CF-8) type steels.

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.

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

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SAE WEB ADDRESS:

For more information on this standard, visit
<https://www.sae.org/standards/content/AMS5360G/>

AMS2700	Passivation of Corrosion Resistant Steels
AMS2750	Pyrometry
AMS2804	Identification, Castings
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 of Metallic Materials
ASTM E1417/E1417M	Liquid Penetrant 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 purchaser (see 8.2.1 and 8.2.2).

Table 1 - Composition

Element	Min	Max
Carbon	--	0.15
Manganese	--	2.00
Silicon	--	0.75
Phosphorus	--	0.04
Sulfur	--	0.03
Chromium	16.00	18.00
Nickel	12.00	14.00
Molybdenum	1.50	2.25
Copper	--	0.75

3.1.1 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 purchaser (see 8.2.3).

3.1.2 Check Analysis

Composition variations shall meet the requirements of AMS2248.

3.2 Melting Practice

Castings and specimens shall be poured at casting 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 purchaser (see 8.2.6).
- 3.2.3 If melts (see 8.2.4) are modified by replenishment (see 8.2.7), producer shall have a written procedure acceptable to 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

Castings shall be delivered in the solution heat treated condition.

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, producer shall have a written procedure acceptable to purchaser. Control factors of 4.4.2.2 shall apply.
- 3.4.2 Each master heat shall be qualified by evaluation of chemical analysis 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 purchaser.

3.4.3 Chemical Analysis Specimens

Shall be of any convenient size and shape.

3.4.4 Tensile Specimens

Room temperature tensile properties are not required for qualification. If purchaser requires these properties (see 3.6.2), 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 purchaser and producer (see 8.2.9 and 8.5).

3.5 Heat Treatment

Castings and representative specimens shall be heat treated as follows. Pyrometry shall be in accordance with AMS2750.

3.5.1 Castings and Specimens

3.5.1.1 Solution Heat Treatment

Heat within the range of 1925 to 1975 °F (1052 to 1079 °C), holding at the selected temperature within ± 25 °F (± 14 °C) for not less than 30 minutes and rapid cooling in air, oil, water, or argon.

3.6 Properties

3.6.1 Hardness

Castings and representative specimens, heat treated to the condition of 3.3, shall have hardness not higher than 90 HRB, determined in accordance with ASTM E18.

3.6.2 Room Temperature Tensile Properties

May be specified by purchaser in accordance with AMS2360.

3.7 Quality

3.7.1 Castings, as received by 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 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 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 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 purchaser.

3.7.4 Acceptance standards for radiographic, fluorescent penetrant, visual, and other inspection methods shall be as agreed upon by purchaser and 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 purchaser.

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

3.8 Any exceptions shall be authorized by 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 producer's tests and shall be responsible for the performance of all required tests. 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), tensile properties if specified (3.6.2), 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

Hardness (3.6.1), 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 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 purchaser deems confirmatory testing to be required.

4.3 Sampling and Testing

The minimum testing performed by 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 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 purchaser.
- 4.3.3 When specified by purchaser (see 8.5), tensile property tests shall be conducted to determine conformance with 3.6.2. Sampling and test frequency is dependent upon the type and origin of specimen specified by purchaser (see 3.4.4 and 3.6) or selected by producer (see 4.3.3.4). When 3.4.2.1 applies, specimen source and test frequency shall be acceptable to purchaser.
 - 4.3.3.1 For separately-cast specimens in the solution heat treated condition, one specimen from each master heat shall be tested for conformance to 3.6.2.
 - 4.3.3.2 For integrally-cast specimens in the solution heat treated condition, two specimens from each lot (see 8.2.10) shall be randomly selected and tested for conformance with properties specified by purchaser (see 3.6.2 and 8.5).
 - 4.3.3.3 For specimens machined-from-casting, one casting shall be randomly selected from each lot and tested in the solution heat treated condition at each location shown on the engineering drawing for conformance with properties specified by purchaser (see 3.6.2 and 8.5).
 - 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 purchaser and producer.
 - 4.3.3.4 When acceptable to 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 purchaser (see 8.5).
 - 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 purchaser, 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 purchaser and producer.

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

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 purchaser before castings for production use are supplied, unless such approval be waived by purchaser.

4.4.2 For each casting part number, 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, producer shall submit a statement of the proposed change for purchaser reapproval. When requested, producer shall also submit test specimens, sample castings, or both to purchaser for reapproval.

4.4.2.1 Production castings produced prior to receipt of purchaser's approval shall be at 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. Supplier's 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 of 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 purchaser and producer, purchaser shall be entitled to review proprietary control factor details and coding at 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, 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 purchaser.
- 4.5.1.4 Nonconformances shall be documented and approved by purchaser in accordance with purchaser's material review requirements.
- 4.5.2 The certification document and test report(s) shall include or be traceable to the purchase order number, master heat identification, heat treat/lot number, AMS5360G, 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, when specified (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)
- 4.5.4 The producer shall retain records of processing and inspection in accordance with purchaser requirements.
- 4.5.5 When castings produced to this specification have exceptions authorized by purchaser taken to the technical requirements listed in Section 3, the report shall contain a statement, "This material is certified as AMS5360G(EXC) because of the following exceptions," and the specific exceptions shall be listed.

4.6 Resampling and Retesting

If results of a valid test fail to meet specified requirements, two additional specimens in accordance with 4.3 from the same master heat, modified melt (see 3.2.3), or lot, as applicable, shall be tested for each nonconforming characteristic. Results of each additional test, and the average of the results of all tests (original and retests) shall meet specified requirements; otherwise, the master heat or lot shall be rejected. Results of all tests shall be reported.

- 4.6.1 A test may be declared invalid if failure is due to specimen mispreparation, test equipment malfunction, improper test procedure, or the presence of random process defects such as inclusions or gas holes in a tensile specimen.

5. PREPARATION FOR DELIVERY

5.1 Identification

Unless otherwise specified by purchaser, individual castings shall be identified in accordance with AMS2804.

5.1.1 Traceability

Individual castings shall be traceable to their conditions of manufacture and inspection up to and including the point of acceptance by purchaser.

5.1.2 Serialization

When specified (see 4.5.2 and 8.5) each casting shall be serialized with a unique non-repeating serial number.