AEROSPACE MATERIAL SPECIFICATION

AMS5350™	REV. K

Issued 1947-12
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Reaffirmed 2022-11

Superseding AMS5350J

Steel, Corrosion and Moderate Heat-Resistant, Investment Castings 12.5Cr (410) Hardened and Tempered (Composition similar to UNS J91152)

RATIONALE

AMS5350K revises reports (4.5) and serialization (5.1.2), and is a Five-Year Review and update of this specification.

AMS5350K has been reaffirmed to comply with the SAE Five-Year Review policy.

1. SCOPE

1.1 Form

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

1.2 Application

These castings have been used typically for small parts, such as compressor blades and vanes, up to 1000 °F (538 °C), but usage is not limited to such applications. Corrosion resistance is higher than that of AMS5349, but machinability is worse.

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 referenced 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

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

For more information on this standard, visit
https://www.sae.org/standards/content/AMS5350K/

AMS2700 Passivation of Corrosion Resistant Steels

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 E8/E8M Tension Testing of Metallic Materials

ASTM E18 Rockwell Hardness of Metallic Materials

ASTM E140 Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, Scleroscope Hardness, and Leeb Hardness

ASTM E353 Chemical Analysis of Stainless, Heat-Resisting, Maraging, and Other Similar Chromium-Nickel-Iron Alloys

ASTM E1417/E1417M Liquid Penetrant Testing

ASTM E1444/E1444M Magnetic Particle Testing

ASTM E1742/E1742M Radiographic Examination

3. TECHNICAL REQUIREMENTS

3.1 Composition

Castings shall conform to the percentages by weight shown in Table 1, determined by wet chemical methods in accordance with ASTM E353, by spectrochemical methods, or by other analytical methods acceptable to purchaser (see 8.2.1).

Table 1 - Composition

Element	Min	Max
Carbon	0.05	0.15
Manganese	--	1.00
Silicon	--	1.00
Phosphorus	--	0.04
Sulfur	--	0.03
Chromium	11.50	13.50
Nickel	--	0.50
Molybdenum	--	0.50
Aluminum	--	0.05
Copper	--	0.50
Tin	--	0.05

3.1.1 Producer may test for any element not listed in Table 1 and include this analysis in the report of 4.5. Limits of acceptability may be specified by purchaser (see 8.2.2).

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 producer's facility either from a melt (see 8.2.3) of a master heat, or directly from a master heat (see 8.2.4).

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.

3.2.3 If modifications, such as alloy additions or replenishments (see 8.2.7), are made by the producer at remelt, 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 hardened and tempered condition.

3.4 Test Specimens

Specimens shall be separately-cast, integrally-cast (see 8.2.5), 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, hardness and, when required, tensile specimens.

3.4.2.1 If alloy additions or replenishments are made at remelt as in 3.2.3, the frequency of sampling and testing used by the producer for qualification to 3.4.2 shall be acceptable to 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 a 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 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, or cast oversize and subsequently machined to 0.250 inch (6.35 mm) diameter.

3.4.4.2 When integrally-cast specimens and specimens machined from a casting are specified, specimen size and location shall be agreed upon by purchaser and producer.

3.4.5 Hardness Specimens for Response to Heat Treatment

May be a representative specimen or a casting.

3.5 Heat Treatment

To produce the condition in castings for delivery, harden by cooling at a rate equivalent to air cool from the austenitizing temperature and temper to conform to hardness of 3.6.2. Hardening and tempering shall be in accordance with AMS-H-6875.

3.5.1 Response to Heat Treatment

Castings or representative test specimens shall be heat treated as in 3.5, and then as in 3.5.1.1 and 3.5.1.2, for subsequent testing to demonstrate response to heat treatment.

3.5.1.1 Hardening

Heat to 1750 °F ± 10 °F (954 °C ± 6 °C), hold at heat for 60 minutes ± 5 minutes per inch of maximum cross section, and cool at a rate equivalent to air cool.

3.5.1.2 Tempering

Heat to 1350 °F ± 15 °F (732 °C ± 8 °C), hold at heat for 60 minutes ± 5 minutes per inch of maximum cross section and cool in air.

3.5.2 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 purchaser specifies integrally-cast specimens or specimens machined from a casting. Properties for integrally-cast specimens and specimens machined from a casting shall be as specified by purchaser (see 8.5).

3.6.1 Room Temperature Tensile Properties

Shall be as shown in Table 2, determined in accordance with ASTM E8/E8M after heat treatment in accordance with 3.5.1.2. 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	95.0 ksi (656 MPa)
Yield Strength at 0.2% Offset	75.0 ksi (517 MPa)
Elongation in 4D	8%
Reduction of Area	20%

3.6.2 Hardness of Production Castings

Shall be 90 to 105 HRB or equivalent (see 8.3), determined in accordance with ASTM E18 for the heat treat condition of 3.3. and 3.5.

3.6.3 Hardnesses as a Response to Heat Treatment

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

3.6.3.1 Castings and Representative Specimens as Hardened (see 3.5.1.1)

Shall have a hardness not lower than 35 HRC, or equivalent (see 8.3).

3.6.3.2 Castings and Representative Specimens as Hardened and Tempered (see 3.5.1.2)

Should have a hardness of 94 to 100 HRB, or equivalent (see 8.3), but castings shall not be rejected on the basis of hardness if the tensile properties of 3.6.1 are met.

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 another 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 another method specified by purchaser.

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

3.7.4 Acceptance standards for radiographic, fluorescent penetrant, magnetic particle, visual, and other inspection methods shall be agreed upon by purchaser and producer. 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, Grade C of AMS2175 as applicable to steel castings shall apply for each applicable method of inspection.

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 another welding program acceptable to purchaser may be used.

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), hardness of production castings (3.6.2), response to heat treatment after hardening (3.6.3.1), and applicable requirements of quality (3.7) are acceptance tests and shall be performed as specified in 4.3.

4.2.2 Periodic Tests

Tensile properties (3.6.1), response to heat treatment after hardening and tempering (3.6.3.2), and radiographic soundness (3.7.2) are periodic tests and shall be performed at a frequency selected by producer, unless 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), or 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 the 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 tensile tests are required, they shall be conducted to determine conformance with Table 2. Sampling and test frequency is dependent upon the type and origin of specimen specified by purchaser (see 3.4.4) or selected by producer (see 4.3.3.4). When 3.4.2.1 applies, test frequency shall be acceptable to purchaser.

4.3.3.1 For separately-cast specimens in the fully heat-treated condition of 3.5.1.2, 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 fully heat-treated condition of 3.5.1.2, two specimens from each lot (see 8.2.6) shall be randomly selected and tested for conformance to properties specified by purchaser.

4.3.3.3 For specimens machined from a casting, one casting shall be randomly selected from each lot and tested after heat treatment in accordance with 3.5.1.2 at each location shown on the engineering drawing for conformance to the properties specified by purchaser.

4.3.3.3.1 When size and location of specimens are not shown, two test 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 a 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 the requirements of 3.6.1 or to alternative 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 origin 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.

4.3.5 Castings in the heat-treated condition of 3.5 for delivery shall be tested for hardness to determine conformance to 3.6.2. Unless otherwise specified by purchaser, the number of castings from each lot shall be in accordance with Table 3.

4.3.5.1 If a single casting from the inspection lot fails to meet the specified requirement, the entire lot shall be 100% inspected or reheat treated in accordance with 4.6.2.

Table 3 - Hardness test schedule

Lot Size	Sample Size
1 to 8	All
9 to 50	8
51 to 90	13
91 to 150	20
151 to 280	32
281 to 500	50
501 to 1200	80
1201 to 3200	125
3201 and over	200

4.3.6 For the hardened condition of 3.5.1.1, one specimen from each master heat shall be tested for hardness to determine conformance to 3.6.3.1.

4.3.7 For the hardened and tempered condition of 3.5.1.2, one specimen shall be tested for hardness to determine conformance to 3.6.3.2.

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 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 factors shown below. Supplier's procedures shall identify tolerances, ranges, and/or control limits, as applicable. Control factors for separately-cast test 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 and alloy addition procedures, if applicable
Time molten metal is in furnace
Solidification and cooling procedures
Cleaning operations (mechanical and chemical)
Heat treatment for delivery and response to heat treatment
Straightening
Final inspection methods
Location and size of integrally-cast specimens and specimens machined from a casting, if applicable

4.4.2.2.1 Any of the control factors for which parameters are considered proprietary by 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, 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 re-tests 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 pre-production results shall be reported at the frequency specified by and in a format acceptable to the purchaser.

4.5.1.4 Objective evidence of the purchaser’s review and acceptance of nonconforming material shall be provided with the certification document at each shipment (see Section 7).

4.5.2 The certification document and test report(s) shall be traceable to the purchase order number, master heat identification, heat treat/lot number, AMS5350K, part number, quantity, and when required (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.