SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

AMS 5352E

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Superseding AMS 5352D

Steel, Corrosion-Resistant, Investment Castings 17Cr - 0.55Mo (0.95 - 1.20C) Annealed

(Composition similar to UNS J91639)

RATIONALE

AMS 5352E, has been revised to update master heat controls and reporting requirements, adds a new provision for serialization, and is a Five Year Review and update of this specification.

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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 hardness up to 58 HRC and having resistance to corrosion and to wear, but usage is not limited to such applications. Optimum corrosion resistance is obtained by hardening from 1850 to 1950 °F (1010 to 1066 °C) and tempering at not higher than 800 °F (427 °C).

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 canceled 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 724-776-4970 (outside USA), www.sae.org.

AMS 2175	Castings, Classification and Inspection of
AMS 2248	Chemical Check Analysis Limits, Corrosion and Heat-Resistant Steels and Alloys, Maraging and Other Highly-Alloyed Steels, and Iron Alloys
AMS 2694	Repair Welding of Aerospace Castings
AMS 2700	Passivation of Corrosion Resistant Steels
AMS 2804	Identification, Castings

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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 E 18	Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials
ASTM E 353	Chemical Analysis of Stainless, Heat Resisting, Maraging, and Other Similar Chromium-Nickel-Iron Alloys
ASTM E 1077	Estimating the Depth of Decarburization of Steel Specimens
ASTM E 1417	Liquid Penetrant Examination
ASTM E 1444	Magnetic Particle Examination
ASTM E 1742	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 E 353, 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	0.95	1.20
Manganese	--	1.00
Silicon	--	1.00
Phosphorus	--	0.04
Sulfur	--	0.03
Chromium	16.00	18.00
Molybdenum	0.35	0.75
Nickel	--	0.50
Copper	--	0.75

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3.1.1 Vendor 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 applicable requirements of AMS 2248.

3.2 Melting Practice

Castings and specimens shall be poured at casting vendor'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 are modified by replenishment (See 8.2.7), vendor 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 annealed condition.

3.4 Test Specimens

Specimens shall be 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, vendor 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 and hardness specimens.

3.4.2.1 If replenishments are made at remelt as in 3.2.3, the frequency of sampling and testing used by the vendor 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 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, anneal to conform to the hardness requirements of 3.6.1.

3.5.1 Response to Heat Treatment

Castings or representative test specimens shall be annealed as in 3.5 and shall be heat treated as follows for subsequent testing to demonstrate response to heat treatment.

3.5.1.1 Hardening

Heat to 1875 °F ± 25 (1024 °C ± 14), hold at heat for not less than 30 minutes, and cool at a rate equivalent to cooling in still air.

3.5.2 Hardness specimens used for master heat qualification may be heat treated separately from castings

3.6 Properties

3.6.1 Hardness

Shall be as follows, determined in accordance with ASTM E 18.

3.6.1.1 Hardness of Production Castings

Shall be not higher than 30 HRC, or equivalent (See 8.3) for the annealed condition.

3.6.1.2 Hardness as a Response to Heat Treatment

Castings and representative specimens, annealed and hardened to the condition of 3.5.1.1, shall have a hardness not lower than 58 HRC, or equivalent (See 8.3).

3.6.2 Decarburization

Shall be not greater than 0.005 inches (0.13 mm), determined on castings or representative specimens annealed in a production heat treat load.

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3.6.2.1 Decarburization shall be measured in accordance with ASTM E 1077 on a hardened but untempered specimen protected during heat treatment to prevent changes in surface carbon content. In case of dispute, the depth of decarburization determined using the microhardness traverse method shall govern.

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 requirements of AMS 2700.

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 E 1742 or other method specified by purchaser.

3.7.3 When specified, castings shall be subjected to additional nondestructive testing as follows:

3.7.3.1 Fluorescent penetrant inspection in accordance with ASTM E 1417 or other method specified by purchaser.

3.7.3.2 Magnetic particle inspection in accordance with ASTM E 1444 or other 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 vendor (See 8.2.9). AMS 2175 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 AMS 2175 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 AMS 2694 or other welding program acceptable to purchaser may be used.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The vendor of castings shall supply all samples for vendor'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 (3.6.2.1 as annealed), response to heat treatment after hardening (3.6.2.2 as hardened) and applicable requirements of quality (3.7) are acceptance tests and shall be performed as specified in 4.3.

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4.2.2 PeriodiC Tests

Decarburization (3.6.3) and radiographic soundness (3.7.2) are periodic tests and shall be performed at a frequency selected by vendor, 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 vendor 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 Castings shall be inspected in accordance with 3.7 to the methods, frequency, and acceptance standards specified by purchaser.

4.3.4 Castings in the annealed condition of 3.5 for delivery shall be tested for hardness to determine conformance to 3.6.1.1. Unless otherwise specified by purchaser, one casting per lot shall be hardness tested.

4.3.4.1 In the event of failure, the entire lot shall be 100% inspected or reheat treated in accordance with 4.6.2.

4.3.5 For the hardened condition of 3.5.1.1, one specimen from each master heat shall be tested for hardness to determine conformance to 3.6.1.2.

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, vendor 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, vendor shall submit a statement of the proposed change for purchaser reapproval. When requested, vendor 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 vendor'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 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

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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 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 vendor 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 vendor, purchaser shall be entitled to review proprietary control factor details and coding at vendor's facility.

4.5 4.5 Reports

The vendor 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, vendor 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 Objective evidence of purchaser's review and acceptance of nonconforming material shall be provided with the certification document at each shipment. (See 7.)

4.5.2 The statement of conformity and test report(s) shall be traceable to the purchase order number, master heat identification, heat treat lot number, AMS 5352E, part number, quantity, and when required (See 5.1.2) the list of individual serial numbers or serial number range.

4.5.2.1 4.5.2.1If 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)
Hardness of production castings (3.6.1.1 as annealed)
Response to heat treatment after hardening (3.6.1.2 as hardened)

4.5.3.2 For each lot

Inspection results (See 4.3.4)

4.5.4 The vendor shall retain records of processing and inspection in accordance with purchaser requirements.

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4.6 Resampling and Retesting

If the results of a valid test fail to meet the 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, or improper test procedure.

4.6.2 Unless otherwise authorized by purchaser, castings and specimens may be subjected to not more than one reheat treatment cycle of 3.5, 3.5.1.1, or as specified by purchaser, respectively in the event of hardness and/or property failure. Upon reheat treatment, castings and specimens shall be submitted for testing in accordance with 4.3.

5. PREPARATION FOR DELIVERY

5.1 Identification

Unless otherwise specified by purchaser, individual castings shall be identified in accordance with AMS 2804.

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.

5.2 Packaging

Castings shall be prepared for shipment in accordance with commercial practice and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the castings to ensure carrier acceptance and safe delivery.

6. ACKNOWLEDGMENT

A vendor shall mention this specification number and its revision letter in all quotations and when acknowledging purchase orders.

7. REJECTIONS

Castings not conforming to this specification, or to modifications authorized by purchaser, will be subject to rejection.

8. NOTES

8.1 A change bar (I) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this specification. An (R) symbol to the left of the document title indicates a complete revision of the specification, including technical revisions. Change bars and (R) are not used in original publications, nor in specifications that contain editorial changes only.

8.2 Terms used in AMS are clarified in ARP1917 and as follows:

8.2.1 "Acceptable to Purchaser"

Does not require prior written approval from purchaser, but allows vendor to make a decision and purchaser the right to disapprove the decision.

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