SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

SAE AMS 5380F

Issued SEP 1947
Revised JAN 1999
Reaffirmed SEP 2007

Superseding AMS 5380E

(R)

Cobalt Alloy, Corrosion and Heat Resistant, Investment Castings 50.5Co - 26Cr - 15Ni - 6.0Mo As Cast

UNS R30030

RATIONALE

This document has been reaffirmed to comply with the SAE 5-year Review policy.

1. SCOPE:

1.1 Form:

This specification covers a corrosion and heat resistant cobalt alloy in the form of investment castings.

1.2 Application:

These castings have been used typically for parts such as turbine vanes requiring high strength up to 1500 °F (816 °C), and oxidation resistance up to 2000 °F (1095 °C), but usage is not limited to such applications.

2. APPLICABLE DOCUMENTS:

The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order.

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AMS 2269	Chemical Check Analysis Limits, Nickel, Nickel Alloys, and Cobalt Alloys
AMS 2360	Room Temperature Tensile Properties of Castings
AMS 2361	Elevated Temperature Tensile Testing of Castings
AMS 2694	Repair Welding of Aerospace Castings
AMS 2804	Identification, Castings

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2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM E 8	Tension Testing of Metallic Materials
ASTM E 8M	Tension Testing of Metallic Materials (Metric)
ASTM E 21	Elevated Temperature Tension Tests of Metallic Materials
ASTM E 354	Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt Alloys
ASTM E 1417	Liquid Penetrant Examination

2.3 U.S. Government Publications:

Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-STD-453	Inspection, Radiographic (Cancelled and superseded by ASTM E 1742)
MIL-STD-2175	Castings, Classification and Inspection of

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 E 354, by spectrochemical methods, or by other analytical methods acceptable to purchaser (See 8.2.1 and 8.2.2).

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TABLE 1 - Composition

Element	min	max
Carbon	0.40	0.50
Manganese	--	1.00
Silicon	--	1.00
Phosphorus	--	0.040
Sulfur	--	0.030
Chromium	24.00	28.00
Nickel	14.00	16.00
Molybdenum	5.50	6.50
Iron	--	2.00
Other elements (3.1.1)	--	--
Cobalt	remainder	

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 requirements of AMS 2269.

3.2 Melt 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 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.

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 modifications, such as alloy additions or replenishments, are made by the vendor at remelt, 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 as-cast condition.

3.4 Test Specimens:

Specimens shall be either separately-cast, integrally-cast (See 8.2.7), 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 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 vendor 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 E 8 or ASTM E 8M (See 8.3) with 0.250 inch (6.35 mm) diameter at the reduced parallel gage section.

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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 vendor (See 8.2.8 and 8.5).

3.5 Heat Treatment:

Not applicable

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.

3.6.1 Room Temperature Tensile Properties: Tensile properties may be specified by purchaser, in accordance with AMS 2360.

3.6.2 Elevated Temperature Tensile Properties at 1500 °F (816 °C): Shall be as follows, determined in accordance with ASTM E 21 on specimens heated to 1500 °F ± 10 (816 °C ± 6), held at heat for not less than 10 minutes before testing, and tested at 1500 °F ± 10 (816 °C ± 6). Properties other than those listed may be defined as in AMS 2361.

3.6.2.1 Separately-Cast Specimens: Shall be as shown in Table 2.

TABLE 2 - Minimum Elevated Temperature Tensile Properties

Property	Value
Tensile strength	55.0 ksi (380 MPa)
Elongation in 4D	10%

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

3.6.3.1 As Cast: Not higher than 30 HRC, or equivalent.

3.6.3.2 After Thermal Exposure: Not higher than 43 HRC, or equivalent after being heated to 1475 °F ± 10 (802 °C ± 6), holding at heat for 50 hours ± 1, and cooling to room temperature.

3.7 Quality:

3.7.1 Castings, as received by purchaser. shall be uniform in quality and condition. Castings shall, to the extent defined in 3.7.2., 3.7.3, and 3.7.4, or in supplemental standards specified by the purchaser, be free from porosity, foreign materials, and imperfections detrimental to their performance. Castings shall be free of cracks, laps, hot tears, and cold shuts, and free of scale and other surface contamination which would obscure defects.

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 MIL-STD-453 or other method specified by purchaser.

3.7.3 When specified, castings shall be subjected to fluorescent penetrant inspection in accordance with ASTM E 1417 or other method specified by purchaser.

3.7.4 Acceptance standards for radiographic, fluorescent penetrant, visual, and other inspection methods shall be agreed upon by purchaser and vendor (See 8.2.8). MIL-STD-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 MIL-STD-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), room temperature tensile properties if specified (3.6.1), elevated temperature tensile properties (3.6.2), as-cast hardness (3.6.3.1), and quality (3.7) are acceptance tests and shall be performed as specified in 4.3.

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4.2.2 Periodic Tests: Hardness after thermal exposure (3.6.3.2) 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 Tensile tests 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 vendor (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 as cast condition, one specimen from each master heat shall be tested to Table 2.

4.3.3.2 For integrally-cast specimens in the as-cast condition, two specimens from each lot (See 8.2.9) shall be randomly selected and tested to Table 2.

4.3.3.3 For specimens machined from casting, one casting shall be randomly selected from each lot and tested in the as-cast condition, at locations shown on the engineering drawing for conformance with Table 2.

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 vendor.

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 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, vendor shall include in the report of 4.5 a description of the origin of the specimen that was tested.

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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 vendor.

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 One casting or representative specimen from each master heat shall be tested for hardness to determine conformance with 3.6.3.1.

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
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)
Straightening
Final inspection methods
Location and size of integrally-cast specimens and specimens machined from a casting, if applicable.

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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 Reports:

The vendor of castings shall furnish with each shipment a report showing the results of tests to determine conformance to the acceptance test requirements. This report shall include the purchase order number, master heat identification, lot identification, AMS 5380F, part number, quantity, and source of tensile property specimens (See 4.3.3.4.1).

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 test. The results of each additional test, and the average of the results of all tests (original and retests) shall meet the 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 AMS 2804.

5.2 Traceability:

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

5.3 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.

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