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INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 5383D

Issued SEP 1966
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Reaffirmed SEP 2000

Superseding AMS 5383C

Nickel Alloy, Corrosion and Heat Resistant, Investment Castings 52.5Ni - 19Cr - 3.0Mo - 5.1(Cb+Ta) - 0.90Ti - 0.60Al - 18Fe Vacuum Melted Homogenization and Solution Heat Treated

UNS N07718

1. SCOPE:

1.1 Form:

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

1.2 Application:

These castings have been used typically for structural parts requiring strength up to 1300 °F (704 °C) and oxidation resistance up to 1800 °F (982 °C), but usage is not limited to such applications.

1.3 Classification:

Castings conforming to this specification are classified as follows:

Class 1 Trace element limits conforming to AMS 2280-1
Class 2 Trace element limits conforming to AMS 2280-2
Class 3 Trace element limits do not apply

1.3.1 Castings shall conform to Class 3 unless Class 1 or Class 2 is specified by purchaser.

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.

QUESTIONS REGARDING THIS DOCUMENT: (724) 772-7161 FAX: (724) 776-0243
TO PLACE A DOCUMENT ORDER: (724) 776-4970 FAX: (724) 776-0790
SAE WEB ADDRESS: http://www.sae.org

2.1 SAE Publications:

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

AMS 2268	Chemical Check Analysis Limits, Cast Nickel and Nickel Alloys
AMS 2280	Trace Element Control, Nickel Alloy Castings
AMS 2360	Room Temperature Tensile Properties of Castings
AMS 2362	Stress Rupture Properties of Castings
AMS 2694	Repair Welding of Aerospace Castings
AMS 2750	Pyrometry
AMS 2804	Identification, Castings

2.2 ASTM Publications:

Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

ASTM E 8	Tension Testing of Metallic Materials
ASTM E 18	Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials
ASTM E 139	Conducting Creep, Creep-Rupture, and Stress-Rupture Tests of Metallic Materials
ASTM E 354	Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt Alloys

2.3 U.S.Government Publications:

Available from Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-STD-453	Inspection, Radiographic
MIL-STD-2073-1	DOD Materiel, Procedures for Development and Application of Packaging Requirements
MIL-STD-2175	Castings, Classification and Inspection of
MIL-STD-6866	Inspection, Liquid Penetrant

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).

TABLE 1 - Composition

Element	min	max
Carbon	--	0.08
Manganese	--	0.35
Silicon	--	0.35
Phosphorus	--	0.015
Sulfur	--	0.015
Chromium	17.00	21.00
Nickel	50.00	55.00
Molybdenum	2.80	3.30
Columbium + Tantalum	4.75	5.50
Titanium	0.65	1.15
Aluminum	0.40	0.80
Titanium + Aluminum	--	1.75
Cobalt	--	1.00
Tantalum (3.1.4)	--	0.10
Boron	--	0.006
Copper	--	0.30
Iron	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 Trace Elements: Shall conform to AMS 2280, Class 1 or Class 2, when specified by purchaser.

3.1.3 Check Analysis: Composition variations shall meet the requirements of AMS 2268.

3.1.4 Determination not required for routine acceptance.

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.

3.2.1.1 The metal for castings and specimens shall be melted and poured under vacuum without loss of vacuum between melting and pouring. When authorized by purchaser (See 8.2.6), protective atmosphere may be used in lieu of vacuum 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.

3.2.3 If 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:

Homogenization and solution heat treated.

3.4 Test Specimens:

Specimens shall be either separately cast, integrally cast (See 8.2.7), or machined from castings, 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, tensile, and stress rupture 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 and stress rupture qualification 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 and Stress Rupture Specimens: Shall be of standard proportions in accordance with ASTM publications referenced in 3.6.

3.4.4.1 Separately-cast and integrally-cast tensile 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 or specimens machined from casting are specified, specimen size and location shall be agreed upon by purchaser and vendor. (See 8.2.8 and 8.4.)

3.5 Heat Treatment:

Castings and representative tensile and stress-rupture specimens shall be heat treated in accordance with AMS 2750 except as specified in 3.5.1 and 3.5.2.

3.5.1 Castings and Specimens:

3.5.1.1 Homogenization Heat Treatment: Heat in a suitable protective atmosphere to 2000 °F ± 25 (1093 °C ± 14), hold at heat for 1 to 2 hours, and cool at a rate equivalent to an air cool or faster to 900 °F (482 °C). Any convenient rate may be used below 900 °F (482 °C).

3.5.1.2 Solution Heat Treatment: Heat in a suitable protective atmosphere to a temperature within the range of 1750 to 1800 °F (954 to 982 °C), hold at the selected temperature within ±25 °F (±14 °C) for not less than one hour, and cool at a rate equivalent to an air cool or faster.

3.5.2 Specimens: After homogenization and solution heat treatment as in 3.5.1, specimens shall be precipitation heat treated in accordance with the following:

3.5.2.1 Heat to 1325 °F ± 15 (718 °C ± 8), hold at heat for 8 hours ± 0.5, furnace cool to 1150 °F ± 15 (621 °C ± 8), hold at 1150 °F ± 15 (621 °C ± 8) for a total precipitation time of 18 hours, and cool at a rate equivalent to an air cool or faster.

3.5.3 Tensile and stress-rupture 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 casting.

3.6.1 Room Temperature Tensile Properties: Shall be as specified in Table 2; determined in accordance with ASTM E 8. Properties other than those listed may be defined as specified in AMS 2360.

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

TABLE 2 - Minimum Room Temperature Tensile Properties

Property	Value
Tensile Strength	125 ksi (862 MPa)
Yield Strength at 0.2% Offset	110 ksi (758 MPa)
Elongation in 4D	5%
Reduction of Area	10%

3.6.1.2 Integrally-Cast Specimens or Specimens Machined from Castings: Shall be as shown in Table 3.

TABLE 3 - Minimum Room Temperature Tensile Properties

Property	Value
Tensile Strength	120 ksi (827 MPa)
Yield Strength at 0.2% Offset	105 ksi (724 MPa)
Elongation in 4D	3%
Reduction of Area	8%

3.6.2 Stress-Rupture Properties at 1300 °F (704 °C): Shall be as follows; determined in accordance with ASTM E 139. Properties other than those listed may be defined as specified in AMS 2362.

3.6.2.1 Specimens, maintained at 1300 °F ± 3 (704 °C ± 2) while a load sufficient to produce an initial axial stress of 65.0 ksi (448 MPa) is applied continuously, shall not rupture in less than 23 hours. The test shall be continued to rupture without change of load. Elongation after rupture, measured at room temperature, shall be not less than 3% in 4D.

3.6.2.2 The test of 3.6.2.1 may be conducted using a load higher than required to produce an initial axial stress of 65.0 ksi (448 MPa) but load shall not be changed while test is in progress. Time to rupture and elongation requirements shall be as specified in 3.6.2.1.

3.6.2.3 When authorized by purchaser, the test of 3.6.2.1 may be conducted using incremental loading. In such case, the load required to produce an initial axial stress of 65.0 ksi (448 MPa) shall be used to rupture or for 23 hours, whichever occurs first. After the 23 hours and at intervals of 8 to 16 hours, preferably 8 to 10 hours, thereafter, the stress shall be increased in increments of 5 ksi (34.5 MPa). Time to rupture and elongation requirements shall be as specified in 3.6.2.1.

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

3.6.3.1 Castings: Castings, in the homogenized and solution heat treated condition of 3.5.1, shall have hardness not higher than 25 HRC, or equivalent. (See 8.3).

3.6.3.2 Representative Specimens: Representative specimens, heat treated to the homogenized, solution, and precipitation heat treated condition of 3.5.2, shall have hardness of 34 to 44 HRC, or equivalent (See 8.3).

3.7 Quality:

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.

3.7.1 Unless otherwise specified by purchaser, the following shall apply:

3.7.1.1 Castings shall be free of cracks, laps, hot tears, and cold shuts.

3.7.1.2 Castings shall be free of scale and other process-induced surface contamination which would obscure defects.

3.7.2 Acceptance standards for radiographic, fluorescent penetrant, visual, and other inspection methods shall be as 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).

3.7.2.1 When acceptance standards are not specified, Grade C of MIL-STD-2175 shall apply.

3.7.3 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.

3.7.3.1 Radiographic inspection shall be conducted in accordance with MIL-STD-453 or other process method specified by purchaser.

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

3.7.4.1 Fluorescent penetrant inspection in accordance with MIL-STD-6866 or other process method specified by purchaser.

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 performing all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the castings conform to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests for composition (3.1), tensile properties (3.6.1), stress-rupture properties (3.6.2), hardness (3.6.3), and quality (3.7) are acceptance tests and shall be performed as specified in 4.3.

4.2.2 Periodic Tests: Tests for radiographic soundness (3.7.3) are periodic tests and shall be performed at a frequency selected by vendor unless a frequency of testing is specified by purchaser.

4.2.3 Preproduction Tests: Tests for 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 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, unless 3.4.2.1 applies, in which case 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 and stress-rupture property tests shall be conducted to determine conformance with Table 2 or Table 3, and 3.6.2. Sampling and test frequency is dependent upon the type and origin of specimen specified by purchaser (See 3.6) 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 homogenized, solution, and precipitation heat treated condition of 3.5.2, at least two specimens from each master heat shall be tested; one to 3.6.1, and one to 3.6.2.

4.3.3.2 For integrally-cast specimens in the homogenized, solution, and precipitation heat treated condition of 3.5.2, at least four specimens from each lot (See 8.2.9) shall be randomly selected and tested; two to 3.6.1, and two to 3.6.2.

4.3.3.3 For specimens machined from casting, at least one casting shall be randomly selected from each lot and tested after homogenization, solution, and precipitation heat treatment to 3.5.2 at locations shown on the engineering drawing for conformance with 3.6.1 and 3.6.2.

4.3.3.3.1 When size and location of specimens are not shown, at least four specimens shall be tested, two from the thickest section and two 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 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 for that type of specimen.

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.

4.3.3.5 When casting size, section thickness, gating method, or other factors do not permit conformance to 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 After homogenization and solution heat treatment of 3.5.1, castings shall be tested for hardness to determine conformance with 3.6.3.1. Unless otherwise specified by purchaser, one casting per lot shall be hardness tested.

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

4.3.6 After homogenization, solution, and precipitation heat treatment to 3.5.2, one specimen from 3.4 shall be tested for hardness to determine conformance with 3.6.3.2.

4.3.6.1 In event of failure, specimens may be reheat 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 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 changes 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 factors shown below. 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):

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
Mold back up material (weight, thickness, or number of dips)
Type of furnace, vacuum, and charge for melting
Mold preheat and metal pouring temperatures
Fluxing or deoxidation procedure
Replenishment and alloy addition procedure
Time that molten metal is in the 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 shown above for which parameters are considered proprietary by the 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 acceptance tests to determine conformance to the technical requirements. This report shall include the purchase order number, master heat identification, heat treat/lot identification, AMS 5383D, part number, quantity, and source of tensile and stress-rupture property specimens.

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, or lot, as applicable, shall be tested for each nonconforming characteristic. 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, including data which does not meet the specified requirements.