Society of Automotive Engineers, Inc.
400 COMMONWEALTH DRIVE, WARRENDALE, PA. 15096

AEROSPACE MATERIAL SPECIFICATION

AMS 5396A
Superseding AMS 5396

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UNS N10001

ALLOY CASTINGS, INVESTMENT, CORROSION AND HEAT RESISTANT
61.5Ni - 28Mo - 5.5Fe - 0.40V

1. SCOPE:

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

1.2 Application: Primarily for small parts, such as exducers and fans, requiring good corrosion resistance and strength up to 1400°F (760°C).

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications (AMS) shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2350 - Standards and Test Methods
AMS 2360 - Room Temperature Tensile Properties of Castings
AMS 2361 - Elevated Temperature Tensile Properties of Castings
AMS 2635 - Radiographic Inspection
AMS 2645 - Fluorescent Penetrant Inspection

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM E8 - Tension Testing of Metallic Materials
ASTM E10 - Brinell Hardness of Metallic Materials
ASTM E21 - Elevated Temperature Tension Tests of Metallic Materials
ASTM E192 - Reference Radiographs of Investment Steel Castings for Aerospace Applications
ASTM E354 - Chemical Analysis of High Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt-Base Alloys

2.3 Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

2.3.1 Federal Standards:

Federal Test Method Standard No. 151 - Metals; Test Methods

2.3.2 Military Standards:

MIL-STD-794 - Parts and Equipment, Procedures for Packaging and Packing of

3. TECHNICAL REQUIREMENTS:

3.1 Composition: Shall conform to the following percentages by weight, determined by wet chemical methods in accordance with ASTM E354, by spectrographic methods in accordance with Federal Test method Standard No. 151, Method 112, or by other approved analytical methods:

	min	max
Carbon	--	0.12
Manganese	--	1.00
Silicon	--	1.00
Phosphorus	--	0.030
Sulfur	--	0.030
Molybdenum	26.00	30.00
Iron	4.00	7.00
Vanadium	0.20	0.60
Chromium	--	1.00
Cobalt	--	2.50
Nickel	remainder	

3.2 Condition: As cast.

3.3 Casting: Castings shall be poured either from remelted metal from a master heat or directly from a master heat. In either case, metal for casting shall be qualified as in 3.4.

3.3.1 A master heat is refined metal of a single furnace charge or metal blended as in 3.3.2. Gates, sprues, risers, and rejected castings shall be used only in preparation of master heats, they shall not be remelted directly without refining, for pouring of castings.

3.3.2 Unless prohibited by purchaser, metal from two or more master heats may be blended provided that the composition of each master heat to be blended is within the limits of 3.1 and that the total weight of metal blended does not exceed 10,000 lb (4540 kg). Ingot and pig may be blended together, shot may be blended, but shot shall not be blended with ingot or pig. When two or more master heats are blended, the resultant blend shall be considered a master heat.

3.4 Master Heat Qualification: Each master heat shall be qualified by evaluation of chemical analysis and tensile test specimens conforming to 3.4.1 and 3.4.2, respectively. A master heat may be considered conditionally qualified if vendor's test results show conformance to all applicable requirements of this specification. However, except when purchaser waives confirmatory testing, final qualification shall be based on purchaser's test results. Conditional qualification of a master heat shall not be construed as a guarantee of acceptance of castings poured therefrom.

3.4.1 Chemical Analysis Specimens: Shall be of any convenient size, shape, and form for vendor's tests. When chemical analysis specimens are required by purchaser, specimens shall be cast to a size, shape, and form agreed upon by purchaser and vendor.

3.4.2 Tensile Test Specimens: Shall be cast from remelted metal from each master heat except when castings are poured directly from a master heat, in which case the specimens shall also be poured directly from the master heat. Specimens shall be of standard proportions in accordance with ASTM E8 with 0.250 in. (6.35 mm) diameter at the reduced parallel gage section. They shall be cast to size or shall be cast oversize and subsequently machined to 0.250 in. (6.35 mm) diameter. Center gating may be used.

3.5 Properties: Castings and representative tensile test specimens produced in accordance with 3.4.2 shall conform to the following requirements:

3.5.1 Tensile Properties:

3.5.1.1 Separately-Cast Specimens:

3.5.1.1.1 At Room Temperature: Shall be as follows, determined in accordance with ASTM E8:

Tensile Strength, min	75,000 psi (517 MPa)
Yield Strength at 2.0% Offset, min	50,000 psi (345 MPa)
Elongation in 1 in. (25.4 mm) or 4D, min	10%

3.5.1.1.2 At 1500°F (816°C): Shall be as follows, determined in accordance with ASTM E21 on specimens heated to 1500°F ± 10 (816°C ± 6), held at 1500°F ± 10 (816°C ± 6) for 30 min. before testing, and tested at 1500°F ± 10 (816°C ± 6) at a rate of 0.03 - 0.07 in. per in. per min. (0.03 - 0.07 mm/mm/min.):

Tensile Strength, min	53,000 psi (365 MPa)
Elongation in 1 in. (25.4 mm) or 4D, min	10%

3.5.1.2 Specimens Cut from Castings: When specified on the drawing or when agreed upon by purchaser and vendor, tensile test specimens conforming to ASTM E8 shall be machined from castings selected at random from each master heat. Property requirements for such specimens shall be as specified on the drawing or as agreed upon by purchaser and vendor and may be defined as specified in AMS 2360 and/or AMS 2361.

3.5.2 Hardness: Shall be 180 - 235 HB or equivalent, determined in accordance with ASTM E10.

3.6 Quality:

3.6.1 Castings, as received by the purchaser, shall be uniform in quality and condition, sound, and free from foreign materials and from internal and external imperfections detrimental to usage of the castings.

3.6.1.1 Castings shall have smooth surfaces and shall be well cleaned. Metallic shot or grit shall not be used for final cleaning, unless otherwise permitted.

3.6.2 Castings shall be produced under radiographic control, unless otherwise specified. This control shall consist of radiographic examination of castings in accordance with AMS 2635 until proper foundry technique, which will produce castings free from harmful internal imperfections, is established for each part number and of production castings as necessary to ensure maintenance of satisfactory quality.

3.6.3 When specified, castings shall be subject to fluorescent penetrant inspection in accordance with AMS 2645.

3.6.4 Radiographic, fluorescent penetrant, and other quality standards shall be as agreed upon by purchaser and vendor. ASTM E192 may be used to define radiographic acceptance standards.

3.6.5 Castings shall not be repaired by peening, plugging, welding, or other methods without written permission from purchaser.

3.6.5.1 When permitted in writing by purchaser, defects in castings may be removed and the castings repaired by welding provided the weld repair area has properties comparable to those of the parent metal. Repair welds shall be subjected to the same inspection procedures and acceptance standards required of the casting. Weld repair areas shall be suitably marked to facilitate inspection. Repair welding shall be performed prior to any nondestructive testing specified herein.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of castings shall supply all samples and shall be responsible for performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.5. Purchaser reserves the right to perform such confirmatory testing as he deems necessary to ensure that the castings conform to the requirements of this specification.

Ø 4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests to determine conformance to composition (3.1), room-temperature tensile Ø properties of separately-cast test specimens (3.5.1.1.1), hardness (3.5.2), and quality (3.6) requirements and, when specified, tensile properties of specimens cut from castings (3.5.1.2) are classified as acceptance tests.

4.2.2 Periodic Tests: Tests to determine conformance to elevated-temperature tensile properties of Ø separately-cast test specimens (3.5.1.1.2) are classified as periodic tests.

4.2.3 Preproduction Tests: Tests to determine conformance to all technical requirements of this specifica- Ø tion are classified as preproduction tests.

4.2.3.1 For direct U.S. Military procurement, substantiating test data and, when requested, preproduction Ø test material shall be submitted to the cognizant agency as directed by the procuring activity, the contracting officer, or the request for procurement.

4.3 Sampling: Shall be in accordance with the following:

Ø 4.3.1 Two chemical analysis specimens in accordance with 3.4.1 and/or a casting from each master heat.

Ø 4.3.2 Two preproduction castings in accordance with 4.4.1 of each part number.

Ø 4.3.3 Three tensile test specimens in accordance with 3.4.2 from each master heat.

4.3.4 One or more castings from each master heat when properties of specimens machined from castings Ø are required. Specific size, locations, and number of specimens machined from castings shall be as specified on the drawing or as agreed upon by purchaser and vendor. When size, location, and number of test specimens are not specified, not less than four tensile test specimens, two from the thickest section and two from the thinnest section, shall be cut from a casting or castings from each master heat.

4.4 Approval:

4.4.1 Sample castings from new or reworked master patterns and the casting procedure shall be approved Ø by purchaser before castings for production use are supplied, unless such approval be waived.

4.4.2 Vendor shall establish separately for tensile test specimens used for master heat qualification and for Ø production of sample castings of each part number the control factors of processing which will produce tensile test specimens meeting master heat qualification requirements and acceptable castings; these shall constitute the approved casting procedures and shall be used for producing subsequent master heat qualification specimens and production castings. If necessary to make any change in control factors of processing, vendor shall submit for reapproval a statement of the proposed changes in processing and, when requested, sample test specimens, castings, or both. Preproduction castings incorporating the revised operations shall not be shipped prior to receipt of reapproval.

4.4.2.1 Control factors for producing test specimens and castings include, but are not limited to, the following:

Ø Type of furnace and its capacity
Size of furnace charge
Furnace atmosphere
Fluxing or deoxidation procedure
Mold refractory formulation
Mold back-up material
Gating practices
Mold preheat and pouring temperatures (variations of ±25°F (±15°C) from established limits are permissible)
Solidification and cooling procedures
Cleaning operations
Methods of routine inspection