AEROSPACE MATERIAL SPECIFICATION

AMS5362™	REV. M

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Superseding AMS5362L

Steel, Corrosion and Heat Resistant, Investment Castings 19Cr - 12Ni - 1.0Cb (Nb) Solution Heat Treated

(Composition similar to UNS J92811)

RATIONALE

AMS5362M prohibits unauthorized exceptions (3.8, 4.5.1, 8.5), updates composition testing (3.1), adds AMS2761 (3.5), adds strain rate control (3.6.1.2) revises quality 3.7.4.1, adds country of origin (4.5), deletes redundant definitions (8.2), allows prior revisions (8.4) updates ordering information (8.6), and is the result of a Five-Year Review and update of the specification.

1. SCOPE

1.1 Form

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

1.2 Application

These castings have been used typically for structural parts, where welding during fabrication may be required, for use up to 1500 °F (816 °C), but usage is not limited to such applications.

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

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/AMS5362M/

AMS2694 In-Process Welding of Castings

AMS2700 Passivation of Corrosion Resistant Steels

AMS2761 Heat Treatment of Steel Raw Materials

AMS2804 Identification, Castings

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 A262 Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels

ASTM A751 Chemical Analysis of Steel Products

ASTM E8/E8M Tension Testing of Metallic Materials

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 A751, or by other analytical methods acceptable to purchaser (see 8.2).

Table 1 - Composition

Element	Min	Max
Carbon	--	0.12
Manganese	--	2.00
Silicon	--	1.50
Phosphorus	--	0.04
Sulfur	--	0.03
Chromium	18.00	19.50
Nickel	10.00	14.00
Columbium (Niobium)	10xC	1.50
Tantalum	--	0.05
Molybdenum	--	0.75
Copper	--	0.75
Iron	remainder	

3.1.1 Producer 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.

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 of a master heat, or directly from a master heat (see 3.4.2 and 8.2).

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).

3.2.3 If modifications, such as alloy additions or replenishments (see 8.2), 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

Solution heat treated.

3.4 Test Specimens

Specimens shall be either separately-cast, integrally-cast (see 8.2), 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 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 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 or specimens machined from a casting are specified, specimen size and location shall be as agreed upon by purchaser and producer (see 8.2 and 8.6).

3.5 Heat Treatment

Castings and representative tensile specimens shall be heat treated in accordance with AMS2761 except as specified in 3.5.1.

3.5.1 Castings and Specimens

3.5.1.1 Solution Heat Treatment

Heat to 1950 °F ± 50 °F (1066 °C ± 28 °C), hold at heat for not less than 1 hour per inch (25 mm) of maximum section thickness but in no case less than 30 minutes, and cool at a rate equivalent to a still air cool or faster.

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 separately-cast specimens unless purchaser specifies integrally-cast specimens or specimens machined from casting. Properties for specimens machined from casting shall be as specified by purchaser (see 8.2 and 8.6).

3.6.1 Room Temperature Tensile Properties

Shall be as specified in Table 2; determined in accordance with ASTM E8/E8M. Properties other than those listed may be defined as specified in AMS2360.

3.6.1.1 Separately-Cast and Integrally-Cast Specimens

Shall be as shown in Table 2.

Table 2 - Minimum room temperature tensile properties

Properties	Value
Tensile Strength	70 ksi (483 MPa)
Yield Strength at 0.2% Offset	30.0 ksi (207 MPa)
Elongation in 4D	30%

3.6.1.2 Unless otherwise specified, the strain rate shall be set at 0.005 in/in/min (0.005 mm/mm/min) and maintained within a tolerance of ±0.002 in/in/min (0.002 mm/mm/min) through 0.2% offset yield strain. The strain rate after yield may be increased to any value up to 0.5 in/in/min (or mm/mm/min) or equivalent crosshead speed as a function of gage length.

3.6.2 Embrittlement

Specimens cut from castings or representative specimens shall, after sensitizing, pass the intergranular corrosion test performed in accordance with ASTM A262, Practice E.

3.7 Quality

3.7.1 Castings, as received by purchaser (see 8.2), 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. Radiographic indications of gas holes, sand spots, and inclusions shall be cause for rejection when closer to the edge than twice their maximum dimension.

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.

3.8 Exceptions

Any exceptions shall be authorized by the purchaser (see 8.2) and reported as in 4.5.1.

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), tensile properties (3.6.1), and the applicable requirements of quality (3.7) are acceptance tests and shall be performed as specified in 4.3.

4.2.2 Periodic Tests

Embrittlement (3.6.2), corrosion resistance (3.7.1.1), and radiographic soundness (3.7.2) are periodic tests and shall be performed at a frequency selected by producer unless a 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), and 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 Tensile tests shall be conducted to determine conformance with Table 2. Sampling and test frequency are dependent upon the type and origin of specimen specified by purchaser (see 3.4.4 and 3.6) 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 solution heat treated condition of 3.5.1, 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 solution heat treated condition of 3.5.1, two specimens from each lot (see 8.2.) shall be randomly selected and tested for conformance to 3.6.1.

4.3.3.3 For specimens machined from casting, one casting shall be randomly selected from each lot and tested after solution heat treatment in conformance with 3.5.1.1 at locations shown on the engineering drawing for conformance with 3.6.1.

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 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 requirements of 3.6, or to alternative requirements specified by purchaser.

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 to 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.

4.4 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 changes 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 following factors. 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 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 that molten metal is in furnace
Solidification and cooling procedures
Cleaning operations (mechanical and chemical)
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 report showing the producer's name and country where the metal was melted (e.g., final melt in the case of metal processed by multiple melting operations) and the results of tests to determine conformance to the acceptance test requirements, and stating that the product conforms to the other technical requirements. This report shall include the purchase order number, master heat identification, heat treat/lot identification, AMS5362M, part number, quantity, and source of tensile property specimens (see 4.3.3.4.1).

4.5.1 When material produced to this specification has exceptions taken to the technical requirements listed in Section 3, the report shall contain a statement "This material is certified as AMS5362M(EXC) because of the following exceptions:" and the specific exceptions shall be listed.

4.6 Resampling and Retesting

If results of a valid test fail to meet specified 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 mis-preparation, 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 AMS2804.