

# AEROSPACE MATERIAL SPECIFICATION



AMS 5352D

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Superseding AMS 5352C

(R)

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

UNS J91639

## 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, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

|          |                                                                                                                                           |
|----------|-------------------------------------------------------------------------------------------------------------------------------------------|
| 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 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 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 1417 | Liquid Penetrant Examination                                                                            |
| ASTM E 1444 | Magnetic Particle Examination                                                                           |
| ASTM E 1742 | Radiographic Examination                                                                                |

## 2.3 U.S. Government Publications:

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

|              |                                                      |
|--------------|------------------------------------------------------|
| MIL-STD-2175 | Castings, Classification and Inspection of           |
| QQ-P-35      | Passivation Treatments for Corrosion Resistant Steel |

## 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 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  |

3.1.1 Vendor may test for any element not 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 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 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 modifications, such as alloy additions or replenishments (See 8.2.10), 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 annealed condition.

### 3.4 Test Specimens:

Specimens shall be 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 hardness 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.

3.4.3 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:

Castings or representative test specimens shall be annealed to conform to the 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.

### 3.6 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.

3.6.2.1 Decarburization shall be measured by the microscopic method, by HR30N scale hardness testing method, or by microhardness traverse method on a hardened but untempered specimen protected during heat treatment to prevent changes in surface carbon content. Depth of decarburization, when measured by a hardness method, is defined as the perpendicular distance from the surface to the depth under that surface below which there is no further increase in hardness. Such measurements shall be far enough from any adjacent surface to be uninfluenced by decarburization on the adjacent surface. 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 QQ-P-35.

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 another 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 another method specified by purchaser.
- 3.7.3.2 Magnetic particle inspection in accordance with ASTM E 1444 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 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 another 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.
- 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 3.6.2.1. 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 3.6.2.2.
- #### 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 factors shown below. 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)

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 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, 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, AMS 5352D, part number, and quantity.

#### 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. The 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.
- 5.2 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 this AMS are defined as follows. Other terms not specifically defined are clarified in ARP1917.
- 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.