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AEROSPACE MATERIAL SPECIFICATION

AMS 2372B
Superseding AMS 2372A

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QUALITY ASSURANCE SAMPLING OF CARBON AND LOW-ALLOY STEELS
Forgings and Forging Stock

1. SCOPE: This specification covers quality assurance sampling procedures which may be used to determine conformance to applicable specification requirements of carbon and low-alloy steel forgings and forging stock.

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

2.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2350 - Standards and Test Methods
AMS 2808 - Identification, Forgings

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

ASTM A370 - Mechanical Testing of Steel Products

3. TECHNICAL REQUIREMENTS:

3.1 General Requirements:

3.1.1 Omission from this specification of confirmatory tests of certain material properties or attributes controlled by the applicable material specification does not relieve the vendor of responsibility for furnishing products which conform in all respects to the applicable material specification.

3.1.2 In the event of a conflict between the requirements specified herein and the requirements of a particular material specification, requirements of the material specification shall take precedence.

3.1.3 When instructions are issued by purchaser regarding quality assurance sampling procedures, such instructions shall take precedence over the requirements of this specification or the particular specification in which this specification is invoked.

3.2 Responsibility for Tests: The vendor of the product shall supply all Ø samples for vendor's tests and shall be responsible for performing all required tests. Results of such tests shall be reported to the purchaser as required by the applicable material specification.

3.3 Detail Requirements:

3.3.1 Forging Stock:

3.3.1.1 Composition:

3.3.1.1.1 The reported chemical composition of the steel subjected to a single melting operation shall be that of a sample taken immediately before or during the pouring of a heat. Analysis results on the sample shall be within the composition limits established by the material specification, excluding any consideration of product check analysis.

3.3.1.1.1.1 If the sample of 3.3.1.1.1 is lost, a new sample shall be taken from the semi-finished or finished product.

3.3.1.1.2 For remelted steels, analyses shall be obtained from the remelted ingot or product thereof in accordance with a sampling plan that will allow the reported chemical composition of the steel to conform to one of the following options: (1) the average of all ingots in the remelted heat; (2) the average of the ingots directly involved with the order; (3) the average of samples representing the first and last usable metal poured from the master heat; or (4) the analysis of each ingot involved with the order. If an average is reported, the analysis of each element shall fall within the compositional limits established by the material specification; the individual analysis may include the applicable product check analysis allowances but no average shall include analyses which are both above and below the compositional limits.

3.3.1.1.2.1 When the remelting method is vacuum arc remelting and the applicable material specification establishes minimum values for carbon or manganese, or both, these elements shall be determined and reported for each remelted ingot.

3.3.1.1.2.2 The master heat analysis may be used for reporting the analyses of those elements governed only by a maximum in the material specification if the analysis is within the compositional limits and the element routinely decreases or remains constant during remelting.

3.3.1.1.2.3 Analyses of samples made prior to discard need not be reported.

3.3.1.2 Other Properties: The product of each heat shall be subjected to such tests and inspections as necessary to ensure conformance to applicable requirements. When material is melted by a consumable electrode remelt method, a heat shall consist of all the consumable electrode remelted ingots originally melted as a single furnace charge.

3.3.2 Forgings: Shall be subjected to such tests and inspections as necessary to ensure conformance to all applicable requirements of the material specification or part drawing.

3.3.2.1 Classification: For the purpose of clarifying test requirements forgings shall be classified as follows:

Class	Description
I	Forgings furnished in the final heat treated condition and requiring destructive testing for verification of specified mechanical properties.
II	Forgings furnished normalized, normalized and tempered, normalized and annealed, or annealed only, requiring testing to ensure conformance to specified mechanical properties after subsequent heat treatment.
III	Forgings furnished hardened and tempered to a specified hardness range only.
IV	Forgings furnished normalized, normalized and tempered, normalized and annealed, or annealed only, e.g., carburizing grades.

3.3.2.2 Test Methods: Shall be in accordance with the requirements of the applicable material specification. If a test method is not specified, the method of test shall be as agreed upon by purchaser and vendor.

3.3.2.3 Inspection Lot: Unless otherwise agreed upon by purchaser and vendor,
ø an inspection lot shall consist of forgings of the same part number, made from one mill heat of steel, and heat treated as a batch or sequentially heat treated in a continuous furnace.

3.3.2.3.1 When a batch furnace is controlled within specified limits and
ø equipped with recording pyrometers so that complete records of heat treatment are available, those batches sequentially treated in the same furnace may be considered as one heat treat lot, provided there is no change in the furnace setting or interruption of power.

3.3.3 Tests:

3.3.3.1 General: Tests for properties which are characteristic of a heat, such as composition, hardenability, cleanliness, etc, which are made on the forging stock, need not be repeated on forgings from that heat provided that these tests have been performed on the stock and that heat identity of the forgings is maintained.

3.3.3.2 Grain Flow: When grain flow is specified, a preproduction forging shall be sectioned and macroetched to reveal the grain flow pattern. The Ø pattern shall be in essential agreement with flow lines sketched on the drawing. Grain flow, except in areas of die forging which contain end grain, shall follow the general contour of the forgings, showing no evidence of re-entrant flow.

3.3.3.3 Decarburization: When depth of decarburization is specified, the location of specimens, frequency of testing, and method of testing shall be selected by the vendor unless otherwise specified by purchaser, drawing, or material specification.

3.3.3.4 Nondestructive Testing: Shall be performed to ensure freedom from Ø imperfections. The methods of test, acceptance standards, and frequency of testing shall be as specified by purchaser, drawing, or material specification.

3.3.3.5 Dimensions: Forgings shall be inspected to ensure conformance to Ø dimensions shown on the applicable drawing. The frequency of inspection shall be selected by the vendor unless frequency is specified by the purchaser.

3.3.3.6 Tensile Property Tests: When tensile testing of a forging is specified, Ø the location of the specimens within the part shall be as shown on the drawing or sketch or in the material specification.

3.3.3.6.1 Tensile Specimens:

3.3.3.6.1.1 Orientation: Longitudinal specimens shall be taken with the axis of Ø the specimen within 15 deg of parallel to the forging flow lines. Transverse specimens shall be taken with the axis of the specimen within 15 deg of perpendicular to the forging flow lines.

3.3.3.6.1.2 Size: Specimens shall conform to ASTM A370 and shall be either Ø 0.500 or 0.250 in. (12.50 or 6.25 mm) in diameter at the reduced parallel gage section, standard rectangular specimens, or subsize specimens proportional to the standard.

3.3.3.6.1.3 Acceptance Tests: Class I forgings shall be sectioned and tested on the basis of one per inspection lot, unless otherwise specified. Once a valid hardness/tensile property relationship has been established for a given forging and heat treat cycle, the frequency of destructive testing may be reduced when permitted by purchaser, and hardness used as the conformance criterion.

3.3.3.6.1.4 Periodic Tests: Class II forgings selected for destructive testing shall, if necessary, be rough machined to an appropriate section size prior to heat treating to the specified final hardness. In the case of ultra-high-strength alloy steel forgings, specimen blanks may be cut from the proper locations and heat treated in accordance with specification requirements. Testing shall be performed on forgings from each mill heat, unless otherwise specified.

3.3.3.6.1.5 Integral Coupon Tests: Integral coupon tests may be used for acceptance or periodic tests, when agreed upon by purchaser and vendor. A sufficient number of forgings shall have been destructively tested to establish a correlation between the part properties and those of the integral coupon.

3.3.3.7 Hardness Tests: Sampling for hardness shall be as shown in Table I or Table II.

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TABLE I

Class I or Class III Forgings

Lot Quantity	Sample Size
1 - 44	100%
45 - 65	44
66 - 110	60
111 - 180	67
180 - 300	73
301 - 500	78
501 - 800	80
Over 800	10% (85 pcs min)

TABLE II

Class II or Class IV Forgings

Lot Quantity	Sample Size
1 - 20	100%
21 - 100	25% (20 pcs min)
Over 100	10% (25 pcs min)

3.3.3.7.1 Each furnace load or container of forgings shall be included in this selection of samples.

3.3.3.7.2 All samples shall conform to the specified hardness or 100% inspection shall be applied. If pieces are checked 100%, the vendor may either reheat treat nonconforming pieces, submit nonconforming pieces to the purchaser for consideration, or scrap the pieces.