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AEROSPACE MATERIAL SPECIFICATION

SAE AMS 2375C

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Superseding AMS 2375B

Control of Forgings Requiring First Article Approval

1. SCOPE:

1.1 Purpose:

This specification covers procedures for obtaining first-article (preproduction) approval of forgings and the controls to be exercised in producing subsequent production forgings.

1.2 Application:

This procedure has been used typically for forgings which require preproduction approval and where assurance is required that production lots are of essentially the same metallurgical quality and are produced by the same basic procedures as the forging originally qualified.

2. APPLICABLE DOCUMENTS:

The following publications form a part of this specification to the extent specified herein. The applicable issue of referenced publications shall be the issue in effect on the date of the purchase order.

2.1 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM E 3 Preparation of Metallographic Specimens

3. TECHNICAL REQUIREMENTS:

3.1 Forging Stock:

3.1.1 The forging vendor shall determine that the forging stock conforms to the applicable material specification and will yield acceptable forgings. Tests which are characteristic of a heat or lot, and which are conducted by the forging stock vendor, need not be repeated by the forging vendor provided the results of such tests have been supplied by the forging stock vendor.

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3.1.2 When specified, forging stock shall be procured from sources approved by purchaser of the forgings.

3.2 Preproduction Forgings:

3.2.1 Procedure: The forging vendor shall produce and heat treat, to final condition, one or more preproduction forgings and shall test a forging or sections thereof to determine conformance to all requirements of the material specification, the drawing, and any additional requirements specified by purchaser. The preproduction forgings shall be made by practices to be used on production forgings and, unless otherwise specified, may be produced as part of the initial production run. A duplicate preproduction forging or the remaining section of such forgings shall be submitted to purchaser for confirmatory testing, when requested.

3.2.1.1 When forgings are to be supplied in other than the final heat treated condition, the test forging(s) shall be heat treated to the final heat treated condition of the part. If the as-forged section size is too large to achieve proper heat treatment response, the forging, or a section thereof, shall be machined to a configuration of the same equivalent round as that of the heaviest section of the heat treat configuration.

3.2.1.1.1 If the final heat treated condition of the forgings requires a tensile strength of 200 ksi (1379 MPa) or higher, and the forgings are supplied in a different condition, the vendor may excise oversize test coupons from such forgings. Such coupons shall be given the final heat treatment prior to machining to specimen size for testing.

3.2.2 Specimen Locations: The location(s) from which coupons are to be taken for mechanical property tests and the sections for grain flow examination shall be as specified by purchaser. The forging vendor shall perform the required tests on specimens from these locations. If locations are not specified, the forging vendor shall select representative areas for testing and, when required, shall obtain concurrence of purchaser. Mechanical property test specimens shall be taken in the transverse direction whenever practicable unless only longitudinal properties are specified in the material specification.

3.2.3 Properties:

3.2.3.1 Grain Flow: A representative forging shall be sectioned as indicated on the drawing and the sections suitably etched to show the grain flow. Photographs showing the grain flow pattern shall be made of each section and the photographs shall be identified to indicate the corresponding sections in the forging. The grain flow shall conform to the requirements of the drawing and good forging practice consistent with the part shape, without re-entrant flow lines. When the specified alloy is not conducive to good grain flow determination, a substitute alloy or melting practice showing good grain flow and having equivalent forgability shall be substituted and so indicated in the test report.

3.2.3.2 Hardness: Hardness surveys shall be made across the heaviest section of test forgings of carbon and alloy steels, corrosion and heat resistant steels and alloys, copper alloys, and aluminum alloys, unless otherwise specified.

3.2.3.3 Microstructure: Sections shall be taken from the fully heat-treated forging at the center of the heaviest usable section and at the surface of the heaviest and thinnest sections and prepared for metallographic examination in accordance with ASTM E 3. There shall be no detrimental microstructural abnormalities related to improper forging or heat treating practice or to forging stock quality. Photographs of the microstructures shall be submitted to purchaser and any abnormal microstructural conditions identified.

3.2.3.4 Mechanical Properties: Test specimens from the representative forging(s) shall meet the specified mechanical properties for the part in the final heat treated condition.

3.3 Process Control Factors:

A resume of the process control factors (See 4.4.2.1), established for producing forgings of each part number, shall be submitted with the results of tests on the preproduction forging(s); when permitted by purchaser, the resume need not be submitted with the test results but shall be kept on file for review by purchaser.

3.4 Production Forgings:

Shall be produced using essentially the same operations, practices, and process control factors used on the approved preproduction forging(s).

3.4.1 Production forgings shall not be shipped until the forging vendor has received written approval of the preproduction forging(s), unless preshipment approval is waived by purchaser.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

The vendor of forgings 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 forgings conform to specified requirements.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests of forging stock and forgings to determine conformance to applicable requirements of the material specification (3.2.1) and to any additional requirements specified by purchaser are acceptance tests and shall be performed on each heat or lot, as applicable. Such tests of forging stock shall be performed prior to use of a new heat or lot for production forgings.

4.2.2 Preproduction Tests: Tests of preproduction forgings to determine conformance to all applicable technical requirements of the material specification, to requirements for grain flow (3.2.3.1), hardness (3.2.3.2), microstructure (3.2.3.3), and mechanical properties (3.2.3.4), and to any additional requirements specified by purchaser are preproduction tests and shall be conducted under the following circumstances:

4.2.2.1 The first production of a new forging.

4.2.2.2 At any time a change is made in forging design or in process control factors (4.4.2).

4.2.2.2.1 Forger shall obtain purchaser's concurrence on changes which are deemed not to affect preproduction test results.

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

4.3 Sampling and Testing:

Shall be as follows; a lot shall be all forgings of the same part number or configuration, opposite hands being considered one configuration, produced from the same heat of forging stock, heated and forged in the same manner, and heat treated in a continuous furnace or in a series of batch-type furnace operations with no change in furnace settings or interruption of power.

4.3.1 For Acceptance Tests: As specified on forging drawing, material specification, or quality assurance specification. For forgings supplied in the final heat treat condition, a forging from each lot shall be subjected to destructive testing. On forgings which contain a test prolongation, each prolongation shall be tested unless a sampling plan is agreed upon by purchaser and vendor. Each prolongation, and the forging it represents, shall be given an identical serial number.

4.3.2 For Preproduction Tests: As specified in Section 3; tests shall be performed on the first production of a new forging by a vendor and following any change in configuration or forging design.

4.4 Approval:

4.4.1 Preproduction forgings and the forging procedure shall be approved by purchaser before production forgings are supplied, unless preproduction approval is waived by purchaser. Neither the approval of preproduction forgings and procedures nor the waiver of preproduction approval shall relieve the forging vendor of responsibility for continued conformance to all requirements.

4.4.2 The forging vendor shall establish for each part number or configuration parameters for process control factors which will produce forgings conforming to the requirements of this specification and the material specification. These control factors shall constitute the approved manufacturing procedures and shall be used for production forgings. If necessary to make any change in parameters for process control factors, the forging vendor shall submit for reapproval a statement of the proposed changes and, when requested, perform preproduction tests of revised forgings. Production forgings incorporating the revised operations shall not be shipped prior to receipt of reapproval unless preshipment approval is waived by purchaser.

4.4.2.1 Process control factors for producing forgings include, but are not limited to, the following:

Type (ingot, bloom, billet, or bar), nominal size (cross-sectional area), shape, and nominal multiple-weight of forging stock; rounds and round-corner-squares of the same nominal cross-sectional area are considered the same shape
Inspection and qualification of forging stock
Processing sequence or number of operations that would result in different cross-sectional structure, grain flow, or working of the metal
Type of forging equipment (press, hammer, ring roll, etc.)
Description of dies
Thermal cycling, including heating of stock for forging, annealing, and heat treatment of forgings
Protective atmosphere and/or coatings
Cleaning operations (e.g., chemical descaling, blasting)
Inspection procedures

4.4.2.1.1 Any of the above process control factors for which parameters are considered proprietary by the vendor may be assigned a code designation. Each variation in such factors shall be assigned a modified code designation. The vendor shall maintain complete records of all proprietary processes and factors.

4.5 Records:

4.5.1 Maintenance of Facilities: Each forging vendor shall keep records demonstrating that the facilities used to produce, control, measure, and test forging stock and forgings during manufacture and inspection are properly maintained and are checked for accuracy at stated intervals against acceptable standards for accuracy. Records shall be maintained on file for not less than seven years, unless otherwise specified by purchaser.

4.5.2 Process Sheets: For each forging part number or configuration, opposite hands being considered a single configuration, the forging vendor shall prepare and maintain documented instructions defining the processing methods and routing in manufacturing and inspection cycles.

4.6 Surveillance Visits:

The forging vendor shall, when requested, permit purchaser's authorized personnel to survey all facilities and controls related to production of forgings and to review vendor's control of materials and of chemical and metallurgical processing during production.

4.7 Reports:

The forging vendor shall furnish with the preproduction forging(s) or sections thereof a report showing the results of tests to determine conformance to the technical requirements of this specification, the applicable material specification, and the drawing and shall include photographs of the grain flow and microstructures.