

AERONAUTICAL MATERIAL SPECIFICATION

Society of Automotive Engineers, Inc.
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AMS 4220 C

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ALUMINUM ALLOY CASTINGS, SAND
4Cu - 2Ni - 1.5Mg - 0.2Cr (Al42-T75)
Solution Treated and Overaged

1. ACKNOWLEDGMENT: A vendor shall mention this specification number and its revision letter in all quotations and when acknowledging purchase orders.
2. APPLICATION: Primarily for air-cooled cylinder heads.
3. COMPOSITION:

Copper	3.7 - 4.5
Nickel	1.8 - 2.3
Magnesium	1.2 - 1.7
Chromium	0.15 - 0.25
Titanium	0.07 - 0.18
Iron	0.8 max
Silicon	0.6 max
Manganese	0.1 max
Zinc	0.1 max
Other Impurities, each	0.05 max
Other Impurities, total	0.15 max
Aluminum	remainder

- 3.1 If boron is present in the amount of 0.001 per cent or more, the titanium content may be as low as 0.02 per cent.

4. CONDITION: Solution heat treated and overaged.

5. TECHNICAL REQUIREMENTS:

- 5.1 Casting:

- 5.1.1 All metal which is melted for castings shall be ingot conforming in composition to Section 3 above; gates, risers and rejected castings may be used but shall first be converted into such ingot. Furnace or ladle additions of small amounts of grain refining elements or alloys are permissible. When permitted by purchaser, molten metal may be taken from the alloying furnaces for pouring into castings without first casting into ingot and remelting provided that a sample for chemical analysis is taken after the last addition of metal to the furnace prior to removal of the alloy to the holding furnace or pouring ladle.
- 5.1.2 A melt shall be the metal withdrawn from a batch furnace charge of 2000 pounds or less as melted for pouring castings, or when permitted by the purchaser, a melt shall be 3000 pounds or less of metal withdrawn from one continuous furnace in not more than 8 consecutive hours.
- 5.1.3 During melting, the metal shall be heated to not over 1450 F. The metal being poured into the mold shall not exceed a temperature of 1420 F. Written permission shall be obtained from purchaser by letter or by notation on the drawing before deviating from the requirements of this paragraph.

Section 7C of the SAE Technical Board rules provides that: "All technical reports, including standards approved and practices recommended, are advisory only. Their use by anyone engaged in industry or trade is entirely voluntary. There is no agreement to adhere to any SAE standard or recommended practice, and no commitment to conform to or be guided by any technical report. In formulating and approving technical reports, the Board and its Committees will not investigate or consider patents which may apply to the subject matter. Prospective users of the report are responsible for protecting themselves against liability for infringement of patents."

5.2 Test Specimens: Tensile test specimens, and chemical analysis specimens when required, shall be cast with each melt of metal for castings, and when requested, shall be supplied with the castings.

5.2.1 Tensile Test Specimens: Shall be standard (0.5-inch diameter at the reduced parallel section) and shall be cast to size in molds made with the regular foundry mix of green sand, without using chills. Metal for the specimens shall be part of the melt which is used for the castings. If the metal for castings is given any treatment, such as fluxing or cooling and reheating, the metal for the specimens shall be a portion of the metal so treated, and during such treatment shall be heated to the same maximum temperature and held for approximately the same length of time as the molten metal for castings. The temperature of the metal during pouring of the specimens shall be not lower than the temperature of the metal during pouring of the castings.

5.2.2 Chemical Analysis Specimens: When required by purchaser, shall be of size and shape agreed upon by purchaser and vendor.

5.3 Heat Treatment: All castings and tensile test specimens representing them shall be heat treated as follows:

5.3.1 Tensile test specimens from each melt, together with production castings, shall be heated to 960-970 F, held at heat for not less than 6 hours and cooled in air. At least one set of tensile test specimens shall be put into a batch-type furnace with each load of castings or into a continuous furnace at intervals of not longer than 3 hours.

5.3.2 Tensile test specimens from each melt, together with production castings, shall, after solution treatment as in 5.3.1, be heated uniformly to approximately 550 F, but to not lower than 500 F, held at heat for not less than 2 hours and cooled in air. At least one set of tensile test specimens shall be put into a batch-type furnace with each load of castings or into a continuous furnace at intervals if not longer than 3 hours.

5.4 Tensile Properties:

5.4.1 Tensile Test Specimens:

Tensile Strength, psi	29,000 min
Elongation, % in 2 in.	1 min

5.4.2 Tensile Properties of Castings: When tensile properties of actual castings are determined for acceptance, not less than 4, and preferably 10, tensile test specimens shall be cut from thick and thin sections. The average values of all specimens selected shall conform to the following:

Tensile Strength, psi	20,000 min
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Note. Conformance to this requirement may be used as basis for acceptance of castings.

5.5 Hardness of Castings: Except at sprues and risers the castings shall have hardness of Brinell 70-85 using 500 kg load and 10 mm ball or 1000 kg load and 9/16 in. ball, or Brinell 75-90 using 1000 kg load and 10 mm ball.

5.5.1 Hardness of Cylinder Heads After Assembling: Shall be Brinell 60-75 using 500 kg load and 10 mm ball or 1000 kg load and 9/16 inch ball, or Brinell 65-80 using 1000 kg load and 10 mm ball. This Brinell test shall be made at the spot indicated on the drawing.

6. QUALITY:

6.1 Castings shall be uniform in quality and condition, sound, and free from foreign materials and from internal and external defects detrimental to fabrication or to performance of parts. Castings shall have smooth surfaces and shall be well cleaned.

6.2 When castings are broken for fracture test, the fracture shall have essentially uniform color and be substantially free from oxides and other defects.

6.3 Cylinder head fins shall show some ductility when being fractured; surfaces of the fracture shall show a fine structure. Cylinder head castings having brittle coarse grained fins shall be rejected.

6.4 Castings shall not be repaired by plugging, welding, or other methods without written permission from purchaser, but imperfect cylinder head fins may be accepted to the extent of 0.5% of the total fin surface according to the following:

6.4.1 Defective areas shall be smoothly blended without sharp corners.

6.4.2 After blending, the depth of the remaining portion of any fin shall be not less than 50% of the nominal depth of that fin.

6.4.3 Not more than 25% of the allowable imperfect fin surfaces shall be within any one area of 4 sq. in. of the head.

6.5 Castings shall not be impregnated, chemically treated, or coated to prevent leaking, unless specified or allowed by written permission which states the method to be used. Impregnated castings shall be marked IMP.

7. REPORTS:

7.1 Unless otherwise specified, the vendor of castings shall furnish with each shipment three copies of a report of the results of tests to determine conformance of the castings to the requirements of this specification. This report shall show the chemical composition of the castings, properties of the tensile test specimens, melt numbers, material specification number, purchase order number, part number, and quantity. If the accuracy of control is adequate, each melt need not be analyzed, but the frequency of analysis shall be as agreed upon by purchaser and vendor.

7.2 Unless otherwise specified, the vendor of finished or semi-finished parts shall furnish with each shipment three copies of a report showing the purchase order number, material specification number, contractor or other direct supplier of castings, part number, and quantity. When castings for making parts are produced or purchased by the parts vendor, that vendor shall inspect each shipment or melt of castings to determine conformance to the requirements of this specification, and shall include in the report a statement that the castings conform, or shall include copies of laboratory reports showing the results of tests to determine conformance.