



AEROSPACE MATERIAL SPECIFICATION

Society of Automotive Engineers, Inc.
TWO PENNSYLVANIA PLAZA, NEW YORK, N.Y. 1000

AMS 6435A

Superseding AMS 6435

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STEEL SHEET, STRIP, AND PLATE
0.80Cr - 1.8Ni - 0.35Mo - 0.20V (0.33 - 0.38C)
Premium Quality, Consumable Electrode Melted, Annealed

1. **ACKNOWLEDGMENT:** A vendor shall mention this specification number and its revision letter in all quotations and when acknowledging purchase orders.
2. **APPLICATION:** A weldable grade alloy steel intended primarily for heat treated parts which require through hardening to high yield strengths and which may be used at operational stress levels approaching the yield strength. This alloy steel may be notch sensitive when heat treated to 240,000 psi or higher tensile strength and, consequently, caution should be exercised in this respect.

3. **COMPOSITION:**

	min	max
Carbon	0.33	0.38
Manganese	0.60	0.90
Silicon	0.40	0.60
Phosphorus	--	0.010
Sulfur	--	0.010
Chromium	0.65	0.90
Nickel	1.65	2.00
Molybdenum	0.30	0.40
Vanadium	0.17	0.23
Copper	--	0.35

- 3.1 **Check Analysis:** Composition variations shall meet the requirements of the latest issue of AMS 2259, paragraph titled "Low Alloy Steels", except that carbon shall vary not more than 0.01 under min or over max and no variation will be permitted for phosphorus and sulfur.
4. **CONDITION:** Unless otherwise ordered, the product shall be supplied hot finished, annealed, and descaled having hardness not higher than Rockwell C 30 or equivalent. When product is ordered spheroidize annealed, hardness shall be not higher than Rockwell B 100 or equivalent.
5. **TECHNICAL REQUIREMENTS:** When ASTM methods are specified for determining conformance to the following requirements, tests shall be conducted in accordance with the issue of the ASTM method listed in the latest issue of AMS 2350.
 - 5.1 **Grain Size:** Predominantly 5 or finer with occasional grains as large as 3 permissible, ASTM E112, McQuaid-Ehn test.
 - 5.2 **Decarburization:**
 - 5.2.1 **Material Under 0.045 In. in Thickness:** The method of test and the allowance shall be as agreed upon by purchaser and vendor.
 - 5.2.2 **Material 0.045 In. and Over in Thickness:**
 - 5.2.2.1 **Specimens:** Shall be the full thickness of the material except that specimens from plate over 0.249 in. thick shall be slices approximately 0.250 in. thick cut parallel to and preserving one original surface of the plate. Recommended specimen size is 1 x 4 inches.

5.2.2.2 Procedure: Specimens from material 0.045 to 0.375 in., excl, in thickness shall be hardened by austenitizing and quenching; preferably, they shall not be tempered but, if tempered, the tempering temperature shall be not higher than 300 F (149 C). During heat treatment, specimens shall be protected by suitable atmosphere or medium or by suitable plating to prevent carburization or further decarburization. Protective plating, if used, shall then be removed from specimens of material 0.045 to 0.250, excl, in thickness and a portion of the specimen shall be step ground to a depth of 0.050 in. or half thickness, whichever is less. Specimens from material 0.250 in. to 0.375 in., excl, in thickness shall be ground to remove 0.020 in. from the original surface of the plate and a portion of the specimen shall be further ground to a depth of at least 1/3 the original thickness of the specimen. At least three Rockwell hardness readings shall be taken on each prepared step and each group of readings averaged.

5.2.2.3 Allowance:

5.2.2.3.1 Material 0.045 to 0.250 In., Excl, Thick: Unless otherwise specified, the product shall be free from complete decarburization. It shall also be free from partial decarburization to the extent that the difference in hardness between the surface and the nondecarburized depth below the surface shall be not greater than 2 points on the Rockwell A scale.

5.2.2.3.2 Material 0.250 to 0.375 In., Excl, Thick: The difference in hardness between the two prepared steps shall be not greater than 3 points on the Rockwell A scale.

5.2.2.3.3 Material 0.375 In. and Over in Thickness. The total decarburization as determined microscopically on the plate as supplied shall be not greater than the following:

Nominal Thickness	Depth of Decarburization
Inches	Inch
0.375 to 0.500, incl	0.015
Over 0.500 to 1.000, incl	0.025
Over 1.000 to 2.000, incl	0.035

5.3 Hardenability: Shall be J56=1 max and J47=15 min when determined in accordance with the Method of Determining Hardenability published in the latest issue of the SAE Handbook, except that a laminated end-quench test specimen (Fig. 1) shall be used and the steel shall be normalized at 1700 F $\pm$ 10 (926.7 C $\pm$ 5.6) and the test specimen austenitized at 1625 F $\pm$ 10 (885 C $\pm$ 5.6)

5.4 Tensile Properties: Material shall conform to the following requirements when heated to 1625 F $\pm$ 25 (885 C $\pm$ 14), held at heat for 1 hr, quenched in oil, tempered at 400 - 500 F (204.4 - 260 C) for not less than 2 hr, and tested with axis of specimen perpendicular to the direction of rolling:

Tensile Strength, psi	240,000 min
Yield Strength at 0.2% Offset or at 0.0185 in. in 2 in. Extension Under Load (E = 29,000,000), psi	210,000 min
Elongation, % in 2 in. or 4D	
Nominal Thickness, Inches	
Up to 0.070, incl	5 min
Over 0.070 to 0.249, incl	6 min
Over 0.249	8 min

5.5 Inclusion Rating: The inclusion rating determined in accordance with ASTM E45, Method D using not less than 9 specimens per heat, selected parallel to the direction of rolling and representing the worst area of inclusions in the inspection samples, shall be as specified below. The method of selection of specimens shall be such that suitable rating of the heat of steel being qualified is assured. Two-thirds of all specimens as well as the average of all specimens shall not exceed the following limits:

Type	Inclusion Rating			
	A	B	C	D
Thin	1.5	1.5	1.0	2.0
Thick	1.0	1.0	1.0	1.5

6. **QUALITY:** Steel shall be premium quality and shall conform to the requirements of the latest issue of AMS 2300. Unless otherwise permitted, material shall be multiple melted using consumable electrode practice in the remelt cycle; at least one of the melting cycles shall be under vacuum. The product shall be uniform in quality and condition, clean, sound, and free from foreign materials and from internal and external imperfections detrimental to fabrication or to performance of parts.

7. **TOLERANCES:** Unless otherwise specified, tolerances shall conform to all applicable requirements of the latest issue of AMS 2252; for strip, tolerances for cold finished shall apply.

8. **REPORTS:**

8.1 Unless otherwise specified, the vendor of the product shall furnish with each shipment three copies of a report of the results of tests for chemical composition, grain size, hardenability, AMS 2300 frequency-severity rating, and inclusion rating of each heat in the shipment and the results of tests on each thickness from each heat to determine conformance to the tensile property requirements of this specification. A heat shall be the consumable electrode remelted ingots produced from steel originally melted as a single furnace charge. When permitted by purchaser, a heat may be the consumable electrode remelted product of individual melts of similar composition produced from the same lots of controlled raw material and having the same average composition as agreed upon by purchaser and vendor. This report shall include the purchase order number, heat number, material specification number and its revision letter, size, and quantity from each heat.

8.2 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 and its revision letter, contractor or other direct supplier of material, part number, and quantity. When material for making parts is produced or purchased by the parts vendor, that vendor shall inspect each lot of material to determine conformance to the requirements of this specification, and shall include in the report a statement that the material conforms, or shall include copies of laboratory reports showing the results of tests to determine conformance.

9. **IDENTIFICATION:** Unless otherwise specified, each sheet, strip, and plate shall be marked as in 9.1 unless purchaser permits a method from 9.2.

9.1 Each sheet, strip, and plate shall be marked on one face, in the respective location indicated below, with AMS 6435A, heat number, manufacturer's identification, and nominal thickness in inches. The characters shall be of such size as to be clearly legible, shall be applied using a suitable marking fluid, and shall be capable of being removed in hot alkaline cleaning solution without rubbing. The markings shall have no deleterious effect on the material or its performance and shall be sufficiently stable to withstand normal handling. The specification number, manufacturer's identification, and nominal thickness shall be continuously line marked; the heat number may be included in the line marking or may be marked at one location on each piece.

9.1.1 **Flat Strip 6 In. and Under in Width:** Shall be marked in one or more lengthwise rows of characters recurring at intervals not greater than 3 feet.

9.1.2 **Flat Sheet, Flat Strip Over 6 In. in Width, and Plate:** Shall be marked in lengthwise rows of characters recurring at intervals not greater than 3 ft, the rows being spaced not more than 6 in. apart and alternately staggered.

9.1.3 **Coiled Sheet and Strip:** Shall be marked near the outside end of the coil. The inside end of the coil also shall be marked or shall have a tag or label attached and marked with the information of 9.1 above.

- 9.2 When purchaser permits, each sheet, strip, and plate may be marked near one end, coils being marked near the outside end, with AMS 6435A, heat number, manufacturer's identification, and nominal thickness in inches, using any suitable marking fluid. As an alternate method, individual pieces and bundles shall have attached a metal or plastic tag embossed with the above information or shall be boxed and the box marked with the same information.
- Ø 10. PROTECTIVE TREATMENT: Unless otherwise specified, the product shall be oiled prior to shipping.
11. PACKAGING: Material shall be packaged with paper interleaving to prevent scratching of surfaces during shipping and handling. Sheet, strip, and plate, up to 1/2 in. thick shall be boxed in wooden boxes of one ton lifts. Plate 1/2 in. thick and heavier shall be shipped with standard mill packing in lifts not exceeding one ton.
12. REJECTIONS: Material not conforming to this specification or to authorized modifications will be subject to rejection.

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