



AEROSPACE MATERIAL SPECIFICATIONS

SOCIETY OF AUTOMOTIVE ENGINEERS, Inc.

485 Lexington Ave., New York, N. Y. 10017

AMS 6413D

Superseding AMS 6413C

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STEEL TUBING, MECHANICAL

0.80Cr - 1.8Ni - 0.25Mo (0.35 - 0.40C) (SAE 4337)

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 parts with sections 0.875 in. or less in thickness at the time of heat treatment which require a through-hardening steel capable of developing hardness as high as Rockwell C 50 when properly hardened and tempered and also parts of greater thickness but requiring proportionately lower hardness.

3. **COMPOSITION:**

	min	max
Carbon	0.35	0.40
Manganese	0.65	0.85
Silicon	0.20	0.35
Phosphorus	--	0.025
Sulfur	--	0.025
Chromium	0.70	0.90
Nickel	1.65	2.00
Molybdenum	0.20	0.30
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."
4. **CONDITION:** In a machinable condition and cold finished, having hardness not higher than Rockwell C 25 or equivalent, except that tubing ordered hot finished shall be furnished in a machinable condition having hardness not higher than Rockwell B 99 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 **Hardenability:** The hardenability shall be J50=10 min and J44=18 min when determined by the standard end-quench test specimen in accordance with the SAE Method of Determining Hardenability published in the latest issue of the SAE Handbook, except that the steel shall be normalized at 1700 F \pm 10 (926.7 C \pm 5.6) and the test specimen austenitized at 1500 F \pm 10 (815.5 C \pm 5.6). The hardenability test is not required on tubing which will not yield a suitable specimen but the steel from which the tubing is made shall conform to the hardenability specified.
 - 5.2 **Grain Size:** Predominantly 5 or finer with occasional grains as large as 3 permissible, ASTM E112, McQuaid-Ehn test.
 - 5.3 **Decarburization:**
 - 5.3.1 Tubing ordered ground, turned, or polished shall be free from decarburization on the ground, turned, or polished surfaces. Inside decarburization shall not exceed the maximum depth specified in 5.3.3.

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5.3.2 Allowable decarburization of pierced billets, of tubing for redrawing, or of tubing ordered to specified microstructural requirements shall be as agreed upon by purchaser and vendor.

5.3.3 Decarburization of tubing to which 5.3.1 or 5.3.2 is not applicable shall be not greater than the following:

Nominal Wall Thickness Inches	Depth of Decarburization, Inch	
	Inside	Outside
Up to 0.109, incl	0.008	0.015
Over 0.109 to 0.203, incl	0.010	0.020
Over 0.203 to 0.400, incl	0.012	0.025
Over 0.400 to 0.600, incl	0.015	0.030
Over 0.600 to 1.000, incl	0.017	0.035
Over 1.000	0.020	0.040

5.3.4 Unless otherwise agreed upon by purchaser and vendor, decarburization shall be measured by the microscopic method, or by Rockwell Superficial 30-N scale hardness method, or equivalent hardness testing method, on hardened but untempered specimens 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 measured from the surface to the nondecarburized depth under that surface below which there is no further increase in hardness. Measurements shall be far enough away from any adjacent surface to be uninfluenced by any decarburization or lack of decarburization thereon.

5.3.4.1 When determining the depth of decarburization, it is permissible to disregard local areas provided the decarburization of such areas does not exceed the limits above by more than 0.005 in. and the width is 0.065 in. or less.

6. **QUALITY:** Steel shall be aircraft quality and shall conform to the latest issue of AMS 2301. Tubing 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 2253.

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, hardenability, grain size, and AMS 2301 frequency-severity rating of each heat in the shipment. This report shall include the purchase order number, heat number, material specification number, 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, 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, tubing shall be identified as follows:

9.1 Each tube 0.500 in. and over in OD or least width of flat surface shall be marked in a row of characters recurring at intervals not greater than 3 ft with AMS 6413D, heat number, and manufacturer's identification. 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.