AEROSPACE
MATERIAL SPECIFICATIONS
SOCIETY OF AUTOMOTIVE ENGINEERS, Inc. 485 Lexington Ave., New York 17, N.Y.

AMS 6445

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Revised

STEEL BARS, FORGINGS, AND TUBING
1.05Cr - 1.1Mn (0.92 - 1.02C) (Modified 51100)
Premium Bearing Quality, Consumable Electrode Vacuum Melted

1. ACKNOWLEDGMENT: A vendor shall mention this specification number in all quotations and when acknowledging purchase orders.

2. FORM: Bars, wire, forgings, forging stock, and mechanical tubing.

3. APPLICATION: Primarily for critical bearing components requiring a through-hardening steel usually with hardness of approximately Rockwell C 60 and section thicknesses between 0.4 and 0.8 in. and subject to very rigid inspection standards.

4. COMPOSITION:

Carbon	0.92 - 1.02
Manganese	0.95 - 1.25
Silicon	0.50 - 0.70
Phosphorus	0.025 max
Sulfur	0.025 max
Chromium	0.90 - 1.15
Nickel	0.35 max
Molybdenum	0.10 max
Copper	0.25 max

4.1 Check Analysis: Composition variations shall meet the requirements of the latest issue of AMS 2259, paragraph titled "Low Alloy Steel."

5. CONDITION:

5.1 Bars and Wire: Unless otherwise specified, bars and wire shall be supplied in a machinable condition with microstructure of spheroidized cementite in ferrite matrix and having hardness not higher than Brinell 207 or equivalent, except that bars and wire ordered cold finished may have hardness as high as Brinell 248 or equivalent.

5.2 Forgings: As ordered.

5.3 Forging Stock: As ordered by the forging manufacturer.

5.4 Mechanical Tubing: Unless otherwise specified, tubing shall be supplied cold finished, in a machinable condition with microstructure of spheriodized cementite in a ferrite matrix and having hardness not higher than Rockwell C 24 or equivalent except that mechanical tubing ordered hot finished shall have hardness not higher than Rockwell B 95 or equivalent.

6. 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.

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6.1 Hardenability: Specimens from bars shall be full cross section of the material, ground on both faces normal to the axis so that length is 0.75 inch. Specimens from mechanical tubing shall be full sections of the tubing, shall have wall thickness of 0.75 in. or less with wall thicknesses over 0.75 in. being turned to 0.75 in., and shall be ground on both faces normal to the axis so that length is 0.625 inch. The specimens shall be protected by suitable means, or treated in an atmosphere, to minimize scaling and prevent either carburization or decarburization during heat treatment. The specimens shall be placed in a furnace which is at 1530 F ± 15 (832.2 C ± 8.3), allowed to heat to 1530 F ± 15 (832.2 C ± 8.3), held at heat for 30 min., and quenched in commercial paraffin oil (100 SUS at 100 F (37.8 C)) at room temperature. The hardened specimens shall have substantially uniform hardness not lower than Rockwell C 63 at any point below any permissible decarburization.

6.2 Decarburization:

6.2.1 Bars, wire, and mechanical tubing ordered ground, turned, or polished shall be free from decarburization on the ground, turned, or polished surfaces. Decarburization on tubing ID shall not exceed the maximum depth specified in 6.2.4.

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

6.2.3 Decarburization of bars and wire to which 6.2.1 or 6.2.2 is not applicable shall be not greater than the following:

Nominal Diameter or Distance Between Parallel Sides Inches	Depth of Decarburization Inch
Up to 0.50, incl	0.015
Over 0.50 to 1.00, incl	0.020
Over 1.00 to 1.50, incl	0.025
Over 1.50 to 2.00, incl	0.030
Over 2.00 to 2.50, incl	0.035
Over 2.50 to 3.00, incl	0.040
Over 3.00	0.045

6.2.4 Decarburization of all mechanical tubing to which 6.2.1 or 6.2.2 is not applicable shall be not greater than the following:

Nominal Wall Thickness Inches	Depth of Decarburization, Inch ID and OD
All	0.025

6.2.5 Unless otherwise agreed upon by purchaser and vendor, decarburization shall be measured by Rockwell Superficial 30-N scale hardness method, or by 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 from the surface to the non-decarburized depth under that surface below which there is no further increase in hardness; such measurements shall be far enough away from any adjacent surface to be uninfluenced by any decarburization or lack of decarburization thereon.

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

6.3 Inclusion Rating:

6.3.1 Fracture Test: The producer of the material shall prepare specimens, approximately 0.375 in. in thickness, cut from and representing the cross section of forging stock from the top and bottom of at least the first ingot, middle ingot, and last usable consumable ingot. These ingots shall be the product of a single air melt heat or a master heat. A master heat shall be defined as the electrodes produced from the same lot of controlled raw material. These specimens shall be normalized, annealed, hardened, and fractured. The fractured specimens shall show freedom from pipe, porosity, excessive segregation, and injurious inclusions. The fractured surfaces shall show no non-metallic streaks over 1/16 in. in length and not more than one non-metallic 1/32 - 1/16 in. in length shall be permitted for each 10 sq in. or fraction thereof of such surfaces.

6.3.2 Micro Inclusion Test: The producer of the material shall prepare radial specimens, approximately 0.28 sq in. in surface area, cut midway between center and surface of the hardened fracture samples. The specimens shall be polished, on a face longitudinal to the direction of rolling, for micro inclusion rating in accordance with the Jernkontoret chart in ASTM E45. No sample shall exceed the following limits:

Inclusion Type	Dimensional Limitation Thickness or Diameter, In.	Worst Field
A - Thin	0.00016 max	2.0
A - Heavy	0.00040 max	1.0
B - Thin	0.0003 to 0.0005, excl	1.5
B - Heavy	0.0005 to 0.0010, incl	1.0
C - Thin	0.00020 max	1.5
C - Heavy	0.00035 max	1.0
D - Thin	0.0002 to 0.0004, excl	1.5
D - Heavy	0.0004 to 0.0010, incl	1.0

6.3.2.1 For types A, B, and C thin combined, there shall be not more than three fields of No. 2.0 A type or No. 1.5 B and C types and not more than five other lower rateable A, B, and C type thin fields per specimen. For type D thin, there shall be not more than three No. 1.5 fields and no more than five other lower rateable D type thin fields per specimen. There shall be not more than one field each of No. 1.0 A, B, C, or D type heavy per specimen.

6.3.2.2 A rateable field is defined as one which has a type A, B, C, or D inclusion rating of at least No. 1.0 thin or heavy in accordance with the dimensional limitation of 6.3.3 and the Jernkontoret chart, Plate 1, ASTM E45.

7. QUALITY: Steel shall be premium quality and shall conform to the requirements of the latest issue of AMS 2300; it shall be multiple melted using vacuum consumable electrode process in the remelt cycle, unless otherwise permitted. 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.

8. TOLERANCES: Unless otherwise specified, tolerances shall conform to all applicable requirements of the following:

8.1 Bars and Wire: The latest issue of AMS 2251; for bars ordered cold finished and for all hexagons, tolerances for cold finished shall apply.

8.2 Mechanical Tubing: The latest issue of AMS 2253.

9. REPORTS:

9.1 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, and inclusion 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. If forgings are supplied, the part number and size of stock used to make the forgings shall also be included.

9.2 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.

10. IDENTIFICATION:

10.1 Bars, Wire, and Mechanical Tubing: Individual pieces or bundles shall have attached a metal or plastic tag embossed with the purchase order number, AMS 6445, nominal size, and heat number, or shall be boxed and the box marked with the same information. In addition to the above identification, flats 2 in. and larger in both dimensions, other bars 2 in. and over in diameter or distance between parallel sides, and mechanical tubing when size permits, shall be stamped with the heat number within 2 in. of one end.