

AEROSPACE MATERIAL SPECIFICATION



AMS 6456C

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Superseding AMS 6456B

Steel, Welding Wire
0.80Cr - 1.8Ni - 0.25Mo (0.35 - 0.40C) (SAE 4340 Mod)
Vacuum Melted, Environment-Controlled Packaging

1. SCOPE:

1.1 Form:

This specification covers a low-alloy steel in the form of welding wire.

1.2 Application:

This wire has been used typically as filler metal for gas-metal-arc or gas-tungsten-arc welding of critical weldments of low-alloy steels requiring a joint capable of being heat treated to a strength level approximating that of the basis metal, but usage is not limited to such applications.

1.3 Classification:

Wire shall be classified as follows:

Type 1 - Bare Wire

Type 2 - Copper Coated

1.3.1 Type 1 shall be supplied unless Type 2 is specified.

2. APPLICABLE DOCUMENTS:

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been cancelled and no superseding document has been specified, the last published issue of that document shall apply.

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TO PLACE A DOCUMENT ORDER:

Tel: 877-606-7323 (inside USA and Canada)
Tel: 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: custsvc@sae.org
<http://www.sae.org>

SAE WEB ADDRESS:

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001 or www.sae.org.

AMS 2259	Chemical Check Analysis Limits, Wrought Low-Alloy and Carbon Steels
AMS 2370	Quality Assurance Sampling and Testing, Carbon and Low-Alloy Steel Wrought Products and Forging Stock
AMS 2813	Packaging and Marking of Packages of Welding Wire, Standard Method
AMS 2814	Packaging and Marking of Packages of Welding Wire, Premium Quality
AMS 2816	Identification, Welding Wire, Tab Marking Method
AMS 2819	Identification, Welding Wire, Direct Color Code System
AMS 6359	Steel Sheet, Strip, and Plate, 0.80Cr - 1.8Ni - 0.25Mo (0.38 - 0.43C) (SAE 4340)
ARP1876	Weldability Test for Weld Filler Metal Wire
ARP4926	Alloy Verification and Chemical Composition Inspection of Welding Wire

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959 or www.astm.org.

ASTM E 8	Tension Testing of Metallic Materials
ASTM E 8M	Tension Testing of Metallic Materials (Metric)
ASTM E 350	Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron
ASTM E 1742	Radiographic Examination

3. TECHNICAL REQUIREMENTS:

3.1 Wire Composition:

Shall conform to the percentages by weight shown in Table 1, determined by wet chemical methods in accordance with ASTM E 350, by spectrochemical methods, or by other analytical methods acceptable to purchaser.

TABLE 1 – Composition

Element	min	max
Carbon (3.1.1.1)	0.35	0.40
Manganese	0.60	0.90
Silicon	0.15	0.35
Phosphorus	--	0.008
Sulfur	--	0.008
Chromium	0.70	0.90
Nickel	1.65	2.00
Molybdenum	0.20	0.30
Copper (3.1.1.2)	--	0.30
Oxygen (3.1.1.1)	--	0.0100 (100 ppm)
Nitrogen (3.1.1.1)	--	0.0050 (50 ppm)
Hydrogen (3.1.1.1)	--	0.0010 (10 ppm)

3.1.1 Chemical analysis of initial ingot, bar, or rod stock before drawing, other than those analyses required to be done on the finished wire, is acceptable provided processes used for drawing or rolling, annealing, and cleaning are controlled to ensure continued conformance to composition requirements.

3.1.1.1 Carbon, oxygen, nitrogen, and hydrogen shall also be periodically determined on finished wire (See 4.2.2).

3.1.1.2 For Type 2 (copper coated) wire, copper shall also be periodically determined on finished wire (See 4.2.2).

3.1.2 Check Analysis: Composition variations shall meet the applicable requirements of AMS 2259.

3.2 Melting Practice:

Steel shall be multiple melted using consumable electrode vacuum practice in the remelt cycle or shall be induction melted under vacuum.

3.3 Condition:

Cold worked, bright finish, in a temper and with a surface finish which will provide proper feeding of the wire in machine welding equipment.

3.4 Fabrication:

3.4.1 Wire shall be formed from rod or bar descaled by a process which does not affect the composition of the wire.

- 3.4.2 In process annealing, if required, between cold rolling or drawing operations, shall be performed in vacuum or in protective atmosphere to avoid surface oxidation and absorption of other extraneous elements.
- 3.4.3 Butt welding is permissible provided both ends to be joined are either alloy verified using a method or methods capable of distinguishing the alloy from all other alloys processed within the facility or the repair is made at the wire processing station. The butt weld shall not interfere with uniform, uninterrupted feeding of the wire in machine welding equipment.
- 3.4.4 Drawing compounds, oxides, dirt, oil, and other foreign materials shall be removed by cleaning processes which will neither result in pitting nor cause gas absorption by the wire or deposition of substances harmful to welding operations.
- 3.4.5 Residual elements and dissolved gases deposited on or absorbed by the wire during processing, that can adversely affect the welding characteristics, the operation of the equipment, or the properties of the weld metal, shall be removed.
- 3.4.6 When Type 2, copper coated, wire is specified, the copper coating shall be clean, bright, and uniform in appearance. A maximum of four discontinuities in any 36-inch (914-mm) length are acceptable provided the exposed wire is clean and bright. The maximum allowable discontinuity size shall be 0.25 inch (6.4 mm) in length. The thickness of the copper coating shall not exceed 0.0005 inch (0.0127 mm) on the diameter.
- 3.5 Properties:
- Wire shall conform to the following requirements:
- 3.5.1 Weldability: Melted wire shall flow smoothly and evenly during welding and shall produce acceptable welds. ARP1876 may be used to resolve disputes.
- 3.5.2 Spooled Wire: Shall conform to 3.5.2.1 and 3.5.2.2.
- 3.5.2.1 Cast: Wire, wound on standard 12-inch (305-mm) diameter spools, shall have imparted to it a curvature such that a specimen sufficient in length to form one loop with a 1-inch (25-mm) overlap, when cut from the spool and laid on a flat surface, shall form a circle 15 to 50 inches (381 to 1270 mm) in diameter.
- 3.5.2.2 Helix: The specimen on which cast was determined, when laid on a flat surface and measured between adjacent turns, shall show a vertical separation not greater than 1 inch (25 mm).
- 3.5.3 Tensile Properties: When specified, specimens, prepared in accordance with 4.3.1 and tested in accordance with ASTM E 8 or ASTM E 8M, shall have average tensile strength not lower than 90% of the average of the control specimens of 4.3.1. Elongation of the welded specimens shall be not less than 6% in 2 inches (50.8 mm).

3.6 Quality:

Wire, as received by purchaser, shall be uniform in quality and condition, sound, and free from foreign materials and from imperfections detrimental to welding operations, operation of welding equipment, or properties of the deposited weld metal.

- 3.6.1 Surface irregularities inherent with a forming process which does not tear the wire surface are acceptable provided the wire conforms to the tolerances of 3.7.

3.7 Sizes and Tolerances:

Wire shall be supplied in the sizes and to the tolerances shown in 3.7.1 and 3.7.2.

- 3.7.1 Diameter: Shall be as shown in Table 2.

TABLE 2A - Sizes and Diameter Tolerances, Inch/Pound Units

Form	Nominal Diameter Inch	Tolerance Inch Plus and Minus
Cut Lengths	0.030, 0.045	0.001
Cut Lengths	0.052, 0.062, 0.078, 0.094, 0.125, 0.156, 0.188	0.002
Spools	0.007, 0.010, 0.015	0.0005
Spools	0.020, 0.030, 0.035, 0.045	0.001
Spools	0.062, 0.078, 0.094	0.002

TABLE 2B - Sizes and Diameter Tolerances, SI Units

Form	Nominal Diameter Millimeters	Tolerance Millimeter Plus and Minus
Cut Lengths	0.76, 1.14	0.025
Cut Lengths	1.32, 1.57, 1.98, 2.39, 3.18, 3.96, 4.78	0.05
Spools	0.18, 0.25, 0.38	0.013
Spools	0.51, 0.76, 0.89, 1.14	0.025
Spools	1.57, 1.98, 2.39	0.05

- 3.7.2 Length: Cut lengths shall be furnished in 18, 27, or 36-inch (457, 686, or 914-mm) lengths, as ordered, and shall not vary more than +0, -1/2 inch (-13 mm) from the length ordered.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

The vendor of wire 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 wire conforms to specified requirements.

4.2 Classification of Tests:

- 4.2.1 Acceptance Tests: Composition (3.1.1), tensile properties (3.5.3) when specified, sizes and tolerances (3.7), and alloy verification (5.2) are acceptance tests and shall be performed on each heat or lot as applicable.
- 4.2.2 Periodic Tests: Determination of carbon, hydrogen, oxygen, and nitrogen (3.1.1.1), determination of copper (if Type 2) on finished wire (3.1.1.2), weldability (3.5.1), cast (3.5.2.1), and helix (3.5.2.2) are periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

4.3 Sampling and Testing:

Shall be in accordance with AMS 2370 and as specified herein.

- 4.3.1 Tensile Specimens: Shall be obtained from a single-vee-groove, butt-joint weld made between two pieces of AMS 6359 plate, 0.250 inch (6.35 mm) in nominal thickness, chamfered full depth to a 60-degree included angle; the weld shall be perpendicular to the longitudinal grain direction of the test pieces. Samples, prior to machining the tensile specimens, shall be heat treated to a tensile strength not lower than 180 ksi (1241 MPa). After heat treatment, the weld metal shall be finished flush with the parent metal on both faces and standard sheet-type rectangular tensile specimens conforming to ASTM E 8 or ASTM E 8M prepared with the weld in the approximate center of the gage length. The weld area in the location of the test specimens shall be free from defects detrimental to the tensile properties of the weld, determined by radiographic inspection in accordance with ASTM E 1742. Three control standard sheet-type, rectangular tensile specimens shall be machined from AMS 6359 plate, 0.250 inch (6.35 mm) in nominal thickness, from the same heat as that used for the welded specimens, heat treated with the welded specimens, and tested for comparative tensile properties.

4.4 Reports:

The vendor of wire shall furnish with each shipment a report showing the results of tests for chemical composition of each heat and stating that the wire conforms to the other technical requirements. This report shall include the purchase order number, heat and lot numbers, AMS 6456C, nominal size, and quantity.

4.5 Resampling and Retesting:

Shall be in accordance with AMS 2370.

5. PREPARATION FOR DELIVERY:

- 5.1 Wire shall be supplied either on spools in one continuous length for machine welding or in cut lengths for manual welding, as ordered. Wire on each spool or in each package of cut lengths shall be from the same heat of steel.