AEROSPACE MATERIAL SPECIFICATION

AMS6461™	REV. L

Issued	1958-08
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Superseding AMS6461K

Steel, Welding Wire
0.95Cr - 0.20V (0.28 - 0.33C) (SAE 6130)
Vacuum Melted, Environment Controlled Packaging
(Composition similar to UNS K13148)

RATIONALE

AMS6461L is stabilized as mature technology.

STABILIZED NOTICE

AMS6461L has been declared "STABILIZED" by the SAE AMS E Carbon and Low Alloy Steels Committee. This document will no longer be updated and may no longer represent standard industry practice. This document was stabilized because this document contains mature technology that is not expected to change and thus no further revisions are anticipated. Previously this document was reaffirmed as non-current. The last technical update of this document occurred in June 2001. Users of this document should refer to the cognizant engineering organization for disposition of any issues with reports/certifications to this specification; including exceptions listed on the certification.

NOTE: In many cases, the purchaser may represent a sub tier supplier and not the cognizant engineering organization.

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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-tungsten-arc and gas-metal-arc welding of critical weldments of low-alloy steels where the joint is capable of being heat treated to 180 ksi (1241 MPa) minimum tensile strength, 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

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 canceled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

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 6350	Steel Sheet, Strip, and Plate, 0.95Cr - 0.20Mo (0.28 - 0.33C) (SAE 4130)
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.

ASTM D 2650	Chemical Composition of Gasses by Mass Spectroscopy
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 Composition:

Wire 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)	0.28	0.33
Manganese	0.60	0.90
Silicon	0.15	0.35
Phosphorus	--	0.008
Sulfur	--	0.008
Phosphorus + Sulfur	--	0.012
Chromium	0.80	1.10
Vanadium	0.15	0.25
Nickel	--	0.25
Molybdenum	--	0.06
Copper (3.1.1)	--	0.35
Oxygen (3.1.1)	--	0.0025 (25 ppm)
Nitrogen (3.1.1)	--	0.005 (50 ppm)
Hydrogen (3.1.1) (3.1.4)	--	0.0025 (25 ppm)

3.1.1 Shall be determined on finished wire for carbon, and on finished wire for copper if wire is supplied copper clad.

3.1.2 The hydrogen content of the wire shall be determined at final diameter in accordance with ASTM D 2650.

3.1.3 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 the processes used for drawing or rolling, annealing, and cleaning are controlled to ensure continued conformance to requirements.

3.1.4 Check Analysis: Composition variations shall meet the applicable requirements of AMS 2259, except that the limit for phosphorus plus sulfur includes the check analysis tolerance. No variation is permitted for oxygen, nitrogen, and hydrogen.

3.2 Melting Practice:

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

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 that 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 protective atmosphere to avoid surface oxidation and absorption of other extraneous elements.

3.4.3 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.

3.4.4 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 others processed in 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.

3.4.5 Residual elements and dissolved gasses picked up during wire 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 (91.4 mm) length are acceptable provided the exposed wire is clean and bright. The maximum allowable discontinuity size shall be 0.25 inch (6.35 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 (300-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: Specimen, 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 5% 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.

3.7 Sizes and Tolerances:

Wire shall be furnished in the standard 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	0.062, 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 - Standard Diameters and Tolerances, SI Units

Form	Nominal Diameter Millimeters	Tolerance Millimeter Plus and Minus
Cut Lengths	0.76, 1.14	0.025
Cut Lengths	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), 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: Weldability (3.5.1), cast (3.5.2.1), helix (3.5.2.2), and tensile properties (3.5.3) 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.