SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

SAE AMS6459 | REV. E

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Superseding AMS6459D

Steel, Welding Wire
1.0Cr - 1.0Mo - 0.12V (0.18 - 0.23C)
Vacuum Melted

(Composition similar to UNS K22720)

RATIONALE

AMS6459E results from a Five Year Review and update of this specification.

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 weld joint capable of being heat treated to a strength approximating that of the parent metal, but usage is not limited to such applications.

1.3 Classification

Wire supplied to this specification is classified as follows:

Type 1 - Bare
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.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/AMS6459E

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org

AMS2259 Chemical Check Analysis Limits, Wrought Low-Alloy and Carbon Steels

AMS2370 Quality Assurance Sampling and Testing, Carbon and Low-Alloy Steel Wrought Products and Forging Stock

AMS2813 Packaging and Marking of Packages of Welding Wire, Standard Method

AMS2814 Packaging and Marking of Packages of Welding Wire, Premium Quality

AMS2816 Identification, Welding Wire, Tab Marking Method

AMS2819 Identification, Welding Wire, Direct Color Code System

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 International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org

ASTM E 350 Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron

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)	0.18	0.23	
Manganese	0.40	0.60	
Silicon	0.60	0.90	
Phosphorus	--	0.015	
Sulfur	--	0.008	
Chromium	0.80	1.20	
Molybdenum	0.80	1.20	
Vanadium	0.08	0.15	
Copper (3.1.1.2)	--	0.50	
Oxygen (3.1.1.1)	--	0.010	(100 ppm)
Nitrogen (3.1.1.1)	--	0.005	(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, 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 determined periodically on finished wire (See 4.2.2).

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

3.1.2 Check Analysis

Composition variations shall meet the applicable requirements of AMS2259. No variation is permitted for oxygen, nitrogen, and hydrogen.

3.2 Melting Practice

Steel shall be vacuum induction melted or vacuum arc remelted.

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. Surface irregularities inherent with a forming process that do not tear the wire surface are acceptable provided the wire conforms to the tolerance of 3.7

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 materials.

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 Residual material, drawing compounds, oxides, dirt, oil, dissolved gasses and other foreign materials picked up during wire processing that can adversely affect the weld characteristics, the operation of the equipment or the properties of the weld metal shall be removed by cleaning processes that will neither result in pitting nor cause gas absorption by the wire or deposition of substances harmful to welding operations.

3.4.4.1 Residual material 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.

3.4.5 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 determined by a procedure agreed upon by purchase and vendor. The referee method of ARP1876 may be used to resolve weldability disputes.

3.5.2 Spooled Wire

Shall conform to 3.5.2.1, 3.5.2.2 and 3.5.2.3

3.5.2.1 Winding

Filler metal in coils and on spools shall be wound so that kinks, waves, sharp bends, overlapping, or wedging are not encountered, leaving the filler metal free to unwind without restriction. The outside end of the electrode (the end where welding is to begin) shall be identified so it can be located readily and shall be fastened to avoid unwinding. The winding shall be level winding.

3.5.2.2 Cast

Wire, wound on standard diameter spools as shown in Table 2 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 (cast) within the limits shown in Table 2..

3.5.2.3 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 shown in Table 2.

TABLE 2A - CAST AND HELIX REQUIREMENTS - INCH-POUND UNITS

Spool Diameter Inches	Wire Diameter Inches	Cast-Diameter Inches		Helix Inches
		min	max	max
4	All	4	9	0.5
All other	≤0.030	12	n/a	1
	>0.030	15	n/a	1

TABLE 2B - CAST AND HELIX REQUIREMENTS - SI UNITS

Spool Diameter Millimeters	Wire Diameter Millimeters	Cast Millimeters		Helix Millimeters
		min	max	max
102	All	100	230	13
All other	≤0.8	305	n/a	25
	>0.8	380	n/a	25

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 supplied in sizes and to the tolerances shown in 3.7.1 and 3.7.2.

3.7.1 Diameter

Shall be as shown in Table 3.

TABLE 3A - 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 3B - 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	1.31, 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, -l/2 inch (+0, -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), 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, oxygen, nitrogen, and hydrogen (3.1.1.1) and of copper on finished wire (3.1.1.2), weldability (3.5.1), cast (3.5.2.2), and helix (3.5.2.3) 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 AMS2370 and as specified herein.