



AEROSPACE MATERIAL SPECIFICATION

AMS6469™**REV. E**

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Superseding AMS6469D

Steel, Welding Wire
1.75Mn - 0.78Cr - 2.8Ni - 0.85Mo - (0.09 - 0.12C)
Vacuum Melted, Environment-Controlled Packaging

RATIONALE

AMS6469E is stabilized as mature technology.

STABILIZED NOTICE

AMS6469E 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 This document will no longer be updated and may no longer represent standard industry practice.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 January 2003. 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 low-alloy steels of similar composition where the weld area is required to have strength and notch-toughness comparable to that of the parent metal without the need for post-weld heat treatment, 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.

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
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 A 370 Mechanical Testing of Steel Products
 ASTM D 2650 Chemical Composition of Gases by Mass Spectrometry
 ASTM E 350 Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron
 ASTM E 1742 Radiographic Examination

2.3 U.S. Government Publications:

Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-S-24371 Steel Plate, Structural, High Yield Strength (HY-130)

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)	0.09	0.12
Manganese	1.50	2.00
Silicon	0.30	0.50
Phosphorus	--	0.008
Sulfur	--	0.008
Chromium	0.65	0.90
Nickel	2.60	3.10
Molybdenum	0.70	1.00
Titanium	--	0.04
Aluminum	--	0.04
Copper (3.1.1.2)	--	0.15
Vanadium	--	0.04
Oxygen (3.1.1.1)	--	0.0100 (100 ppm)
Nitrogen (3.1.1.1)	--	0.0050 (50 ppm)
Hydrogen (3.1.1.1)	--	0.0003 (3 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 periodically determined on finished wire (See 4.2.2).
- 3.1.1.1.1 The hydrogen content of the wire shall be determined in accordance with ASTM D 2650.
- 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. No variation over maximum is permitted for oxygen, nitrogen, and hydrogen.
- 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 is 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).

3.6 Mechanical Properties:

When wire is deposited on parent metal conforming to MIL-S-24371, an all-weld-metal specimen prepared by gas-metal-arc (GMAW) process and tested in accordance with 4.3.1 shall conform to the requirements of Table 2.

TABLE 2 - Mechanical Properties

Property	Value
Yield Strength at 0.2% Offset	135 to 150 ksi (931 to 1034 MPa)
Elongation in 2 Inches (50.8 mm), minimum	14%
Charpy V-Notch Impact Energy, Minimum Average (See 3.6.2 and 3.6.3)	
At 30 °F (-1 °C)	50 foot-pounds (68 J)
At 75 °F (24 °C)	50 foot-pounds (68 J)

- 3.6.1 Tensile strength and reduction of area shall be recorded for information only.
- 3.6.2 For each testing temperature, the average values, computed from the three middle tests of five tests run, shall be equal to or greater than the minimum average value specified. Only one specimen may show an impact value below the minimum average specified and that value shall be no more than 10 foot-pounds (13.6 J) below the specified minimum average.

3.6.3 The average impact value obtained at 75 °F (24 °C) shall be not more than 10 foot-pounds (13.6 J) higher than the average value obtained at 30 °F (-1 °C).

3.7 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.

3.7.1 Surface irregularities inherent with a forming process which does not tear the wire surface are acceptable provided the wire conforms to the tolerances of 3.8.

3.8 Sizes and Tolerances:

Wire shall be supplied in sizes and to the tolerances shown in 3.8.1 and 3.8.2.

3.8.1 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

3.8.2 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, -½ 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), sizes and tolerances (3.8), 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 on finished wire (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), helix (3.5.2.2), and mechanical properties (3.6) 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 Mechanical Property Specimens: Shall be obtained from a single-vee-groove, butt-joint weld made between two pieces of MIL-S-24371 plate, 0.40 inch (10.2 mm) minimum thickness, chamfered full depth to a 60-degree included angle. The weld shall be perpendicular to the longitudinal grain direction of the test pieces. The weld metal shall be deposited by the gas-metal-arc-weld (GMAW) process without subsequent heat treatment. Standard sheet-type rectangular tensile specimens conforming to ASTM A 370 shall be prepared with the weld in the approximate center of the gage length. For impact specimens, specimens shall conform to ASTM A 370 with the notch located in the approximate center of the weld and in the thickness direction of the plate. The weld area in the location of the test specimens shall be free from defects detrimental to the properties of the weld, determined by radiographic inspection in accordance with ASTM E 1742. Tests shall be in accordance with ASTM A 370. Not less than five of each type of specimen shall be tested.

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 6469E, nominal size, and quantity.

4.5 Resampling and Retesting:

Shall be in accordance with AMS 2370.