SAE The Engineering Resource For Advancing Mobility
400 COMMONWEALTH DRIVE WARRENDALE, PA 15096

AEROSPACE MATERIAL SPECIFICATION

AMS 6465A
Superseding AMS 6465

Issued 9-15-75
Revised 10-1-83

STEEL WELDING WIRE
2.0Cr - 10Ni - 8.0Co - 1.0Mo - 0.02Al - 0.06V (0.10 - 0.14C)
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: Primarily for use as filler metal for gas-tungsten-arc and gas-metal-arc welding of steels of similar composition which may be heat treated after welding.

1.2.1 Welds, properly deposited using the gas-tungsten-arc process with heat input controls, should provide not less than 180,000 psi (1240 MPa) tensile yield strength in the as-deposited condition. Aging should not be required to achieve this strength; however, properties can be improved by heating to 950°F ± 10 (510°C ± 5), holding at heat for not less than 5 hr for sections 2.0 in. (50 mm) and under in nominal thickness and for 10 hr +0.5, -0, for thicker sections, and cooling in air.

1.2.2 Welds deposited by the gas-metal-arc welding process may not exhibit properties shown in 1.2.1 unless supplementary gas shielding is used.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications (AMS) shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2248 - Chemical Check Analysis Limits, Wrought Corrosion and Heat Resistant Steels and Alloys, Maraging and Other Highly-Alloyed Steels, and Iron Alloys
AMS 2350 - Standards and Test Methods
AMS 2370 - Quality Assurance Sampling of Carbon and Low-Alloy Steels, Wrought Products Except Forgings and Forging Stock
AMS 2635 - Radiographic Inspection
AMS 2814 - Packaging of Welding Wire, Premium Quality
AMS 2815 - Identification, Welding Wire, Line Code System
AMS 2816 - Identification, Welding Wire, Color Code System
AMS 6543 - Steel Bars, Forgings, and Forged Billet, 2.0Cr - 10Ni - 8.0Co - 1.0Mo (0.10 - 0.14C), Vacuum Melted, Solution Heat Treated
AMS 6544 - Steel Plate, 2.0Cr - 10Ni - 8.0Co - 1.0Mo (0.10 - 0.14C) Vacuum Melted, Solution Heat Treated

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM E8 - Tension Testing of Metallic Materials
ASTM E23 - Notched Bar Impact Testing of Metallic Materials
ASTM E353 - Chemical Analysis of Stainless, Heat-Resisting, Maraging, and Other Similar Chromium-Nickel-Iron Alloys

2.3 U.S. Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

2.3.1 Federal Standards:

Federal Test Method Standard No. 151 - Metals; Test Methods

3. TECHNICAL REQUIREMENTS:

3.1 Composition: Shall conform to the following percentages by weight, determined by wet chemical methods in accordance with ASTM E353, by spectrographic methods in accordance with Federal Test Method Standard No. 151, Method 112, or by other analytical methods approved by purchaser:

	min	max
Carbon	0.10 -	0.14
Manganese	0.07 -	0.17
Silicon	0.15 -	0.25
Phosphorus	--	0.006
Sulfur	--	0.006
Chromium	1.80 -	2.20
Nickel	9.50 -	10.50
Cobalt	7.50 -	8.50
Molybdenum	0.90 -	1.10
Aluminum	0.01 -	0.03
Vanadium	0.04 -	0.09
Titanium	--	0.02
Oxygen	--	0.0025 (25 ppm)
Nitrogen	--	0.005 (50 ppm)
Hydrogen	--	0.0003 (3 ppm)

3.1.1 Check Analysis: Composition variations shall meet the applicable Ø requirements of AMS 2248. No variation is permitted for oxygen, nitrogen, and hydrogen.

3.2 Condition: Cold finished, bright finish, and stress-relieved in a temper which will provide proper feeding of the wire in machine welding equipment.

3.2.1 Wire shall be furnished on disposable spools for machine welding and in cut lengths for manual welding, as ordered. Surface texture of spooled wire shall be as agreed upon by purchaser and vendor.

3.2.2 Drawing compounds, oxides, and dirt 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.

3.2.3 Residual elements and dissolved gasses deposited on, or absorbed by, the welding wire as a result of cleaning or drawing operations shall be removed by vacuum degassing. Annealing, if required, shall be performed in vacuum or inert gas atmosphere.

3.3 Properties: Wire shall conform to the following requirements:

3.3.1 Weldability: Melted wire shall flow smoothly and evenly during welding and shall produce acceptable welds, determined by a procedure agreed upon by purchaser and vendor.

3.3.2 Spooled Wire: Shall conform to 3.3.2.1 and 3.3.2.2, unless otherwise agreed upon by purchaser and vendor.

3.3.2.1 Cast: Wire wound on standard 12-in. (300-mm) diameter spools shall have imparted to it a curvature such that a specimen sufficient in length (4 - 8 ft (1200 - 2400 mm)) to form one loop, when cut from the spool and laid on a flat surface, shall form a circle not less than 15 in. (375 mm) and not greater than 30 in. (750 mm) in diameter.

3.3.2.2 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 in. (25 mm).

3.3.3 Mechanical Properties:

3.3.3.1 Tensile Properties: Specimens, prepared in accordance with 4.3.2 and tested in accordance with ASTM E8, shall have average tensile and yield strengths not lower than 90% of the average of the control specimens of 4.3.2; elongation of the welded specimens shall be not less than 15% in 2.0 in. (50 mm).

3.3.3.2 Impact Properties: Charpy V-Notch specimens, prepared in accordance with 4.3.3 and tested at 0°F (-18°C) in accordance with ASTM E23, shall have average impact strength not lower than 60 ft-lb (80 J).

3.4 Quality:

3.4.1 Steel shall be vacuum induction melted; it may be remelted using vacuum consumable electrode process but remelting is not required.

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

3.5 Sizes and Tolerances: Unless otherwise specified, wire shall be supplied in the sizes and to the tolerances shown in 3.5.1 and 3.5.2.

3.5.1 Diameter:

TABLE I

Form	Nominal Diameter Inch	Tolerance, Inch plus	Tolerance, Inch minus
Cut Lengths	0.094, 0.125, 0.156, 0.188	0.003	0.003
Cut Lengths	0.030, 0.045, 0.062, 0.078	0.002	0.002
Spools	0.062, 0.078, 0.094	0.002	0.002
Spools	0.030, 0.035, 0.045	0.001	0.002
Spools	0.007, 0.010, 0.015, 0.020	0.0005	0.0005

TABLE I (SI)

Form	Nominal Diameter Millimetres	Tolerance, Millimetre plus	minus
Cut Lengths	2.35, 3.10, 4.00, 4.75	0.08	0.08
Cut Lengths	0.75, 1.15, 1.55, 2.00	0.05	0.05
Spools	1.55, 2.00, 2.35	0.05	0.05
Spools	0.75, 0.90, 1.15	0.03	0.05
Spools	0.20, 0.25, 0.40, 0.50	0.015	0.015

3.5.2 Length: Cut lengths shall be furnished in 18, 27, or 36 in. (450, 675, or 900 mm) lengths, as ordered, and shall not vary more than +0, -0.5 in. (-12 mm) from the length ordered.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of wire shall supply all samples Ø for vendor's tests and shall be responsible for performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.4. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the wire conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests to determine conformance to requirements for Ø composition (3.1) and tolerances (3.5) are classified as acceptance tests and shall be performed on each heat or lot as applicable.

4.2.2 Periodic Tests: Tests to determine conformance to requirements for Ø weldability (3.3.1), cast (3.3.2.1), helix (3.3.2.2), and mechanical properties (3.3.3) are classified as periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

4.3 Sampling: Shall be in accordance with AMS 2370 and the following; when steel Ø is vacuum consumable electrode remelted, a heat shall be the consumable electrode remelted ingots produced from steel originally melted as a single furnace charge:

4.3.1 Samples for composition (3.1) shall be taken from a vacuum induction melted ingot.

4.3.2 Specimens for tensile property testing shall be obtained from a single-vee-groove, butt-joint weld made between two pieces of AMS 6543 bar or AMS 6544 plate nominally 0.500 in. (12.50 mm) thick, chamfered full depth to a 40 deg included angle; the weld shall be perpendicular to the longitudinal grain direction of the test pieces. The test pieces shall be of sufficient size to permit cutting six transverse weld tensile specimens to the configuration of Fig. 1. The specimens, prior to the welding, shall be aged by heating to 950°F ± 10 (510°C ± 5), holding at heat for not less than 5 hr, and cooling in air. The specimens shall be machined on both faces to 0.375 in. ± 0.010 (9.50 mm ± 0.25) thick, centered on the original thickness. The weld in the specimen shall be free from defects detrimental to the tensile properties of the weld, determined by radiographic inspection in accordance with AMS 2635. Three control tensile specimens shall be machined to the configuration of Fig. 1 from 0.500 in. (12.50 mm) thick bar or plate of the same heat as that used for the welded specimens and aged with the weld specimens. All weld specimens shall be tested in the as-welded condition.

4.3.3 Five Charpy V-Notch specimens shall be taken transverse to the weld joint from panels prepared as in 4.3.2. Preparation and testing shall be in accordance with ASTM E23. The specimens shall be located approximately 0.125 in. (3.12 mm) from the top surface of the weld. The V-notch shall be centered in the weld metal with the line of the notch root perpendicular to the plane of the surface of the panel. Either three (the lowest and highest values may be disregarded) or five tests shall be used to determine the average.

4.4 Reports:

4.4.1 The vendor of wire shall furnish with each shipment three copies of a report showing the results of tests for chemical composition of each heat and stating that the wire conforms to the other technical requirements of this specification. This report shall include the purchase order number, heat number, AMS 6465A, nominal size, and quantity from each heat.

4.4.2 When parts made of this wire or assemblies requiring use of this welding wire are supplied, the part or assembly manufacturer shall inspect each lot of wire to determine conformance to the requirements of this specification and shall furnish with each shipment three copies of a report stating that the wire conforms. This report shall include the purchase order number, AMS 6465A, part or assembly number, and quantity.

4.5 Resampling and Retesting: Shall be in accordance with AMS 2370.

5. PREPARATION FOR DELIVERY:

5.1 Layer Winding: Wire furnished on spools shall be closely wound in layers but Ø adjacent turns within a layer need not necessarily be touching; shall be wound so as to avoid producing kinks, waves, and sharp bends; and shall be free to unwind without restriction caused by overlapping or wedging. The outside end of the spooled wire shall be so treated that it may be readily located. An 8-in. (200-mm) length of wire shall be made accessible at both ends of each spool for alloy verification.

5.2 Heat: Wire on each spool shall be of one continuous length from the same heat of steel. No package of cut lengths shall contain wire from more than one heat of steel.

5.3 Identification: Wire shall be identified in accordance with AMS 2815 unless identification in accordance with AMS 2816 is specified by purchaser. Tab marking of cut lengths is permissible.

5.3.1 Alloy verification shall be performed by a method agreed upon by purchaser Ø and vendor.

5.4 Packaging and Marking: Shall be in accordance with AMS 2814.

6. ACKNOWLEDGMENT: A vendor shall mention this specification number and its revision letter in all quotations and when acknowledging purchase orders.

7. REJECTIONS: Wire not conforming to this specification or to modifications authorized by purchaser will be subject to rejection.

8. NOTES:

8.1 Marginal Indicia: The phi (Ø) symbol is used to indicate technical changes from the previous issue of this specification.

8.2 For direct U.S. Military procurement, purchase documents should specify not less than the following:

Title, number, and date of this specification
Size and form (spools or cut lengths) of wire desired
Length of cut lengths or weight of spools desired
Quantity of wire desired
Method of test and acceptance standards for weldability (See 3.3.1)
Method for alloy verification (5.3.1)
Applicable level of packaging (See AMS 2814)

8.3 Wire meeting the requirements of this specification has been classified under Federal Supply Classification (FSC) 3439.

This specification is under the jurisdiction of AMS Committee "E".