

STEEL WELDING WIRE

1.0Cr - 10Ni - 3.8Co - 0.45Mo - 0.08V (0.14 - 0.17C)
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 low-alloy steels having similar composition and requiring a combination of high strength and high notch toughness without the need for post-weld heat treatment.

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 6523 - Steel Sheet, Strip, and Plate, 0.75Cr - 9.0Ni - 4.5Co - 1.0Mo - 0.09V (0.17 - 0.23C), Premium Quality, Consumable Electrode Melted, Annealed

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

ASTM E350 - Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron

ASTM E399 - Plane-Strain Fracture Toughness of Metallic Materials

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 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 E350, by spectrographic methods in accordance with Federal Test Method Standard No. 151, Method 112, or by other analytical methods approved by purchaser:

	min	max	Target Maxima
Carbon	0.14	0.17	--
Manganese	0.40	0.55	--
Silicon	0.15	0.25	--
Phosphorus	--	0.008	0.006
Sulfur	--	0.008	0.005
Chromium	0.90	1.05	--
Nickel	9.75	10.25	--
Cobalt	3.50	4.00	--
Molybdenum	0.40	0.50	--
Vanadium	0.06	0.10	--
Copper	--	0.10	--
Oxygen	--	0.0050 (50 ppm)	25 ppm
Nitrogen	--	0.0080 (80 ppm)	50 ppm
Hydrogen	--	0.0010 (10 ppm)	5 ppm

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

3.2 Condition: Cold finished, bright finish, 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 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 in an inert gas atmosphere.
- 3.2.4 Environment shall be controlled during manufacture, shipping, and storage so as to prevent contamination or corrosion of the wire and to help maintain target maxima limits as in 3.1.
- 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 \emptyset 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 Fracture-Toughness: When specified by purchaser, or when composition (3.1) is in excess of target maximum for any element, test specimens prepared as in 4.3.2.1 shall be subjected to fracture-toughness testing. The method of testing and standards for acceptance shall be as agreed upon by purchaser and vendor. ASTM E399, using the compact tension specimen, is a suggested method of testing.
- 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.

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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:

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TABLE I

Form	Nominal Diameter Inch	Tolerance, Inch	
		plus	minus
Cut Lengths	0.094, 0.125, 0.156, 0.180	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 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 4.5. 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 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 weldability (3.3.1), cast (3.3.2.1), helix (3.3.2.2), and, when specified by purchaser, fracture-toughness (3.3.3) are classified as periodic tests shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.
- 4.2.3 Preproduction Tests: Tests to determine conformance to all technical requirements of this specification are classified as preproduction tests and shall be performed prior to or on the initial shipment of wire to a purchaser, when a change in material or processing, or both, requires reapproval as in 4.4.2, and when purchaser deems confirmatory testing to be required.
- 4.2.3.1 For direct U.S. Military procurement, substantiating test data and, when requested, preproduction test material shall be submitted to the cognizant agency as directed by the procuring activity, the contracting officer, or the request for procurement.
- 4.3 Sampling: Shall be in accordance with the following; when steel 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 For Acceptance Tests: AMS 2370.
- 4.3.2 For Periodic Tests and Preproduction Tests: As agreed upon by purchaser and vendor and as follows:
- 4.3.2.1 Specimens for fracture toughness testing shall be prepared from a double-vee-groove, butt-joint weld made between two pieces of AMS 6523 steel plate, 1.00 - 1.25 in. (25 - 31 mm) in thickness, which have been chamfered full depth to a 60 deg included angle; the weld shall be perpendicular to the longitudinal grain direction of the test pieces. The weld metal shall be finished flush with the parent metal on both faces. The weld area in the location from which the test specimens are machined shall be free from defects detrimental to properties of the weld, determined by radiographic inspection in accordance with AMS 2635. The number and configuration of test specimens for fracture toughness testing shall be as agreed upon by purchaser and vendor.
- 4.4 Approval:
- 4.4.1 Sample wire shall be approved by purchaser before wire for production use is supplied, unless such approval be waived by purchaser. Results of tests on production wire shall be essentially equivalent to those on the approved sample.