

INCH-POUND

MIL-E-21562E(SH)

24 March 1989

SUPERSEDING

MIL-E-21562D(SHIPS)

25 May 1972

(See 6.6)

MILITARY SPECIFICATION

ELECTRODES AND RODS - WELDING, BARE, NICKEL ALLOY

This specification is approved for use by the Naval Sea Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers nickel, nickel alloy and copper-nickel alloy bare welding electrodes and rods for use with the submerged arc (when used with a neutral flux), gas metal-arc (GMA) and gas tungsten-arc (GTA) welding processes.

1.2 Classification. Electrodes and rods shall be furnished in the following classes, types and sizes as specified (see 6.2).

Class 1 - Wound bare electrode (wire form) (see table I for types and sizes).

1a - 25 pound spool weight.

1b - 2 pound spool weight (furnished in 0.035 inch only.)

1c - 100 pound drum weight.

1d - 200 pound drum weight.

1e - 300 pound drum weight.

1f - 400 pound drum weight.

1g - 500 pound drum weight.

1h - 600 pound drum weight.

1i - 700 pound drum weight.

Class 2 - Cut length rods (see table II for types and sizes).

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Sea Systems Command, SEA 55Z3, Department of the Navy, Washington, DC 20362-5101 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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TABLE I. Electrodes, class 1, types and sizes.

Types	Alloy	Diameter size (inch)
MIL-EN60	Ni-Cu	0.035, 0.045, 0.062
MIL-EN61	Ni	
MIL-EN62	Ni-Cr-Fe	
MIL-EN64	Ni-Cu-Al	
MIL-EN67	Cu-Ni (70-30)	
MIL-EN6A	Ni-Cr-Fe-Ti-Mn	
MIL-EN82	Ni-Cr-Mn-Cb	
MIL-EN82H	Ni-Cr-Mn-Cb	
MIL-EN6N	Ni-Cr (80-20)	
MIL-EN625	Ni-Cr-Mo-Cb	

TABLE II. Rods, class 2, types and sizes.

Types	Alloy	Diameter size (inch)
MIL-RN60	Ni-Cu	0.035, 0.045, 1/16, 5/64, 3/32, 1/8, 5/32, 3/16, 1/4
MIL-RN61	Ni	
MIL-RN62	Ni-Cr-Fe	
MIL-RN64	Ni-Cu-Al	
MIL-RN65	Ni-Fe-Cr-Mo-Cu	
MIL-RN67	Cu-Ni (70-30)	
MIL-RN69	Ni-Cr-Fe-Ti-Al-Cb	
MIL-RN6A	Ni-Cr-Fe-Ti-Mn	
MIL-RN82	Ni-Cr-Mn-Cb	
MIL-RN82H	Ni-Cr-Mn-Cb	
MIL-RN6N	Ni-Cr (80-20)	
MIL-RN625	Ni-Cr-Mo-Cb	

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications and standards. The following specifications and standards form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

FEDERAL

PPP-F-320 - Fiberboard; Corrugated and Solid, Sheet Stock (Container Grade), and Cut Shapes.

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- MIL-W-10430 - Welding Rods and Electrodes; Preparation for Delivery of.
- MIL-A-18455 - Argon, Technical.
- MIL-L-19140 - Lumber and Plywood, Fire-Retardant Treated.
- MIL-I-45208 - Inspection System Requirements.

STANDARDS

MILITARY

- MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
- MIL-STD-271 - Requirements for Nondestructive Testing Methods.

(Unless otherwise indicated, copies of federal and military specifications and standards are available from the Naval Publications and Forms Center, (ATTN: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

2.1.2 Other Government publication. The following other Government publication forms a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

PUBLICATION

NAVAL SEA SYSTEMS COMMAND (NAVSEA)

- 0900-LP-003-9000 - Radiographic Standards for Production and Repair Welds.

(Application for copies should be addressed to the Naval Publications and Forms Center, (ATTN: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DoDISS cited in the solicitation. Unless otherwise specified, the issues of the documents not listed in the DoDISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN IRON AND STEEL INSTITUTE (AISI)

Steel Products Manual

(Application for copies should be addressed to the American Iron and Steel Institute, 1000 16th St. NW, Washington, DC 20036.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- B 167 - Standard Specification for Nickel-Chromium-Iron Alloys (UNS N06600 and N06690) Seamless Pipe and Tube. (DoD adopted)
- B 168 - Standard Specification for Nickel-Chromium-Iron Alloys (UNS N06600 and N06690) Plate, Sheet, and Strip. (DoD adopted)

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ASTM (Continued)

E 354 - Standard Methods for Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt Alloys.

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

AMERICAN WELDING SOCIETY (AWS)

B4.0 - Standard Methods for Mechanical Testing of Welds.
(DoD adopted)

(Application for copies should be addressed to the American Welding Society, Inc., 550 NW LeJeune Road, P.O. Box 351040, Miami, FL 33135.)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Qualification. The electrodes and rods furnished under this specification shall be products which are authorized by the qualifying activity for listing on the applicable qualified products list at the time of award of contract (see 4.3 and 6.4).

3.2 Recovered materials. Unless otherwise specified herein, all equipment, material, and articles incorporated in the products covered by this specification shall be new and may be fabricated using materials produced from recovered materials to the maximum extent practicable without jeopardizing the intended use. The term "recovered materials" means materials which have been collected or recovered from solid waste and reprocessed to become a source of raw materials, as opposed to virgin raw materials. None of the above shall be interpreted to mean that the use of used or rebuilt products is allowed under this specification unless otherwise specifically specified.

3.3 General requirements.

3.3.1 Finish. Electrodes and rods shall have a clean finish, free from slivers, depressions, scratches, scale or contaminants such as oil or preservatives that would adversely affect the welding characteristics or the operation of the equipment.

3.3.2 Chemical composition. The chemical composition of bare electrodes (wire form) and rods shall be as specified in table III.

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TABLE III. Chemical composition percent of electrodes and rods. 1/2/

Types MIL-	Carbon ^{6/} Percent	Manga- nese ^{6/} Percent	Iron Percent	Sulfur ^{3/} Percent	Silicon Percent	Copper Percent	Nickel plus cobalt Percent	Alumi- num Percent	Titanium Percent	Chromium Percent	Columbium plus tantalum Percent	Molyb- denum Percent	Phosphorus Percent	Lead Percent	Other elements total ^{4/} Percent
EN60; RN60	.15	4.00	2.50	0.015	1.25	Balance	62.0 to 69.0	1.25	1.5 to 3.0	---	---	---	0.020	0.010	0.50
EN61; RN61	.15	1.00	1.00	.015	0.75	0.25	93.0 minimum	1.50	2.0 to 3.5	---	---	---	.030	.010	.50
EN62; RN62	.08	1.00	6.0 to 10.0	.015	.35	.50	70.0 minimum	---	---	14.0 to 17.0	5/1.5 to 3.0	---	.030	.010	1.0
EN64; RN64	.25	1.50	2.00	.015	1.00	Balance	63.0 to 70.0	2.0 to 4.0	0.25 to 1.00	---	---	---	.030	.010	0.50
EN65	.05	1.00	22.0 minimum	.03	0.50	1.5 to 3.0	38.0 to 46.0	0.20	0.60 to 1.2	19.5 to 23.5	---	2.5 to 3.5	.030	.010	.50
EN67; RN67	.04	1.00	0.4 to 0.7	.015	.25	Balance	29.0 to 32.0	---	0.2 to 0.5	---	---	---	.020	.010	.50
EN69	.08	1.00	5.0 to 9.0	.015	.50	0.50	70.0 minimum	0.4 to 1.0	2.00 to 2.75	14.0 to 17.0	0.70 to 1.20	---	.030	.010	.50
EN6A; RN6A	.08	2.00 to 2.75	8.00	.015	.35	.50	67.0 minimum	---	2.5 to 3.5	14.0 to 17.0	---	---	.030	.010	.50
EN82; RN82	.10	2.50 to 3.50	3.00	.015	.50	.50	67.0 minimum	---	0.75	18.0 to 22.0	5/2.0 to 3.0	---	.030	.010	.50
EN82H; RN82H	.30 to 0.10	2.50 to 3.50	3.00	.015	.50	.50	67.0 minimum	---	0.75	18.0 to 22.0	5/2.0 to 3.0	---	.030	.010	.50
EN6N; RN6N	.08 to 0.15	1.00	2.00	.015	.30	.50	75.0 minimum	0.40	0.15 to 0.50	19.0 to 21.0	---	---	.030	.010	.50
EN625; RN625	.10	0.50	5.00	.015	.50	1.00	58.0 minimum	.40	.40	20.0 to 23.0	3.15 to 4.15	8.0 to 10.0	.020	.010	.50

See footnotes at top of next page.

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- 1/ Analysis shall be made for the elements for which specific values are shown. If, however, the presence of other elements is indicated in the course of routine analysis, further analysis shall be made to determine that the total of these other elements is not present in excess of the limits specified for "other elements, total".
- 2/ Single values shown are maximum percentages, except where otherwise specified.
- 3/ When specified (see 6.2), sulfur shall not exceed 0.007 percent.
- 4/ Includes lead, tin, and zinc.
- 5/ Tantalum shall not exceed 0.30 percent.
- 6/ When specified (see 6.2), a minimum carbon content shall be required.

3.3.3 Mechanical properties. The deposited weld metal shall exhibit mechanical properties specified in table IV.

TABLE IV. Mechanical properties of welds.

Types MIL-	Tensile <u>1/5/</u> strength	Elonga- tion in 4X dia.	Ductility (full capacity of jig)	Fissures per bend specimen
	lb/in ² minimum	Percent minimum		
EN60;RN60	70,000	30	Side bends (2)	<u>4/</u>
EN61;RN61	60,000	20	----	<u>4/</u>
EN62;RN62	80,000	30	Side bends (2)	
EN64;RN64	<u>2/</u> 100,000	15	----	
RN65	80,000	25	----	
EN67;RN67	50,000	30	Side bends (2)	<u>4/</u>
RN69	<u>3/</u> 125,000	5	----	
EN6A;RN6A	80,000	30	Side bends (2)	<u>4/</u>
EN82;RN82	80,000	30	Side bends (2)	<u>4/</u>
EN82H;RN82H	80,000	30	Side bends (2)	<u>4/</u>
EN6N;RN6N	80,000	20	----	
EN625;RN625	110,000	30	Side bends (2)	<u>4/</u>

- 1/ As welded properties.
- 2/ Charge welded plate into a furnace which has been preheated to 1450 degrees Fahrenheit (°F), bring to a steady state and hold at temperature for 30 minutes and air cool or water quench. Age harden at 1100 ± 25°F for 16 hours and furnace at approximately 25°F per hour down to 900°F and air cool to room temperature.
- 3/ Stress relief at 1800 ± 25°F for 30 minutes. Age harden at 1300°F for 20 hours and air cool to room temperature.
- 4/ The presence in either specimen of (a) a single tear, fissure, crack or non-metallic having a dimension larger than 3/32 inch measured in any direction, or (b) more than one fissure from 1/16 inch to 3/32 inch, inclusive, measured in any direction, or (c) more than six fissures visible to the unaided eye 1/16 inch or less measured in any direction, (d) more than six fissures total, all sizes, visible to the unaided eye shall be cause for rejection.
- 5/ Two-tenths percent offset yield strength shall be reported for information.

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3.3.4 Soundness. The groove welds shall meet the requirements in accordance with class I of NAVSEA 0900-LP-003-9000.

3.3.5 Alloy identity. Each end of wire to be spliced during processing shall be sampled for alloy identity (see 4.6.4), except when splicing is done to repair a wire break without removing the wire from the process line. The sample shall be tested for alloy identity prior to release for shipment.

3.3.5.1 Ends of the coil. Both ends of each coil, drawn to finish size, shall be tested for alloy identity (see 4.6.4) before rewinding, spooling, or straightening and cutting into rods or electrodes.

3.3.5.1.1 Continuous process operation. For continuous process operation where rod coil is drawn to finish size, straightened and cut to length without removal from the machine, both ends of each rod coil shall be sampled for alloy identity test immediately prior to the start of the continuous processing operation. The sample shall be tested for alloy identity prior to release for shipment.

3.3.5.1.2 Spliced rod coils. When rod coils are to be spliced during continuous processing operations, each end of each rod coil to be spliced shall be alloy identity sampled just prior to splicing. The sample shall be alloy identity tested prior to release for shipment. In addition, the leading end of the first coil and the tail end of the last coil for each continuous process run shall be alloy identity tested. When alloy identity testing is accomplished in accordance with 3.3.5.1.1, these requirements are met as well.

3.3.5.2 Marking after tests. When specified (see 6.2), each electrode or rod shall be tested for alloy identity in accordance with 4.6.4 after final marking (see 5.2). Identification marking of each spool, coil, or container of electrodes, or rods tested after final marking and meeting the acceptance criteria of 4.6.4 shall include the words "ALLOY TESTED".

3.4 Class 1 - wound electrode.

3.4.1 Tolerance (diameter size). Wound electrode shall not vary from the nominal diameter by more than plus 0.001 inch, minus 0.002 inch.

3.4.2 Weight of wound electrode. The nominal net weight of wound electrode shall be as follows:

Class 1a - 25 pounds, plus or minus 20 percent. (Up to 20 percent of any lot of spools may contain 12 to 20 pounds net weight.)

Class 1b - 2 pounds, plus or minus 10 percent.

Class 1c through 1i - 100 to 700 pounds (see 6.2).

3.4.3 Winding. Each spool shall contain electrode of one continuous length made from a single heat of material. The electrode shall be closely wound in layers so as to avoid producing kinks, waves or sharp bends, and shall be free to unwind without restriction caused by overlapping or wedging. The outside end of wound electrode shall be securely fastened at a readily located point. The starting end of spooled and coiled electrode shall be firmly fastened so that it is readily visible to the welder or welding operator, and both ends of the electrode shall be accessible for inspection purposes.

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3.4.4 Cast and helix - class 1a.

3.4.4.1 Cast. Sufficient electrode wire shall be taken from the spool to form one complete circle. This wire, when laid on a flat surface, shall form a circle not less than 15 inches and not greater than 50 inches in diameter.

3.4.4.2 Helix. The electrode shall not exhibit a tendency toward spiraling that interferes with welding performance. The vertical separation between turns of the released specimen as specified in 3.4.4.1 shall not exceed 1 inch.

3.4.5 Temper - class 1b. The electrode shall possess a temper that assures uniform feeding in welding equipment.

3.4.6 Electrode identification. MIL-type, size, lot or control number and date of processing (cleaning and spooling) shall be shown on the spool flange exposed to view when loaded in the equipment.

3.4.7 Cast and helix - classes 1c through 1i. The wire shall be suitable for uniform, uninterrupted feeding in automatic and semi-automatic welding equipment.

3.5 Class 2 - cut length rods.

3.5.1 Tolerance (diameter size). Rods shall not vary from the nominal diameter by more than plus 0.002 inch, minus 0.003 inch.

3.5.2 Length. The length of rods shall be 12, 18 or 36 inches, plus 0, minus 1/2 inch as specified (see 6.2). In the case of 36-inch rods, up to 10 percent of rods in any one container may be shorter than 36 inches, but not shorter than 24 inches.

3.5.3 Identification. Cut-length rods shall be identified by positive and legible methods such as imprinting or indenting the applicable type designation number (see table II) at one or more locations on the rod surface approximately 1 inch from rod end, or shall be identified by pressure-sensitive, plastic-coated tape imprinted with applicable type number at one or more locations and attached to the rod 1 inch from its end. Imprints on rods or on tape shall be with fade-proof ink and shall be resistant to oils, solvents and all atmospheric conditions and to normal wear and tear encountered in shipping and handling. The MIL-type, size, lot or control number and date of processing shall be marked on interior packages (see 5.2).

3.5.4 Production equipment inspection. When a change is made in a production run of one MIL-type rod to another, inspection shall be performed prior to starting the new run to assure that equipment and process lines are purged of material from the previous production run. This inspection shall be performed for all equipment used in manufacturing operations where the material is not segregated and positively identified, for example, cutting to length.

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4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items must meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program (see 6.3). The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of assuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of the manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.2 Classification of inspections. The inspection requirements specified herein are classified as follows:

- (a) Qualification inspection (see 4.3).
- (b) Quality conformance inspection (see 4.5).

4.3 Qualification inspection. Qualification inspection shall be conducted at a laboratory satisfactory to the Naval Sea Systems Command (NAVSEA). Qualification inspection shall consist of the examinations specified in 4.5.1 and the tests specified in table V. The contractor shall provide and maintain an inspection system acceptable to the Government for supplies and services covered by this specification. The inspection system shall be in accordance with MIL-I-45208.

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TABLE V. Summary of required tests.

Type MIL-	Class	Size	Test procedures	Qualification tests							Require- ments	
				Cast	Helix	Radio- graphic	Ten- sile	Bend (see note 1)	Chemical	Metallur- gical		Alloy identity
All	All	All	4.6.4.1 4.6.4.2	---	---	---	---	---	---	---	---	3.3.5; 3.3.5.1
All	1a and 1c thru 1i	See 4.3	3.4.4	X	---	---	---	---	---	---	---	3.4.4.1; 3.4.4.2
All	1a and 1c thru 1i	See 4.3	Figure 1 and notes	---	---	X	X	X	---	Fissure exami- nation	---	Table IV; 3.3.4
All	1a and 1c thru 1i	See 4.3	See note 2	---	---	---	---	---	X (see note 2)	---	---	Table III
Quality conformance tests												
All	All	All	4.6.4.1 4.6.4.2	---	---	---	---	---	---	---	---	3.3.5; 3.3.5.1
EN60; RN60 EN62; RN62 EN67; RN67	All	All	See note 2	---	---	---	---	---	X (see note 2)	---	---	Table III
EN6A; RN6A EN82; RN82 EN82H; RN82H EN625; RN625	All	All	3.4.4	X	---	---	---	---	---	---	---	3.4.4.1; 3.4.4.2
			Figure 1 and notes	---	---	X	X	X	---	X	---	Table IV; 3.3.4

See notes at top of next page.

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NOTES:

1. Side bends required for specific types listed under quality conformance tests and indicated in table IV.
2. Chemical analysis shall be in accordance with ASTM E 354. The ladle analysis may be used in lieu of the finished electrode or rod analysis when the following provisions are met:
 - (a) The melting of the alloy is a part of the contractor's integrated production systems.
 - (b) The ladle sample is taken from the molten stream while pouring the ladle contents into the ingot mold. The ladle sample is then analyzed to verify conformance to 3.3.2.
 - (c) A statistical study shows that the melting and pouring practice is such that there is no essential difference in the chemical composition of the ladle sample and the finished electrode or rod sample (see 4.4.4).
 - (d) The two samples are identified by the same heat number.
 - (e) The ladle sample has the closest spectrographic comparison match with the finished electrode or rod sample of all the heats of the same MIL type melted in the preceding 12 months.

In case of a dispute, the wet chemical analysis of the finished electrode or rod shall be used.

4.3.1 Class 1 and class 2. Where qualification is desired on the alloy types furnished in both class 1 and class 2 (see tables I and II), tests shall be conducted on class 1a, 1/16-inch diameter electrodes of the particular type alloy, and qualification will include both class 1 electrodes and class 2 rods (except as specified in 4.3.2) and all sizes for the particular alloy involved, if production cleaning methods are the same for all classes and sizes.

4.3.2 Class 2 rods only. Where qualification is desired on alloy types (see table II) furnished in class 2 rods only (RN65 and RN69), tests shall be conducted on 1/16-inch diameter rods and qualification will include all other sizes of the class and type alloy involved. Welds shall be made with the gas tungsten arc method.

4.3.3 Samples for qualification tests. One spool of class 1a, 1/16-inch diameter electrodes or a quantity of class 2 rods sufficient for tests, in accordance with 4.3.1 or 4.3.2, shall be selected from production runs in the presence of the Government representative for transmittal to the testing laboratory.

4.4 Sampling for quality conformance inspection.

4.4.1 Lot. For the purposes of sampling and inspection, a lot of cut-length rod or wound electrode is defined as the quantity of one type and size produced from the same heat of metal. The lot size shall be expressed in pounds of rod or of wound electrode.

4.4.2 Sampling for inspection of filled containers. Unit packages and shipping containers shall be sampled and inspected in accordance with MIL-W-10430.

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4.4.3 Sampling for examination of cut rods and wound electrode. Sample rods and wire shall be selected either from the production line immediately prior to packaging or from filled unit packages. If selected from the production line, the total sample shall be in accordance with 4.4.3.2 and the electrodes or rods shall be selected throughout the run so that all parts of the run are represented. If selection is made after the packaging operation, the total sample shall be in accordance with 4.4.3.2, and approximately the same number of electrodes or rods shall be selected from each of the sample unit packages: five cut lengths (rods) of each 5- or 10-pound package, 3 feet of each 2-pound spool, and sufficient electrode to form one complete circle shall be taken from each spool 25 pounds (nominal) or larger.

4.4.3.1 Defective material. Any sample coil, spool, or box which contains any nonconforming material shall be counted as defective. If in any sample, the number of coils, spools, or boxes which do not conform to this specification exceeds the acceptance number in 4.4.3.2, this shall be cause for rejection of the lot.

4.4.3.2 Inspection levels. Sampling for examination of all classes of electrodes and cut rods shall be in accordance with the procedures of MIL-STD-105 at an acceptable quality level equal to 2.5 percent defective. The lot size shall be in terms of pounds whereas the sample size shall be in number of spools, packages, or drums. The inspection levels for each class are as follows:

<u>Class</u>	<u>Type</u>	<u>Inspection level (pound of spools, packages or drums)</u>
1a	25 pound spools	S-3
1c	100 pound drums	S-3
1d	200 pound drums	S-3
1b	2 pound spools	L-1
2 (cut rods)	5 or 10 pound packages	S-4
1e to 1i	300 to 700 pound drums	S-2

4.4.4 Sampling for chemical analysis. One specimen for chemical analysis shall be selected from the lot (see note 2 to table V and 4.4.1). If any specimen fails any requirement specified in 3.3.2, this shall be cause for rejection of the lot.

4.4.5 Sampling for weld tests. Sufficient quantity of class 1 or 2 material shall be selected from each lot (see 4.4.1) for preparation of welds and mechanical property and radiographic tests (see table V - quality conformance tests). Where a heat of metal is processed to both class 1 electrodes and class 2 rods of the same size and sample selected from class 1 and passes mechanical and radiographic tests, it will not be necessary to perform these tests using class 2 rods of the same size. Where a heat of metal is processed to class 2 rods, only the required mechanical and radiographic tests shall be performed on welds made with tungsten-arc method. Failure of any electrode or rod, under test, to meet mechanical property and radiographic requirements shall be cause for rejecting the lot represented.

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4.5 Quality conformance inspection. Quality conformance inspection shall consist of the visual and dimensional examination of 4.5.1 and the tests specified in table V using samples of filler metal selected in accordance with 4.4.4 and 4.4.5.

4.5.1 Visual and dimensional examination. The sample lengths and pieces selected in accordance with 4.4.3 shall be examined to verify conformance as specified in 3.3.1, 3.4.1, and 3.5.3 and measured to verify conformance as specified in 3.5.1 and 3.5.2.

4.5.1.1 Sampling for examination of cast and helix. Specimens of class 1a electrode shall be cut from the 25-pound spools selected in accordance with 4.4.3.2, and shall be examined to determine conformance to 3.4.4.1 and 3.4.4.2. If any specimen fails in either examination, both tests shall be performed on every 25-pound spool.

4.5.2 Quality conformance tests. The tests specified in table V for quality conformance shall be performed using samples of filler metal selected in accordance with 4.4.4 and 4.4.5.

4.6 Test procedures.

4.6.1 Summary of tests. Table V summarizes the tests required for qualifying electrodes (see details under qualification tests and for quality conformance inspection under quality conformance tests) of all filler metal types, classes and sizes.

4.6.2 Welding equipment. Qualified manual semi-automatic or machine GMA welding equipment shall be used for testing electrode wire. Equipment shall be supplied with welding current from either a motor generator or a rectifier. The shielding gas shall be argon in accordance with MIL-A-18455. The range of arc current for each type and size of welding wire for each thickness of plate and shielding gas shall be as recommended by the exhibitor.

4.6.3 General welding procedure.

4.6.3.1 Base plate. Base plate shall be of alloy similar in composition to the electrode under test (see ASTM B 167 or B 168) except MIL-EN6A weld joints shall consist of one member of Ni-Cr-Fe alloy, the other member mild steel or corrosion resisting steel of AISI 300 or 400 series in accordance with the Steel Products Manual.

4.6.4 Alloy identity.

4.6.4.1 Procedure. The alloy identity test method may include chemical analysis, metal-sorting devices, other approved methods or a combination of methods. The test method shall be submitted for approval to NAVSEA.

4.6.4.2 Acceptance criteria. If the test demonstrates that the material is not of the type specified, the material shall be rejected.

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4.7 Replacement, retest, rejection and resubmittal.

4.7.1 Replacement of test specimens. A test specimen may be discarded and a replacement test specimen selected.

4.7.2 Retest. When one or more representative test specimens does not conform to specification requirements for the tested characteristic, only a single retest of each nonconforming characteristic may be performed to establish product acceptability. Retests shall be performed on twice the number of representative specimens that were originally nonconforming.

4.7.3 Rejection. When any retest specimen does not conform to specification requirements for the characteristic being retested, the lot represented by that specimen shall be rejected.

4.7.4 Resubmittal of rejected lots. A rejected lot may be resubmitted for acceptance testing provided that the rejected lot is reworked, as necessary, to correct the nonconforming condition. When a rejected lot consists of more than one piece, each remaining piece in the lot may be tested for the nonconforming characteristic and each piece that conforms to specification requirements may be offered for acceptance.

4.8 Inspection of packaging. Sample packs, and the inspection of the preservation, packing and marking for shipment, stowage and storage shall be in accordance with the requirements of section 5 and the documents specified therein.

5. PACKAGING

(The packaging requirements specified herein apply only for direct Government acquisition.)

5.1 General.5.1.1 Navy shipboard stowage fire-retardant requirements.

- (a) Treated lumber and plywood. When specified (see 6.2), all lumber and plywood including laminated veneer material used in shipping container and pallet construction, members, blocking, bracing, and reinforcing shall be fire-retardant treated material conforming to MIL-L-19140 as follows:

Levels A and B - Type II - weather resistant.
Category 1 - general use.

Level C - Type I - non-weather resistant.
Category 1 - general use.

- (b) Fiberboard. Unless otherwise specified (see 6.2), fiberboard used in the construction of class-domestic, non-weather resistant fiberboard and cleated fiberboard boxes including interior packing forms shall meet the flamespread index and the specific optic density requirements of PPP-F-320.

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5.2 Packaging. Electrodes and rods shall be furnished on class 3 spools, in class 4 drums, and class 6 containers, as applicable, and shall be preserved level A, C or commercial, packed level A, B, C or commercial and marked in accordance with MIL-W-10430.

5.2.1 Alternate class 6 container. In lieu of the class 6 container specified in MIL-W-10430, rods of like type and diameter may be packaged in 10-pound spiral-wound fiber tubes from 0.125 to 0.135 inch thick containing three layers of 0.007 to 0.008 inch thick waterproof duplex kraft wound with a 1/4-inch overlap. End closures shall be snug fitting flexible polyethylene caps reinforced and sealed with waterproof tape.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. The purpose of this specification is to ensure acquisition of nickel alloy filler metals meeting the minimum standards of quality control and chemical composition as specified herein. The minimum mechanical properties indicated herein represent controlled minimum properties used as the basis of acceptance from lot to lot of filler metal. These values also are considered representative of what can be expected when welding, under controlled conditions, base plates of compositions similar to those of the filler metal, where such compositions are available in wrought forms. Since this specification provides for the welding of these materials to themselves, for joining clad materials and for dissimilar welding of alloys to ordinary steel or corrosion resisting steels of the AISI 300 and 400 series, the mechanical property requirements indicated herein will generally not be suitable for design purposes. In such instances it is recommended that pilot weld tests be made representative of the welding procedures and alloys involved to establish mechanical properties for representative joints contemplated and made under controlled conditions.

6.1.1 Types MIL-EN60 and MIL-RN60. Types MIL-EN60 and MIL-RN60 are recommended for welding nickel-copper alloy to itself and to steel, welding the clad side of nickel-copper alloy clad steel, and for overlaying nickel-copper alloy on steel. For certain overlaying applications, a barrier layer of nickel is required below the nickel-copper alloy overlay, and the manufacturer should be consulted.

6.1.2 Types MIL-EN61 and MIL-RN61. Types MIL-EN61 and MIL-RN61 are recommended for the welding of nickel to itself, welding the clad side of nickel clad steel, and overlaying nickel on steel.

6.1.3 Types MIL-EN62 and MIL-RN62. Types MIL-EN62 and MIL-RN62 are recommended for welding nickel-chromium-iron alloy to itself.

6.1.4 Types MIL-EN64 and MIL-RN64. Types MIL-EN64 and MIL-RN64 are recommended for welding nickel-copper-aluminum alloy to itself. The deposited weld metal is age-hardenable, although the increment from age-hardening and mechanical properties to be expected after welding and aging will be lower than values obtainable from wrought material.

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6.1.5 Type MIL-RN65. Type MIL-RN65 is recommended for the GTA welding of nickel-iron-chromium-molybdenum-copper alloy to itself. GMA welding of this material is not recommended.

6.1.6 Types MIL-EN67 and MIL-RN67. Types MIL-EN67 and MIL-RN67 are recommended for the welding of 70-30, 80-20 and 90-10 copper-nickel alloys to themselves and to steel.

6.1.7 Type MIL-RN69. Type MIL-RN69 is recommended for the tungsten-arc welding of nickel-chromium-iron-titanium-aluminum-columbium to itself. The deposited weld metal is age-hardenable, although the increment from age-hardening and mechanical properties to be expected after welding and aging will be lower than values obtainable from wrought material.

6.1.8 Types MIL-EN6A and MIL-RN6A. Types MIL-EN6A and MIL-RN6A are recommended for the welding of nickel-chromium-iron-titanium-manganese alloys to steel, for overlaying nickel-chromium-iron alloy on steel, and for joining various heat and corrosion resistant alloys to each other and to steel and for welding the clad side of nickel-chromium-iron alloy clad steel.

6.1.9 Types MIL-EN6N and MIL-RN6N. Types MIL-EN6N and MIL-RN6N are recommended for joining of 80-20 nickel-chromium alloys to themselves, and for overlaying nickel-chromium alloy on steel.

6.1.10 Types MIL-EN82, MIL-EN82H, MIL-RN82 and MIL-RN82H. Types MIL-EN82, MIL-EN82H, MIL-RN82 and MIL-RN82H are recommended for welding of nickel-chromium-iron alloy to itself and to steel, for overlaying nickel-chromium-iron alloy on steel, and for welding the clad side of Ni-Cr-Fe alloy clad steel.

6.1.11 Types MIL-EN625 and MIL-RN625. Types MIL-EN625 and MIL-RN625 are recommended for welding of nickel-chromium-molybdenum-columbium alloy to itself and to steel and the overlaying of nickel-chromium-molybdenum-columbium alloy on steel.

6.2 Acquisition requirements. Acquisition documents must specify the following:

- (a) Title, number and date of this specification.
- (b) Class, sub-class (spool or drum size), type, and diameter size required (see 1.2).
- (c) Spooled electrode, drums of electrode and cut-length rods should be ordered in units as follows:
 - Class 1a - 25 pound (wound on spool).
 - Class 1b - 40 pounds (twenty 2-pound spools).
 - Class 1c - 100 pounds (furnished in a drum).
 - Class 1d - 200 pounds (furnished in a drum).
 - Class 1e - 300 pounds (furnished in a drum).
 - Class 1f - 400 pounds (furnished in a drum).
 - Class 1g - 500 pounds (furnished in a drum).
 - Class 1h - 600 pounds (furnished in a drum).
 - Class 1i - 700 pounds (furnished in a drum).
 - Class 2 (rods) - 5 or 10 pounds.

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- (d) Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1 and 2.2).
- (e) If maximum sulfur content is restricted to 0.007 percent (see table III, footnote 3).
- (f) If a minimum carbon content is required (see table III, footnote 6).
- (g) Whether alloy identity testing of each electrode or rod after final marking is required (see 3.3.5.2).
- (h) Tolerances on weight for classes 1c through 1i if required (see 3.4.2).
- (i) Whether 12, 18 or 36 inch rods are required (see 3.5.2).
- (j) Fire-retardant requirements (see 5.1.1).
- (k) Levels of packaging required (see 5.2).

6.3 Consideration of data requirements. The following data requirements should be considered when this specification is applied on a contract. The applicable Data Item Descriptions (DID's) should be reviewed in conjunction with the specific acquisition to ensure that only essential data are requested/provided and that the DID's are tailored to reflect the requirements of the specific acquisition. To ensure correct contractual application of the data requirements, a Contract Data Requirements List (DD Form 1423) must be prepared to obtain the data, except where DoD FAR Supplement 27.475-1 exempts the requirement for a DD Form 1423.

<u>Reference Paragraph</u>	<u>DID Number</u>	<u>DID Title</u>	<u>Suggested Tailoring</u>
4.1.1	DI-MISC-80678	Certification data/ report	----

The above DID's were those cleared as of the date of this specification. The current issue of DoD 5010.12-L, Acquisition Management Systems and Data Requirements Control List (AMSDL), must be researched to ensure that only current, cleared DID's are cited on the DD Form 1423.

6.4 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award contract, qualified for inclusion in Qualified Products List No. 21562 whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or purchase orders for the products covered by this specification. The activity responsible for the Qualified Products List is the Naval Sea Systems Command, SEA 5523, Department of the Navy, Washington, DC 20362-5101 and information pertaining to qualification of products may be obtained from that activity. Application for qualification tests must be made in accordance with "Provisions Governing Qualification SD-6" (see 6.4.1).

6.4.1 Copies of "Provisions Governing Qualification SD-6" may be obtained upon application to Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

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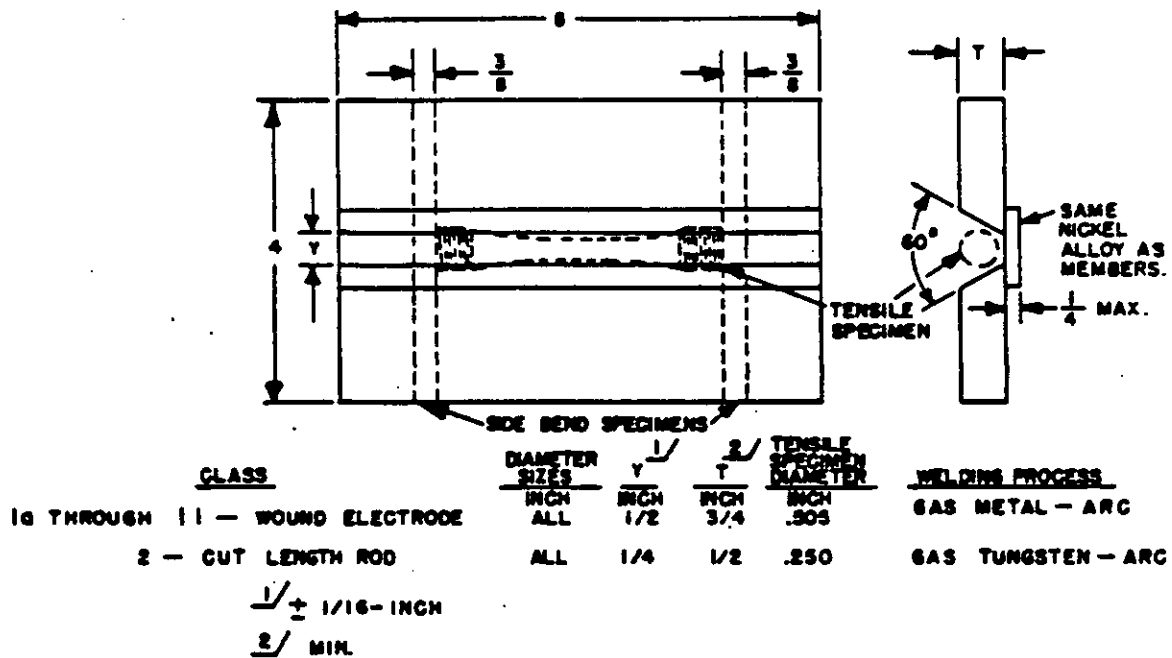
6.5 Subject term (key word) listing.

Alloy identity
Gas metal-arc
Gas tungsten-arc
Winding

6.6 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

Preparing activity:
Navy - SH
(Project 3439-N600)

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FIGURE 1. Test joint for mechanical properties.

NOTES:

1. Weld joint members shall be restrained by clamping to a grooved copper back-up plate.
2. Welding conditions and procedure shall be in accordance with accepted practices. Position shall be flat.
3. Completed welds shall be radiographed in accordance with requirements of MIL-STD-271 sensitivity level 2-2T after removal of backing strip and grinding smoothly the as-welded surface.
4. The radiograph shall meet the radiographic standards in accordance with class I of NAVSEA 0900-LP-003-9000 as specified in 3.3.4.
5. All-weld metal tensile specimens shall be machined and tested in accordance with ANSI/AWS B4.0. Tension testing shall be conducted at room temperature.
6. Side bend specimens shall be prepared and tested in accordance with ANSI/AWS B4.0 (see table V for electrode and rod types requiring side bend tests).

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL*(See Instructions - Reverse Side)***1. DOCUMENT NUMBER**

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2. DOCUMENT TITLE

ELECTRODES AND RODS - WELDING, BARE, NICKEL ALLOY

3a. NAME OF SUBMITTING ORGANIZATION**4. TYPE OF ORGANIZATION (Mark one)** **VENDOR** **USER** **MANUFACTURER** **OTHER (Specify):** _____**b. ADDRESS (Street, City, State, ZIP Code)****5. PROBLEM AREAS****a. Paragraph Number and Wording:****b. Recommended Wording:****c. Reason/Rationale for Recommendation:****6. REMARKS****7a. NAME OF SUBMITTER (Last, First, MI) - Optional****b. WORK TELEPHONE NUMBER (Include Area Code) - Optional****c. MAILING ADDRESS (Street, City, State, ZIP Code) - Optional****8. DATE OF SUBMISSION (YYMMDD)****(TO DETACH THIS FORM, CUT ALONG THIS LINE.)**