

INCH-POUND

MIL-E-22200/10C(SH)  
27 June 1994  
SUPERSEDING  
MIL-E-22200/10B(SH)  
24 March 1989  
(See 6.8)

## MILITARY SPECIFICATION

### ELECTRODES, WELDING, MINERAL COVERED, IRON-POWDER, LOW-HYDROGEN MEDIUM, HIGH TENSILE AND HIGHER- STRENGTH LOW ALLOY STEELS

This specification is approved for use within 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 iron-powder, low-hydrogen types of covered electrodes for the fabrication and repair welding of low and medium carbon, high tensile, and higher-strength low-alloy steels for as-welded and stress-relieved application.

1.2 Classification. Iron-powder, low-hydrogen electrodes shall be furnished in the types, classes, and sizes shown in table I, as specified (see 6.2).

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, SEA 03R42, Naval Sea Systems Command, 2531 Jefferson Davis Highway, Arlington, VA 22242-5160 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. Types, classes, and sizes.

Types <u>1/</u> <u>2/</u>	Class	Positions of welding	Sizes (diameter) <u>3/</u> (inches)
MIL-7018-M	1	All	3/32, 1/8, 5/32
	2	Horizontal fillets and flat	3/16, 7/32, 1/4
	3	Flat	5/16
MIL-10018-M1 MIL-12018-M2	1	All	3/32, 1/8, 5/32
	2	Horizontal fillets and flat	3/16, 7/32, 1/4

- 1/ Type classifications of electrodes shall be determined according to the capability of the electrode to meet the tests specified herein, when used in the positions of welding specified in table I and in section 4. An electrode will be approved under one type classification and an electrode will not be approved if it differs in type from that stated in the manufacturer's request for test. The position description indicates the maximum size qualified under the specification. However, reference should be made to the Qualified Products List (QPL) for the selection of electrodes for all positions of welding.
- 2/ The suffix RC added to the MIL type pertains to restriction of the copper content (see 3.5). Requirements, tests, and acceptance criteria remain otherwise unchanged.
- 3/ Electrodes of other sizes or for other positions may be tested for qualification subject to NAVSEA approval.

## 2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications and standards. The following specifications and standards form a part of this specification 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).

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## SPECIFICATIONS

## MILITARY

- MIL-S-16216 - Steel Plate, Alloy, Structural, High Yield Strength (HY-80 and HY-100).
- MIL-E-22200 - Electrodes, Welding, Covered; General Specification for.
- MIL-S-22698 - Steel Plate, Shapes, and Bars Weldable Ordinary Strength and Higher Strength: Structural.
- MIL-S-24645 - Steel, Plate, Sheet, or Coil, Age-Hardening Alloy, Structural, High Yield Strength (HSLA-80 and HSLA-100).

## STANDARDS

## MILITARY

- MIL-STD-271 - Requirements for Nondestructive Testing Methods.
- MIL-STD-2035 - Nondestructive Testing Acceptance Criteria
- MIL-STD-2149 - Standard Procedures for Explosion Testing Ferrous and Non-Ferrous Metallic Materials and Weldments.

(Unless otherwise indicated, copies of federal and military specifications and standards are available from the Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

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 specified in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents cited in the solicitation (see 6.2).

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- A 36 - Standard Specification for Structural Steel.
- A 131 - Standard Specification for Structural Steel for Ships.
- A 285 - Standard Specification for Pressure Vessel Plates, Carbon Steel, Low- and Intermediate-Tensile Strength. (DoD adopted)
- A 710 - Standard Specification for Low-Carbon Age-Hardening Nickel-Copper-Chromium-Molybdenum-Columbium and Nickel-Copper-Columbium Alloy Steels.
- E 604 - Standard Test Method for Dynamic Tear Testing of Metallic Materials. (DoD adopted)

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

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AMERICAN WELDING SOCIETY (AWS)

- A4.3 - Standard Methods for the Determination of Diffusible Hydrogen Content of Martensitic, Bainitic, and Ferritic Steel Weld Metal Produced by Arc Welding.
- 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 specific exemption has been obtained.

### 3. REQUIREMENTS

3.1 Qualification. Electrodes 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 General. Electrodes furnished under this specification shall conform to the requirements of MIL-E-22200 and as specified herein.

#### 3.3 Composition and iron content.

3.3.1 Composition. The chemical composition of the electrode covering, except as specified in 3.3.2, is optional with the contractor. The water content of the covering shall be not greater than the percent-by-weight values specified in table II. In addition, the diffusible hydrogen levels in milliliters per one hundred grams (mL/100 g) of deposited weld metal shall be not greater than the following values for welds deposited with electrodes removed from sealed manufacturer's containers (see 4.6):

- (a) Electrodes 1/8 inch size and smaller, maximum average value of 3.2 mL/100 g and maximum single value of 4.0 mL/100 g.
- (b) Electrodes 5/32 inch size and larger, maximum average value of 3.5 mL/100 g and maximum single value of 4.3 mL/100 g.

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TABLE II. Water content.

Types	Percent by weight maximum	
	Condition A <u>1/</u>	Condition B <u>2/ 3/</u>
MIL-7018-M	0.10	0.20
MIL-10018-M1	.10	.20
MIL-12018-M2	.10	.20

- 1/ Condition A - When removed from sealed manufacturer container.
- 2/ Condition B - After 9 hours exposure at 80 percent relative humidity (R.H.) and 80 degrees Fahrenheit (°F) (see 4.7).
- 3/ For receipt inspection by the procuring activity, the maximum value shall be 0.25.

3.3.2 Total iron content. The total iron content of the covering, including any combined iron in addition to metallic iron powder, shall be not less than 15 percent.

3.4 Groove welds. The mechanical properties of groove welds shall be as specified in table III. When specified (see 6.2), the welded test assembly shall be stress relieved as follows:

- (a) MIL-7018-M:  $1,150 \pm 25^{\circ}\text{F}$ , held at this temperature for 1 hour minimum and furnace cooled at  $200^{\circ}\text{F}$  per hour/or slower to below  $500^{\circ}\text{F}$ .
- (b) MIL-10018-M1:  $1,125 \pm 25^{\circ}\text{F}$ , held at this temperature for 1 hour minimum and furnace cooled at  $200^{\circ}\text{F}$  per hour or slower to  $500^{\circ}\text{F}$ .

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TABLE III. Mechanical properties. 1/

Types		MIL-7018-M	MIL-10018-M1			MIL-12018-M2	
Yield strength (1000 pounds per square inch (ksi))	As welded	53 to 72 <u>2/</u> <u>3/</u>	82 to 110 <u>2/</u>			102 to 123 <u>4/</u> <u>5/</u>	
	Stress relieved	51	80			---	
Elongation in 2 inches minimum (percent)	As welded	24	<u>6/</u> 20			<u>6/</u> 18	
	Stress relieved	24	20			---	
Transverse side bend		---	<u>7/</u>			<u>7/</u>	
Impact tests <u>8/</u>							
Charpy V-Notch							
As welded	Energy ft-lb minimum average	<u>9/</u> 50	<u>9/</u> 35	<u>9/</u> 60	<u>9/</u> <u>10/</u> 45	<u>9/</u> 60	
	Temperature °F	Minus 20	Minus 60	0	Minus 60	0	
Stress relieved	Energy ft-lb minimum average	<u>9/</u> 35	<u>9/</u> 20	<u>9/</u> 50	---	---	
	Temperature °F	Minus 20	Minus 60	0	---	---	
Dynamic tear							
As welded	Energy ft-lb minimum average						
		Temperature °F	---	Minus 20	30	Minus 20	30
Explosion test series		---	<u>14/</u>			<u>14/</u>	

- 1/ The ultimate tensile strength and percent reduction of area shall be recorded for information only.
- 2/ Yield strength shall be the average of two tests with no value more than 2 ksi below the minimum specified value.
- 3/ For MIL-7018-M, the upper value of the yield strength may be 5 ksi higher than the indicated value for the 3/32 inch size electrode.

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- 4/ Maximum yield strength may be 125,000 psi when specified (see 6.2). Single values may not be less than 100,000 psi or greater than 125,000 psi, or, when specified, (see 6.2), 130,000 psi.
- 5/ These values are minimum and maximum averages determined by testing all specimens required from each qualification and conformance test weld.
- 6/ For high cooling rate tests, the minimum elongation is 15 percent for MIL-12018-M2 and 18 percent for MIL-10018-M1.
- 7/ Transverse side bend specimens after bending shall have no cracks or other indications greater than 1/8 inch in any direction on a convex surface. Tears less than 1/8 inch on the corners of the bend specimen are acceptable.
- 8/ Where both Charpy V-notch and dynamic tear testing are performed, the dynamic tear test shall be considered the authoritative test.
- 9/ For each testing temperature, the average values of five tests shall be equal to or greater than the minimum average value specified. No two specimens shall have values below the minimum average specified. One specimen can have a value of 10 foot-pounds below the minimum average specified.
- 10/ For high cooling rate tests of type MIL-12018-M2, the average Charpy V-notch toughness at minus 60°F shall be not less than 40 foot-pounds.
- 11/ For each testing temperature, the average values of two tests shall be equal to or greater than the minimum average value specified. One specimen may have a value of 50 foot-pounds below the minimum average specified.
- 12/ For high cooling rate tests, dynamic tear test results shall be reported for information only.
- 13/ For each testing temperature, the average values of two tests shall be equal to or greater than the minimum average value specified. One specimen may have a value of 25 foot-pounds below the minimum average specified.
- 14/ Acceptance criteria shall be in accordance with MIL-STD-2149.

3.5 Chemical composition of deposited weld metal. Chemical composition of deposited weld metal shall be as specified in table IV.

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TABLE IV. Chemical composition (percent) of deposited weld metal. 1/

Element	MIL-7018-M	MIL-10018-M1	MIL-12018-M2
Carbon	0.10	0.06	0.07
Manganese	.40 to 1.60	.80 to 1.85	.80 to 1.85
Silicon	.80	.65	.65
Phosphorus	.030	.025	.025
Sulfur	.020	.017	.012
Chromium	.15	.40	.65
Nickel	.25	1.25 to 3.00	1.50 to 4.00
Molybdenum	.35	.50	.90
Vanadium	.05	.05	.05
Copper	<u>2/</u>	<u>2/</u>	<u>2/ 3/</u>
Boron	----	----	<u>3/</u>

- 1/ Single values are maximum percentages.
- 2/ When specified (see 6.2), use of the suffix RC, for example MIL-10018-M1RC, indicates that the maximum copper content of the deposited weld metal shall be 0.15 percent. The remaining basic compositional requirements remain unchanged for the specific MIL-type.
- 3/ Copper (except for suffix RC electrodes) and boron shall be reported for information only.

3.6 Electrode identification. Electrodes shall be identified as specified in MIL-E-22200.

3.6.1 Heat and lot identification. When specified (see 6.2), each electrode shall be marked with heat, lot or other controlled marking code identification as specified in MIL-E-22200.

3.7 Electrode lengths. The specified lengths of electrodes shall be as specified in table V.



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TABLE V. Electrode lengths.

Diameter (inch)	Electrode lengths overall (inches)
3/32	9, 12 or 14 <u>1/</u>
1/8, 5/32, 3/16	14
7/32, 1/4, 5/16	18

1/ (See 6.2).

3.8 Core wire alloy identity. The core wire alloy identity requirements shall be as specified in MIL-E-22200.

3.9 Nondestructive testing.

3.9.1 Radiography. Radiographs of welds deposited with all types electrodes shall be in accordance with class 1 acceptance criteria as specified in MIL-STD-2035.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection and compliance. The responsibility for inspection and compliance shall be in accordance with MIL-E-22200 and as specified herein.

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

- (a) Qualification inspection (see 4.3).
- (b) Quality conformance (see 4.4).

4.3 Qualification inspection. Qualification inspection shall be in accordance with MIL-E-22200 and tables VI and VII herein. Schedule A tests shall be conducted by the contractor, and upon successful completion of schedule A tests, schedule B welding and testing will be conducted by the Government. Schedule B test weldment shall be in accordance with 4.5.2.

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TABLE VI. Summary of other tests. 1/

Tests	Procedures	Requirements
Visual and dimensional	MIL-E-22200	MIL-E-22200 and 3.7 herein
Concentricity	MIL-E-22200	MIL-E-22200
Dielectric strength 2/	MIL-E-22200	MIL-E-22200
Covering, flaking, and cracking 2/	MIL-E-22200	MIL-E-22200
Total iron in covering 2/	MIL-E-22200	3.3.2 herein
Alloy identity for core wire	MIL-E-22200	MIL-E-22200
Covering moisture	MIL-E-22200 and 4.7 herein	3.3.1 herein
Diffusible hydrogen	4.6 herein	3.3.1 herein

1/ These tests are required for qualification schedule A testing and conformance testing unless otherwise noted.

2/ Required for qualification (QPL) schedule A testing only.

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TABLE VII. Summary of weld metal tests required for qualification. 1/ 2/

Test		Schedule		Test Procedures	Requirements
		A	B		
MIL-7018-M					
Chemical analysis		X	--	4.8 herein	Table IV herein
Welded test assembly		X	--	4.5 herein	Figures 1 and 2 herein
Nondestructive testing		X	--	4.10 herein	3.9 herein
Tensile		X	--	4.9 herein	Table III herein
I m p a c t	Charpy V-notch	X	--	4.9 herein	Table III herein
MIL-10018-M1					
Chemical analysis		X	--	4.8 herein	Table IV herein
Welded test assembly		X	X	4.5 herein	Figures 1 and 2 herein
Nondestructive testing		X	X	4.10 herein	3.9 herein
Tensile		X	X	4.9 herein	Table III herein
Transverse side bend		X	X	4.9 herein	Table III herein
I m p a c t  3/	Charpy V-notch	X	X	4.9 herein	Table III herein
	Dynamic tear	X	X	4.9 herein	Table III herein
Explosion test series 4/		--	X	4.5.2 herein	Table III herein

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TABLE VII. Summary of weld metal tests required for qualification.(cont'd)1/2/

Test		Schedule		Test Procedures	Requirements
		A	B		
MIL-12018-M2					
Chemical analysis		X	--	4.8 herein	Table IV herein
Welded test assembly		X	X	4.5 herein	Figures 2 and 3 herein
Nondestructive testing		X	X	4.10 herein	3.9 herein
Tensile		X	X	4.9 herein	Table III herein
Transverse side bend		X	X	4.9 herein	Table III herein
I m p a c t 3/	Charpy V-notch	X	X	4.9 herein	Table III herein
	Dynamic tear	X	X	4.9 herein	Table III herein
Explosion test series 4/		--	X	4.5.2 herein	Table III herein

- 1/ Tests shall be conducted for both the as-welded and stress-relieved conditions as applicable.
- 2/ Electrode types shall be tested using direct current (dc), reverse polarity.
- 3/ For the types MIL-10018-M1 and MIL-12018-M2 electrodes, both the Charpy V-notch and the dynamic tear test shall be conducted for conformance to table III.
- 4/ For the types MIL-10018-M1 and MIL-12018-M2 electrodes, all sizes shall be qualification tested in accordance with MIL-STD-2149 for conformance to table III herein, except a smaller size electrode of the same type and class previously qualified shall be evaluated on the basis of Charpy V-notch and dynamic tear tests conducted at table III temperatures and the explosion test assemblies shall be omitted.

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4.3.1 Schedule A testing. Schedule A testing shall be required for all electrodes and manufacturer certified test data shall include:

- (a) Data acquired from a production run sampling.
- (b) Material traceable from the heat batch or electrode lot traceable to the core wire heat through coupon welding to the test specimen.
- (c) Coupon welding parameters and bead placement.
- (d) Test specimen data as required by table VII and supplemented by adjunct table VI testing.

4.3.2 Schedule B testing. Schedule B testing shall be required for MIL-10018-M1/MIL-12018-M2 only, and test data shall be presented in an Engineering Technical Report which includes:

- (a) Proof test data substantiating schedule A data.
- (b) Explosion test result evaluation.

#### 4.4 Quality conformance inspection.

4.4.1 Quality conformance inspection. For type MIL-12018-M2, quality conformance tests shall be conducted on samples selected as specified in 4.4.3 from electrodes produced from each lot as specified in 4.4.2. One sample shall be subjected to all the tests specified in tables VI and VIII herein (that is, nondestructive, mechanical, and complete chemical analysis). For types MIL-7018-M, and MIL-10018-M1, quality conformance tests shall be conducted on samples selected as specified in 4.4.3 from electrodes produced from each wet mix of covering mixture in each lot as specified in 4.4.2. One sample shall be subjected to all the tests specified in tables VI and VIII herein (that is, nondestructive, mechanical, and complete chemical analysis). The samples representing each of the remaining wet mixes of covering mixture in each lot shall be subjected to equivalency tests as specified in 4.4.1.1.

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TABLE VIII. Summary of weld metal tests required for quality conformance inspection.

Test		Test Procedures	Requirements
		<u>1/</u> MIL-7018-M <u>1/</u> MIL-10018-M1	
Chemical		4.8 herein	Table IV herein
Welded test assembly		4.5.1 herein	Figures 1 and 2 herein
Nondestructive testing		4.10 herein	3.9 herein
Tensile		4.9 herein	Table III herein
I m p a c t	Charpy V-notch <u>2/</u>	4.9 herein	Table III herein
	Dynamic tear <u>2/</u>	4.9 herein	Table III herein
MIL-12018-M2			
Chemical		4.8 herein	Table IV herein
Welded test assembly		4.5.1 herein	Figures 2 and 3 herein
Nondestructive testing		4.10 herein	3.9 herein
Tensile		4.9 herein	Table III herein
I m p a c t	Charpy V-notch <u>2/</u>	4.9 herein	Table III herein
	Dynamic tear <u>2/</u>	4.9 herein	Table III herein

- 1/ For type MIL-7018-M, and MIL-10018-M1, stress relieved mechanical and impact properties shall be determined only when specified (see 6.2).
- 2/ For type MIL-7018-M, only Charpy V-notch shall be performed. For type MIL-10018-M1 and MIL-12018-M2, either the Charpy V-notch or the dynamic tear test shall be performed.

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4.4.1.1 Wet mix equivalency tests. Weld deposits shall be chemically analyzed for manganese, nickel (except MIL-7018-M) and copper (for MIL-types with an RC suffix) using procedures specified in MIL-E-22200 to the requirements of table IV. Wet mix equivalency tests are not needed when the lot is identified by controlled covering mixture chemical composition as defined in MIL-E-22200. The alternate chemical analysis method of MIL-E-22200 may be used for these tests.

4.4.2 Lot. A lot of electrodes shall be as specified in MIL-E-22200 for inspection level B for types MIL-7018-M, and MIL-10018-M1. A lot of electrodes shall be as specified in MIL-E-22200 for inspection level A for type MIL-12018-M2. Subject to NAVSEA approval, a modified inspection level A plan may be used for MIL-12018-M2 electrodes which will allow a lot to be defined as the quantity of any one size and type produced in one continuous 8-hour period from covering identified by wet mix or controlled chemical composition and core wire identified by heat number or controlled chemical composition. When electrode covering is identified by wet mix, wet mix equivalency testing shall be performed and reported for those wet mixes not selected for full lot conformance testing. An appropriate statistically based process and quality control plan and recent conformance test data must be approved by NAVSEA. This plan and data must demonstrate acceptable quality control and consistent chemical analysis and mechanical properties for at least 25 consecutive wet mixes. Should a lot fail quality conformance testing due to unacceptable toughness or yield strength using the modified inspection level A plan, then testing must revert back to the standard inspection level A until 5 consecutive wet mixes are successfully tested and the data approved by NAVSEA. Based on successful test results obtained using the modified inspection level A plan after a minimum trial period of one year, inspection level B may be used for MIL-12018-M2 electrodes, subject to NAVSEA approval.

4.4.3 Sampling for quality conformance inspection. Sampling for quality conformance inspection shall be in accordance with MIL-E-22200, except that electrodes for the covering moisture or the diffusible hydrogen test taken from the production line shall be packaged for delivery to the test site. Any packages taken from stock shall be unopened when delivered to the test site.

4.4.3.1 Unsatisfactory test results. If the results of the first tests are determined to be unsatisfactory, two retests of the failed test shall be permitted. The results of both retests shall meet the requirements for quality conformance inspection.

4.4.4 Visual and dimensional inspection. Before the quality conformance inspection has begun, a visual and dimensional inspection shall be made in accordance with MIL-E-22200.

#### 4.5 Weld metal test procedures.

4.5.1 Flat and vertical groove-weld metal test. The test assembly shall be welded, machined, and tested as specified below.

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- (a) For test specimens of weld metal deposited by the type MIL-7018-M electrodes, steel base plate materials shall be in accordance with either MIL-S-22698, ASTM A 36, ASTM A 131, or ASTM A 285, grade A or grade B.
- (b) For weld metal deposited by the type MIL-10018-M1 electrodes, the base plate material shall be HY-80 steel in accordance with MIL-S-16216 when dynamic tear tests are being conducted. When Charpy V-notch tests are being conducted, the base plate material shall be HY-80 steel in accordance with the chemical composition requirements of MIL-S-16216. The plate material can be in the as-rolled condition without being quenched and tempered nor tested for mechanical properties. When specified (see 6.2), a second test weldment shall be made and quality conformance tested using ASTM A 710 grade A or MIL-S-24645 grade HSLA-80 steel base plate material. If it is necessary to splice two plates together to form the base plates, they shall be welded with full penetration welds.
- (c) For weld metal deposited by type MIL-12018-M2 electrodes, the base plate material shall be HY-100 steel in accordance with MIL-S-16216 when dynamic tear tests are being conducted. When Charpy V-notch tests are being conducted, the base plate material shall be HY-100 steel in accordance with the chemical composition requirements of MIL-S-16216. The plate material can be in the as-rolled condition without being quenched and tempered nor tested for mechanical properties. If it is necessary to splice two plates together to form the base plates, they shall be welded with full penetration welds.
- (d) For type MIL-10018-M1 electrodes, test plates shall be in accordance with figure 2 for both low cooling rate tests and high cooling rate tests. For type MIL-12018-M2 electrodes, test plates shall be in accordance with figure 2 for the low cooling rate test and in accordance with figure 3 for high cooling rate tests. For high cooling rate type MIL-12018-M2 test assemblies, results from each side shall be reported separately, with side 1 depicting results from the first side welded. Failure of either side shall constitute failure of the entire test assembly. Alternatively, high cooling rate quality conformance testing of type MIL-12018-M2 electrodes may be performed in accordance with figure 2 when approved by NAVSEA provided:
- (1) Test data from both figure 2 and figure 3 test plates demonstrate comparability with respect to cooling rate and performance.
  - (2) Written quality conformance test procedures submitted for approval establish welding parameter controls and comparative differences in acceptance criteria for figure 2 test plates.



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- (3) When both test plates are tested, results from the figure 3 test plates shall be the authoritative test.

The welding position and welding parameters shall be as specified in table IX. The weld reinforcement shall be no greater than 3/16 inch. The test plates shall be insulated or separated from the work bench. In all cases, weldments shall be fully restrained by clamps or other means during heating, welding, and cooling to room temperature. The table or other supporting device shall be stiff enough to prevent weldment distortion. Welding current shall be d.c., reverse polarity.

- (e) For type MIL-7018-M electrodes, one test weldment shall be fabricated using the flat position with 3/16 inch and larger diameter electrodes and the vertical-up position with 5/32 inch and smaller diameter electrodes. The preheat and interpass temperature shall be  $225 \pm 25^{\circ}\text{F}$  except for ASTM A 710 steel and MIL-S-24645 which shall be  $60^{\circ}\text{F}$  minimum. The heat input shall be 50 to 60 kilojoules per inch (kJ/in) for the 1/8 inch and larger diameter electrodes and 30 to 40 kJ/in for the 3/32 inch diameter electrode. The weld reinforcement shall be no greater than 3/16 inch. The backing bar shall be 1/2 inch thick.
- (f) Heat input requirements for test assemblies:
- (1) Operational heat input shall be the actual heat input recorded or calculated for individual passes during welding of the test assemblies. For individual electrodes, not greater than 20 percent of the individual passes shall be 2 to 5 kJ/in greater than the heat input specified for the high cooling rate test, or 2 to 5 kJ/in less than the heat input specified for the low cooling rate test.
  - (2) Average heat input shall be the average of the operational heat input of all passes in the test assembly and shall fall within plus or minus 2 kJ/in of the heat input specified.
  - (3) The root layer may be excluded from all heat input calculations.
  - (4) A weld pass shall be defined as one bead extending from the beginning to the end of the test assembly. Each weld pass shall be completed prior to commencing any other weld pass.
  - (5) Specified heat inputs reflect minimum acceptable ranges and qualification or quality conformance testing at values beyond the specified range shall be accepted. Heat input (kJ/in) shall be calculated using the following formula:

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$$\text{Heat Input} = \frac{\text{Arc Voltage} \times \text{Welding Amperage} \times 60}{\text{Rate of Travel (inches per minute)} \times 1000}$$

- (g) For MIL-7018-M, welding amperage shall be in accordance with the manufacturer's recommendations and the actual values used shall be recorded and reported. Welding current shall be d.c., reverse polarity.
- (h) Peening of weld beads shall not be permitted.
- (j) Weld bead placement shall be as shown on figure 4. Where necessary, the root opening may be increased to allow proper bead placement and avoid slag entrapment. The total number of weld passes, the actual root opening and the actual bead placement shall be recorded and reported with a schematic sketch.

TABLE IX. Welding parameters. 1/ 2/

MIL-type	10018-M1					
Electrode size tested (inches)	3/32		1/8		5/32	
Welding process	SMAW		SMAW		SMAW	
Position	Verti cal up	Flat	Verti cal up	Flat	Verti cal up	Flat
Welding current $\pm$ 5 percent (amperes)	95	95	<u>3/</u>	140	<u>3/</u>	170
Plate thickness (inches)	1	3/4	1	3/4	1	3/4
Cooling rate <u>4/</u>	High	Low	High	Low	High	Low
Heat input (kJ/in) <u>3/</u>	25 to 35	30 to 40	30 to 40	40 to 50	30 to 40	50 to 60
Preheat and interpass temperature ( $^{\circ}$ F) <u>3/</u>	125 to 150	300 to 325	125 to 150	300 to 325	125 to 150	300 to 325

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TABLE IX. Welding parameters. 1/ 2/

MIL-type	10018-M1					
Electrode size tested (inches)	3/16		7/32		1/4	
Welding process	SMAW		SMAW		SMAW	
Position	Flat		Flat		Flat	
Welding current $\pm$ 5 percent (amperes)	<u>3/</u>	225	<u>3/</u>	300	<u>3/</u>	350
Plate thickness (inches)	1	3/4	1	3/4	1	3/4
Cooling rate <u>4/</u>	High	Low	High	Low	High	Low
Heat input (kJ/in) <u>3/</u>	30 to 40	50 to 60	30 to 40	50 to 60	30 to 40	50 to 60
Preheat and interpass temperature ( $^{\circ}$ F) <u>3/</u>	125 to 150	300 to 325	125 to 150	300 to 325	125 to 150	300 to 325
MIL-type	10018-M1		<u>5/</u> 12018-M2			
Electrode size tested (inches)	5/16		3/32		1/8	
Welding process	SMAW		SMAW		SMAW	
Position	Flat		Verti cal up	Flat	Verti cal up	Flat
Welding current $\pm$ 5 percent (amperes)	<u>3/</u>	430	<u>3/</u>	<u>3/</u>	<u>3/</u>	<u>3/</u>
Plate thickness (inches)	1	3/4	2 <u>4/</u>	3/4	2 <u>4/</u>	3/4
Cooling rate <u>4/</u>	High	Low	High	Low	High	Low
Heat input (kJ/in) <u>3/</u>	30 to 40	50 to 60	<u>3/</u>	<u>3/</u>	40	50
Preheat and interpass temperature ( $^{\circ}$ F) <u>3/</u>	125 to 150	300 to 325	200 to 225	300 to 325	200 to 225	300 to 325

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TABLE IX. Welding parameters. 1/ 2/

MIL-type	5/ MIL-12018-M2			
Electrode size tested (inches)	5/32		3/16	
Welding process	SMAW		SMAW	
Position	Horiz ontal	Flat	Flat	
Welding current $\pm$ 5 percent (amperes)	3/	3/	3/	3/
Plate thickness (inches)	2 4/	3/4	2 4/	3/4
Cooling rate 4/	High	Low	High	Low
Heat input (kJ/in) 3/	30	45	3/	3/
Preheat and interpass temperature ( $^{\circ}$ F) 3/	200 to 225	300 to 325	200 to 225	300 to 325

- 1/ Electrode size qualification requirements shall be as specified in footnote 4/ of table VII.
- 2/ Weldments shall be tested in the as-welded condition unless otherwise specified (see 6.2).
- 3/ Welding parameters shall be selected by the supplier consistent with all other specified parameters. Heat input shall be not less than 20 kJ/in in range and shall be specified to reflect the minimum and maximum cooling rate the purchasing activity will use with agreement from the supplier (see 6.2).
- 4/ See 4.5.1 (d).
- 5/ For quality conformance testing, electrode representing the highest carbon equivalent (see 4.4.1) shall be used for high cooling rate tests and electrode representing lowest carbon equivalent shall be used for the low cooling rate tests.

4.5.2 Explosion test series.

4.5.2.1 Test requirements. Two crack starter tests shall be conducted at zero degrees Fahrenheit in accordance with MIL-STD-2149. The mechanical

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prolongations will be tested by NAVSEA in accordance with MIL-STD-2149.

4.5.2.2 Welding parameters. Fabrication of the explosion test assemblies and mechanical property prolongation assemblies shall be as follows:

- (a) Base plate material shall be as follows: for MIL-10018-M1 weld metal testing, HY-80, in accordance with MIL-S-16216 and for MIL-12018-M2 weld metal testing, HY-100, in accordance with MIL-S-16216.
- (b) Dimensions of the test assemblies shall be in accordance with MIL-STD-2149.
- (c) The weldments shall be fabricated in the flat position with 3/16 inch and larger diameter electrodes or in the vertical-up position with 5/32 inch and small diameter electrodes using dc, reverse polarity.
- (d) The preheat and interpass temperature shall be  $250 \pm 25^{\circ}\text{F}$ .
- (e) The welding-heat input shall be 50 to 60 kJ/in for the 1/8 inch size and larger electrodes and 30 to 40 kJ/in for 3/32 inch size electrodes.
- (f) Peening of weld beads shall not be permitted.
- (g) Welding amperage shall be in accordance with the manufacturer's recommendations and the actual values used shall be recorded and reported.
- (h) The joint surfaces shall not be clad or buttered.
- (i) Welding should be continuous except for interpass cooling. Heat soaking for hydrogen removal is prohibited. Time delay per pass beyond that necessary for interpass cooling shall be reported.

4.6 Diffusible hydrogen. The diffusible hydrogen test shall be performed in accordance with AWS A4.3. One set of specimens shall be prepared and tested for every lot of each size and MIL-type of electrodes furnished.

4.7 Moisture resistance test procedure. The electrode sample shall be exposed in a Blue M environmental chamber model FR 251-1 or equivalent for not less than 9 hours at  $80^{\circ}\text{F}$  minus 0, plus  $5^{\circ}\text{F}$  and 80 percent R.H. minus 0, plus 5 percent. The chamber shall have a two-pen recorder with the first pen for dry bulb temperature and the second pen for the differential between wet bulb and dry bulb temperatures. The chamber is available in all standard voltages for the various power supplies. The procedure shall be as follows:

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- (a) The electrode sample in unopened packages shall be heated to a temperature minus 0, plus 10°F above the dew point of the chamber at the time of loading. In this case, the dewpoint temperature is 73°F.
- (b) The electrode sample shall be loaded into the chamber without delay after the packages are opened.
- (c) The electrodes shall be placed in the chamber in a vertical or horizontal position on 1 inch centers with the length of the electrodes as perpendicular as practical to the general air flow.
- (d) Time, temperature, and humidity shall be continuously recorded for the period that the electrodes are in the chamber.
- (e) Counting of exposure time shall start when the required temperature and humidity in the chamber are established.
- (f) At the end of the exposure time, the electrodes shall be removed from the chamber and a sample of the coating taken for moisture determination in accordance with MIL-E-22200.

4.7.1 Frequency of testing. The test of 4.7 shall be conducted for each lot except that after testing 10 consecutive lots with satisfactory test results, the frequency of testing can be reduced to one lot in every 10 lots. However, one unsatisfactory test result shall require reversion to the above cycle.

4.8 Chemical analysis. Chemical analysis shall be performed as specified in MIL-E-22200. For each diameter of MIL-12018-M2 electrode, two chemistry pads per lot shall be prepared. One pad shall use electrode from the beginning of the lot and one pad shall use electrode from the end of the lot. A high carbon equivalent lot and a low carbon equivalent lot from each order shall be selected based on the average carbon equivalent (see 4.8.1.3). For each order or heat of core wire (whichever is smaller), one low cooling rate low carbon equivalent chemistry weld and one high cooling rate high carbon equivalent chemistry weld shall be tested. When specified (see 6.2), electrode representing the highest and lowest carbon equivalent in the lot or order shall be identified for receipt inspection by the user.

4.8.1 Chemical range limits. The chemical compositions specified in table IV are minimum and maximum limits. However, this specification does not imply and it should not be inferred that each of the possible chemistry compositions defined by these limits will meet the full requirements of this specification, for example, mechanical properties. Once a formulation is developed and qualified, and the aim values for each element have been established, changes to the formulation or aim values shall require requalification. NAVSEA may waive requalification for minor changes.

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4.8.1.1 Chemical range limits for MIL-7018-M. At the time of qualification, the aim values and typical ranges shall be reported for each element which represent expected variations due to manufacturing tolerances.

4.8.1.2 Chemical range limits for MIL-10018-M1 and MIL-12018-M2 electrodes. At the time of qualification, or for products qualified to previous revisions of this specification, the aim values and maximum and minimum limits for each major alloying element (C, Si, Mn, Cr, Cu, Ni, Mo, and V) and related maximum and minimum carbon equivalent on formulations shall be established for acceptance of this product, shall be reported to NAVSEA and shall represent statistically determined variations due to manufacturing tolerances. The carbon equivalent shall be determined using the formula specified in 4.8.1.3. The maximum and minimum chemical range limits and related carbon equivalents shall be supported by data to demonstrate that mechanical properties can be achieved with the range established. It is not intended that data be provided to support the maximum and minimum limit for each element. The data must demonstrate that material with high and low carbon equivalent due to the elements promoting hardenability at the high limits or low limits of the composition range for the formulation will meet the mechanical properties requirements.

4.8.1.2.1 Uniformity of composition plan for MIL-10018-M1 and MIL-12018-M2 types. The manufacturer must have a NAVSEA approved test plan to verify uniformity of chemical composition in each lot. The test plan must exhibit a 95 percent confidence level, based on statistical analysis of actual test data, that not less than 95 percent of the material from each lot will be within the chemistry range specified for each element in accordance with 4.8.1.2. The plan shall identify how any material found to fall outside the 95 percent confidence limits established during qualifications shall be discarded or subjected to additional conformance testing to confirm that mechanical properties are acceptable.

4.8.1.3 Carbon equivalent control for MIL-12018-M2. The manufacturer shall establish the chemical uniformity of the lot of MIL-12018-M2 electrodes and shall calculate the high and low carbon equivalent (C.E.) based on actual chemical analysis and statistically determined extremes of core wire and coating composition (see 4.8.1.2) using the following formula:

$$C.E. = \%C + \frac{\%Si}{30} + \frac{(\%Mn + \%Cr + \%Cu)}{20} + \frac{\%Ni}{60} + \frac{\%Mo}{15} + \frac{\%V}{10} + 5(\%B)$$

where

%	is percent
C	is carbon
Si	is silicon
Mn	is manganese
Cr	is chromium
Cu	is copper
Ni	is nickel
Mo	is molybdenum
V	is vanadium
B	is boron



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4.9 Mechanical tests. Mechanical tests of welded test assemblies shall be in accordance with MIL-E-22200 unless otherwise specified below.

4.9.1 Tensile test requirements. Two tensile test specimens shall be prepared and tested in accordance with AWS B4.0.

4.9.2 Transverse side bend requirements. Two transverse side bend specimens shall be prepared and tested in accordance with AWS B4.0.

4.9.3 Impact test requirements.

4.9.3.1 Charpy V-Notch testing. The Charpy V-notch specimens shall be machined to dimensions as specified in AWS B4.0. The notch shall be perpendicular to the plate surface. Impact properties for five specimens shall be obtained at each test temperature specified in table III plus or minus 3°F.

4.9.3.2 Dynamic tear testing. Dynamic tear testing shall have specimens machined and tested in accordance with ASTM E 604. Two dynamic tear specimens shall be tested at each temperature as specified in table III.

4.10 Nondestructive testing.

4.10.1 Radiography. The weld shall be inspected radiographically to level 2-2T as specified in MIL-STD-271. Radiographic inspection is not required for MIL-12018-M2 weldments made at high cooling rates.

4.11 Identification, requirements, rejection, and retest. The identification of melts, heats, or lots; the general requirements for test specimens; the rejection of nonconforming lots or specimens; and the retest and resubmittal of nonconforming lots shall be in accordance with MIL-E-22200, except as specified herein.

4.12 Certification of quality conformance. A certification of quality conformance shall be furnished with each lot of material offered for acceptance. The certification shall include quantitative results of specified chemical and mechanical tests, and qualitative results of nondestructive tests on the lot. The minimum quality conformance test result data required shall be in accordance with 4.12.1. The cause for any retest shall be reported for information and the results of all tests, including failures, shall be reported. Wet mix equivalency test results data is shown in the sample form on figure 5 (see 6.3).

4.12.1 Quality conformance test data. The minimum quality conformance test data shall include results of all tests required by this specification and MIL-E-22200. Operational parameters for any welded test assemblies shall also be reported. The manufacturer, customer, MIL-type, heat, lot, size and form shall be identified. The certification shall include the statement: "We hereby certify that the above material has been inspected and tested in accordance with the listed specification and is in conformance with all



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requirements." and shall bear the signature of the responsible company official.

4.13 Inspection of packaging. Sample packages and packs, and the inspection of the preservation-packaging, packing and marking for shipment and storage shall be in accordance with the requirements of section 5.

## 5. PACKAGING

5.1 Packaging. Packaging shall be as specified in MIL-E-22200.

## 6. NOTES

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

6.1 Intended use. This specification is intended to cover several arc-welding steel electrodes of various alloys and strength levels that deposit weld metal that meets the mechanical property requirements given herein. These electrodes have an extremely low covering moisture content and should reduce the likelihood of underbead cracking in welding of such high yield strength steels as HY-80 and HY-100 of MIL-S-16216.

6.1.1 MIL-7018-M. This type is intended for general use in the welding of ordinary strength and high tensile steels such as grade DH-36 and grade EH-36T of MIL-S-22698 and for attachment of such steels to high yield strength steels such as HY-80 and HY-100. This type can be used for as-welded and stress-relieved applications. This electrode is intended for use with dc, reverse polarity electrical characteristics only.

6.1.2 MIL-10018-M1. This type is intended for general use in the welding of HY-80, and HSLA-80 steels for as-welded and stress-relieved applications. This electrode is intended for use with dc, reverse polarity electrical characteristics only.

6.1.3 MIL-12018-M2. This type is intended for general use in the welding of HY-100 and HSLA-100 steel for as-welded applications. This electrode is intended for use with dc, reverse polarity electrical characteristics only.

6.1.4 All types with suffix RC. This type is intended to cover electrodes for welding pressure and strength welds that will be subject to irradiation.

6.2 Acquisition requirements. Acquisition documents must specify the following:

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- (a) Title, number and date of this specification.
- (b) Type, class, and size required (see 1.2).
- (c) Issue of the DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1 and 2.2).
- (d) Whether stress relieving treatments are required (see 3.4).
- (e) Whether higher maximum yield strength is allowed (see footnote 4/ of table III).
- (e) Whether the copper content is restricted as designated by the suffix RC to the MIL-type (see footnote 2/ to table IV).
- (f) Whether heat or lot identification is required for individual electrodes (see 3.6.1).
- (g) For 3/32 inch size electrode, the length required (see footnote 1/ to table V).
- (h) Whether stress relieved quality conformance inspection is required for types MIL-7018-M and MIL-10018-M1 (see footnote 2/ to table VIII and footnote 2/ to table IX).
- (i) Whether a second test weldment using grade A, ASTM A 710 or grade HSLA-80, MIL-S-24645 steel base plate material is required (see 4.5.1(b)).
- (j) What preheat and interpass temperature; and, heat input requirements are required (see table IX, footnote 3/).
- (k) Whether representative electrode must be identified for receipt inspection (see 4.8).

6.2.1 Ordering unit. Electrodes should be ordered by the pound.

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 (CDRL) (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.

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Reference Paragraph	DID Number	DID Title	Suggested Tailoring
4.12	DI-MISC-80678	Certification/ data report	Figure 5

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 of contract, qualified for inclusion in Qualified Products List QPL-22200 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 Commander, SEA 03R42, Naval Sea Systems Command, 2531 Jefferson Davis Highway, Arlington, VA 22242-5160 and information pertaining to qualification of products may be obtained from that activity. Application for qualification tests shall 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 Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

6.5 Inspection after delivery. Post delivery inspection of electrodes to determine conformance to this specification and for acceptance thereof is the responsibility of the contracting activity. Post delivery inspection testing of electrodes intended for critical applications, such as submarine structures, shall be in accordance with the applicable fabrication document.

6.6 Subject term (key word) listing.

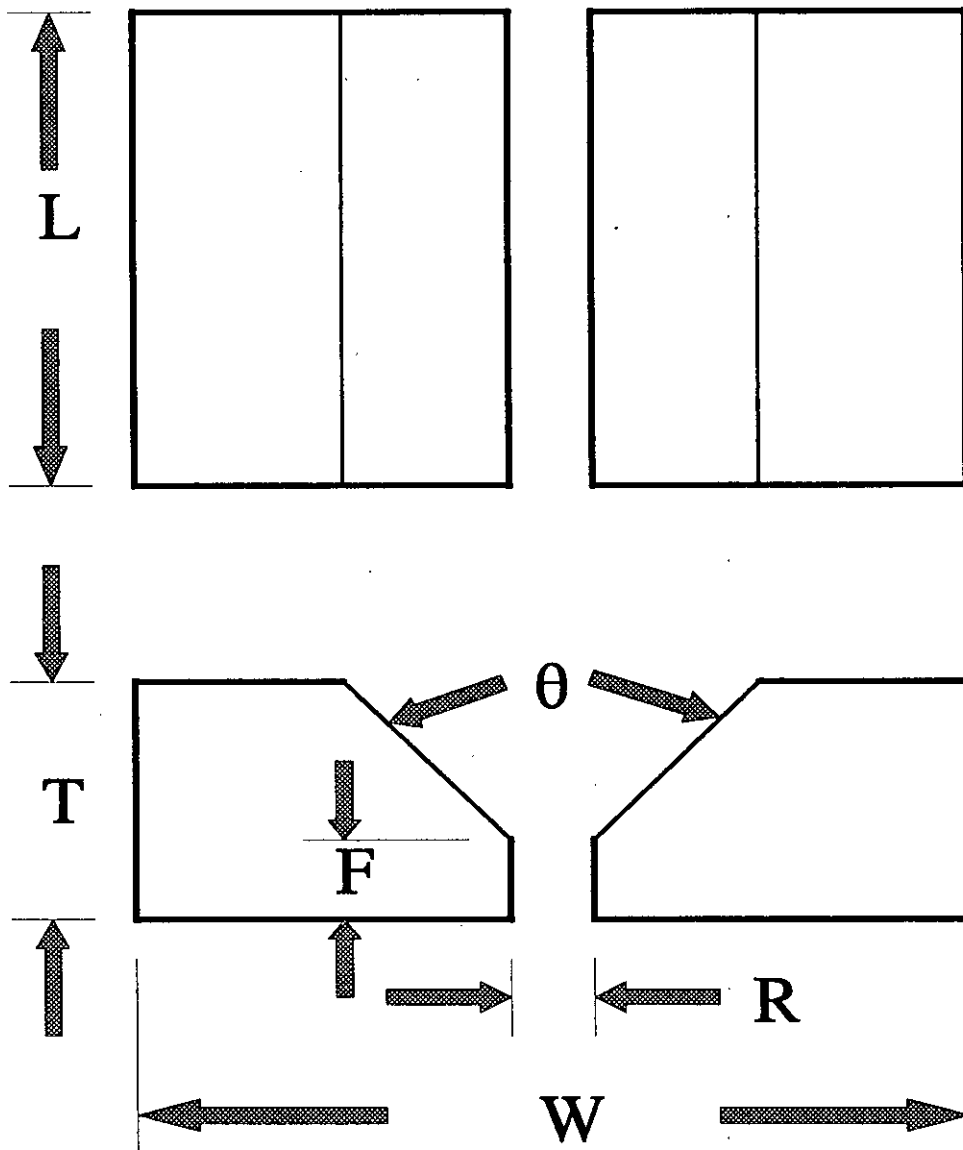
Dynamic tear  
Elongation  
HSLA-80 and -100 steel  
HY-80 and -100 steel  
Moisture resistant  
Stress-relieved  
Yield strength

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6.7 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-N839)

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1/ See table XIV.

FIGURE 1. Welded test assembly for MIL-7018-M and MIL-10018-M1 for stress relieved applications. 1/

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TABLE XIV. Welded test assembly.

MIL-type	Stress relieved applications	
	7018-M	
Purpose	Qualification	Quality conformance
Welding process	SMAW	SMAW
Stress relief	(See note 1.)	(See note 1.)
Base material	4.5.1	4.5.1
Welding parameters	(See note 2.)	(See note 2.)
Joint configuration	Figure 1	Figure 1
Thickness (T) (inches)	3/4	3/4
Width (W) (inches)	15 minimum	15 minimum
Length (L) (inches)	18 minimum	18 minimum
Root opening (R) (inches)	1/4	1/4
Root face (F) (inches)	0 to 3/16	0 to 3/16
Included angle (X) (degrees)	45	45
Backing strap dimensions (inches)	1/2 by 1	1/2 by 1
Test specimens (number/type)	2 Tensile 5 Charpy (See note 3.)	2 Tensile 5 Charpy (See note 3.)

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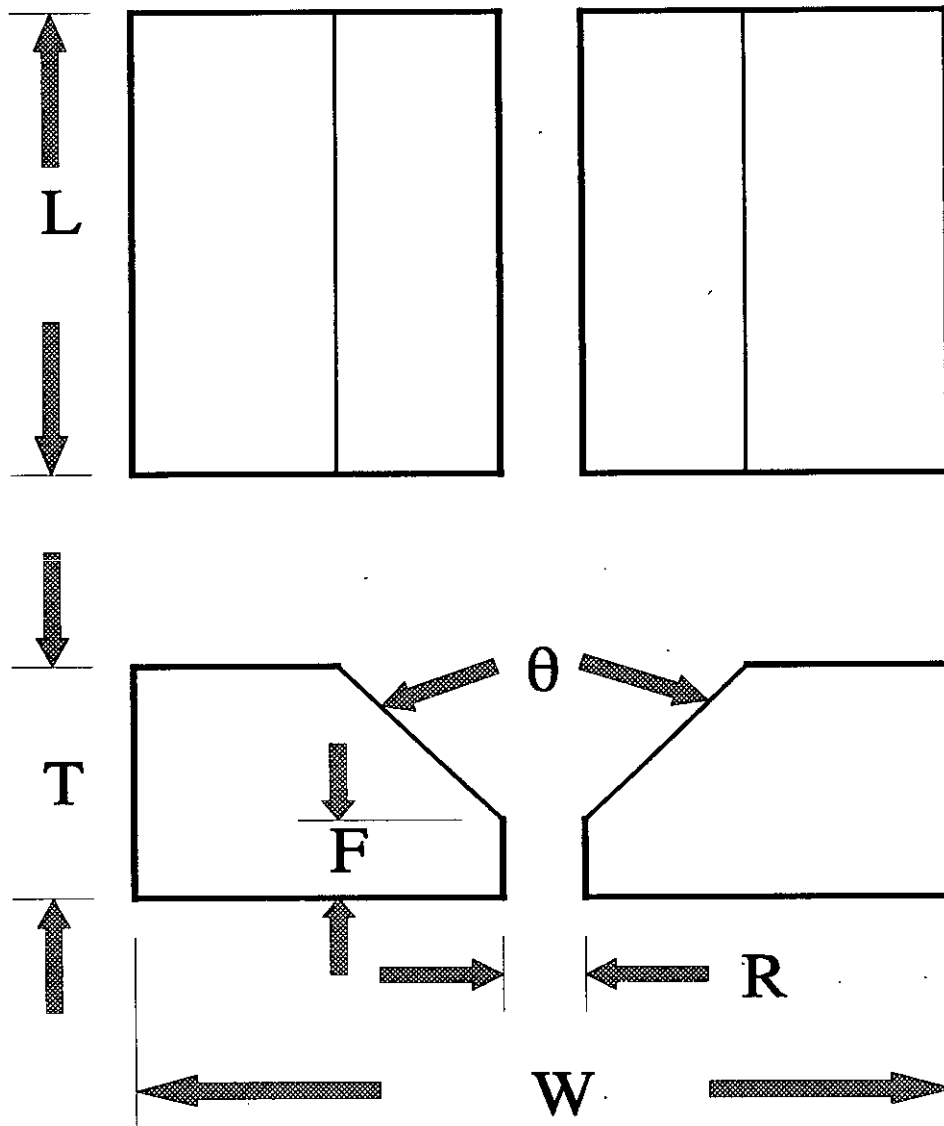
TABLE XIV. Welded test assembly. (cont'd)

MIL-type	Stress relieved applications	
	10018-M1	
Purpose	Qualification	Quality conformance
Welding process	SMAW	SMAW
Stress relief	(See note 1.)	(See note 1.)
Base material	4.5.1	4.5.1
Welding parameters	(See note 2.)	(See note 2.)
Cooling rate	High and low	High and low
Joint configuration	Figure 1	Figure 1
Thickness (T) (inches)	3/4	3/4
Width (W) (inches)	15 minimum	15 minimum
Length (L) (inches)	24 minimum	24 minimum
Root opening (R) (inches)	1/4	1/4
Root face (F) (inches)	0 to 3/16	0 to 3/16
Included angle (X) (degrees)	45	45
Backing strap dimensions (inches)	1/2 by 1	1/2 by 1
Test specimens (number/type)	2 Tensile 2 Bend 10 Charpy (See note 3.)	2 Tensile 2 Bend 10 Charpy (See note 3.)

## Notes to table XIV:

1. Prior to machining specimens or removing backing strip, weldments shall be stress relieved in accordance with 3.4.
2. Welding currents and pass sequence shall be in accordance with sound welding practices, and as recommended by the manufacturer. The minimum preheat and maximum interpass temperatures shall be 250 and 500°F, respectively. Should welding be interrupted, the assembly may be allowed to cool in still air at room temperature, and prior to resumption of welding, the assembly shall be reheated to the minimum preheat temperature.
3. After completion of the weld and stress relief, it shall be allowed to cool, the weld reinforcement and backing strip shall be removed flush with the base plate. The backing strip may be removed by the air carbon arc gouging process. No base metal shall be removed within 1/2 inch of the edges of the face of the weld by flame cutting. Only sawing or machining shall be used.

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1/ See table XV.

FIGURE 2. Welded test assembly for MIL-7018-M and MIL-10018-M1 tests and for MIL-12018-M2 low cooling rate tests. 1/



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TABLE XV. Welded test assembly.

MIL-type	7018-M	
Purpose	Qualification	Quality conformance
Welding process	SMAW	SMAW
Stress relief	(See note 1.)	(See note 1.)
Base material	4.5.1	4.5.1
Welding parameters	(See note 2.)	(See note 2.)
Joint configuration	Figure 2	Figure 2
Thickness (T) (inches)	3/4	3/4
Width (W) (inches)	15 minimum	15 minimum
Length (L) (inches)	18 minimum	18 minimum
Root opening (R) (inches)	1/4	1/4
Root face (F) (inches)	0 to 3/16	0 to 3/16
Included angle (X) (degrees)	45	45
Backing strap dimensions (inches)	1/2 by 1	1/2 by 1
Test specimens (number/type)	2 Tensile 5 Charpy (See note 3.)	2 Tensile 5 Charpy (See note 3.)

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TABLE XV. Welded test assembly. (cont'd)

MIL-type	10018-M1	
Purpose	Qualification	Quality conformance
Welding process	SMAW	SMAW
Stress relief	(See note 1.)	(See note 1.)
Base material	4.5.1	4.5.1
Welding parameters	(See note 2.)	(See note 2.)
Cooling rate	High and low	High and low
Joint configuration	Figure 2	Figure 2
Thickness (T) (inches)	3/4	3/4
Width (W) (inches)	15 minimum	15 minimum
Length (L) (inches)	24 minimum	24 minimum
Root opening (R) (inches)	1/4	1/4
Root face (F) (inches)	0 to 3/16	0 to 3/16
Included angle (X) (degrees)	45	45
Backing strap dimensions (inches)	1/2 by 1	1/2 by 1
Test specimens (number/type)	2 Tensile 2 Bend 10 Charpy AND 4 DT (See note 3.)	2 Tensile 2 Bend 10 Charpy OR 4 DT (See note 3.)

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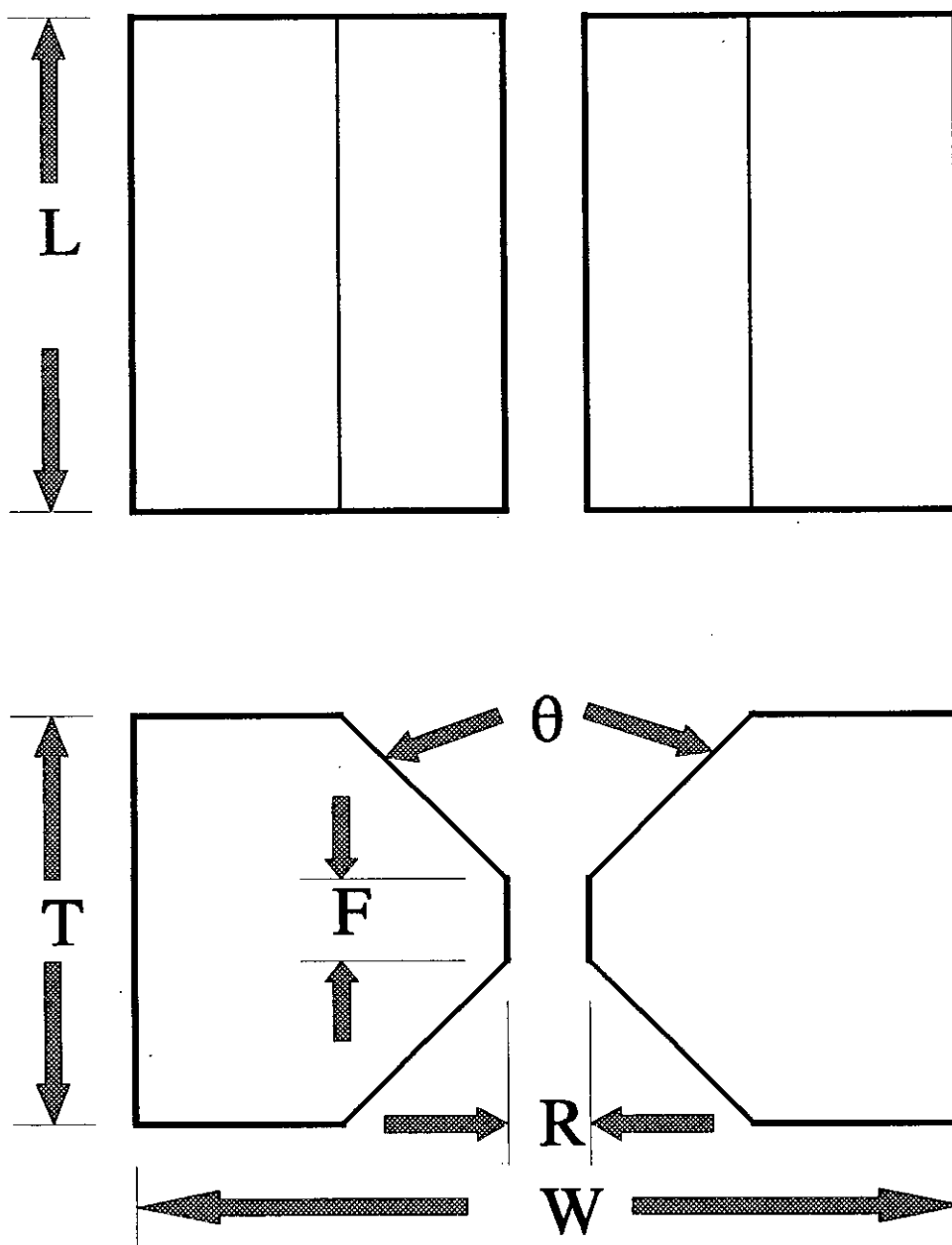
TABLE XV. Welded test assembly. (cont'd)

MIL-type	12018-M2	
Purpose	Qualification	Quality conformance
Welding process	SMAW	SMAW
Stress Relief	(See note 1.)	(See note 1.)
Base material	4.5.1	4.5.1
Welding parameters	(See note 2.)	(See note 2.)
Cooling rate	Low	Low
Joint Configuration	Figure 2	Figure 2
Thickness (T) (inches)	3/4	3/4
Width (W) (inches)	15 minimum	15 minimum
Length (L) (inches)	30 minimum	24 minimum
Root opening (R) (inches)	1/2	1/2
Root face (F) (inches)	0 to 3/16	0 to 3/16
Included angle (X) (degrees)	45	45
Backing strap dimensions (inches)	1/2 by 1	1/2 by 1
Test specimens (number/type)	2 Tensile 2 Bend 10 Charpy <u>AND</u> 4 DT (See note 3.)	2 Tensile 2 Bend 10 Charpy <u>OR</u> 4 DT (See note 3.)

## Notes to table XIV:

1. Welded test assemblies shall not be stress relieved. Heat soaking for hydrogen removal is prohibited.
2. The welding-heat input shall be as specified in 4.5.1. Welding may be continuous except for interpass cooling. Time delay per pass beyond that necessary for interpass cooling shall be reported. The preheat and interpass temperature shall be in accordance with 4.5.1. When MIL-10018-M1 tests are conducted with MIL-S-24645 or ASTM A 710 steel, the preheat for the high cooling rate test shall be 60 to 125°F.
3. After completion of the weld, it shall be allowed to cool, the weld reinforcement backing strip shall be removed flush with the base plate. The backing strip may be removed by the air carbon arc gouging process. No base metal shall be removed within 1/2 inch of the edges of the face of the weld by flame cutting. Only sawing or machining shall be used.

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1/ See table XVI.

FIGURE 3. Welded test assembly for MIL-12018-M2 high cooling rate tests. 1/

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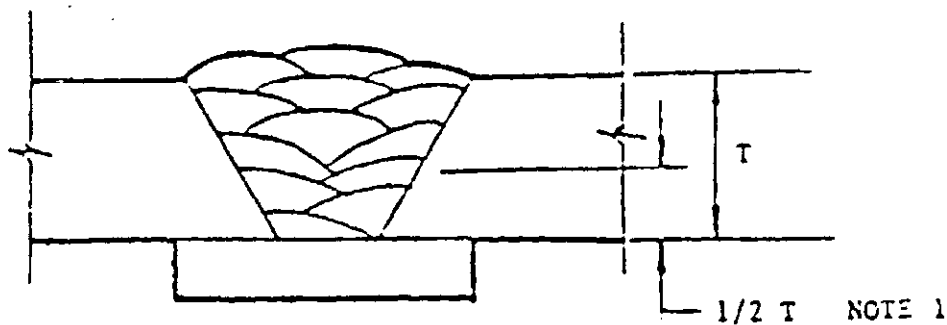
TABLE XVI. Welded test assembly.

MIL-type	12018-M2	
Purpose	Qualification	Quality conformance
Welding process	SMAW	SMAW
Stress Relief	(See note 1.)	(See note 1.)
Base material	4.5.1	4.5.1
Welding parameters	(See note 2.)	(See note 2.)
Cooling rate	High	High
Joint Configuration	Figure 3	Figure 3
Thickness (T) (inches)	2	2
Width (W) (inches)	15 minimum	15 minimum
Length (L) (inches)	30 minimum	24 minimum
Root opening (R) (inches)	0 to 3/16	0 to 3/16
Root face (F) (inches)	0 to 3/16	0 to 3/16
Included angle (X) (degrees)	45	45
Backing strap dimensions (inches)	N.A.	N.A.
Test specimens (number/type)	From <u>EACH</u> side: 2 Tensile 2 Bend 10 Charpy <u>AND</u> 4 DT (See note 3.)	From <u>EACH</u> side: 2 Tensile 2 Bend 10 Charpy <u>OR</u> 4 DT (See note 3.)

## Notes to table XV:

1. Welded test assemblies shall not be stress relieved. Heat soaking for hydrogen removal is prohibited.
2. The welding-heat input shall be as specified in 4.5.1. Welding may be continuous except for interpass cooling. Time delay per pass beyond that necessary for interpass cooling shall be reported. The preheat and interpass temperature shall be in accordance with 4.5.1.
3. After completion of the weld, it shall be allowed to cool, the weld reinforcement shall be removed flush with the base plate. No base metal shall be removed within 1/2 inch of the edges of the face of the weld by flame cutting. Only sawing or machining shall be used.

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## NOTES

1. The split-weave technique (the practice of depositing only two wide-weave beads per weld layer) shall be limited to the first  $1/2T$  of weld joint thickness. Each weld layer beyond the first  $1/2T$  of weld joint thickness shall contain three or more weld beads. For MIL-10018-M1 and MIL-12018-M2 electrodes, groove-weld metal test plates shall be in accordance with table IX.

FIGURE 4. Test weldment bead placement.

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CERTIFICATION OF WET MIX EQUIVALENCY TESTS (SEE NOTES 1 AND 2)

Manufacturer or distributor \_\_\_\_\_ Customer's name \_\_\_\_\_  
 Address \_\_\_\_\_  
 Date \_\_\_\_\_ Customer's order no. \_\_\_\_\_  
 Specification MIL- \_\_\_\_\_  
 Type MIL- \_\_\_\_\_  
 Diameter size \_\_\_\_\_ Core wire heat no. \_\_\_\_\_  
 Lot no. \_\_\_\_\_ Wet mix no. \_\_\_\_\_  
Chemical analysis  
 Manganese \_\_\_\_\_  
 Nickel \_\_\_\_\_  
 Copper (see note 3) \_\_\_\_\_ Amperage \_\_\_\_\_

We hereby certify that the above material has been tested in accordance with the listed specification and is in conformance with all requirements.

\_\_\_\_\_  
 Authorized contractor representative

## NOTES:

1. Items not applicable to the type electrode involved or exempted by the acquisition document shall be marked N/A.
2. One copy of this form shall be employed for certifying equivalency of each wet mix in a lot where applicable. One copy of the quality conformance certificate for the lot shall be forwarded with copies of the mix equivalency certificates for each additional mix from that lot that is included in the shipment.
3. Copper content is required for MIL-types with RC suffix (see footnote 2/ to table IV).

FIGURE 5. Sample certification of wet mix equivalency tests.

## STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the comment number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of this form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

**I. RECOMMEND A CHANGE:**

1. DOCUMENT NUMBER  
MIL-E-22200/10C

2. DOCUMENT DATE (YYMMDD)

## 3. DOCUMENT TITLE

ELECTRODES, WELDING, MINERAL COVERED, IRON-POWDER, LOW-HYDROGEN MEDIUM, HIGH TENSILE AND HIGHER-STRENGTH LOW ALLOY STEELS

4. NATURE OF CHANGE (identity paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)

## 5. REASON FOR RECOMMENDATION

## 6. SUBMITTER

A. NAME (Last, First, Middle Initial)

b. ORGANIZATION

c. ADDRESS (include Zip Code)

d. TELEPHONE (Include Area Code)

7. DATE SUBMITTED (YYMMDD)

(1) Commercial  
(2) DSN  
(if applicable)

## 8. PREPARING ACTIVITY

A. NAME Technical Point of Contact (TPOC)

JOHN DORN, SEA 03M21

ADDRESS ALL CORRESPONDENCE AS FOLLOWS:

b. TELEPHONE (Include Area Code)

(1) Commercial:

DSN:

TPOC: 703-602-0205

8-332-0205

c. ADDRESS (Include Zip Code)

COMMANDER, NAVAL SEA SYSTEMS COMMAND

ATTN: SEA 03R42

2531 JEFFERSON DAVIS HIGHWAY

ARLINGTON, VA 22242-5160

IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT:

Defense Quality and Standardization Office

5203 Leesburg Pike, Suite 1403

Falls Church, VA 22041-3466

Telephone 703-756-2340 DSN 289-2340