INCH-POUND

MIL-DTL-442F
9 January 2008
SUPERSEDING
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10 November 2000

DETAIL SPECIFICATION

CABLE, (WIRE), TWO CONDUCTOR, PARALLEL

Inactive for new design after 16 June 1997

This specification is approved for use by all
Departments and Agencies of the Department of Defense.

1. SCOPE

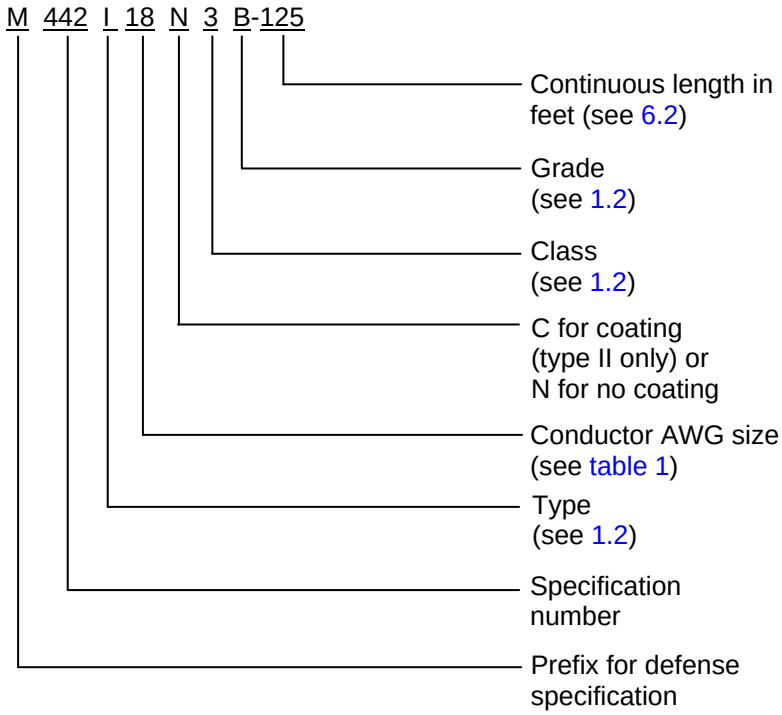
1.1 Scope. This specification covers cables that have two parallel conductors that can be separated for any desired distance by tearing apart by hand.

1.2 Classification. Cables are of the following types, classes, and grades as specified (see table 1 and 6.2).

Type I	-	Solid copper wire conductor
Type II	-	Stranded copper wire conductor
Type III	-	Stranded high tensile copper alloy wire conductor
Class 1	-	Vinyl polymer insulated
Class 2	-	Synthetic rubber insulated
Class 3	-	Natural rubber insulated
Grade A	-	Finished cable conforming to flexibility requirements at -55 °C
Grade B	-	Finished cable conforming to flexibility requirements at -40 °C

Comments, suggestions, or questions on this document should be addressed to Defense Supply Center, Columbus, ATTN: DSCC-VAI, P.O. Box 3990, Columbus, Ohio 43218-3990, or email to WireCable@dscc.dla.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at http://assist.daps.dla.mil.

1.3 Part or Identifying Number (PIN). The PIN to be used for cable acquired to the specification may be created as follows:



2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, or 5 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

FEDERAL STANDARDS

FED-STD-228 – Cable and Wire, Insulated; Methods of Testing

FED-STD-601 – Rubber, Sampling and Testing

COMMERCIAL ITEM DESCRIPTION

A-A-59551 – Wire, Electrical, Copper (Uninsulated)

(Copies of these documents are available online at http://assist.daps.dla.mil/quicksearch/ or http://assist.daps.dla.mil or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the in the solicitation or contract.

ASTM INTERNATIONAL

ASTM-D412	-	Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension
ASTM-D572	-	Standard Test Method for Rubber – Deterioration by Heat and Oxygen
ASTM-D1149	-	Rubber Deterioration-Surface Ozone Cracking in a Chamber
ASTM-D3354	-	Standard Test Method for Blocking Load of Plastic Film by the Parallel Plate Method (non adopted NGS document)
ASTM-G21	-	Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi

(Copies of these documents are available online at http://www.astm.org or from the ASTM International, P.O. Box C700, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.)

NATIONAL CONFERENCE OF STANDARDS LABORATORIES (NCSL)

NCSL - Z540.1 – Calibration Laboratories and Measuring and Test Equipment

(Copies of these documents are available online at http://www.ncsli.org or from the National Conference of Standards Laboratories (NCSL), 2995 Wilderness Place, Suite 107, Boulder, CO 80301-5404.)

2.4 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 Construction. The cable shall be constructed to permit separation of the individual conductors for any given distance and still retain complete insulation coverage when slit at the end and intentionally torn apart. The physical and electrical characteristics of the wire shall be as specified in table 1.

TABLE I. Physical and electrical characteristics.

Cable types	Conductor 1/ AWG	Area, circular mils (nominal)	No. of strands (minimum)	Strand diameter Inch (mm) (nominal)	Overall max. dia. of cross-section, inch (mm)	
					Width	Height
I	20 18	1020 1620	Solid Solid	.032 (.81) .040 (1.02)	.188 (4.78) .204 (5.18)	.094 (2.39) .102 (2.59)
II	22 20 18	640 1020 1620	16 26 41	.0063 (.16) .0063 (.16) .0063 (.16)	.188 (4.78) .219 (5.56) .219 (5.56)	.094 (2.39) .109 (2.77) .109 (2.77)
III	18	1620	41	.0063 (.16)	.219 (5.56)	.109 (2.77)

1/ See 6.2

3.2 Material.

3.2.1 Conductor.

3.2.1.1 Types I and II. Type I and II conductors shall be drawn and annealed copper wire material with no coating, conforming to A-A-59551. When specified (see 6.2 and 6.8), type II conductors shall be coated with a tin lead alloy (2 to 3 % minimum).

3.2.1.1.1 Pure tin. The use of pure tin, as an underplate or final finish, is prohibited both internally and externally. Tin content of cable wire and solder shall not exceed 97 percent, by mass. Tin shall be alloyed with a minimum of 3 percent lead, by mass (see 6.8).

3.2.1.2 Type III. Type III conductor shall be composed of high tensile copper alloy (nominal composition of 99% copper and 1% cadmium) strands so as to meet the breaking strength and electrical requirements specified herein.

3.2.1.2.1 Resistance (type III). The maximum conductor dc resistance at 20 °C for type III conductor shall be 10 ohms/1,000 feet.

3.2.2 Size. Each conductor shall consist of one or an assembly of strands, and the conductor size and thickness of insulation surrounding each conductor shall be as specified in table 1 and 3.3, respectively.

3.2.3 Joints. Joints in a solid conductor or in any of the individual wires of a stranded conductor shall be so constructed and disposed throughout the conductor that the diameter, configuration, conductor resistance, flexibility, and mechanical strength of the complete conductor are not adversely affected.

3.2.4 Separator. A separator shall be provided between the conductor and insulation for class 2 and 3 cables. The separator shall consist of dry, soft, fungus- resistant cotton braid and so applied that the separator shall cover the conductor completely. The separator on one conductor shall be colored white and the separator on the other conductor shall be black. When tin coated copper conductors are specified, the separator may be omitted.

3.2.5 Breaking strength (type III). The type III finished cable shall withstand 175 pounds in tension without rupture of the insulation or either conductor.

3.2.6 Recycled, recovered, or environmentally preferable materials. Recycled, recovered, or environmentally preferable materials should be used to the maximum extent possible, provided that the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life cycle costs.

3.3 Insulation (classes 1, 2, and 3). The minimum insulation thickness between conductors shall be .0469 inches (1.19 mm), the maximum insulation thickness surrounding each conductor shall be .0345 inches (.88 mm), and there shall be not less than .013 inch (.33 mm) of insulation at any point on each conductor. The insulation material shall meet the applicable physical property values specified in table II and table III accordingly.

TABLE II. Insulation physical properties.

Property	Class 1	Class 2	Class 3
Tensile strength (psi) minimum	1,500	1,200	3,000
Ultimate elongation (percent) minimum	150	300 1/	650 1/
Tension set maximum in inches (mm) (2 inch to 5 inch stretch)	Not applicable	.5 (12.70)	.063 (1.60)

1/ 2.0 inch gauge length.

TABLE III. Insulation physical properties (after aging).

Property	Class 1	Class 2	Class 3
Tensile strength (psi) minimum	Not applicable	900	2,500
Ultimate elongation (percent) minimum	Not applicable	195 1/	455 1/

1/ 2.0 inch gauge length.

3.3.1 Vinyl polymer compound (class 1). The insulation material shall be a black, fungus-resistant vinyl polymer compound.

3.3.1.1 Heat resistance. The vinyl polymer compound shall not become soft or tacky as determined by the “blocking test” when exposed to the conditions specified in 4.4.8.1.1.

3.3.2 Synthetic rubber compound (class 2). The insulation material shall be a vulcanized copolymer of butadiene and styrene or a blend of synthetic and natural rubber.

3.3.2.1 Synthetic rubber compound aging. The insulation material shall meet the physical property values of table III when exposed to the conditions specified in 4.4.8.2.

3.3.3 Natural rubber compound (class 3). The insulation material shall be a cured natural rubber.

3.3.3.1 Natural rubber compound aging. The insulation material shall meet the physical property values of table III when exposed to the conditions specified in 4.4.8.3.

3.4 Finished cable.

3.4.1 Dielectric strength. The cable shall withstand a potential of 1,000 volts at 60 Hz for a minimum of one minute duration.

3.4.2 Insulation resistance. The minimum resistance value per 1,000 feet of cable shall be 50 megohms when a dc voltage between 200 to 500 volts is applied for a minimum of one minute duration.

3.4.3 Flexibility. The cable shall be flexible when exposed to temperatures of –40 °C or –55 °C as applicable for the specified cable grade, and shall show no evidence of cracking, chipping, or other damage when flexed at this temperature.

3.4.4 Ozone resistance (class 2 and 3). Insulation for class 2 and 3 cable shall conform to the ozone resistance in accordance with requirements of ASTM-D1149.

3.5 Workmanship. The cable shall be free of kinks, abrasions, cracks, and peeled surfaces. The cable shall be clean, smooth, uniform in cross section and free from any defects that adversely affect the serviceability of the product.

4. VERIFICATION

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

Conformance inspection (see 4.3)

4.2 Test equipment and inspection facilities. Test and measuring equipment and inspection facilities of sufficient accuracy, quality, and quantity to permit performance of the required inspection shall be established and maintained by the contractor. The establishment and maintenance of a calibration system to control the accuracy of the measuring and test equipment (e.g., Industry Standard, Defense Standard) shall be in accordance with NCSL-Z540.1 or equivalent.

4.3 Conformance inspection. Conformance inspection shall consist of group A and B inspections. Conformance inspection shall be performed on every lot of cable procured under this specification.

4.3.1 Inspection lot. Unless otherwise specified by the contract, an inspection lot shall consist of finished cable on reels or spools of one type, class, grade, and conductor AWG produced under essentially the same conditions, on the same machine and offered for inspection at one time.

4.3.2 Unit of product. The unit of product shall be the quantity of cable offered for inspection on one reel or spool.

4.3.3 Group A inspection. Group A inspection shall consist of the inspections specified in table IV and shall be performed on each lot of cable acquired under the specification. Group A inspections may be performed at an appropriate stage of the manufacturing operation rather than on the finished cable.

TABLE IV. Group A inspections.

Inspection	Requirement	Verification
Resistance (type III)	3.2.1.2.1	4.4.3
Size	3.2.2	4.4.5
Joints	3.2.3	4.4.4
Separator (colors)	3.2.4	4.4.6
Breaking strength (type III)	3.2.5	4.4.7
Insulation (thickness)	3.3	4.4.8
Vinyl polymer compound (color)	3.3.1	4.4.8.1
Dielectric strength	3.4.1	4.4.9.1
Insulation resistance	3.4.2	4.4.9.2
Flexibility	3.4.3	4.4.9.3
Ozone resistance	3.4.4	4.4.9.4
Workmanship	3.5	4.4.10

4.3.4 Group B inspections.

4.3.4.1 Material. One reel or spool shall be selected at random as a control sample from each 200 produced, or from each month's production, whichever occurs first. Test specimens from this control sample shall be subjected to the verifications listed in table V.

TABLE V. Group B inspections.

Inspections	Requirement	Verification
Construction	3.1	4.4.1
Material	3.2	4.4.2, 4.4.10
Conductor	3.2.1	4.4.2.1
Separator (fungus)	3.2.4	4.4.6
Insulation (physical property values)	3.3	4.4.8
Vinyl polymer compound (fungus resistant)	3.3.1	4.4.8.1

4.3.4.2 Environmental. One reel or spool shall be selected at random as a control sample from each 100 produced, or from each month's production, whichever occurs first. Test specimens from this control sample shall have passed the group A inspection specified herein, and shall be subjected to the verifications in table VI.

TABLE VI. Environmental inspections.

Inspection	Requirement	Verification
Vinyl polymer heat resistance	3.3.1.1	4.4.8.1.1
Synthetic rubber compound aging	3.3.2.1	4.4.8.2
Natural rubber compound aging	3.3.3.1	4.4.8.3

4.3.4.3 Specimen lengths. Unless otherwise specified herein, the specimen shall be of the length specified in the applicable test method.

4.3.5 Rejected lot. If one or more specimens in the lot fail to pass a group A or group B verification test or inspection, the entire lot shall be rejected. Disposition shall be in accordance with the contract (see 6.2).

4.3.6 Non compliance. If a specimen fails to pass group B inspections (see 4.3.4), the contractor shall take action according to the contract (see 6.2).

4.4 Methods of inspection.

4.4.1 Construction. Construction of the cable to permit separation of the individual conductors shall be tested by taking a 2-foot specimen and slitting the end approximately .5 inch (12.7 mm) in length between the two conductors. Grasp each conductor and tear the entire two-foot length. The cable should separate cleanly without exposing any bare wire.

4.4.2 Material examination. All material, including conductors, shall be examined for compliance with specified requirements.

4.4.2.1 Conductor. The material for types I and II conductors shall be inspected for conformance with A-A-59551 and type III conductor shall be inspected to verify conformance with 3.2.1.2.

4.4.3 Conductor resistance (type III). Resistance of the type III conductor of the finished cable shall be tested in accordance with method 6021.1 of FED-STD-228.

4.4.4 Joints. The joints shall be considered acceptable when the diameter, conductor resistance (type III only), flexibility, and tensile strength tests have been successfully completed.

4.4.5 Size. Conductor diameter, either stranded or solid conductor, shall be inspected to verify conformance with requirements.

4.4.6 Separator. The separator, when used for class 2 and 3 cable, shall be checked visually to verify its presence and color. Fungus resistance shall be tested in accordance with ASTM-G21.

4.4.7 Breaking strength (type III). The breaking strength of the type III finished cable shall be determined by using a specimen of full cross section with the insulation intact. The ends of the specimen shall be secured to fixtures attached to the stationary and movable heads of a tensile testing machine, in accordance with method 3211 of FED-STD-228, by wrapping the specimen once around the fixture and making the end fast to the fixture. The fixtures shall be cylindrical, not less than .5 inch (12.7 mm) in diameter and positioned with their axes normal to and about one half of the radius from the centerline of the pull of the machine. The distance between centers of the fixtures at the start of the test shall be approximately 10 inches (254 mm) with the sample taut. The speed of travel of the movable head, with no load, shall be not more than .5 inch (12.7 mm) per minute.

4.4.8 Insulation (classes 1, 2, and 3). Insulation thickness shall be inspected in accordance with method 1013 of FED-STD-228 to verify compliance with the tolerances specified in 3.3. The physical property values, as specified in table II and table III, shall be verified through tests conducted in accordance with table VII using dumbbell specimens cut from sheets of the same material.

TABLE VII. Insulation physical property tests for dumbbell specimens.

Tests	Test method specification
Tensile strength	ASTM-D412
Elongation, ultimate	ASTM-D412
Tension set	ASTM-D412
Accelerated aging	FED-STD-601 method 7001

4.4.8.1 Vinyl polymer compound (class 1). The color of the insulation material shall be visually checked, and the fungus resistance shall be tested in accordance with ASTM-G21.

4.4.8.1.1 Heat resistance. Heat resistance shall be verified by the “Blocking Test” method, which shall be conducted in accordance with ASTM-D3354 when exposed to a temperature of 70±1 °C for 48 hours with an applied pressure of .33 psi. The test specimens shall be cut from the sheet used to obtain the tensile strength specimens of table VII.

4.4.8.2 Synthetic rubber compound (class 2) aging. The synthetic rubber compound shall be subjected to the “Oxygen Pressure Test”, ASTM-D572, after being exposed to 70±1 °C under sustained oxygen pressure of 290 to 310 psi for a minimum of 96 hours. The specimen shall then be tested to verify its table III physical properties using the applicable test method of table VII.

4.4.8.3 Natural rubber compound (class 3) aging. This material shall be subjected to the “Oxygen Pressure Test”, ASTM-D572, after being exposed to 70±1 °C under sustained oxygen pressure of 290 to 310 psi for a minimum of 96 hours. The specimen shall then be tested to verify its table III physical properties using the applicable test method of table VII.

4.4.9 Finished cable.

4.4.9.1 Dielectric strength. This test shall be performed in accordance with method 6111 of FED-STD-228.

4.4.9.2 Insulation resistance. This test shall be performed at a temperature of 15.6 °C in accordance with method 6031 of FED-STD-228. This test shall be performed as soon as possible after the dielectric strength test.

4.4.9.3 Flexibility. This test shall be performed on a specimen of finished cable approximately 7.5 inches (191 mm) long. The specimen shall be in a non-flexed position while exposed to the temperatures specified in 3.4.3. After thermal equilibrium is reached, a 1.0 inch (25.4 mm) mandrel shall be securely clamped at both ends in a horizontal position to prevent rotation and the specimen wrapped twice around the mandrel. An 11.023 pound (5 kilogram) weight shall be suspended from one end of the specimen from the mandrel. The two turns of the specimen shall be completely in contact with the mandrel prior to releasing the weight so that the specimen will be kept taut when unwinding. The free end shall not be longer than .5 inch (12.7 mm) to permit rapid unwinding of the specimen to occur from the mandrel. The mandrel shall be positioned at sufficient height to permit the specimen to drop free after unwinding from the mandrel. The specimens and test equipment shall be maintained at the specified temperature during the test, and the specimen shall be left undisturbed at that temperature for 5 minutes thereafter. The specimens shall then be visually examined for any cracks, chips, or other damage. Note: A clamp is needed to suspend the weight from the specimen, since at low temperatures the surface of the coating becomes too hard to permit any other type of attachment to be effective. For this purpose, a heavy-duty battery clip, Number 21 Mueller Universal battery clip, or its equivalent, has been satisfactory in the past.

4.4.9.4 Ozone resistance. This test shall be performed in accordance with the ozone resistance test in accordance with ASTM-D1149 except as indicated below for ozone concentration and test temperature.

4.4.9.5 Chamber environment. The ozone concentration used in this test shall be 50±3 parts of ozone per 1x 10^9 parts of air. Temperature shall be as specified in the applicable specification sheet.

4.4.10 Visual and mechanical examination. Finished cable shall be examined to determine that the materials, physical dimensions, construction, and workmanship are in accordance with the applicable requirements.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the military service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

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

6.1 Intended use. Cables covered by this specification are intended for use as shown in table VIII. The cables covered by this specification are defense unique because they must fire explosives and operate rockets under rugged, high temperature and humidity battlefield conditions not typically found in commercial operations.

TABLE VIII. Cross reference of intended use for type and class of cable.

Intended use	Type	Class	AWG
Lead wire in firing explosive charges electrically in demolition operations	I	1	20
	II, III	1	18
Rocket connectors	II	2	22, 20
General defense application where voltage does not exceed 300 volts	I, II	1, 2, 3	20, 18

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of this specification.

b. The specific issue of individual documents referenced (see 2.2.1 and 2.3).

c. Cable type, conductor AWG size , class, and grade (see 1.2 and table 1). When specifying type II, include tin coating if required (see 3.2.1.1).

d. The quantity required (length, number of reels, etc.).

e. Packaging requirements (see 5.1 and 6.5). The reel or spool should be marked for identification with the following: Type, conductor AWG size, grade, class, “in accordance with MIL-DTL-442” (without the quotation marks), date, name of manufacturer, and length of wire in units of feet.

f. Specify action to be taken if a lot fails any of the tests or inspections. In the past, if an inspection lot was rejected, the contractor was allowed to rework the lot to correct the defects, or screen out the defective units and resubmit the lot for re-inspection. Such lots were separated from new lots and were identified as re-inspected lots (see 4.3.5).

6.3 Cross-reference of classifications. Table IX shows all items of older classifications in previous issues of this specification and their equivalents in this issue.

TABLE IX. Cross-reference of classification of previous issues to current issue of this specification.

Old		New		
Type	AWG	Type	Class	AWG
I	20	I	1	20
II	18	II	1	18
III	18	III	1	18
IV	20	II	2	20
V	22	II	2	22
VI	18	II	2	18
Class 1		Grade A		
Class 2		Grade B		

6.4 Subject term (key word) listing.

Butadiene
Demolition charge
Explosives
Lead
Rocket connector
Rubber
Styrene
Vinyl polymer

6.5 Packaging. MIL-DTL-12000 has been used in the past to specify requirements for the preservation, packing, unitization, and marking of cable, cord, and wire for storage and domestic and overseas shipments.

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 extent of the changes.

6.7 Environmentally preferable material. Environmentally preferable materials should be used to the maximum extent possible to meet the requirements of this specification. As of the dating of this document, the U.S. Environmentally Protection Agency (EPA) is focusing efforts on reducing 31 priority chemicals. The list of chemicals is available on their website at http://www.epa.gov/epaoswer/hazwaste/minimize/chemlist.htm. Further information is available at the following EPA site: http://www.epa.gov/epaoswer/hazwaste/minimize/. Included in the EPA list of 31 priority chemicals are cadmium, lead, and mercury. Use of the materials on the list should be minimized or eliminated unless needed to meet the requirements specified herein (see section 3).

6.8 Tin whisker growth. The use of alloys with tin content greater than 97 percent, by mass, may exhibit tin whisker growth problems after manufacture. Tin whiskers may occur anytime from a day to years after manufacture, and can develop under typical operating conditions, on products that use such materials. Conformal coatings applied over top of a whisker-prone surface will not prevent the formation of tin whiskers. For additional information on this matter, refer to ASTM-B545 (Standard Specification for Electrodeposited Coatings of Tin).

CONCLUDING MATERIAL

Custodians:
Army - CR
Navy - OS
Air Force - 11
DLA - CC

Preparing Activity:
DLA - CC

(Project 6145-2006-011)

Review activities:
Army - AT, CR4, MI
Navy – MC

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at http://assist.daps.dla.mil.