

INCH - POUND

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SUPERSEDING
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MILITARY SPECIFICATION

RUBBER, SYNTHETIC, HEAT-SHRINKABLE

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

1. SCOPE

1.1 Scope. This specification covers the requirements for flexible, electrical insulating, extruded tubing, molded parts, and extruded shapes whose dimensions will reduce to a predetermined size upon the application of heat.

1.2 Classification. The heat-shrinkable rubber will consist of the following types and classes, 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, U.S. Army Missile Command, ATTN: AMSMI-RD-SE-TD-ST, Redstone Arsenal, AL 35898-5270 by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A

DISTRIBUTION STATEMENT A.
distribution is unlimited.

FSC 5970

Approved for public release;

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1.2.1 Type I. Cross-linked, modified polychloroprene (Neoprene) tubing, molded parts, and extruded shapes, flexible general purpose cable-jacketing, cable harness, boots and transitions, service temperature range of -55 to 90° Celsius (C).

- a. Class 1 - Tubing-cable-jacketing material, expansion ratio 1.75.
- b. Class 2 - Molded parts and extruded shapes, cable harness boots and transitions, expansion ratio 2.5.

1.2.2 Type II. Cross-linked modified flame-retardant silicone rubber tubing, molded parts and extruded shapes, highly flexible, ablative-resistant.

- a. Class 1 - Tubing, expansion ratio 1.75, service temperature range of -70 to 180°C.
- b. Class 2 - Molded parts and extruded shapes, expansion ratio 2 to 4, service temperature range -75 to 135°C.

1.2.3 Type III. Cross-linked, modified viton tubing, molded parts and extruded shapes, flexible for materials exposed to extended periods of high temperature and solvent attack.

- a. Class 1 - Tubing, expansion ratio 2, service temperature range -55 to 200°C.
- b. Class 2 - Molded parts and extruded shapes, expansion ratio 3.5, service temperature range of -55 to 200°C.

1.2.4 Type IV. Cross-linked, modified, propellant-resistant butyl rubber tubing, molded parts and extruded shapes flexible, for protection of cable assemblies exposed to hypergolic fuels.

- a. Class 1 - Tubing, expansion ratio 2, service temperature range of -55 to 125°C.
- b. Class 2 - Molded parts and extruded shapes, expansion ratio 2.5, service temperature range of -55 to 125°C.

1.2.5 Type V. Cross-linked, modified, flame-resistant elastomeric polyolefin tubing, highly flexible airborne harnessing or jacketing material where low weight, high flame-resistance, and thin walls are required, low shrinking temperature, expansion ratios 2 to 4, service temperature range of -55 to 135°C.

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1.2.6 Type VI. Cross-linked, modified, flame-resistant ethylene-propylene rubber tubing, molded parts, and extruded shapes, flexible, ozone resistant, mechanically tough.

- a. Class 1 - Tubing, expansion ratio 2, service temperature of -70 to 115°C.
- b. Class 2 - Molded parts and extruded shapes, expansion ratio 4, service temperature range of -75 to 125°C.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 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 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-B-585 - Boxes, Wood, Wirebound
- PPP-B-591 - Boxes, Fiber Board, Wood-Cleated
- PPP-B-601 - Boxes, Wood, Cleated-Plywood
- PPP-B-621 - Boxes, Wood, Nailed and Lock-Corner
- PPP-B-636 - Boxes, Shipping, Fiberboard
- PPP-T-76 - Tape, Packaging, Paper (For Carton Sealing)

MILITARY

- MIL-P-116 - Preservation, Methods of
- MIL-H-5606 - Hydraulic Fluid, Petroleum Base:
Aircraft, Missile, and Ordnance
- MIL-P-7254 - Propellant, Nitric Acid
- MIL-L-7808 - Lubricating Oil, Aircraft Turbine
Engine, Synthetic Base, NATO Code
Number O-148
- MIL-P-26539 - Propellants, Nitrogen Tetroxide

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MIL-P-27402 - Propellant, Hydrazine - uns-
Dimethylhydrazine (50% N_2H_4 - 50%
UDMH)

STANDARDS

MILITARY

MIL-STD-104 - Limits for Electrical Insulation
Color
MIL-STD-129 - Marking for Shipment and Storage
MIL-STD-1190 - Minimum Guidelines for Level C
Preservation, Packing, and Marking.

(Unless otherwise indicated, copies of the federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, Bldg. 4D, 700 Robbins Ave., 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 cited 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)

ASTM D 257 - D-C Resistance or Conductance of
Insulating Materials, Standard Test
Methods for
ASTM D 412 - Rubber Properties in Tension, Standard
Test Methods for
ASTM D 518 - Rubber Deterioration - Surface Cracking,
Standard Test Method for
ASTM D 570 - Water Absorption of Plastics, Standard
Test Method for
ASTM D 635 - Rate of Burning and/or Extent and Time
Burning of Self-Supporting Plastics in a
Horizontal Position, Standard Test Method
for
ASTM D 746 - Brittleness Temperature of Plastics and
Elastomers by Impact, Standard Test Method
for

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ASTM D 792	-	Specific Gravity (Relative Density) and Density of Plastics by Displacement, Standard Test Methods for
ASTM D 876	-	Nonrigid Vinyl Chloride Polymer Tubing used for Electrical Insulation, Standard Methods of Testing
ASTM D 1149	-	Rubber Deterioration - Surface Ozone Cracking in a Chamber, Standard Test Method for
ASTM D 2240	-	Rubber Property-Durometer Hardness, Standard Test Method for
ASTM D 2671	-	Heat-Shrinkable Tubing for Electrical Use, Standard Methods of Testing
ASTM G 21	-	Determining Resistance of Synthetic Polymeric Materials to Fungi, Standard Practice for

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

(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 First article. When specified (see 6.2), a sample shall be subjected to first article inspection (see 6.3) in accordance with 4.4.

3.2 Materials. Type I synthetic rubber specified herein shall be fabricated from a cross-linked, stabilized, modified polychloroprene (Neoprene) composition. Type II synthetic rubber shall be fabricated from a cross-linked, stabilized, flame-retardant, modified silicone rubber composition. Type III synthetic rubber shall be fabricated from a cross-linked, stabilized, flame-resistant, modified viton composition. Type IV synthetic rubber shall be fabricated from a cross-linked,

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stabilized, propellant-resistant, modified butyl rubber composition. Type V material shall be fabricated from a cross-linked, stabilized, flame-resistant, modified elastomeric polyolefin composition. Type VI synthetic rubber shall be fabricated from a cross-linked, stabilized, flame-resistant, modified ethylene-propylene rubber composition. These expanded synthetic rubbers shall shrink to predetermined dimensions upon the application of heat as follows:

- a. Types I, IV, VI - Heat in excess of 135°C
- b. Types II, III - Heat in excess of 175°C
- c. Type V - Heat in excess of 90°C

3.3 Dimensions and tolerances (see table I).

3.3.1 Extruded tubing. Unless otherwise specified (see 6.2), Types I through VI extruded tubing shall have the sizes and tolerances specified in table I, as supplied and after heating (see 4.7.3). The length of tubing shall be as specified in the contract or order.

3.3.2 Molded parts and extruded shapes. The dimensions and tolerances of heat-shrinkable molded parts and extruded shapes shall be as specified on the applicable drawings or as specified in the contract or order (see 6.2).

3.3.3 Nonstandard dimensions. Nonstandard thicknesses and shapes shall be specified by the procuring activity. Dimensional tolerances for these nonstandard thicknesses or shapes shall conform to the tolerances for the nearest standard size, unless otherwise specified (see 6.2).

3.3.4 Storage. The heat-shrinkable tubing, molded parts, and extruded shapes shall meet the requirements of this specification after accelerated storage conditioning (see 4.4.3).

3.4 Physical, electrical, and chemical properties.

3.4.1 Tubing. Types I through VI synthetic rubber tubing shall have the physical, electrical, and chemical property requirements as specified in table II (see 4.6.1).

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TABLE I. Tubing sizes and tolerances, types I through VI.

EXPANDED - AS SUPPLIED						RECOVERED DIMENSIONS - AFTER HEATING										WALL THICKNESS, INCH				
MINIMUM INSIDE DIAMETER, INCHES						MAXIMUM INSIDE DIAMETER, INCHES														
Size, Inches	Type I	Type II	Type III	Type IV	Type V	Type VI	Type I	Type II	Type III	Type IV	Type V	Type VI	Type I	Type II	Type III	Type IV	Type V	Type VI	Type I	Type II
0.046875	..	..	..	..	0.046	..	..	..	..	..	0.023	..	..	..	..	..	..	..	..	..
0.0625	..	..	..	..	0.063	..	..	..	..	..	0.031	..	..	..	..	..	..	..	..	..
0.06375	..	..	..	..	0.063	..	..	..	..	..	0.046	..	..	..	..	..	..	..	..	..
0.125	..	..	..	..	0.125	..	..	..	..	..	0.062	..	..	..	..	..	..	..	..	..
0.1675	..	..	..	..	0.167	..	..	..	..	..	0.083	..	..	..	..	..	..	..	..	..
0.25	0.250	0.250	0.250	0.250	0.250	0.250	0.143	0.143	0.125	0.125	0.125	0.125	0.125	0.035 ± .010	0.030 ± .010	0.035 ± .010	0.025 ± .003	0.030 ± .010	0.018 ± .003	..
0.375	0.375	0.375	0.375	0.375	0.375	0.375	0.214	0.214	0.187	0.187	0.187	0.187	0.187	0.040 ± .010	0.035 ± .010	0.040 ± .010	0.025 ± .003	0.035 ± .010	0.017 ± .003	..
0.5	0.500	0.500	0.500	0.500	0.500	0.500	0.286	0.286	0.250	0.250	0.250	0.250	0.250	0.048 ± .010	0.043 ± .010	0.050 ± .015	0.025 ± .003	0.043 ± .010	0.020 ± .003	..
0.625	0.625	0.625	0.625	..	..	0.625	0.357	0.357	0.312	..	..	..	..	0.052 ± .015	0.047 ± .012	..	..	0.047 ± .012	..	..
0.75	0.750	0.750	0.750	0.750	0.750	0.750	0.428	0.428	0.375	0.375	0.375	0.375	0.375	0.057 ± .015	0.052 ± .015	0.060 ± .015	0.030 ± .003	0.052 ± .015	0.030 ± .003	..
0.875	0.875	0.875	0.875	..	..	0.875	0.500	0.500	0.437	..	..	..	..	0.065 ± .015	0.060 ± .015	..	..	0.060 ± .015	..	..
1.0	1.00	1.00	1.00	1.00	1.00	1.00	0.570	0.570	0.500	0.500	0.500	0.500	0.500	0.070 ± .015	0.065 ± .015	0.075 ± .020	0.035 ± .005	0.065 ± .015	0.035 ± .005	..
1.25	1.25	1.25	1.25	..	..	1.25	0.714	0.714	0.625	..	..	..	..	0.087 ± .020	0.087 ± .020	..	..	0.070 ± .020	..	..
1.5	1.50	1.50	1.50	1.50	1.50	1.50	0.857	0.857	0.760	0.750	0.750	0.750	0.750	0.095 ± .020	0.085 ± .020	0.100 ± .020	0.040 ± .006	0.075 ± .020	0.040 ± .006	..
1.75	1.75	1.75	..	..	..	..	1.00	1.00	..	..	..	..	..	0.107 ± .020	0.107 ± .020	..	..	..	..	..
2.0	2.00	2.00	2.00	2.00	2.00	..	1.14	1.14	1.00	1.00	1.00	..	..	0.110 ± .020	0.110 ± .020	0.130 ± .020	0.045 ± .007	..	..	..
2.5	..	..	..	2.50	..	..	..	..	..	1.25	..	..	..	..	..	..	..	..	..	..
3.0	3.00	..	..	3.00	3.00	..	1.71	..	..	1.50	1.50	..	..	0.125 ± .020	..	0.140 ± .020	0.050 ± .008	..	..	..
4.0	4.00	..	..	4.00	4.00	..	2.28	..	..	2.00	2.00	..	..	0.140 ± .020	..	0.150 ± .020	0.055 ± .009	..	..	..

TABLE II. Physical, electrical, and chemical properties of synthetic rubber tubing, class I.

Property	Conditioning (see 4.6.3)						Requirement						Method
	Type I	Type II	Type III	Type IV	Type V	Type VI	Type I	Type II	Type III	Type IV	Type V	Type VI	
	10	10	10	10	10	10	10	10	10	10	10	10	
Longitudinal Change percent, maximum	10	10	10	10	10	10	10	10	10	10	10	10	Paragraph 4.7.5
Tensile Strength, psi, minimum	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	ASTM D 412 (See 4.6.1)
Tensile Stress at 100 percent elongation, psi, minimum	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	ASTM D 412 (See 4.6.1)
Elongation, percent, minimum	200	200	200	200	200	200	200	200	200	200	200	200	ASTM D 412 (See 4.6.1)
Specific Gravity, maximum	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	ASTM D 792
Hardness, Shore A	60 ± 5	60 ± 5	60 ± 5	60 ± 5	60 ± 5	60 ± 5	60 ± 5	60 ± 5	60 ± 5	60 ± 5	60 ± 5	60 ± 5	ASTM D 2240
Low Temperature	Pass or Fail	Pass or Fail	Pass or Fail	Pass or Fail	Pass or Fail	Pass or Fail	Pass or Fail	Pass or Fail	Pass or Fail	Pass or Fail	Pass or Fail	Pass or Fail	ASTM D 3971
Heat Shock	Pass or Fail	Pass or Fail	Pass or Fail	Pass or Fail	Pass or Fail	Pass or Fail	Pass or Fail	Pass or Fail	Pass or Fail	Pass or Fail	Pass or Fail	Pass or Fail	Paragraph 4.7.4
Heat Aging, followed by tensile test:	No dripping, flowing, or cracking												Paragraph 4.7.5
Tensile Strength, psi, minimum	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	ASTM D 412 (See 4.6.1)
Elongation, percent, minimum	150	150	150	150	150	150	150	150	150	150	150	150	ASTM D 412 (See 4.6.1)
Dielectric Strength, volts/mil, minimum	200	200	200	200	200	200	200	200	200	200	200	200	ASTM D 974
Volume Resistance, ohm-cm, minimum	1 x 10 ⁹	1 x 10 ¹¹	1 x 10 ⁹	1 x 10 ⁹	1 x 10 ⁹	1 x 10 ⁹	1 x 10 ⁹	1 x 10 ¹¹	1 x 10 ⁹	1 x 10 ¹⁶	1 x 10 ¹⁴	1 x 10 ¹¹	ASTM D 257
Permeability, seconds, maximum	15, self-sealing*	60, self-sealing** 1/2	15, self-sealing*	15, self-sealing*	15, self-sealing*	15, self-sealing*	15, self-sealing*	60, self-sealing** 1/2	15, self-sealing*	15, self-sealing*	15, self-sealing*	15, self-sealing*	* ASTM D 991 - ASTM D 3971, Sec. 4.7.2
Purges Resistance	Rating of 0												ASTM D 21
Water Absorption, percent, maximum	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	ASTM D 379, Procedure A
Solvent Resistance, followed by tensile test:													Paragraphs 3.5 and 4.7.6
Tensile Strength, psi, minimum	900	900	900	900	900	900	900	900	900	900	900	900	ASTM D 412 (See 4.6.1)
Elongation, percent, minimum	120	120	120	120	120	120	120	120	120	120	120	120	ASTM D 412 (See 4.6.1)
Eccentricity, percent, maximum	60	60	60	60	60	60	60	60	60	60	60	60	ASTM D 3971 (Sec. 4.1.1)

1/2 Not more than 25 percent of indicator flag burned; no dripping or leaking.

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3.4.2 Molded parts and extruded shapes. The synthetic rubber molded parts and extruded shapes shall have the physical, electrical, and chemical property requirements (see 4.6.2) as specified in table III.

3.5 Solvent resistance. Type I classes 1 and 2, type II classes 1 and 2, type III classes 1 and 2, type IV classes 1 and 2, type V, and type VI classes 1 and 2, shall be resistant to solvents when tested (see 4.7.6) in accordance with tables II and III.

3.6 Propellant resistance type IV. Type IV classes 1 and 2 shall be resistant to hydrazine/unsymmetrical dimethylhydrazine (UDMH), nitrogen, tetroxide, and nitric acid (see 4.7.7 and 6.2).

WARNING

UDMH is hazardous material and should be handled in accordance with the manufacturer's safety data sheet.

3.7 Eccentricity of tubing. A thin wall area, due to eccentricity, shall be not greater than that shown in table II (see 4.7.8).

3.8 Ozone resistance type VI. When specified in the contract or order (see 6.2), type VI classes 1 and 2 shall be tested for ozone resistance requirements (see 4.7.9).

3.9 Color. All types and classes of the tubing, molded parts and extruded shapes, except type V tubing, shall be black. Type V tubing shall be furnished in the following colors when specified - black, white, red, yellow, and blue (see 4.8).

3.10 Workmanship. The synthetic rubber tubes, parts, and shapes shall be free from foreign material, flaws, pinholes, bubbles, cracks, inclusions, and excessive flash, and shall be homogeneous in texture (see 4.5.2.1).

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

TABLE III. Physical, electrical, and chemical properties of synthetic rubber molded parts and extruded shapes, class II.

Property	Conditioning (see 4.6.3)					Requirement				Method
	Type I	Type II	Type III	Type IV	Type V	Type I	Type II	Type III	Type IV	Type V
Elastic Memory, percent, minimum	↗	↗	↗	↗	↗	Expansion 150 Retraction 40	Expansion 250 Retraction 40	Expansion 200 Retraction 40	Expansion 150 Retraction 40	Expansion 275 Retraction 40
Tensile Strength, psi, minimum	↗	↗	↗	↗	↗	1500	600	1000	1200	1000
Tensile Stress at 100 percent elongation, psi, minimum	↗	↗	↗	↗	↗	750	600	1200	1000	750
Elongation, percent, minimum	↗	↗	↗	↗	↗	200	200	300	300	400
Specific Gravity, maximum	↗	↗	↗	↗	↗	1.30	1.30	1.35	1.40	1.25
Hardness, Shore A	↗	↗	↗	↗	↗	70 ± 5	42 ± 5	48 ± 5	50 ± 5	85 ± 5
Low Temperature	↗	↗	↗	↗	↗	Pass or Fail	Pass or Fail	Pass or Fail	Pass or Fail	Pass or Fail
Heat Shock	↗	↗	↗	↗	↗	Pass or Fail	Pass or Fail	Pass or Fail	Pass or Fail	Pass or Fail
Heat Aging, followed by tests for	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗
Tensile Strength, psi, minimum	↗	↗	↗	↗	↗	1200	400	1200	1000	1500
Elongation, percent, minimum	↗	↗	↗	↗	↗	150	120	250	100	150
Dielectric Strength, volt/mm, minimum	↗	↗	↗	↗	↗	200	200	300	400	225
Volume Resistance, ohm-cm, minimum	↗	↗	↗	↗	↗	1×10^8	1×10^8	1×10^8	1×10^8	1×10^8
Permeability	↗	↗	↗	↗	↗	Self Extinguishing	Self Extinguishing	Self Extinguishing	Self Extinguishing	Self Extinguishing
Fatigue Resistance	↗	↗	↗	↗	↗	Rating of 0	Rating of 0	Rating of 0	Rating of 0	Rating of 0
Water Absorption, percent, maximum	↗	↗	↗	↗	↗	1.0	1.0	0.5	0.5	1.0
Solvent Resistance, followed by tests for	↗	↗	↗	↗	↗	800	400	1500	1200	900
Tensile Strength, psi, minimum	↗	↗	↗	↗	↗	150	120	300	250	200
Elongation, percent, minimum	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗

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inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in this specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items shall 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. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of 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 first article inspection (see 4.4).

4.3 Inspection conditions. Unless otherwise specified, all inspections shall be performed in accordance with the test conditions specified in 4.6.

4.4 First article inspection. When specified in the contract or order (see 3.1, 6.2 and 6.3), a first article sample shall be subjected to first article inspection (see 4.3). Subsequent units shall not be considered for acceptance until Government approval of the first article sample has been obtained.

4.4.1 First article examinations. First article examinations shall consist of all the examinations and tests specified herein plus the storage tests (see 4.4.3.1, and 4.4.3.2).

4.4.3 Storage.

4.4.3.1 Low-temperature storage. The synthetic rubber shall be placed in a temperature of $-55 \pm 30^{\circ}\text{C}$ for not less than 72 hours. Upon completion of the 72-hour exposure, the synthetic rubber shall be allowed to stabilize at normal room temperature and then shall be subjected to all of the acceptance tests specified herein (see 4.4.1).

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4.4.3.2 Ambient storage. The synthetic rubber shall be placed in a temperature chamber at a temperature of $40 \pm 3^\circ\text{C}$ for not less than 336 hours. Upon completion of the 336-hour exposure, the synthetic rubber shall be allowed to stabilize at normal room temperature and then shall be subjected to tests for dimensions, as supplied and after heating in accordance with 4.7.3 (see 4.4.1).

4.5 Acceptance inspection.

4.5.1 Lot size. A lot shall consist of that quantity of synthetic rubber compound produced in one continuous operation by the same manufacturer and manufactured in accordance with the same specification and specification revision.

4.5.2 Sampling.

4.5.2.1 Nondestructive examinations. Unless otherwise specified (see 6.2), sampling for nondestructive examinations shall be in accordance with table IV. The unit of inspection shall be one molded or extruded tube, shape, or part. Nondestructive examinations shall consist of examinations for the workmanship requirements of 3.10 and preparation for delivery requirements of Section 5.

TABLE IV. Sampling plan.

Lot size	Sample size
2 to 8	5
9 to 15	5
16 to 25	5
26 to 50	5
51 to 90	7
91 to 150	11
151 to 280	13
281 to 500	16
501 to 1200	19
1201 to 3200	23
3201 to 10,000	29
10,001 to 35,000	35
35,001 to 150,000	40
150,001 to 500,000	40
500,001 and over	40
Accept on ZERO and reject on 1 or more.	

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4.5.2.2 Destructive examinations and tests. Unless otherwise specified (see 6.2), samples for destructive examinations and tests of tubing shall be selected at random from the lot (see 4.6.1). The samples for destructive examinations and tests of molded parts shall be cut from molded slabs, 6 inches x 6 inches x 0.075 ± 0.010 inches, fabricated from the same batch of material and subjected to the same degree of crosslinking as the molded parts. Destructive examinations and tests shall consist of examinations and tests for tensile strength, heat shock, hardness, elastic memory, and the dimensions and tolerance requirements of 3.3 (see 4.7.3 through 4.7.6).

4.6 Test methods and procedure.

4.6.1 Test for Type I through VI, class 1. Tests shall be performed in accordance with test methods specified in table II to determine tubing properties as required by 3.4.1. Unless otherwise specified, the specimens shall be full sections of tubing for sizes 0.375 and smaller; for sizes 0.5 and larger, specimens shall be cut in accordance with Die D of ASTM D 412.

4.6.2 Tests for Type I through VI, class 2. Tests shall be conducted in accordance with test methods specified in table III to determine properties as required by 3.4.2.

4.6.3 Conditioning. Prior to testing, specimens shall be conditioned as specified in table II or III.

4.6.3.1 Designation. The type of conditioning required shall be designated as follows:

Condition A: As received; no special conditioning after shrinking in accordance with 4.7.3.

Condition E: Temperature conditioning.

4.6.3.2 Conditioning procedure. The conditioning procedures required, with the exception of Condition A, shall be indicated by the following combinations of symbols:

- a. A capital letter indicating the type of conditioning.
- b. A number indicating the duration of the conditioning in hours.

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c. A number indicating the conditioning temperature in degrees Celsius. The numbers shall be separated from each other by a slant mark.

4.6.3.3 Conditioning tolerance. Unless otherwise specified (see 6.2), the conditioning tolerance and additional testing information shall be as specified in table V.

4.7 Tests. Testing to determine compliance with the requirements of tables II and III shall be in accordance with the methods specified in the tables and in accordance with the paragraphs of this specification called out in the above tables.

4.7.1 Examination of product. The heat-shrinkable tubing, molded parts and extruded shapes shall be carefully examined to determine conformance to all requirements for which a specific test method is not specified herein.

TABLE V. Conditioning and testing information.

Conditioning procedure	Conditioning time	Tolerance temperature	Testing temperature
E (high temperature)	+ 1 hour	+ 2°C	23 ± 2°C
E (low temperature)	+ 30 minutes or - zero	+ 2°C	-55 ± 2°C

4.7.2 Elastic memory. A 6 inch by 0.125 inch specimen (see 4.5.2.2) shall be marked with two parallel gage lines 1 inch apart in the central portion of the specimen. The 2-inch portion of the specimen including both gage lines then shall be heated for 1 minute at 150 ± 2°C for Types I, II, IV, and VI, class 2, or 5 minutes at 200 ± 5°C for Type III, class 2, removed from the heat and stretched within 10 seconds until the gage lines are 3 inches apart for Types I and IV, class 2, 4 inches apart for Type III, class 2, or 5 inches apart for Types V and VI, class 2. The extended specimen then shall be cooled in water for 1 minute at 20 to 30°C, released from tension, removed from the water, and wiped dry. After 24 hours at room temperature, the distance between the gage lines shall be measured, and recorded as the extended length. The portion of the specimen including both gage lines then shall be reheated for 1 minute at the temperature specified above, removed from the heat and allowed to retract. The specimen again shall be

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cooled for 1 minute in water at 20 to 30°C, removed from the water, and wiped dry. The distance between gage lines then shall be measured and recorded as the retracted length. Expansion and retraction shall be calculated as follows:

$$\text{Expansion} = (\text{extended length} - 1) \times 100 \text{ percent}$$

$$\text{Retraction} = \frac{\text{extended length} - \text{retracted length}}{\text{extended length} - 1} \times 100 \text{ percent}$$

4.7.3 Dimensional recovery and longitudinal change. Five specimens (see 4.5.2.2) shall be measured for dimensions as supplied, conditioned for 10 minutes in an oven at a temperature of 175 + 5°C for Types I, II, IV, and VI, classes 1 and 2, 200 + 5°C for Type III, classes 1 and 2, and 100 + 3°C for Type V, cooled to room temperature and then remeasured. Tubing specimens shall be measured for length + 0.03125 before and after conditioning, and longitudinal change shall be calculated as a percentage of the original length (see 3.3.1 and 4.6.3.1).

4.7.4 Heat shock. Three test specimens (see 4.5.2.2) of each lot shall be conditioned in an oven as specified in table II or III. The oven shall have an air velocity of 100 to 200 feet per minute past the specimens. While at the conditioning temperature and upon removal, the specimens shall be examined for evidence of dripping, flowing, or cracking.

4.7.5 Heat aging. Three specimens (see 4.5.2.2) shall be conditioned in an oven as specified in table II or III. The oven shall have an air velocity of 100 to 200 feet per minute past the specimens. After conditioning, the specimens shall be removed from the oven, cooled to room temperature, and tested as specified in table II or III.

4.7.6 Solvent resistance. The solvent resistance tests for the types and classes specified in 3.5 shall be performed by completely immersing three specimens (see 4.5.2.2) in each of the following solvents for 24 + 2 hours at 25 + 2°C. The volume of solvent shall be not less than 20 times that of the combined specimens.

- a. JP-4 fuel
- b. Hydraulic fluid conforming to MIL-H-5606
- c. Lubricating oil conforming to MIL-L-7808

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- d. Aviation gasoline 100/130
- e. Water (tap)

After immersion for the specified time, the specimens shall be lightly wiped and air-dried for 30 to 60 minutes at immersion temperature. The specimens shall then be examined for evidence of decomposition, swelling, or tackiness before being subjected to the tensile strength and elongation tests specified in table II or III.

4.7.7 Propellant resistance. Type IV, classes 1 and 2 shall have three 6 inch specimens, prepared and measured in accordance with ASTM D 412. The specimens shall then be completely immersed in each listed propellant for 30 ± 5 minutes at $25 \pm 3^\circ\text{C}$. The volume of the propellant shall be not less than 20 times that of the specimens. After immersion, the specimens shall be rinsed in water, lightly wiped and air-dried for 30 to 60 minutes at room temperature. The specimens shall then be tested for tensile strength and elongation which shall be in accordance with the solvent resistance requirements of tables II, III, and 3.6.

- a. Hydrazine/UDMH (MIL-P-27402)
- b. Nitrogen Tetroxide (MIL-P-26539)
- c. Nitric acid (MIL-P-7254)

4.7.8 Eccentricity. Examinations for eccentricity of tubing shall be in accordance with ASTM D 2671 and shall meet the requirements of table II and 3.7.

4.7.9 Ozone resistance. Type VI, classes 1 and 2 only. Specimens shall be in accordance with ASTM D 518, procedure B, except the thickness for Class 1 specimens shall be the wall thickness of the recovered tubing. The specimens shall be exposed for 7 days to an ozone controlled concentration of 50 ± 3 parts per hundred million (pphm) of air at $38 \pm 1^\circ\text{C}$ in accordance with ASTM D 1149. After conditioning, no cracks shall be visible when the specimens are examined with a seven-power magnifier (see 3.8).

4.8 Examination for color. The heat shrinkable tubing, molded parts and extruded shapes shall be furnished in the color specified in 3.9. Colors shall conform to the requirements of class 1 of MIL-STD-104 (see 3.9).

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4.9 Inspection of packaging. Except when commercial packaging is specified, the sampling and inspection of the preservation and interior package marking shall be in accordance with groups A and B quality conformance inspection requirements of MIL-P-116. The sampling and inspection of the packing for shipment and storage shall be in accordance with the quality assurance provisions of the applicable container specification shown in section 5. The inspection of marking for shipment and storage shall be in accordance with MIL-STD-129. The inspection of commercial packaging shall be as specified in the contract (see 6.2).

5. PACKAGING

5.1 Preservation and packaging (see 6.2).5.1.1 Level A.

5.1.1.1 Cleaning. The synthetic rubber shall be thoroughly cleaned in conformance with process C-1 of MIL-P-116 (see 5.1.2.1).

5.1.1.2 Unit packaging. The synthetic rubber shall be unit packaged in conformance with Method III of MIL-P-116. The synthetic rubber shall be enclosed in a carton conforming to PPP-B-636, Type CF, Class Domestic. The carton shall be closed with tape conforming to PPP-T-76 (see 5.1.2.2).

5.1.1.3 Intermediate packaging. When intermediate packaging is required, unit packages shall be placed in a close-fitting intermediate container conforming to Type CF, Class Domestic, of PPP-B-636. The intermediate container shall be closed as specified in 5.1.1.4.

5.1.1.4 Closure of fiberboard boxes. Unless otherwise specified, containers conforming to Type CF, Class Domestic, of PPP-B-636 shall be closed with six strips of 2-inch tape conforming to PPP-T-76. These strips shall be applied using three on the top seams and three on the bottom. When the bottom of the container is closed with staples or adhesive, only the three pieces of tape on the top seams are required. The tape shall extend at least three inches onto each end and side panel. In instances where the end panel is less than three inches in depth, the tape shall extend to the full depth.

5.1.2 Level B (see 6.4).

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5.1.2.1 Cleaning. Cleaning shall conform to the requirements of 5.1.1.1.

5.1.2.2 Unit packaging. The synthetic rubber shall be unit packaged as specified in 5.1.1.2.

5.1.2.3 Intermediate packaging. Unit packages shall be placed in close-fitting intermediate containers conforming to Type CF, Class Domestic, of PPP-B-636. The intermediate containers shall be closed as specified in 5.1.1.4.

5.1.3 Level C. Unless otherwise specified, preservation and packaging shall afford adequate protection against corrosion, deterioration, and physical damage during shipment from supply source to the first receiving activity.

5.2 Packing (see 6.2).

5.2.1 Level A. The synthetic rubber shall be packed in overseas-type exterior containers conforming to one of the following specifications: PPP-B-585, PPP-B-591, PPP-B-601, or PPP-B-621. The gross weight shall not exceed 200 pounds. The container shall be strapped in accordance with the applicable container specification.

5.2.2 Level B. The synthetic rubber shall be packed in domestic-type exterior containers conforming to one of the following specifications: PPP-B-585, PPP-B-591, PPP-B-601, or PPP-B-621. The gross weight shall not exceed 200 pounds.

5.2.3 Level C. The synthetic rubber shall be packed for shipment in conformance with MIL-STD-1190.

5.3 Marking. Marking shall be in accordance with MIL-STD-129 and shall include the following information:

- a. Manufacturer's name
- b. Product name or designation
- c. Procurement specification number
- d. Manufacturing date (quarter and year material was manufactured)
- e. Special handling and storage precautions.

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5.4 Identification of product.

5.4.1 Molded shapes. Where the size of the material permits, the manufacturer's part number may be marked once on each part.

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 heat-reactive synthetic rubber materials covered by this specification are intended for use in a wide range of applications requiring a tough flexible rubber that will reduce to predetermined dimensions upon application of heat and will maintain good physical properties after heat shrinkage. Some usages include identification and covering splices in cables, lugs, pipes, protecting feed-throughs, jacketing of assemblies, insulating pigtail connections, sleeves for wave guides and rectifier leads, and covers for resistors and diodes.

6.2 Acquisition requirements. Acquisition documents must specify the following:

- a. Title, number, and date of the specification
- b. Classification of types and classes as specified (see 1.2)
- c. 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)
- d. When first article is required (see 3.1 and 4.4)
- e. Sizes and tolerances required, if different (see 3.3.1, 3.3.2, and 3.3.3)
- f. When ozone resistance tests for Type VI are required (see 3.8).
- g. Sampling for nondestructive examinations (see 4.5.2.1 and 4.5.2.2)
- h. Conditioning tolerance if different (see 4.6.3.3)

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- i. Inspection of commercial packaging (see 4.9)
- j. Levels of preservation, packaging, and packing if other than level C (see 5.1 and 5.2)
- k. Material Safety Data Sheets (see 3.6).

6.3 First article. When first article inspection is required, the contracting officer should provide specific guidance to offerers whether the item(s) should be a first article sample, a first production item, or a number of items to be tested as specified in 4.4. The contracting officer should include specific instructions in acquisition documents regarding arrangements for examinations, approval of first article test results and disposition of first articles. Invitations for bids should provide that the Government reserves the right to waive the requirement for samples for first article inspection to those bidders offering a product which has been previously acquired or tested by the Government, and that bidders offering such products, who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract (see 3.1).

6.4 Engineering information.

6.4.1 Service temperature range. The synthetic rubber covered by this specification is suitable for continuous use throughout the temperature range as follows:

<u>Type</u>	<u>Temperature</u>
I, classes 1 and 2	-55 to 90 \pm 2°C
II, class 1	-70 to 180 \pm 5°C
II, class 2	-75 to 135 \pm 5°C
III, classes 1 and 2	-55 to 200 \pm 5°C
IV, classes 1 and 2	-55 to 125 \pm 3°C
V, class 1	-55 to 135 \pm 5°C
VI, class 1	-70 to 115 \pm 3°C
VI, class 2	-75 to 125 \pm 3°C

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6.4.2 Insulation resistance. The synthetic rubber covered by this specification is not suitable for use by itself as an insulation over exposed bare wires or components where high insulation resistance (100 megohms resistance when 500 volts are applied) is required.

6.4.3 Selection of appropriate size tubing. The important considerations in selecting the appropriate size tubing for a particular application are the outside diameter of the part being covered and the final wall thickness of the heat-shrunk tubing. Maximum efficiency usually is obtained when the diameter of the part being covered is approximately midway between the minimum expanded and maximum recovered diameters of the tubing.

6.5 Levels of protection. Level B preservation and packaging is intended to provide economical but limited protection and should be specified only when it is determined to be appropriate.

6.6 Metrication. Metric equivalents in accordance with FED-STD-376 are acceptable for use in this specification.

6.7 Subject term (keyword) listing.

Extruded shapes, flexible
Molded parts
Tubing

6.8 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.

Custodian:
Army - MI

Review Interest:
Army - EA, MR
DLA - GS

User Interest:
Army - ME

Preparing Activity:
Army - MI

Project No. 5970 - 1095

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document 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 the form.

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RECOMMEND A CHANGE:		1. DOCUMENT NUMBER MIL-R-468468	2. DOCUMENT DATE (YYMMDD) 920422
3. DOCUMENT TITLE RUBBER, SYNTHETIC, HEAT-SHRINKABLE			
4. NATURE OF CHANGE (Identify 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) (1) Commercial (2) AUTOVON (if applicable)	7. DATE SUBMITTED (YYMMDD)
8. PREPARING ACTIVITY			
a. NAME COMMANDER S. ARMY MISSILE COMMAND		b. TELEPHONE (Include Area Code) (1) Commercial (2) AUTOVON (205) 876-6980 746-6980	
c. ADDRESS (Include Zip Code) ATTN: AMSMI-RO-S2-TD-ST ROCKSTONE ARSENAL, AL 35898-5270		IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-9866 Telephone (703) 756-2340 AUTOVON 289-2340	