

INCH-POUND

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SUPERSEDING
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MILITARY PERFORMANCE SPECIFICATION

ROPE, NYLON

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 of nylon rope for general purpose use.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 4 and 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 insure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections 4 and 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 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).

STANDARDS

FEDERAL

FED-STD-191 - Textile Test Methods

(Copies of these documents are available online at <http://quicksearch.dla.mil>.)

Comments, suggestions, or questions on this document should be addressed to DLA Troop Support – Industrial Hardware Division (ATTN: Code FHTE), 700 Robbins Avenue, Philadelphia, PA 19111-5096 or email trpsptspecspa@dlamil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at <https://assist.dla.mil>.

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2.3 Non-Government publications. The following document(s) 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 Quality (ASQ):

ASQ Z1.4 - Sampling Procedures and Tables for Inspection by Attribute.

(Copies of these documents are available from <http://asq.org> or the American Society for Quality, 644 North Plankinton Ave., Milwaukee, WI 53203.)

3. REQUIREMENTS

3.1 The requirements specified in 3.11, 3.12, and 3.13 apply only to rope purchased directly by the Government. All other requirements apply to rope purchased as a component for an end item by a contractor and to rope purchased directly by the Government.

3.2 Standard sample. When a specified shade is specified, the rope shall match the specified standard for shade and be equal to or better than the standard in respect to all characteristics for which the standard sample is referenced (see 6.3).

3.3 Materials.

3.3.1 The rope shall be fabricated from bright white, virgin, continuous-filament, heat and light resistant nylon fiber of at least six denier size, having at least 6.5 grams per denier strength. The nylon shall be a long chain polymer made of hexamethylene diamine and adipic acid, or a long chain polymer of epsilon amino caproic acid. Mixtures of nylon fiber types shall not be employed in any one rope. Determination for these requirements shall be made.

3.4 Construction. The ropes shall be of three strands and conform to the requirements specified herein. Each strand shall be made of one size of balanced three ply yarn and shall have equal numbers of yarns. The single yarns shall, be made from grouped filaments conforming to the sizes specified in table I for the respective sizes of rope. The direction of twist of the singles yarn shall be left-hand or "S" twist, and the minimum turns per foot shall conform to table I for the respective sizes of rope. The direction of the rope twist shall be right-hand or "Z" twist. Heat setting of the rope or any of its twisted components will not be permitted.

Table I –Construction.

Rope size (Circumference)	Turns per foot minimum	Denier of single yarns
Inches		
5/8 to 1-1/2, incl.	22	2,500 to 8,000
1-3/4 to 2-1/2, incl.	22	7,500 to 11,000
2-3/4 to 3, incl.	18	10,000 to 16,000
3-1/2 to 6-1/2, incl.	15	15,000 to 16,000
7 to 12, incl.	15	15,000 minimum

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3.5 Physical requirements. The finished rope shall conform to the physical properties specified in table II, when tested as specified in 4.1.5.

Table II. Physical properties.

Circumference at load "P"	Tolerance plus or minus	Approximate diameter	Load "P" 200 X D ²	Feet per load "P" min.	Hardness		Breaking strength (minimum)
					Min.	Max.	
Inches	Inches	Inches	Pounds	Feet	Pounds		Pounds
.625	.062	.187	7	100.0	2	25	950
.750	.062	.250	12	66.0	2	25	1,500
1.000	.062	.312	20	36.0	3	25	2,600
1.125	.062	.375	28	28.5	5	25	3,300
1.250	.062	.437	38	20.0	5	25	4,800
1.500	.062	.500	50	16.5	5	25	5,800
1.750	.062	.562	65	12.5	5	25	7,600
2.000	.062	.625	80	9.7	5	25	9,800
2.250	.062	.750	110	7.2	5	25	13,200
2.500	.062	.812	130	6.2	5	25	15,300
2.750	.062	.875	175	5.0	5	25	19,000
3.000	.125	1.000	200	4.1	20	100	23,200
3.500	.125	1.125	250	3.0	20	100	32,000
3.750	.125	1.250	310	2.6	20	100	36,500
4.000	.187	1.312	345	2.3	20	100	41,300
4.500	.187	1.500	450	1.8	20	100	50,000
5.000	.187	1.625	530	1.5	20	100	60,000
5.500	.187	1.750	610	1.25	20	100	72,000
6.000	.187	2.000	800	1.00	20	100	90,000
6.500	.187	2.125	900	.90	20	100	100,000
7.000	.250	2.250	1,000	.71	20	100	127,000
8.000	.312	2.625	1,400	.55	20	100	164,000
9.000	.375	3.000	1,800	.43	20	100	209,000
10.000	.437	3.250	2,100	.34	20	100	265,000
11.000	.437	3.625	2,600	.285	20	100	316,000
12.000	.500	4.000	3,200	.24	20	100	375,000

3.5.1 Elongation. The elongation of the ropes shall not exceed 55 percent at the breaking point when determined as specified in 4.1.5. The load elongation curve, drawn autographically, shall not exhibit evidence of changes in load applications greater than 5 percent of the load weighed at the instant of change. Changes due to splice slippage shall not be considered in this determination.

3.5.2 Hardness. The finished rope shall meet the minimum hardness specified in table II when tested and shall not exceed the maximum hardness after immersion when tested as specified in 4.1.5.

3.6 Finish. No extraneous material shall be added for the purpose of weighting the rope. The extractable matter of the finished rope shall not exceed 4.0 percent when tested as specified in 4.1 .5.

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3.7 Heat aging. The heat aging test specified in 4.1.5 shall be performed on sample ropes when possible. An alternate method using plied yarns constituting the strands may be substituted. The breaking strength loss shall not exceed 10 percent when comparing the exposed and the unexposed specimens.

3.8 Moisture content. The moisture content of the rope shall not exceed 5.0 percent when tested as specified in 4.1.5.

3.9 Spliceability. The finished ropes shall be spliceable and shall not develop yarn displacement or strand cockles in the splicing test of 4.1.5.

3.10 Color. Unless otherwise specified (see 6.2), the color of the finished rope shall be natural. When colored rope is specified, dyeing of the filaments, yarns, or rope shall be as specified by the procuring activity (see 3.4 and 6.3).

3.10.1 Matching. The shade of the dyed and finished rope shall match the standard sample under natural (north sky) daylight or artificial daylight, having a color temperature of 7500° Kelvin and shall be a good approximation to the standard sample under incandescent lamplight at 2800° Kelvin (see 6.3).

3.10.2 Colorfastness. The dyed and finished rope shall show fastness to weathering equal to or better than the standard sample when tested as specified in 4.1.5. When no standard sample has been established, the dyed rope shall show good fastness to weathering when tested as specified in 4.1.5.

3.11 Identification marker. The manufacturer shall identify his product by inserting a kraft paper or water repellant cotton marker within one strand in all ropes larger than 1-1/8 inches' circumference. The marker shall be completely enveloped by the cover yarns in the strand in which it is enclosed. Unless otherwise specified (see 6.2), the manufacturer's name, year of manufacture, and type of fiber (NYLON) shall be clearly printed on the marker. Italic or script type shall not be used. The printing shall not be affected upon exposure to water or mineral oil, when tested as specified in 4.1.5.

3.12 Identification. In addition to the requirements specified (see 3.11), each package unit shall have a ticket (identification tag) attached to it for identification purposes. The ticket shall conform to the requirements for type B, class 1, size 4 or 5 of MIL-STD-129. The ticket shall be made of not less than 15 point paper stock and shall have a minimum tearing resistance of both directions (total) of 850 grams. The ticket shall be legibly printed, stamped or typed with water insoluble ink. The ticket shall contain the following information:

- (a) Stock number
- (b) Nomenclature
- (c) Specification number
- (d) Length
- (e) Contract number and date
- (f) Date of manufacture (month and year)
- (g) Supplier's name

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3.13 Put-up. Unless otherwise specified, the rope shall be furnished without knots or splices on non-returnable reels (spools) not larger than 6 feet in diameter in the length specified in table III. Broken lengths will be permitted, but no piece shall be less than 600 feet when measured in the relaxed condition. The ends of all rope shall be cut off squarely and be securely whipped, taped or heat sealed to prevent fraying or untwisting. The reels (spools) shall be wound so that each turn and layer is free from entanglement.

3.13.1 When specified, rope shall be put-up in coils in one continuous piece in the minimum length specified (see 6.2). The ends of all rope shall be cut off squarely and be securely whipped, taped or heat sealed to prevent untwisting or fraying of rope. The coils shall be so wound that each turn and layer is free from entanglement.

3.14 Workmanship. The rope shall conform to the quality and grade of product established by this specification. The occurrences of defects shall not exceed the applicable acceptable quality levels established by this specification.

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Table III – Put-up

Circumference	Minimum length	Approximate weight <u>1/</u>
Inches	Feet	Pounds
.625	2,250	23
.750	2,250	35
1.000	2,250	64
1.125	1,620	59
1.250	1,200	61
1.500	1,200	75
1.750	1,200	99
2.000	1,200	127
2.250	1,200	172
2.500	1,200	203
2.750	1,200	248
3.000	1,200	303
3.500	1,200	416
3.750	600	240
4.000	600	272
4.500	600	349
5.000	600	421
5.500	600	506
6.000	600	635
6.500	600	708
<u>2/</u> 7.000	600	900
8.000	600	1,169
9.000	600	1,505
10.000	600	1,918
11.000	600	2,302
12.000	600	2,750

1/ Not a specification requirement – included for informational purposes only.

2/ Also available in 750 ft. length (min,) at 1403 lbs. (approx.)

4. VERIFICATION

4.1 Inspection for quality conformance. Sampling and inspection shall be performed in accordance with ASQ Z1.4, except as otherwise indicated

4.1.1 Component and material inspection. Testing shall be conducted on components in accordance with all requirements of this specification. Determinations shall be made for all characteristics of table IV except material. A certificate of compliance furnished the rope manufacturer by the fiber producer shall be considered acceptable for this characteristic.

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Table IV. Component test.

<u>Characteristic</u>	<u>Paragraph reference</u>
Material	3.3
Denier per filament	3.3
Tenacity (grams Per denier)	3.3
Denier (singles yarn)	3.4
Turns per foot (singles yarn)	3.4
Direction of twist (singles yarn)	3.4
Balanced plied yarn (strand)	3.4

4.1.2 Examination of the end for visual defects. The defects specified in table V shall be counted regardless of their proximity to each other, except where two or more defects represent a single local condition, in which case only the more serious defect shall be counted. The sample unit for this examination shall be one reel, spool or coil, as applicable. Ten percent of the gross length contained on each sample unit, but not less than 100 feet shall be subjected to the visual examination. The lot size for this examination shall be expressed in units of reels, spools or coils each. The acceptable quality level shall be 1.5 major defects and 4.0 total defects (major and minor combined) per 100 units. The inspection level shall be Level I.

Table V. Visual examination – defects

Examine	Defect	Classification	
		Major	Minor
Appearance and workmanship	- Cut, chafed or damaged affecting serviceability	X	
	- Kinks, darting yarns <u>1/</u> broken or loose ends, bulged strands, strand knots	X	
	- Other than 3 strands	X	
Identification marker (Ropes 1.125 circumference or larger)	- Ends not securely whipped taped or heat sealed to prevent fraying or untwisting		X
	- Omitted, incorrect, illegible		X
	- Italic or script type used		X
Identification ticket	- Not completely covered by cover yarns		X
	- Not as specified		X
	- Omitted, incorrect, illegible, insecurely attached		X
Color	- Not as specified		X
	- Not as specified	X	
	- Specific shade, not within established tolerance		X
Cleanness	- Spot or stain, clearly visible <u>2/</u>		X
	- Objectionable odor		X

1/ Darting yarns are internal yarns which project through the cover yarns of the strand at intervals along the rope.

2/ At normal inspection distance (approximately 3 feet).

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4.1.3 Examination for length and winding. The sample unit for this examination shall be one spool, reel, or coil. The inspection level shall be level S-3 and the acceptable quality level shall be 4.0 percent defective. For lots consisting of 500 or fewer units, the sample size shall be 10 and the acceptance number 1. The lot size shall be the number of units in the inspection lot. Defects shall be as specified in 4.1.3.1 and 4.1.3.2.

4.1.3.1 Defects with regard to length shall be considered to exist if any of the following are determined during inspection:

- (a) Length of unit less than length specified (see 3.13).
- (b) Length of unit less than marked on ticket.
- (c) Rope not in a continuous length when coils are specified (see 3.13.1).
- (d) Any piece on reels or spools less than 600 feet in length.

4.1.3.2 Defects with regard to winding shall be considered to exist if any of the following are determined during inspection:

- (a) Improperly or not firmly wound resulting in kinks, knots, entangling or slippage during unwinding or otherwise affecting free unhampered unwinding or rope.
- (b) knot, splice or otherwise joining of ends to make a continuous length.

4.1.4 Examination of preparation for delivery requirements. An examination shall be made to determine that packaging, packing and marking requirements of Section 5 of this specification are complied with. The examination shall be in accordance with the provisions of MIL-C-3131, except that the inspection level shall be S-2 and the acceptable quality level (AQL) shall be 2.5 defects per 100 units.

4.1.5 Testing of end item. The methods of testing specified in FED-STD-191 wherever indicated in table VII, shall be followed. The physical and chemical values specified in Section 3 apply to the results of determination made on a sample unit for test purposes. Test reports shall contain all values utilized in expressing the final result. The sample unit shall be 75 feet of rope. The lot shall be unacceptable if one or more sample units fails to meet any specified test requirement. The sample size (number of test units) shall be in accordance with table VI:

Table VI: Sampling for tests.

No. of reels, spools or coils in lot	Sample size (units)
3 and under	1
4 - 50	2
51 - 500	3
501 and over	5

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Table VII – Test methods

Characteristic	Spec. ref	Test method	No. of determinations. per individual unit of product	Results reported as:
Plied yarns per strand	3.4	Visual	1	Pass or fail
Directional of rope twist	3.4	4050	1	Pass or fail
Circumference	3.5	4.1.5.1	3	Pass or fail
Length per pound	3.5	4.1.5.2	1	Pass or fail (re-reported to nearest 0.1 ft. for ropes 5 inches or less and to nearest .01 ft. for ropes over 5 inches in circumference)
Breaking strength				
Spliced ropes				
Initial	3.5	4.1.5.3.1	1	Pass or fail (report to nearest 10 lbs.)
After heat aging	3.7	4.1.5.3.2.1	1	Pass or fail (report to nearest 10 lbs. and calculated to nearest 0.1 percent)
Alternate plied yarn method				
Control	3.7	4.1.5.3.2.2	3	Average of 3 determinations to nearest 1 lb.
After heat aging	3.7	4.1.5.3.2.2	3	Average of 3 determinations to nearest 1 lb. and calculated to nearest 0.1 percent.
Elongation	3.5.1	4.1.5.4	1	Pass or fail (report to nearest 0.1 percent)
Hardness				
Initial	3.5.2	4.1.5.5.1	3	Average of 3 determinations to nearest 1.0 lb.
After immersion	3.5.2	4.1.5.5.2	3	Average of 3 determinations to nearest 1.0 lb.
Extractable matter	3.6	2611	1	Pass or fail (report to nearest 0.1 percent)
Moisture content	3.8	2600	1	Pass or fail (report to nearest 0.1 percent)

See footnotes at end of table.

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Table VII – Test methods 1/ (continued)

Characteristic	Spec. ref	Test method	No. of determinations. per individual unit of product	Results reported as:
Spliceability	3.9	4.1.5.7	1	Pass or fail
Colorfastness to weathering	3.10.2	4804 <u>3/</u>	1	Pass or fail
Identification marker Material	3.11	<u>2/</u>		
Fastness to oil and water	3.11	4.1.5.8	1	Pass or fail
Identification ticket Material	3.12	<u>2/</u>		

- 1/ Tests to determine compliance with specification requirements. Including quantity of delivery, may be under prevailing atmospheric conditions except in settlement of disputes in which case the tests shall be made upon material which has reached equilibrium under standard conditions specified in FED-STD-191.
- 2/ Test reports showing conformance to this specification shall be available for each lot of rope. Reports shall contain actual test, examination or other verifiable quality data.
- 3/ The time of exposure shall be 40 standard fading hours.

4.1.5.1 Determination of circumference. The circumference shall be measured at the beginning of the breaking strength test with the specimen under the load "P" specified in table II. A hard fiber shall be passed snugly around the rope and cut where it overlaps. The cut length shall be straightened and measured to the nearest .062 (1/16) inch. This determination shall be repeated at least three times in different positions not less than two turns of rope apart. The average of these determinations shall be the circumference of the rope.

4.1.5.2 Determination of length per pound. A minimum of 20 feet of rope shall be measured to nearest .250 (1/4) inch and weighed to within plus or minus 0.5 percent of its total weight. The feet per pound shall be calculated using the following equation:

$$\text{Feet per pound} = \frac{L \times (1 + e/100)}{W}$$

Where:

- L = Measured length of specimen (feet)
w = Measured weight of specimen (pounds)
e = percent elongation at load P (see table II, determined as specified in 4.1.5.4)

Upon completion of this determination, the test length shall be retained for use in additional determinations. From this specimen, a length not less than 4 feet shall be cut to be used in the alternate heat aging test employing plied yarns (4.1.5.3.2.2). The remainder shall be taped off at each end for utilization in the hardness test (4.1.5.5).

4.1.5.3 Determination of breaking strength.

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4.1.5.3.1 Initial. The breaking strength shall be determined in accordance with method 4106 of FED-STD-191 except as modified herein. Lengths for the breaking strength shall be taken from each sample and spliced at each end with at least four full tucks. Should splice slippage be noted during the test, six full tucks shall be used in each splice. The inside length of each eye, measured with the sides of the eye in contact shall be not less than 12 inches. The length between the inner ends of the splices shall be between 3 and 5 feet. Clamps or capstan arrangements may be used in lieu of splices but in case of dispute, spliced specimens shall be used.

4.1.5.3.2 Heat aging. The test specimens shall be heated in a convection air oven for 5 days at a temperature of $175^{\circ} \pm 2^{\circ}\text{F}$. Upon removal from the oven, the specimens shall be allowed to reach equilibrium under the standard condition specified in Method 5850 of FED-STD-191.

4.1.5.3.2.1 Spliced ropes. Three test specimens prepared as specified in 4.1.5.3.1 shall be subjected to the test specified in 4.1.5.3.2. The breaking strength test shall be conducted as specified in 4.1.5.3.1. The percent change in strength shall be calculated based on the average initial strength and after heat aging.

4.1.5.3.2.2 Alternate method using plied yarns. Select one 3-ply yarn from each strand of the 4 foot section cut from the portion of the test sample unit used in the length per pound determination. To insure against loss of twist, heat seal the ends of each selected yarn as it is removed from the strand. After folding in two equal lengths, each yarn shall be halved by heat sealing at the mid-point. These respective lengths shall then be separated into 2 sets, each consisting of 3 yarns. One set shall be employed as a control, while the other shall be subjected to the test specified in 4.1.5.3.2. The breaking strength for each set shall be determined in accordance with method 4102 of FED-STD-191, except the elongation shall not be required. The percent change shall be based on the average strength of the control set and the heat age set.

4.1.5.4 Determination of elongation. A 20 inch gage, minimum, shall be marked off on the tensile specimen in the spliced relaxed condition. The specimen shall be tensioned to the load "P" specified in table II for the respective size rope. The elongation under this tension shall be measured for each breaking strength specimen averaged to the nearest 0.1 percent and recorded as the value "e" for use in determining length per pound (see 4.1.5.2). The elongation at the breaking point shall be determined and calculated to percent as specified in method 4106 of FED-STD-191.

4.1.5.5 Hardness.

4.1.5.5.1 Initial. The portion of the rope remaining from the weight determination shall be used herein. A 14 inch marlinespike shall be inserted between strands until visible on the opposite side. The spike shall be inserted at least 5 feet from a cut end or 5 feet from an area which has been subjected to a previous hardness test. The spike inserted in the rope shall be placed in a compression testing machine in such a manner that the force necessary to push the spike through the rope will be measured with the rope in a relaxed state without tension and completely free to absorb the force of the penetrating spike. Rate of loading shall be 6 inches \pm 1 inch per minute. The load necessary to force the spike to the .500 (1/2) inch diameter mark shall be measured on ropes up to 2.750 (2-3/4) inch circumference inclusive. The 1 inch diameter mark shall be used for larger size ropes.

4.1.5.5.2 After soaking. The length of rope employed in a dry hardness test shall be completely immersed, for 16 hours, in a tank of tap water. At the expiration of this period, the specimen shall be removed from the tank and allowed to drain for two hours. The wet hardness value shall be determined as specified in 4.1.5.5.1.

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4.1.5.6 Extractable matter. The extractable matter shall be determined using the chloroform extraction procedure of method 2611 of FED-STD-191.

4.1.5.7 Determination of spliceability. A breaking strength specimen shall be prepared and spliced at each end with four full tucks. The specimen shall then be allowed to rest 24 hours. Three of the tucks shall then be backed out of the rope. The portions of the rope from which the tucks are removed shall be examined for yarn displacement and strand cockles.

4.1.5.8 Determination of fastness of printed matter of the identification marker to salt water and mineral oil. Three lengths of the marker approximately 1.500 (1-1/2) feet each, one of which will be retained as a control, will be employed in this determination. Immerse one length for two hours in synthetic sea water, composed of 3.0 percent sodium chloride and 0.5 percent anhydrous magnesium chloride, while the remaining length shall be soaked for 2 hours in mineral oil. The fastness of the printed matter shall be considered satisfactory when no perceptible change in color or in legibility is noted during a visual comparison of the exposed specimens with the control specimen following removal from the respective environments.

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

6.1 Intended use. The rope covered by this specification is intended for general purpose uses where high strength or stretch is required as in mooring towing and hoisting operations.

6.2 Ordering data. Procurement documents should specify the following:

- (a) Title, number, and date of this specification.
- (b) Specific color (shade) if other than the natural (see 3.10).
- (c) When information on the identification marker is other than specified (see 3.11).
- (d) Put-up required (see 3.13)
- (e) Selection of applicable levels of preservation, packaging and packing (see 5.1).
- (f) Whether test apparatus is other than specified (see table VII).
- (g) That purchaser will accept at original weight, any unit which has been shortened or cut for test specimens, if in compliance with this specification (see 6.4).
- (h) That nylon rope will be purchased on a price-per-pound basis-net weight.

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6.3 Standard sample (Department of Army only). For access to standard samples, and rope dying instructions address the procuring office issuing the invitation for bids. Procuring offices should note requirements of 3.4 where the prohibition against heat setting of rope may require a waiver when color is required other than natural.

6.4 Adjustments for high moisture content. Material furnished containing an excess of moisture will be accepted by an adjustment on weight to the 5 percent moisture basis.

6.5 Subject term (key word) listing.

Stranded
Three play

6.6 Changes from previous issues. 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 - GL
Navy - SH
Air Force – 99

Preparing Activity:

DLA - IS

(Project 4020-2014-004)

Review Activity:

Army – AR, CR4, EA, MI
Navy – CG, MC
Other - DS

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