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Standard Specification for Asbestos Yarns¹

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This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This specification covers asbestos yarns having a minimum of 75 % asbestos fiber by mass, excluding the mass of other inorganic reinforcing strands which may be present.

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.3 **Warning**—Breathing of asbestos dust is hazardous. Asbestos and asbestos products present demonstrated health risks for users and for those with whom they come into contact. In addition to other precautions, when working with asbestos-cement products, minimize the dust that results. For information on the safe use of chrysotile asbestos, refer to “Safe Use of Chrysotile Asbestos: A Manual on Preventive and Control Measures.”²

1.4 The following safety hazards caveat pertains only to the test methods, Section 13, described in this specification: *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. See 1.3 for a specific safety hazard statement.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

¹ This specification is under the jurisdiction of ASTM Committee C17 on Fiber-Reinforced Cement Products and is the direct responsibility of Subcommittee C17.03 on Asbestos - Cement Sheet Products and Accessories.

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² Available from The Asbestos Institute, http://www.chrysotile.com/en/sr_use/manual.htm.

2. Referenced Documents

2.1 ASTM Standards:³

- D76 Specification for Tensile Testing Machines for Textiles
- D123 Terminology Relating to Textiles
- D861 Practice for Use of the Tex System to Designate Linear Density of Fibers, Yarn Intermediates, and Yarns
- D1118 Test Method for Magnetic Rating of Asbestos Fiber and Asbestos Textiles
- D1423 Test Method for Twist in Yarns by Direct-Counting
- D1918 Test Method for Asbestos Content of Asbestos Textiles
- D2100 Specification for Asbestos Textiles Used for Electrical Insulating Purposes
- D2260 Tables of Conversion Factors and Equivalent Yarn Numbers Measured in Various Numbering Systems
- D2946 Terminology for Asbestos and Asbestos-Cement Products

3. Terminology

3.1 For definitions of other textile terms used in this specification, refer to Terminology D123. For asbestos terms, refer to Terminology D2946.

3.2 Definitions:

3.2.1 *asbestos*, *n*—1. *general*—a group of impure silicate minerals occurring in fibrous form. 2. *textile*—the hydrous magnesium silicate serpentine mineral designated as chrysotile, and having the empirical formula $\text{Mg}_3\text{Si}_2\text{O}_5(\text{OH})_4$.

3.2.2 *asbestos yarn construction number*, *n*—a system of numbers designed to show the construction, namely, the cut of the single yarn, the number of plies, and whether reinforcements are present.

3.2.2.1 *Discussion*—Yarns up to 9-cut, inclusive, have 3-digit construction numbers; the first digit indicates the cut, the second digit the number of plies, and the third digit, the number of reinforcements. Yarns of 10-cut and over have 4-digit construction numbers; the first 2 digits indicate the cut, the third digit, the number of plies, and the fourth digit, the

³ For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

number of reinforcements.

Yarns containing reinforcement are designated by the yarn construction number followed by the description of the reinforcing strands.

Examples:

No. 1010 yarn	10-cut, single, no reinforcement
No. 1420 yarn	14-cut, 2-ply, no reinforcement
No. 931 yarn	9-cut, 3-ply, 1 reinforcement (as specified)

When wire is the reinforcement the cut indicates the yards per pound of asbestos yarn only (mass of the wire not included). When the reinforcement is other than wire, the cut indicates the yards per pound of the complete assembly.

3.2.3 *atmosphere for testing asbestos textiles*, *n*—air maintained at a relative humidity of $50 \pm 2\%$ at $21 \pm 1^\circ\text{C}$.

3.2.4 *cut (asbestos)*, *n*—the number of 100-yd lengths/lb [453.6 g] of asbestos yarn.

3.2.4.1 *Discussion*—The term “cut” represents a length-per-unit-mass unit, and is derived by cutting (dividing) 7000 grains (453.6 g) by the mass of 100 yd in grains or the mass of 91.44 m in grams of a single yarn. The number of such units expresses the number of the cut, and when multiplied by 100, indicates the nominal yards per pound [metres/kilogram].

Example 1—If 5 30-m skeins of single roving, or 150 m, weigh 45.2 g, then 201.6 m weigh 60.7 g.

Cut = $1 \text{ kg}/60.7 \text{ g}$

= 16.47, or 16.47-cut, which is 16-cut on the light side; and $16 \times 201.6 = 3226 \text{ m/kg}$, nominal.

Example 2—If 5 30-yd skeins of single yard, or 150 yd, weigh 637.5 grains, then 100 yd weigh 425 grains:

Cut = $7000/425$

= 16.47, or 16.47-cut, which is 16-cut on the light side; and $16 \times 100 = 1600 \text{ yd/lb}$, nominal.

The term “cut” as applied to asbestos may be defined differently in countries other than the USA.

3.2.5 *ply*, *n*:

3.2.5.1 The number of single yarns twisted together to form a plied yarn; also the number of plied yarns twisted together to form a cord.

3.2.5.2 The individual yarn in a plied yarn or in a cord.

3.2.5.3 One of several layers of fabric.

3.2.6 *twist, direction of*, *n*—the direction of twist in yarns and other textile strands is indicated by the capital letters “S” and “Z” (see Fig. 1).

3.2.6.1 *Discussion*—Yarn has “S” twist if, when the yarn is held in a vertical position, the visible spirals or helices around

its central axis conform in direction of slope to the central portion of the letter “S”; and “Z” twist if the visible spirals or helices conform in direction of slope to the central portion of the letter “Z.”

When two or more yarns, either single or plied, are twisted together, the letters “S” and “Z” are used in a similar manner to indicate the direction of the last twist inserted.

The letters “S” and “Z” are also used to indicate the direction of winding or wrapping of a yarn around a wire or any other core.

4. Classification

4.1 Classes of asbestos yarn are based on their structural component as follows:

4.1.1 *Class A*—Yarn consisting of asbestos fiber or asbestos and other fiber(s).

4.1.2 *Class B*—Asbestos yarn containing wire reinforcement(s).

4.1.3 *Class C*—Asbestos yarn containing organic reinforcing strand(s).

4.1.4 *Class D*—Asbestos yarn containing nonmetallic inorganic reinforcing strand(s).

4.1.5 *Class E*—Asbestos yarn containing a combination of the reinforcing strands used in Classes B through D.

4.2 *Grade*—The grades of asbestos yarn are based on the percentage of asbestos content by mass as stated in Table 1.

5. Ordering Information

5.1 Asbestos yarn is normally purchased on the basis of yarn construction number, class, grade, amount and direction of twist, and breaking strength. Finished yarn package size is as agreed upon between the buyer and the seller.

6. Materials and Manufacture

6.1 *Roving*—Asbestos yarn shall be uniformly spun from a specified grade and cut of roving with or without reinforcement(s).

6.2 *Reinforcement(s)*—The reinforcement(s) may be inserted during the carding process, spinning process, twisting process, or combination of these.

6.3 *Wire Reinforcements*—The wire reinforcement may be brass, copper, zinc, nickel, nichrome, inconel, and monel or other metal or alloy as specified in the order.

6.4 *Organic Reinforcements*—The organic reinforcement(s) may be cotton, nylon, rayon, or other spun or filament yarn(s) as specified in the order.

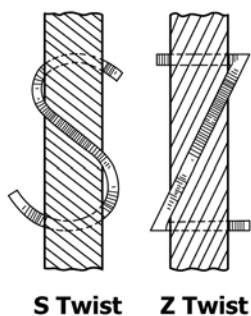


FIG. 1 Direction of Twist

TABLE 1 Grades of Asbestos Yarn

Grade	Asbestos Content, mass %
Commercial	75 up to but not including 80
Underwriters'	80 up to but not including 85
A	85 up to but not including 90
AA	90 up to but not including 95
AAA	95 up to but not including 99
AAAA	99 to 100 inclusive

6.5 Nonmetallic Inorganic Reinforcements—The inorganic reinforcement(s) may be glass, or other ceramic or vitreous spun or filament yarn(s) as specified in the order.

7. Chemical Composition

7.1 Asbestos Content—The asbestos content of the grade specified shall conform with requirements in [Table 1](#).

7.2 Magnetite Content—Yarns to be used for electrical insulating purposes shall conform to the electromagnetic requirements in Specification [D2100](#).

7.3 Reinforcements—Chemical properties of the reinforcements shall meet the specifications for such materials as agreed upon by the purchaser and the seller.

8. Physical Properties

8.1 Electromagnetic Properties —Yarn to be used for electrical insulating purposes shall conform with Specification [D2100](#).

8.2 Reinforcements—The physical properties of the reinforcements shall meet the specifications for such materials as agreed upon by the purchaser and the seller.

9. Mechanical Properties

9.1 Tensile (Breaking) Strength—The tensile (breaking) strength (breaking load) of asbestos yarn shall be as agreed upon by the purchaser and seller.

10. Dimensions, Mass, and Permissible Variations

10.1 The properties of asbestos yarn shall conform to the applicable material specification, subject to the following tolerances:

10.1.1 Yarn Number (Cut)—The linear density in metres per kilogram [yards per pound] of single asbestos yarns shall conform to the limits prescribed in [Table 2](#).

10.1.2 Twist—The direction and amount of twist shall be as agreed upon by the purchaser and the seller.

11. Sampling

11.1 Take five sample tubes at random from each lot of 400 to 500 kg [800 to 1000 lb], or fraction thereof, preferably from more than two containers (cases) of yarn.

12. Specimen Preparation

12.1 Condition all sample in the standard atmosphere for testing asbestos textiles (see section 3.6) for a minimum of 4 h, or until a specimen of the sample shows no progressive change in mass of more than 0.1 % after an exposure of 0.5 h.

13. Test Methods

13.1 Yarn Number (Cut):

13.1.1 Scope—This test method covers the determination of the cut of plain or reinforced, single or plied, asbestos yarn.

13.1.2 Significance and Use—The cut number of a yarn signifies how fine the yarn is and its length per unit mass. This is used to select yarns that are appropriate for the production of asbestos textile products conforming to given specifications.

13.1.3 Hazards—**Warning**—see [1.3](#).

13.1.4 Procedure:

13.1.4.1 Determine the linear density in metres per kilogram [yards per pound] of plain or nonmetallic reinforced asbestos yarn, single or plied, as directed in [13.1.4.2](#), [13.1.4.4](#), and [13.1.4.6](#). Calculate the yarn number (cut) by dividing the metres per kilogram by 201.6 [yards per pound by 100].

13.1.4.2 Single Asbestos Yarn—Determine the metres per kilogram [yards per pound] of conditioned plain or nonmetallic reinforced single asbestos yarn by reeling a 30 ± 0.5 -m [30-yd \pm 20-in.] skein from each of five tubes taken at random from each lot of 400 to 500 kg [800 to 1000 lb]. Determine the mass of each skein to the nearest 0.5 g. Calculate the metres per kilogram [yards per pound] of each specimen using Eq 1:

TABLE 2 Requirements^A for Specific Linear Mass of Standard Single Asbestos

Cut Number	Nominal Specific Length		Specific Permissible Range of Variation of Length per Unit Mass			
	m/kg	yd/lb	per pound, yd/lb	per kg ^B , m/kg	per 30-yd skein, yd/lb	per 10-m skein ^B , m/kg
5-cut	1008	500	460 to 540	830 to 1190	525 to 575	890 to 1120
6-cut	1210	600	552 to 648	995 to 1420	510 to 690	1140 to 1280
7-cut	1411	700	644 to 756	1160 to 1660	595 to 805	1330 to 1490
8-cut	1613	800	736 to 864	1330 to 1900	680 to 920	1530 to 1700
9-cut	1814	900	828 to 972	1490 to 2130	765 to 1035	1720 to 1910
10-cut	2016	1000	920 to 1080	1660 to 2370	850 to 1150	1910 to 2130
12-cut	2419	1200	1104 to 1296	1990 to 2850	1020 to 1380	2290 to 2550
14-cut	2822	1400	1288 to 1512	2320 to 3320	1190 to 1610	2670 to 2970
16-cut	3225	1600	1472 to 1728	2600 to 3780	1360 to 1840	3050 to 3400
18-cut	3629	1800	1656 to 1944	2990 to 4270	1530 to 2070	3430 to 3880
20-cut	4032	2000	1840 to 2160	3320 to 4740	1700 to 2300	3810 to 4250
22-cut	4435	2200	2024 to 2376	3650 to 5220	1870 to 2530	4190 to 4680
24-cut	4838	2400	2208 to 2592	3990 to 5690	2040 to 2760	4570 to 5100
26-cut	5241	2600	2392 to 2808	4320 to 6170	2210 to 2990	4950 to 5530
28-cut	5645	2800	2576 to 3024	4650 to 6640	2380 to 3220	5340 to 5950
30-cut	6048	3000	2760 to 3240	4980 to 7120	2550 to 3450	5720 to 6380
35-cut	7056	3500	3220 to 3780	5810 to 8300	2975 to 4025	5570 to 7440
40-cut	8064	4000	3680 to 4320	6640 to 9490	3400 to 4600	7620 to 8510
45-cut	9072	4500	4140 to 4860	7470 to 10700	3825 to 5175	8580 to 9570
50-cut	10080	5000	4600 to 5400	8300 to 11900	4250 to 5750	9530 to 10600

^A These requirements apply to untreated single asbestos yarns. The m/kg [yd/lb] of treated yarn, such as sized yarn, shall be subject to an additional tolerance of ± 2 %.

^B These tex numbers are determined by dividing 496 050 by the yd/lb. A tex unit is equal to the mass in grams of 1 km of yarn. See Tables D2260 and Practice [D861](#).

$$Y = 30 \times E / 0.95 \times W \text{ or} \quad (1)$$

$$Y = (7000 \times 30 \times E) / (W \times 0.95) \quad (2)$$

where:

Y = metres per kilogram [yards per pound] of single yarn,
 E = number of ends of asbestos yarn,
 W = mass in kilograms [pounds] of a 30-m [30-yd] skein,
 and

0.95 = factor to compensate for an average contraction of 5 % incurred in twisting.

13.1.4.3 Calculate the average metres per kilogram [yards per pound] of the five specimens.

13.1.4.4 *Single Asbestos Yarn in a Plied Yarn*—Determine the metres per kilogram [yards per pound] of the conditioned plain or nonmetallic reinforced single yarn in a plied yarn by reeling a 30 ± 0.5 -m [30-yd \pm 20-in.] skein from each of five tubes taken at random from each lot of 400 to 500 kg [800 to 1000 lb]. Determine the mass of each skein to the nearest 0.5 g. Calculate the metres per kilogram [yards per pound] using Eq 1.

13.1.4.5 Calculate the average metres per kilogram [yards per pound] of the five specimens.

13.1.4.6 *Single Asbestos Yarn in a Plied Metallic Reinforced Yarn*—Determine the metres per kilogram [yards per pound] of the conditioned single yarn in a plied metallic reinforced asbestos yarn by reeling a 30 ± 0.5 -m [30-yd \pm 20-in.] skein from each of five tubes taken at random from each lot of 500 to 600 kg [1000 to 1400 lb]. Determine the mass of each skein to the nearest 0.5 g. Separate and weigh the total metallic reinforcement to the nearest 0.5 g. Subtract this mass from the mass of each skein. Calculate the metres per kilogram [yards per pound] from the net mass of each specimen using Eq 1.

13.1.4.7 Calculate the average metres per kilogram [yards per pound] of the five specimens.

13.1.5 *Precision and Bias*—See 13.6.

13.2 *Tensile (Breaking) Strength (Breaking Load)*:

13.2.1 *Scope*—This test method covers the determination of the tensile (breaking) strength of asbestos yarns.

13.2.2 *Significance and Use*—The tensile strength is the most significant property of asbestos yarn, because this determines what products can be made from it.

13.2.3 *Apparatus*—Use a constant-rate-of-traverse-type tensile testing machine conforming to Specification D76. The tensile testing machine should have a range within which the calibration of the load-indicating device is accurate within ± 1.0 % and the breaking load can be read with a precision of ± 2.0 %. Set the full-scale load of the tensile testing machine so that the estimated load to rupture the yarn falls between 30 and 80 % of full scale.

13.2.4 *Hazards*—Refer to 13.1.3.

13.2.5 *Procedure*—Make all tests on conditioned single strands in the standard atmosphere for testing asbestos. Determine the tensile (breaking) strength (breaking load) of each conditioned single strand on a single strand testing machine of proper capacity with the clamps set 250 mm [10 in.] apart and at a pulling speed of 300 ± 10 mm [12 \pm 0.5 in.]/min. Take three specimens from each tube selected as directed in Section 11, and report the average breaking load per tube. Take care to

avoid loss of twist during the test. Use a holding device of the drum or capstan type. Discard the results from all specimens which break within 12 mm [0.5 in.] of the contact points.

13.2.5.1 Calculate the average breaking loading of all specimens tested.

13.2.6 *Precision and Bias*—See 13.6.

13.3 *Twist*:

13.3.1 *Scope*—This test method covers the determination of the direction of twist and the number turns per unit length of plain or reinforced, single or plied, asbestos yarns.

13.3.2 *Significance and Use*:

13.3.2.1 The direction of twist of a yarn must be known to prevent its unravelling when the yarn is used in a structure formed by spinning or twisting together a number of strands, including the yarn in question, in a specified direction.

13.3.2.2 The number of turns per unit length of a yarn gives an indication of its relative cohesive strength, rigidity, and hardness.

13.3.3 *Apparatus*—Twist tester conforming to the Apparatus Section of Test Method D1423.

13.3.4 *Hazards*—Refer to 13.1.3.

13.3.5 *Procedure*:

13.3.5.1 *Direction of Twist*—Determine the direction of twist as defined in 3.2.6.

13.3.5.2 *Turns of Twist in Single Yarn*—Determine the turns per inch or turns per metre on three specimens from each of the five tubes. Discard the first 2 m [2 yd] of yarn and exercise care in handling specimens to prevent a change in the existing twist. Grip the yarn, drawn just taut enough to prevent sagging, in the twist counter with the clamps set 102 mm [4 in.] apart. Rotate one clamp until the twist is removed.

13.3.5.3 *Turns of Twist in Plied Yarn*—Determine the turns per inch or turns per metre in plied yarn as directed in 13.3, except that the clamps shall be set 245 mm [10 in.] apart.

13.3.5.4 Calculate the average turns per inch of all specimens tested.

13.3.6 *Precision and Bias*—See 13.6.

13.4 *Asbestos Content*—Determine the asbestos content as directed in Test Method D1918.

13.5 *Electromagnetic Properties*:

13.5.1 Determine the magnetic rating of yarn to be used for electrical insulation as directed in Test Method D1118.

13.6 *Precision and Bias*:

13.6.1 *Interlaboratory Test Data*⁴—An interlaboratory test was run in 1973 in which randomly drawn samples of one material were tested in each of five laboratories. Each laboratory used one operator who tested five specimens. The components of variance expressed as standard deviations were calculated to be the values in Table 3.

⁴ Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D13-1058.

TABLE 3 Components of Variance for Yarn Number (Cut), Tensile (Breaking) Strength and Twist

Properties	Standard Deviations	
	Single-Operator Precision (Repeatability)	Interlaboratory (Reproducibility)
Yarn number (cut)		
Single yarn, m/kg [yd/lb]	0.52 [0.26]	0.77 [0.38]
Plied yarn, m/kg [yd/lb]	0.71 [0.35]	0.00 [0.00]
Tensile (breaking) strength		
Single yarn, N [lbf]	2.1 [0.47]	1.2 [0.27]
Plied yarn, N [lbf]	2.0 [0.44]	1.9 [0.42]
Twist		
Single yarn, twist/m [twist/in.]	22 [0.56]	19 [0.48]
Plied yarn, twist/m [twist/in.]	9.8 [0.25]	13 [0.32]

13.6.2 Precision—For the components of variance in [Table 3](#), two averages of observed values should be considered significantly different at the 95 % probability level if the difference equals or exceeds the critical differences listed in [Table 4](#).

NOTE 1—The tabulated values of the critical differences should be considered to be a general statement, particularly with respect to between-laboratory precision. Before a meaningful statement can be made about two specific laboratories, the amount of statistical bias, if any, between them must be established, with each comparison being based on recent data obtained on randomized specimens from one sample of the material tested.

13.6.3 Bias—The true value of the properties listed in [Table 3](#) and [Table 4](#) can only be defined in terms of specific test methods. Within these limitations, the procedures in Specification D299 for determining those properties have no known bias and are usually accepted in commerce.

14. Rejection and Rehearing

14.1 The purchaser and the seller may agree on a procedure to establish conformance, including control charts furnished by the seller, a sequential sampling plan, or the double-sampling plan outlined in [14.2](#).

14.2 In the absence of a control-chart or sequential-sampling plan, proceed as directed in [14.2.1 – 14.2.3](#).

14.2.1 If the test results for the lot conform to the tolerance for all characteristics specified in Sections [6 – 10](#), consider the lot a valid delivery.

14.2.2 If the test result for one or more characteristics do not conform to the tolerances, take a new laboratory sample from either the original lot sample or a new lot sample. Test the new sample for the characteristic(s) that did not conform to the tolerances in the first test, and average the results of the first

TABLE 4 Critical Differences for the Conditions Noted and the Units Indicated^A

Properties	Number of Observations	Single-Operator Precision (Repeatability)	Between-Laboratory (Reproducibility)
Yarn number (cut):			
Single yarn, m/kg [yd/lb]	1	1.45 [0.72]	2.58 [1.28]
	2	1.03 [0.51]	2.36 [1.17]
	5	0.65 [0.32]	2.22 [1.10]
	10	0.45 [0.23]	2.18 [1.08]
Plied yarn, m/kg [yd/lb]	1	1.95 [0.97]	1.95 [0.97]
	2	1.40 [0.69]	1.40 [0.69]
	5	0.85 [0.43]	0.85 [0.43]
	10	0.62 [0.31]	0.62 [0.37]
Breaking strength:			
Single yarn, N [lbf]	1	5.78 [1.30]	6.67 [1.50]
	2	4.09 [0.92]	5.29 [1.19]
	5	2.58 [0.58]	4.23 [0.95]
	10	1.82 [0.41]	3.78 [0.85]
Plied yarn, N [lbf]	1	5.43 [1.22]	7.52 [1.69]
	2	3.83 [0.86]	6.45 [1.45]
	5	2.45 [0.55]	5.74 [1.29]
	10	1.73 [0.39]	5.47 [1.23]
Twist:			
Single yarn, twist/m [twist/in.]	1	61.0 [1.55]	80.3 [2.04]
	2	43.3 [1.10]	67.7 [1.72]
	5	27.2 [0.69]	59.1 [1.50]
	10	19.3 [0.49]	55.9 [1.42]
Plied yarn, twist/m [twist/in.]	1	27.2 [0.69]	44.5 [1.13]
	2	19.3 [0.49]	39.8 [1.01]
	5	12.2 [0.31]	37.0 [0.94]
	10	8.7 [0.22]	35.8 [0.91]

^A The critical differences were calculated using $t = 1.960$ which is based on infinite degrees of freedom.

and second samples as if all results were from one test of double the original number of specimens. If the new average(s) conform(s) to the specified tolerances, consider the lot a valid delivery.

14.2.3 If the test results obtained as directed in [14.2.2](#) do not conform to the specified tolerances, consider the lot a nonvalid delivery.

15. Packaging

15.1 Asbestos yarns shall be wound on paper tubes or cones.

NOTE 2—Various size packages are generally available to meet users' requirements.

16. Keywords

16.1 asbestos; breaking strength; content; electromagnetic properties; reinforcements; twist; yarn; yarn number

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