



Standard Guide for Labeling of UV-Protective Textiles¹

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1. Scope

1.1 This standard describes labeling requirements for textile products intended for the protection of humans from UVA and UVB radiation.

1.2 This standard is not intended to be used for the labeling of medical-device sun protective fabrics and clothing whose labeling is specified in the U.S. Food and Drug Administration's Draft Guidance for the Preparation of a Premarket Notification document.

1.3 The label requirements are in addition to those required by the Care Labeling Rule and fiber content (composition) labeling acts (Wool Products Labeling Act of 1939, and The Textile Fiber Products Identification Act).

1.4 This document contains terminology to be used in the labeling of UV-protective textiles.

1.5 Labeling recommended in this guide will be based on UV protection data collected by instrumental methods.

2. Referenced Documents

2.1 ASTM Standards:

D 123 Terminology Related to Textiles²

D 3938 Guide for Determining or Confirming Care Instructions for Apparel and Other Textile Consumer Products³

D 5489 Guide for Care Symbols for Care Instructions on Textile Products³

D 6544 Practice for the Preparation of Textiles Prior to UV Transmission Testing³

2.2 AATCC Standards:

183 Transmittance or Blocking of Erythemally Weighted Ultraviolet Radiation through Fabrics⁴

2.3 Other Standards:

15 U.S.C., Chapter 2, Subchapter V, The Textile Fiber Products Identification Act⁵

16 C.F.R. Part 303, Rules and Regulations Under the Textile

Fiber Products Identification Act⁵

15 U.S.C., Chapter 2, Subchapter III, et. seq., Wool Products Labeling Act of 1939⁵

16 C.F.R. Part 300, Rules and Regulations Under the Wool Products Identification Act⁵

16 C.F.R. Part 423, Care Labeling of Wearing Apparel and Certain Piece Goods⁵

AS/NZS 4399: 1996, Australian/New Zealand Standard Sun Protective Clothing - Evaluation and Classification⁵

FDA Office of Device Evaluation, Draft Guidance for the Preparation of a Premarket Notification (510(K)) Submission for Sun Protective Clothing, August 10, 1994⁶

3. Terminology

3.1 Definitions:

3.1.1 *UV-protective textile, n*—any textile whose manufacturer and/or seller claims that it protects consumers from ultraviolet (UV) light, claims the reduction of risk of skin injury associated with UV exposure, and/or uses a rating system that quantifies the amount of UV protection afforded.

3.1.1.1 *Discussion*—UV-protective textiles include various articles of apparel, accessories such as hats and shoes, shade devices such as umbrellas, awnings, and baby-carrier covers, and the fabric/materials used to produce these items.

3.1.1.2 *Discussion*—UV-protective textiles are sometimes referred to as sun-protective textiles.

3.1.2 *ultraviolet protection factor (UPF), n*—the ratio of the average effective ultraviolet radiation (UV-R) irradiance transmitted and calculated through air to the average effective ultraviolet radiation (UV-R) irradiance transmitted and calculated through fabric.

3.1.2.1 *Discussion*—A UPF value is a relative ranking of the UV protective capabilities of a textile fabric and should not be construed as a determination of time to sunburn.

3.1.3 *UV-protection categories, n*—a means to indicate the relative amount of protection provided by UV-protective textiles.

3.1.3.1 *Discussion*—Fabrics determined to have UPF values of 15 to 24 are classified in and labeled as having Good UV Protection, fabrics determined to have UPF values between 25

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² *Annual Book of ASTM Standards*, Vol 07.01.

³ *Annual Book of ASTM Standards*, Vol 07.02.

⁴ Available from American Association of Textile Chemists and Colorists, PO Box 12215, Research Triangle Park, NC 27709.

⁵ Available from Superintendent of Documents, US Government Printing Office, Washington, DC 20402.

⁶ Available from Standards Australia, 1 the Crescent, Homebush NSW 2140 Australia and Standards New Zealand, Level 10, Standards House, 155 The Terrace, Wellington 0001, New Zealand.

and 39 are classed in and labeled as having Very Good UV-Protection, and fabrics determined to have UPF values greater than 39 are classed in and labeled as having Excellent UV Protection.

4. Significance and Use

4.1 This guide to labeling provides a uniform system of labeling on UV-protective textiles that informs consumers about the amount of UV-protection provided.

4.2 UV-protective textiles labeled according to this standard will permit consumers to compare the amount of protection provided by various textiles and purchase the product that best meets their sun protection needs.

4.3 UV-labeling is in addition to other required labeling of garments including Permanent Care Labels and fiber content (composition) labels.

4.4 Manufacturers are encouraged to provide information to consumers that aids in selecting products that provide the amount of UV-protection desired.

4.5 UV-protective textiles labeled according to this standard guide will be labeled with a UPF value. AATCC Test Method 183 must be used to determine the mean UPF values of unprepared specimens, of specimens prepared using ASTM D 6544 (prepared-for-testing specimens), and of specimens taken from garments labeled “Wash once before wearing,” these specimens being taken after the garment is laundered once according to label directions. The latter specimens are referred to as laundered-once specimens in this document. A label UPF will be calculated for the various types of specimens following directions provided in this document. Usually, the value to be placed on the product label will be the label UPF calculated for the prepared-for-testing specimens or the label UPF calculated for the unprepared specimens, whichever is the lower value. In the case of products to be labeled “Wash once before wearing” or similar wording, the UPF value to be placed on the product label will be either the UPF calculated for the prepared-for-testing specimens or the laundered-once specimens, whichever value is the lower one.

4.5.1 *Discussion*—The UPF value to be placed on a garment label needs to be the lowest protection value expected during consumer use over a two-year period. Usually, this UPF value will be that obtained for the prepared-for-testing specimens because they have been laundered 40 times and exposed to UV-radiation to simulate conditions expected to lower the UPF during consumer use. However, for certain fabrics, knits in particular, the fabric manufacturer must tenter (stretch) the fabric to standard width for the garment manufacturer. This process decreases the UPF of the fabric dramatically because the optical porosity, which has a significant influence on UPF, is increased and does not represent the lowest UPF provided to the consumer because after the first laundering the protection lost is restored as the fabric is likely to shrinkage reducing the optical porosity of the fabric. In these cases, the value to compare to the prepared-for-testing value is logically that of laundered once specimens.

4.6 UV-protective labeling is intended to be used on textile products whose design or styling provides purposeful protection to covered skin.

4.7 UV protective labeling should be used on any, and all, fabrics and/or garments if those products make a UV protective claim as determined by this Guide.

5. Determination of Mean UPF of Prepared-for-Testing Specimens

5.1 The determination of Mean UPF (UPF_m) of prepared-for-testing specimens is based on measurements on specimens that have been exposed to environments that may alter the transmittance of ultraviolet radiation through them. Fabric specimens shall have been prepared for UV transmittance testing according to ASTM D 6544.

5.2 The measurement site UPF (MS_{UPF}) is the arithmetic average of the UPFs obtained when a prepared-for-testing specimen, is rotated in spectrophotometric equipment as directed in AATCC 183.

$$MS_{UPF} = \frac{UPF = UPF_1 + UPF_2 + \dots + UPF_N}{N}$$

where:

N = the number of measurements at a site on the prepared-for-testing test specimen.

5.3 The test specimen UPF (TS_{UPF}) is the arithmetic average of the measurement site UPFs. The formula for calculating it is:

$$TS_{UPF} = \frac{UPF_1 + UPF_2 + \dots + UPF_N}{N}$$

where:

N = the number of measurement sites.

5.4 The mean UPF (UPF_m) is the arithmetic average of the prepared for testing test specimen UPFs. The formula for calculating it is:

$$UPF_m = \frac{UPF_1 + UPF_2 + \dots + UPF_N}{N}$$

where:

N = the number of prepared-for-testing test specimens.

6. Determination of Mean UPF of Unprepared and Laundered-once Specimens

6.1 The Mean UPF (UPF_m) must be calculated using the UPF specimen values of the unprepared specimens or the UPF values of the laundered-once specimens. Proper sampling procedures as stated in ASTM D 6544 should have been followed in selecting the yardage from which the unprepared specimens are taken and likewise proper sampling procedures should be followed in selecting the garments to be laundered and from which the laundered-once specimens are taken.

6.2 The measurement site UPF (MS_{UPF}) is the arithmetic average of the UPFs obtained when an unprepared specimen or laundered-once specimen, is rotated in spectrophotometric equipment as directed in AATCC 183. The formula to use is that in 5.2 except that N = the number of measurements at a site on the unprepared or laundered-once specimen.

6.3 The test specimen UPF (TS_{UPF}) is the arithmetic average of the measurement site UPFs. The formula to be used is that in 5.3.

6.4 The mean UPF (UPF_m) is the arithmetic average of the test specimen UPFs. The formula for calculating it is in 5.4 except that N = the number of unprepared or laundered-once test specimens.

7. Determination of the Standard Error in the Mean UPF

7.1 The standard deviation (SD) of the mean UPF should be calculated for the prepared-for-testing and for either the unprepared or the laundered-once specimens as follows:

$$SD = \sqrt{\frac{\sum_{i=1}^N (UPF_i - \text{mean}UPF)^2}{N-1}}$$

7.2 The Standard Error (E) in the mean UPF should be calculated for the 99 % confidence level using the following equation:

$$E = \frac{\tau_{\kappa\alpha}SD}{\sqrt{N}}$$

where

- $\tau_{\kappa\alpha}$ = τ variate ($\alpha = 0.005$)
- κ = $N - 1$
- SD = Standard Deviation
- N = number of specimens

NOTE 1—See Annex A1 for values for standard error equation based on the number of specimens.

8. Determination of UPF Value for Label

8.1 The UPF value to be placed on the label is the sample UPF minus the standard error (E) of the sample UPF, the result of which has been rounded down to the nearest multiple of five in all cases except when the calculated UPF is less than the lowest specimen UPF for the sampling unit. The following formula should be used to calculate a UPF for the prepared-for-testing specimen data and for either the unprepared or the laundered-once specimen data as a first step in determining the two UPFs to be compared:

$$UPF \text{ value for label (a multiple of 5)} = \text{Sample UPF} - E$$

8.2 The lower of the two values determined in 8.1 shall be selected.

8.2.1 *Discussion*—The UPF value to be placed on a label is to be the lowest UPF value of the fabric. In most cases preparing the specimens according to ASTM D 6544 will cause the UPF of the prepared-for-testing specimens to be less than that of the unprepared specimens or laundered-once specimens. However, in certain cases, the UPF of the prepared-for-testing specimens may be greater than that of the unprepared specimens or the laundered-once specimens (perhaps due to fabric shrinkage). In this case, the UPF on the label must be the lower of the UPFs, that of the unprepared specimens.

8.3 The selected UPF must be compared to the specimen UPF values of that sample.

8.3.1 When the UPF value calculated in 8.1 and selected in 8.2 is less than the lowest UPF for any specimen in the sample (prepared- for- testing sample, unprepared sample, laundered-once sample), then the value of UPF to be placed on the

product label is the UPF value of the sample which is then rounded down to the nearest multiple of five but not greater than 50.

8.3.2 When the UPF value calculated in 8.1 and selected in 8.2 is greater than the lowest UPF for any specimen in the sample (prepared-for-testing sample, unprepared sample, laundered-once sample), then the value of UPF to be placed on the product label is the UPF of that specimen with the lowest UPF value which is then rounded down to the nearest multiple of five but not greater than 50.

8.3.3 *Discussion*—When variability is low, the UPF value that appears on the label will be the same as the mean UPF but when variability is high, the UPF value that appears on the label will differ from the mean UPF value. Fabrics with an extremely high UPF may have a very high standard deviation that can result in a calculated UPF value for the label that is less than any of the individual UPF measurements. The use of the lowest individual measurement of UPF is therefore more representative of the UV-protection the fabric provides than the calculation that includes the error.

8.4 When the calculated value of UPF for the label is greater than 50, then the value to be placed on the label shall be given as 50+.

8.5 When the calculated value of UPF for the label is less than 15, the product may not be labeled as sun or UV-protective.

9. Determination of Protection Classification

9.1 The UPF value calculated in Section 8 shall be used to determine the protection category for the UV-protective textile.

9.1.1 For the Good UV-protection category to be stated on the label, the UPF value must lie between 15 and 24.

9.1.2 For the Very Good UV-protection category to be stated on the label, the UPF value must be between 25 and 39.

9.1.3 For the Excellent UV-protection category to be stated on the label, the UPF value must be 40 or greater.

10. Determination of Values for Percent UV-B and UV-A Block Number to Appear on Label

10.1 The percent UV-B block number that may appear on a product label shall be the arithmetic mean of at least two determinations of percent UV-B block on two test specimens determined according to test procedures in AATCC 183. The test specimens will be from prepared-for-testing fabric, from unprepared fabric or from laundered-once garments. The calculation sequence shown below must be done using UV-transmittance data for the prepared-for-testing specimens, and using UV-transmittance data for either the unprepared specimens or the laundered-once specimens. The lower of the two values in the comparison of calculated label UV-B will be that placed on the product. The value on the label shall be stated as a whole number no greater than 99 %.

$$\% \text{ UV-B block/measurement (M)} = 100 \% - T(\text{UV-B})$$

where:

$$T(\text{UV-B})_{\text{AVE}} = \frac{\sum_{280 \text{ nm}}^{315 \text{ nm}} T_{\lambda} \Delta \lambda}{\sum_{280 \text{ nm}}^{315 \text{ nm}} \Delta \lambda}$$

$$\text{Specimen \% UV-B block } (M) = \frac{M_1 + M_2 + M_3 \dots + M_n}{N}$$

where:

N = number of sites/measurements/determinations per specimen

$$\text{Mean UV-B Percent block} = \frac{S_1 + S_2 + S_3 \dots + S_n}{N}$$

where:

N = number of specimens

10.2 The percent UV-A block number that may appear on a product label shall be the arithmetic mean of at least two determinations of percent UV-A block on two test specimens determined according to test procedures in AATCC 183. The test specimens will be from prepared-for-testing fabric, from unprepared fabric or from laundered-once garments. The calculation sequence shown below must be done using UV-transmittance data for the prepared-for-testing specimens, and using UV-transmittance data for either the unprepared specimens or the laundered-once specimens. The lower of the two values in the comparison of calculated label UV-A will be that placed on the product. The value on the label shall be stated as a whole number no greater than 99 %.

$$\% \text{ UV-A block/measurement } (M) = 100 \% - T(\text{UV-A})$$

where:

$$T(\text{UV-A}) = \frac{\sum_{315 \text{ nm}}^{400 \text{ nm}} T_\lambda \Delta \lambda}{\sum_{315 \text{ nm}}^{400 \text{ nm}} \Delta \lambda}$$

$$\text{Specimen \% UV-A block } (S) = \frac{M_1 + M_2 + M_3 \dots + M_n}{N}$$

where:

N = number of measurements per specimen.

$$\text{Mean UV-A Percent block} = \frac{S_1 + S_2 + S_3 \dots + S_n}{N}$$

where:

N = number of specimens.

10.3 Percent UV block is to be calculated as:

$$\% \text{ UV block} = 100 \text{ minus } 1/\text{label UPF as determined in Section 8} \times 100$$

11. Label Elements (Marking)

11.1 A label shall contain the following elements:

- (a) a UPF value,
- (b) a classification category, either Good UV Protection, Very Good UV Protection, or Excellent UV Protection,
- (c) a statement that the UV-protective textile product has been labeled according to this ASTM standard guide.

11.2 A label may contain but is not limited to:

- (a) a percent UV-B and a UV-A blocked value or a percent UV-block value.
- (b) a statement that the UV-protection value indicates the lowest amount of protection that can be expected during the life of the product.
- (c) a statement that the product reduces exposure to harmful UV-A and UV-B rays.
- (d) a statement that no textile product provides 100 % protection from UV radiation.
- (e) Warnings such as:
 - (1) The protection offered by this garment may be lessened:

at points where the fabric is in close contact with the skin such as across the shoulders, when the fabric is stretched, when the fabric is damp or wet, and/or with time due to heavy wear and/or laundering.

(2) The protection offered by this hat or shade product does not include protection from reflected or scattered ultraviolet radiation.

(f) a statement that “Only skin covered by the fabric (garment) is protected from sunlight exposure.”

11.3 Labels on UV-protective textiles must not state, nor imply, that the fabric/product prevents skin cancer, aging of the skin, and similar medical claims. Such claims may be appropriate for medical-device UV-protective textiles.

11.4 The same font and type size shall be used for protection category, UPF value, and label percent blocked values.

11.5 The actual size and graphic layout of the labeling information is the responsibility of the final product manufacturer or marketer.

12. Keywords

12.1 apparel; garments; labeling; terminology; UV-blocking; UV protection factors; UV protective textiles

ANNEX
(Mandatory Information)
A1.

See Table A1.1.

TABLE A1.1 Values for Standard Error Equation Based on the Number of Specimens

N (number of specimens)	k (degrees of freedom)	$t_{k,0.005}$ (t-variate)	$t_{k,0.005}^N$
4	3	5.84	2.92
6	5	4.03	1.65
8	7	3.50	1.24
10	9	3.25	1.03

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