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Standard Specification 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sun protective fabrics and clothing whose labeling is specified in the U.S. Food and Drug Administration's Draft Guidance for the Preparation of a Premarket Notification document.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 specification will be based on UV-protection data collected by instrumental methods.

1.6 *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.*

2. Referenced Documents

2.1 ASTM Standards:²

D123 Terminology Relating to Textiles

D3938 Guide for Determining or Confirming Care Instructions for Apparel and Other Textile Products

D6544 Practice for Preparation of Textiles Prior to Ultraviolet (UV) Transmission Testing

2.2 AATCC Standards:³

AATCC LP1 Home Laundering: Washing Machine

AATCC LP2 Home Laundering: Hand Washing

AATCC TM16.3 Colorfastness to Light: Xenon Arc

AATCC TM162 Colorfastness to Water: Chlorinated Pool

AATCC TM172 Colorfastness to Powdered Non-chlorine Bleach in Home Laundering

AATCC TM183 Transmittance or Blocking of Erythemally Weighted Ultraviolet Radiation through Fabrics

AATCC TM188 Colorfastness to Sodium Hypochlorite Bleach in Home Laundering

2.3 Other Standards:

15 U.S.C., Chapter 2, Subchapter V, The Textile Fiber Products Identification Act⁴

15 U.S.C., Chapter 2, Subchapter III, et. seq., Wool Products Labeling Act of 1939⁴

16 C.F.R. Part 303, Rules and Regulations Under the Textile Fiber Products Identification Act⁴

16 C.F.R. Part 300, Rules and Regulations Under the Wool Products Identification Act⁴

16 C.F.R. Part 423, Care Labeling of Wearing Apparel and Certain Piece Goods⁴

AS/NZS 4399: 1996, Australian/New Zealand Standard Sun Protective Clothing – Evaluation and Classification⁴

FDA Office of Device Evaluation, Draft Guidance for the Preparation of a Premarket Notification (510(K)) Submission for Sun Protective Clothing, August 10, 1994⁵

3. Terminology

3.1 For definitions of terms relating to UV-protective textiles refer to Terminology D123.

3.2 The following terms are relevant to this standard: *UV-protective textile*, *ultraviolet protection factor (UPF)*, and *UV-protection categories*.

¹ This specification is under the jurisdiction of ASTM Committee D13 on Textiles and is the direct responsibility of Subcommittee D13.65 on UV Protective Fabrics and Clothing.

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² 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.

³ Available from American Association of Textile Chemists and Colorists (AATCC), P.O. Box 12215, Research Triangle Park, NC 27709, <http://www.aatcc.org>.

⁴ Available from U.S. Government Printing Office Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401, <http://www.access.gpo.gov>.

⁵ 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.

3.3 For definition of other terms related to textiles, refer to Terminology **D123**.

4. Significance and Use

4.1 This specification 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 specification will be labeled with a UPF value. AATCC TM183 must be used to determine the mean UPF values of unprepared specimens, of specimens prepared using Practice **D6544** (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 shrinkage may restore the lost protection by 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 or garments, or both, if those products make a UV-protective claim as determined by this specification.

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 Practice **D6544**. All specimens shall be tested in the dry state. For materials that are intended to be used where there is a likelihood that the garment will be worn wet, specimens may also be tested in the wet state according to AATCC TM183. If the end use product/garment is expected to be worn wet the purchaser and supplier should agree upon whether a material should or should not be tested in the wet state.

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 TM183. The MS_{UPF} shall be calculated for the dry specimen, MS_{UPF} dry using **Eq 1**. Additionally the MS_{UPF} may also be calculated for the wet specimen, MS_{UPF} wet.

$$MS_{UPF} = \frac{UPF = UPF_1 + UPF_2 + \dots + UPF_N}{N} \quad (1)$$

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. Using **Eq 2** Calculate MS_{UPF} for the dry specimen, TS_{UPF} dry and as needed the wet specimen, TS_{UPF} wet.

$$TS_{UPF} = \frac{UPF_1 + UPF_2 + \dots + UPF_N}{N} \quad (2)$$

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. Using **Eq 3** Calculate UPF_m for the dry specimen, UPF_m -dry and as needed the wet specimen, UPF_m -wet.

$$UPF_m = \frac{UPF_1 + UPF_2 + \dots + UPF_N}{N} \quad (3)$$

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 Practice **D6544** 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 TM183. 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 Eq 3 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 dry specimen, SD_{dry} and as needed the wet specimen, SD_{wet} as follows in Eq 4:

$$SD = \sqrt{\frac{\sum_{i=1}^N (UPF_i - meanUPF)^2}{N - 1}} \quad (4)$$

7.2 The Standard Error (E) in the mean UPF should be calculated for the dry specimen, E_{dry} and as needed the wet specimen, E_{wet} for the 99 % confidence level using Eq 5:

$$E = \frac{\tau_{\kappa\alpha} SD}{\sqrt{N}} \quad (5)$$

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. Eq 6 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 in the dry state and as needed the wet state as a first step in determining the UPFs to be compared:

$$UPF \text{ value for label (a multiple of five)} = \text{Sample UPF} - E \quad (6)$$

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 Practice D6544 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 in the dry state and as needed the wet state), 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 in the dry state and as needed the wet state), 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 UVB and UVA Block Number to Appear on Label

10.1 The percent UVB block number that may appear on a product label shall be the arithmetic mean of at least two determinations of percent UVB block on two test specimens determined according to test procedures in AATCC TM183. The test specimens will be from prepared-for-testing fabric,

from unprepared fabric or from laundered-once garments. The calculation sequence including Eq 7, Eq 8, Eq 9, and Eq 10 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 UVB will be that placed on the product. The value on the label shall be stated as a whole number no greater than 99 %.

$$\% \text{ UVB block/measurement } (M) = 100 \% T(\text{UVB}) \quad (7)$$

where:

$$T(\text{UVB})_{\text{AVE}} = \frac{\sum_{\lambda=280 \text{ nm}}^{315 \text{ nm}} T_{\lambda} \Delta \lambda}{\sum_{\lambda=280 \text{ nm}}^{315 \text{ nm}} \Delta \lambda} \quad (8)$$

$$\text{Specimen \% UVB block } (M) = \frac{\sum_{i=1}^N M_i}{N} \quad (9)$$

where:

N = number of sites/measurements/determinations per specimen

$$\text{Mean \% UVB block} = \frac{\sum_{i=1}^N S_i}{N} \quad (10)$$

where:

N = number of specimens

10.2 The percent UVA block number that may appear on a product label shall be the arithmetic mean of at least two determinations of percent UVA block on two test specimens determined according to test procedures in AATCC TM183. The test specimens will be from prepared-for-testing fabric, from unprepared fabric or from laundered-once garments. The calculation sequence including Eq 11, Eq 12, Eq 13, and Eq 14 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. Test specimens shall be evaluated in the dry state and as needed in the wet state. The lower of the two values in the comparison of calculated label UVA will be that placed on the product. The value on the label shall be stated as a whole number no greater than 99 %.

$$\% \text{ UVA block/measurement } (M) = 100 \% T(\text{UVA}) \quad (11)$$

where:

$$T(\text{UVA}) = \frac{\sum_{\lambda=315 \text{ nm}}^{400 \text{ nm}} T_{\lambda} \Delta \lambda}{\sum_{\lambda=315 \text{ nm}}^{400 \text{ nm}} \Delta \lambda} \quad (12)$$

$$\text{Specimen \% UVA block } (M) = \frac{\sum_{i=1}^N M_i}{N} \quad (13)$$

where:

N = number of measurements per specimen.

$$\text{Mean \% UVA block} = \frac{\sum_{i=1}^N S_i}{N} \quad (14)$$

where:

N = number of specimens.

10.3 Percent UV block is to be calculated using $\text{UPF}_{\text{LABEL}}$ from Section 8 as:

$$\% \text{ UV block} = 100 - \frac{1}{\text{UPF}_{\text{LABEL}}} \times 100 \quad (15)$$

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, and
- (c) a statement that the UV-protective textile product has been labeled according to this ASTM standard specification.

11.2 A label may contain but is not limited to:

- (a) a percent UVB and a UVA 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 UVA and UVB rays,
- (d) a statement that no textile product provides 100 % protection from UV radiation, and
- (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 or laundering, or both.

(2) The protection offered by this hat or shade product does not include protection from reflected or scattered ultra-violet 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

ANNEXES

(Mandatory Information)

A1. UV-PROTECTIVE TEST METHODS

INTRODUCTION

Manufacturers and producers of UV-protective textile materials or products, or both, must be aware of the proper existing standards and test methods to meet published voluntary standards for labeling UV-protective clothing for the United States.

A1.1 There are three published voluntary standards:

A1.1.1 ASTM **D6544** – Practice for Preparation of Textiles Prior to Ultraviolet (UV) Transmission Testing

A1.1.2 ASTM D6603 – Specification for Labeling of UV-Protective Textiles

A1.1.3 AATCC TM183 – Transmittance or Blocking of Erythemally Weighted Ultraviolet Radiation Through Fabrics

A1.2 To summarize at a high level, these three standards are used in conjunction with one another to develop the proper UPF values to properly label products as “UV-Protective.”

A1.2.1 Evaluate UV transmission of original specimen (“unprepared”) or “laundered once” specimen using AATCC TM183. The value reported is the AATCC TM183 UPF value.

A1.2.2 Refer to ASTM **D6544** to determine the exposure conditions depending on the product end use. Section 7 lists three options for exposure conditions. Exposure conditions may reference the following test methods and reflect a combination of multiple exposure conditions following these test methods:

A1.2.2.1 ASTM **D3938**

A1.2.2.2 AATCC LP1

A1.2.2.3 AATCC LP2

A1.2.2.4 AATCC TM16.3

A1.2.2.5 AATCC TM162

A1.2.2.6 AATCC TM172

A1.2.2.7 AATCC TM188

A1.2.3 After subjecting the specimens to the specified exposure conditions of ASTM **D6544**, evaluate UV transmission using AATCC TM183. This specimen is referred to as the “prepared-for-testing” specimen, based on the end use of the garment/fabric.

A1.2.4 Refer to ASTM D6603 for additional calculations that need to be performed on the values obtained from AATCC TM183.

A1.2.5 Classification for labeling the UPF value are outlined in ASTM D6603, Section 8.

A2. CRITICAL VALUES FOR CALCULATING THE STANDARD ERROR

See **Table A2.1**.

TABLE A2.1 Values for Standard Error Equation Based on the Number of Specimens

N (number of specimens)	k (degrees of freedom)	$t_{k,0005}$ (t-variate)	$t_{k,0005}/\sqrt{N}$
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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