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**SRL2009-293: DETERMINATION OF THE UV PROTECTION FACTOR
(UPF) FOR A GLOVE SAMPLE**

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Objective: To determine the UPF of a glove sample using AATCC
Test Method 183-2000

Test Fabric: Go Green Gloves

Sponsor: Glove Online, Inc.
P.O. Box 4468
Cary, NC 27519

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Procedure:

The test gloves were stored for at least 4 hours in a chamber with a constant temperature of 70° (±2°) Fahrenheit and a relative humidity of 65% (±2 %).¹

The gloves were removed from the chamber and 2" x 2" samples from both the back and palm surfaces of the gloves were obtained. The UPF was determined for both surfaces using a Labsphere UV Transmittance Analyzer. Model UV-2000S, (Labsphere, North Sutton, NH). After each measurement the test sample was rotated approximately 45° from the previous measurement orientation. Four samples of each glove surface were measured for a total of 12 measurements for each glove surface.

Calculations:

The following equations were used to calculate the UPF, average UVA-range ultraviolet transmittance, average UVB-range ultraviolet transmittance, percent blocking of UVA and percent blocking of UVB of the test sample²:

For UPF:

$$UPF = \frac{\sum_{280 \text{ nm}}^{400 \text{ nm}} E_{\lambda} \times S_{\lambda} \times \Delta\lambda}{\sum_{280 \text{ nm}}^{400 \text{ nm}} E_{\lambda} \times S_{\lambda} \times T_{\lambda} \times \Delta\lambda} \quad (1)$$

where:

E_{λ} = relative erythemal spectral effectiveness

S_{λ} = solar spectral irradiance

T_{λ} = average spectral transmittance of the sample (measured)

$\Delta\lambda$ = measured wavelength interval (nm)

For UV-range transmittance:

$$\tau(\text{UV})_{AV} = \frac{\sum_{280 \text{ nm}}^{400 \text{ nm}} T_{\lambda} \times \Delta\lambda}{\sum_{280 \text{ nm}}^{400 \text{ nm}} \Delta\lambda} \quad (2)$$

For UVA-range transmittance:

$$\tau(\text{UVA})_{AV} = \frac{\sum_{315 \text{ nm}}^{400 \text{ nm}} T_{\lambda} \times \Delta\lambda}{\sum_{315 \text{ nm}}^{400 \text{ nm}} \Delta\lambda} \quad (3)$$

For UVB-range transmittance:

$$\tau(\text{UVB})_{AV} = \frac{\sum_{280 \text{ nm}}^{315 \text{ nm}} T_{\lambda} \times \Delta\lambda}{\sum_{280 \text{ nm}}^{315 \text{ nm}} \Delta\lambda} \quad (4)$$

For percent blocking UVA:

$$\% \text{ Blocking UV} = 100\% - \tau(\text{UV})_{AV} \quad (5)$$

For percent blocking UVA:

$$\% \text{ Blocking UV-A} = 100\% - \tau(\text{UVA})_{AV} \quad (6)$$

For percent blocking UB-B:

$$\% \text{ blocking UV-B} = 100\% - \tau(\text{UVB})_{AV} \quad (7)$$

In addition, for labeling of UV-protective textiles the mean UPF for each test specimen and the mean, standard deviation and standard error for all samples are calculated using the following formulas.

For the mean UPF of each sample:

$$MS_{UPF} = \frac{UPF_1 + UPF_2 + UPF_3}{N}$$

For the mean UPF of all samples:

$$UPF_m = \frac{MS_{UPF1} + MS_{UPF2} + MS_{UPF3} + MS_{UPF4}}{N}$$

For the Standard Deviation (SD) of all samples:

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

For the Standard Error (E) of all samples:

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

where:

$T_{\kappa\alpha}$ = T variate ($\alpha = 0.005$)
 κ = $N-1$
SD = Standard Deviation
N = number of samples

Determination of UPF Value for Label³:

The UPF value to be placed on the label is the mean UPF (UPF_m) minus the standard error (E) of the sample UPFs, the result of which has been rounded down to the nearest multiple of five. If the lowest MS_{UPF} is lower than the UPF_m then the lowest MS_{UPF} will be used as the labeled UPF (not to exceed a value of 50). For obtained UPF values greater than 50, a value of 50+ will be assigned.³

The following formula is used in calculating the UPF value for labeling:

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

When the calculated UPF is less than 15, the fabric cannot be labeled as UV protective.³

Results

Results are summarized in the following Tables:

Table 1. UPF Results for Go Green Glove (Back Surface)

Sample UPF value=	Test Fabric: Go Green Gloves (Back Surface)											
	Specimen 1			Specimen 2			Specimen 3			Specimen 4		
	3148.72	2634.70	6244.13	3569.37	5810.43	5599.43	5772.20	3795.20	2724.74	2765.27	7475.24	3722.03
MS (UPF)=	4009.19			4993.08			4097.38			4654.18		
UPF (m)=	4438.46											
SD=	467.17											
E=	682.07											
UPF-E=	3756.39											
Labeled=	50 +											
Mean T(UVA)=	0.03%											
Mean T(UVB)=	0.03%											
%Block UVA=	99.97%											
%Block UVB=	99.97%											

Table 2. UPF results for Go Green Glove (Palm Surface)

Sample UPF value=	Test Fabric: Go Green Gloves (Palm Surface)											
	Specimen 1			Specimen 2			Specimen 3			Specimen 4		
	6550.35	2706.83	7554.46	3563.68	7250.89	3338.74	3903.02	2468.08	3082.74	2747.28	2920.77	6965.79
MS (UPF)=	5603.88			4717.77			3151.28			4211.28		
UPF (m)=	4421.05											
SD=	1023.63											
E=	1494.50											
UPF-E=	2926.55											
Labeled=	50 +											
Mean T(UVA)=	0.03%											
Mean T(UVB)=	0.03%											
%Block UVA=	99.97%											
%Block UVB=	99.97%											

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Conclusions:

Analysis for both surfaces of the gloves (back and palm surfaces) showed no significant difference in UV transmission. The glove fabrics had a minimum UPF – E value of 2926.55 and may be labeled as UPF 50 +.



J. William Stanfield – Investigator

18 JUN 2009

Date

References:

1. Standard Practice for Conditioning and Testing Textiles, ASTM Designation: D 1776-98. ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA, 19428-2959 USA.
2. Transmittance or Blocking of Erythemally Weighted Ultraviolet Radiation through Fabrics, AATCC Test Method 183-2000. . American Association of Textile Chemists and Colorists, Research Triangle Park, NC 27709.
3. Standard Guide for Labeling of UV-Protective Textiles,“ ASTM Designation: D 6603-00. ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA, 19428-2959 USA.