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September 5, 2000

Dockets Management Branch (HFA-305)
Food and Drug Administration
5630 Fishers Lane, Room 1061
Rockville, MD 20852

RE: Docket No. 78N-0038

Dear Sir or Madam:

Enclosed is our comment for the administrative record for Sunscreen Drug Products for Over-the-Counter Human Use.

Please let me know if you require further information or have any questions.

Sincerely,

Joseph W. Stanfield

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78N-0038

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PROPOSED METHOD FOR ASSESSING SUNSCREEN PHOTOSTABILITY AND BROAD SPECTRUM PROTECTION
Docket No. 78N-0038

1.0 INTRODUCTION

The sun protection factor (SPF) of a sunscreen product is determined using a xenon arc solar simulator which has an emission spectrum resembling the solar spectrum from 290 to about 360 nm when the sun is almost directly overhead. At these high sun angles, which occur at latitudes near the equator and in mid-summer at higher latitudes, the effects of UVB (290-320 nm) predominate, and potential for sunburn and other types of sun damage is greatest. At lower sun angles, the potential for sun damage is lower, but energy from UVA wavelengths (320-400) is responsible for a higher proportion of potential damage. At lower sun angles the actual SPF of a sunscreen in sunlight is lower than the labeled value unless the product provides a substantial level of UVA protection. Nevertheless, SPF provides a useful benchmark of sunscreen protection under the most potentially damaging conditions of sun exposure.

Increasing awareness of the need for protection against the UVA portion of the solar spectrum, as well as the UVB portion, has accelerated development of broad spectrum sunscreen products, which protect against both. Since products providing little UVA protection may have labeled SPF values similar to those of broad spectrum products, there is a need for a reliable and informative index of UVA protection.

Assessment of UVA protection *in vivo* is a formidable problem, because sunlight is always a mixture of UVA and UVB, and the immediate and long-term effects of UVA are normally masked by the effects of energy in the more potent UVB wavelengths. Separation of UVA effects from those of full-spectrum UV is difficult, and eliciting measurable responses to UVA alone requires high energy doses and relatively long exposure times.

Proposed human *in vivo* methods for assessing UVA protection are based on the immediate pigment darkening, persistent pigment darkening, delayed erythema and delayed tanning responses. While each method has its own advantages, none is completely adequate for assigning a clinically relevant index of sunscreen protection in the UVA region. In addition, there is a concern that some broad spectrum sunscreen products may not be photostable, but only *in vitro* methods have been developed for assessing sunscreen photostability. For these reasons, validated *in vitro* methods appear to offer the best alternative for examining the behavior of sunscreens during UV irradiation and for assessing UVA protection. Following is a discussion of the available *in vivo* methods for evaluating UVA protection and the use of *in vitro* methods for evaluating UVA protection and sunscreen photostability.

1.1 Immediate Pigment Darkening

The immediate pigment darkening (IPD) response is a transient brownish-gray coloration of the skin of individuals with pigmented skin after irradiation with UVA radiation. The response is evaluated within 60 seconds after UVA exposure. The IPD protection factor is the ratio of the UVA dose required to produce the response, with and without a sunscreen on the skin. [1]

The IPD test produces rapid results with low doses of UVA. However the response is highly variable and difficult to reproduce accurately. Its clinical significance is unknown because the action spectrum for IPD differs widely from action spectra for erythema and tanning [2,3,4], non-melanoma skin cancer [5] and photoaging [6].Further, the test is performed using human subjects with skin types III and IV, who are not the individuals who have the greatest need for sun protection. [7]. The low UVA doses involved may conceal the effects of sunlight on the stability of the product.

1.2 Persistent Pigment Darkening

The persistent pigment darkening (PPD) response is a longer lasting response of individuals with pigmented skin after irradiation with UVA radiation. The response is evaluated 2 to 24 hours after UVA exposure. The PPD protection factor [8] is the ratio of the UVA dose required to produce the response, with and without a sunscreen on the skin.

The PPD test produces rapid results with moderately low doses of UVA. The response is stable and reproducible, however its clinical significance is also unknown, as in the case of IPD, because the action spectrum for PPD is not defined for wavelengths shorter than 320 nm. Further, the test is performed using human subjects with skin types II, III and IV, which do not include Type I individuals who have the greatest need for sun protection. Again the low UVA doses involved may conceal the effects of sunlight on the stability of the product.

1.3 PFA

The PFA (protection factor A) method is based on the minimal response dose (MRD), which is the smallest UVA dose that produces a delayed minimal erythema or tanning response. A substantially higher energy dose is required to produce the erythema or tanning response to UVA than that required to produce an erythema or tanning response to UVB, with consequently longer exposure times. The response is evaluated 22 to 24 hours after exposure, and is stable, reproducible and clinically significant, in that the action spectra for erythema and tanning [3, 4] are similar to those for skin cancer [5] and photoaging [6]. Further, the test is performed using human subjects with skin types I, II and III, who are the individuals who have the greatest need for sun protection. The UVA protection factor, PFA, is the ratio of the MRD for sunscreen-protected skin to that for unprotected skin.[9]

1.4 Advantages and Limitations of *In Vitro* Methods

A major disadvantage of the above *in vivo* methods is that available UVA sources do not fully reproduce the UVA portion of the solar spectrum.[10] Spectra from xenon arc lamps that are filtered to remove UVB wavelengths are still slightly contaminated with UVB and are deficient in both the short UVA region and the long UVA region, compared to sunlight. This means that the results of *in vivo* UVA protection measurements cannot be extrapolated with confidence to human sun exposure.

Sunscreen measurements obtained *in vitro* are rapid and inexpensive, and reduce the need for studies in human subjects. The major advantage of *in vitro* measurements is the ability to isolate regions of the UV spectrum and explore the parameters of sunscreen protection against any UV effect that has a defined action spectrum. These explorations may aid in designing subsequent experiments under appropriate conditions The major disadvantage is the formidable challenge of simulating human exposure to sunlight with an acceptable degree of fidelity.

Sunscreen protection may be evaluated *in vitro* by measuring the spectrum of UV energy applied and transmitted during the course of irradiation with a sufficient UV dose to deliver the equivalent of one minimum erythema dose through the sunscreen film. The resulting UV transmission spectrum represents the effective transmission spectrum for the product under the conditions of its application amount and the spectral power of the source. The transmission spectrum may be validated using *in vivo* human SPF data obtained for the same product under the same application and source conditions. The validated transmission spectrum may then be used to measure protection in the UVA region for the same source and application conditions. Due to the strong dependence of the integrity and performance of the sunscreen itself on the spectral power of the UV source, results of measurements with one source, e.g. a xenon arc lamp, cannot be extrapolated with confidence to another source, e.g. sunlight, without additional validation.

2.0 IN VITRO ASSESSMENT OF SUNSCREEN PERFORMANCE

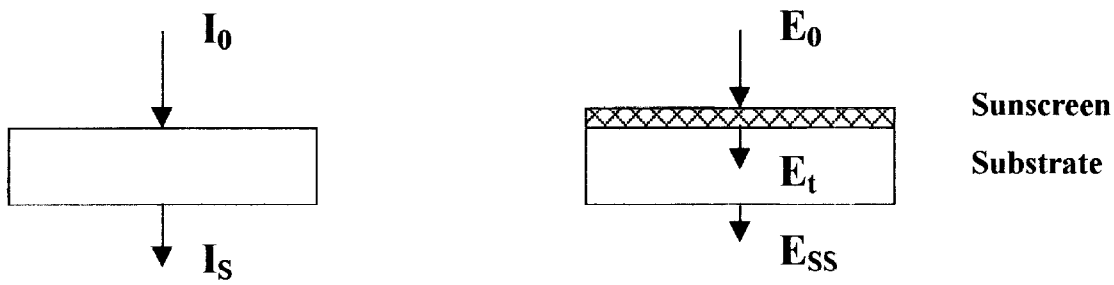
2.1 An *in vitro* Model of Sunscreen SPF

In the SPF test conducted *in vivo* using human subjects[11,12], progressively increasing UV doses are administered to skin sites, with and without sunscreen protection. For the sites where the erythema effective UV dose [4] reaching the skin crosses the erythema threshold, the skin will display an erythema response, which peaks 16 to 24 hours later. The sunscreen SPF is the ratio of the effective UV doses for sunscreen-protected and unprotected skin sites which exhibit minimally perceptible erythema.

In vitro measurements of sunscreen protection simulate the SPF test by using sunscreen applied to an artificially prepared substrate, instead of living skin. The SPF is determined by measuring the erythema effective UV dose transmitted through the substrate alone and

the erythema effective UV dose transmitted through the substrate with the sunscreen present. This is shown schematically in Figure 1. below:

Figure 1. Schematic Diagram of The *in vitro* SPF Test



In Figure 1., $\mathbf{I_0}$ is the erythema effective UV irradiance applied to the surface of the substrate alone and $\mathbf{I_S}$ is the erythema effective UV irradiance transmitted by the substrate alone. $\mathbf{I_0}$ and $\mathbf{I_S}$ are calculated by converting directly measured spectral irradiance values to erythema effective spectral irradiance and integrating over wavelength as shown in equations (1) and (2).

$$\textbf{(1)}\ I_0 = \sum_{\lambda_1}^{\lambda_2} V_\lambda I_{\lambda 0} \Delta\lambda$$

$$\textbf{(2)}\ I_S = \sum_{\lambda_1}^{\lambda_2} V_\lambda I_{\lambda SS} \Delta\lambda$$

Where:
$\lambda 1$ and $\lambda 2$ are lower and upper wavelengths of the range measured (290-400 nm for full spectrum UV and 320-400 nm for UVA only).
V_λ is the erythema effectiveness coefficient from an erythema action spectrum [4].
$I_{\lambda 0}$ and $I_{\lambda S}$ are measured spectral irradiance values.
$\Delta\lambda$ is the wavelength interval.

$\mathbf{I_0}$ and $\mathbf{I_S}$ are used to calculate the SPF of the substrate by the following equation:

(3) $\mathbf{SPF_S = I_0/I_S}$

$\mathbf{SPF_S}$ is assumed to be constant.

$\mathbf{E_0}$ is the erythema effective UV dose applied to the surface of the sunscreen on the substrate; $\mathbf{E_{SS}}$ is the erythema effective UV dose transmitted through the sunscreen and substrate and $\mathbf{E_t}$ is the erythema effective UV dose transmitted through the sunscreen on the substrate. $\mathbf{E_0}$, $\mathbf{E_{SS}}$ and $\mathbf{E_t}$ increase with time, and represent cumulative doses at time, **t**.

$\mathbf{E_0}$ and $\mathbf{E_{SS}}$ are calculated by converting directly measured spectral irradiance values to erythema effective spectral irradiance and integrating over wavelength and time as shown in equations (4) and (5).

$$\textbf{(4)}\ E_0 = \sum_{0}^{t}\sum_{\lambda_1}^{\lambda_2} V_\lambda I_{\lambda 0} \Delta\lambda \Delta t$$

$$\textbf{(5)}\ E_{SS} = \sum_{0}^{t}\sum_{\lambda_1}^{\lambda_2} V_\lambda I_{\lambda SS} \Delta\lambda \Delta t$$

Where
t = time (sec)
λ1 and **λ2** are lower and upper wavelengths of the range measured (290-400 nm for full spectrum UV and 320-400 nm for UVA only).
$\mathbf{V_\lambda}$ is the erythema effectiveness coefficient from the erythema action spectrum [4].
$\mathbf{I_{\lambda 0}}$ and $\mathbf{I_{\lambda SS}}$ are measured spectral irradiance values.
Δλ is the wavelength interval.
Δt is the time interval.

Then $\mathbf{E_t}$ is calculated using equation (6).

(6) $\mathbf{E_t = SPF_S\ E_{SS}}$

and the cumulative SPF of the sunscreen, $\mathbf{SPF_t}$, may be calculated using equation (7).

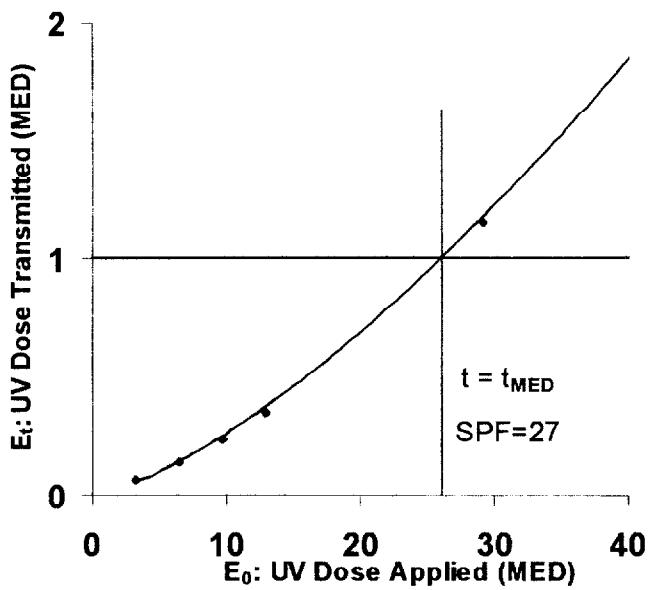
(7) $\mathbf{SPF_t = E_0 / E_t}$

$\mathbf{SPF_t}$ may or may not be constant, depending on the degree of photostability of the sunscreen. The SPF of the sunscreen corresponding to the SPF measured in the human *in vivo* SPF test is the value of $\mathbf{SPF_t}$ at time $\mathbf{t_{MED}}$, which is the time when the value of $\mathbf{E_t}$ reaches the erythema threshold dose, or MED. The value of SPF at times greater than

t_{MED} is meaningless because it cannot be measured *in vivo,* as defined in the SPF test protocol [11,12].

For convenience, the value of 1 MED is assumed to be 0.02 effective J/cm^2. The values of erythema effective UV doses $\mathbf{E_0}$, $\mathbf{E_{SS}}$ and $\mathbf{E_t}$ may be expressed in MEDs by dividing their values in effective J/cm^2 by 0.02. Then the value of $\mathbf{E_0}$ when $\mathbf{E_t}$ reaches 1.0 is the final value of the sunscreen SPF. This is illustrated in Figure 2.

Figure 2. Example of $\mathbf{E_t}$ vs. $\mathbf{E_0}$ for a Typical Sunscreen



The UVA protection factor, which we denote as $\mathbf{APF_t}$, may be calculated as $\mathbf{SPF_t}$ is calculated above, but using the wavelength range from 320 to 400 nm. This will be discussed further in Section 3.3 below.

2.2 Technical Considerations in Sunscreen in vitro Measurements

Over the past two decades, investigators have attempted *in vitro* prediction of sunscreen SPF using a variety of approaches and instrumentation systems, with highly inconsistent results. Failures of *in vitro* SPF prediction have been attributed to:

1. Measurement systems that do not collect all forward-scattered radiation. [14]

2. Sunscreens that protect against erythema by inhibiting free radicals or by anti-inflammatory activity, rather than absorbing or scattering UV energy.[14]

3. Substrates that do not provide normal sunscreen-skin interactions, e.g. skin penetration [13].

4. Failure of the substrate to reproduce skin topography. [13]

5. Inappropriate amount of sunscreen applied to substrate. [19]

6. Use of an inappropriate source spectrum to compute SPF. [15]

7. Fluctuations in UV source output.

8. Lack of photostability of the sunscreen.

Sayre *et al* successfully predicted sunscreen SPF using an *in vitro* test system with an excised mouse skin substrate and an integrating sphere attached to a spectrophotometer. The integrating sphere collected the forward-scattered radiation, correcting geometric problems encountered in other systems.[16]

Sunscreens that protect against erythema by inhibiting free radicals or by anti-inflammatory activity would be expected to produce lower SPF values *in vitro* than *in vivo*. [17] Since sunscreens that protect against erythema by mechanisms other than absorbing UV energy may give consumers a false sense of security against UV damage, it may be preferable to use methods for assessing UV protection that are based solely on sunscreen absorbance of UV radiation. Validated *in vitro* methods for predicting sunscreen SPF that yield values different from those obtained *in vivo* may yield valuable insights into the behavior of sunscreen formulas and their mechanisms for suppressing erythema.

Substrates for *in vitro* measurements of sunscreen protection have included excised mouse skin [13, 17], human stratum corneum [19], Transpore™ tape (3M Corporation, Minneapolis, MN) [15], UV transparent castings from skin replicas [20] and various collagen films. Ideally, the substrate should have a topography similar to that of human skin of the mid-back [19], be composed of proteins and lipids similar to those in human skin, absorb sunscreen active and vehicle ingredients to the same degree and at the same rate as human skin, be exposed to the ambient oxygen environment during UV doses [21] and freely transmit UV energy. In addition, the ideal substrate would not require sacrificing of animals.

If the topography of a substrate is significantly different from that of human skin, it may be possible to adjust the sunscreen application amount to compensate for lack of the filling of "valleys" and coverage of "peaks" on the human skin surface to achieve accurate simulation of the *in vivo* environment.

Diffey and Robson [15] developed the use of Transpore tape as a substrate for *in vitro* SPF prediction. This was an ingenious solution to a difficult problem, but Transpore tape has perforations, which make the use of a backing material essential, and preferentially absorbs solvents and oils. Consequently, Transpore tape is not suitable for use with many marketed sunscreen formulas[19].

If measurements of the erythema effective UV dose applied to the substrate, with and without sunscreen, and measurements of transmitted erythema effective doses are not simultaneous, especially when spectral irradiance measurements are used to compute

erythema effective doses, temporal stability of the UV source is important. It may be desirable to use a feedback-stabilized source. However the author has found that a 150 watt xenon arc lamp (Model 16S, Solar Light Company, Philadelphia, PA) is sufficiently stable to permit these measurements if the supply voltage is constant. This is the same source used by several laboratories in the US for *in vivo* SPF determinations [22], and it complies with COLIPA guidelines for lamp spectra [11].

Although SPFs are determined *in vivo* using xenon arc solar simulators, Diffey and Robson [15] used a noonday 40 degree North latitude solar spectrum to compute predicted SPF. More accurate *in vitro* predictions of labeled SPF are possible using spectra of the lamps employed for *in vivo* SPF determination.

Many early attempts to predict the SPFs of sunscreen formulas containing Avobenzone yielded erroneously high values. Subsequently it was shown that many sunscreen formulas were not photostable [18, 22, 23,24, 25, 26] and had high initial SPFs which declined rapidly during irradiation. SPF ratings determined in the human *in vivo* test were valid, but were overestimated by *in vitro* tests. Pre-irradiation with measured UV doses has permitted more accurate *in vitro* estimates of SPF.

Based on these findings, the author and coworkers have developed a method for simultaneously predicting SPF and assessing photostability [27]. Our method utilizes the 150 watt xenon arc lamp described above to irradiate the sunscreen applied at 1-2 mg/cm^2 to a flat collagen membrane substrate (Lambskin® condom, Carter Wallace, New York) placed in the opening of an integrating sphere attached to a spectroradiometer (Model OL 754, Optronic Laboratories, Orlando, FL). The spectral irradiance of the source and the spectral irradiance of the substrate alone are measured from 290 to 400 nm, at 1 nm intervals. Then the spectral irradiance transmitted by the sunscreen/substrate combination is measured at 1 minute intervals, until the total erythema effective dose transmitted by the sunscreen exceeds 1 MED, where 1 MED= 0.02 erythema effective J/cm^2. Each 1 minute interval represents 2-3 MEDs. This permits computation of the time course of sunscreen SPF (See Figure 2, above.), and the overall SPF of the sunscreen, which corresponds to the SPF measured in the human *in vivo* SPF test, whether or not the sunscreen SPF is constant. It follows that if the SPF is constant during irradiation the sunscreen is photostable and if the SPF decreases during irradiation the sunscreen is not photostable.

Cole and Van Fossen [13] used excised mouse skin as a substrate, applied sunscreens at 2μl/cm^2 and irradiated the preparation with a 150 W xenon arc lamp. Transmitted effective UV power was measured using a broadband detector that had a response curve approximating the erythema response curve for human skin and also using a detector that

had a flat response in the UVA range (Ultraviolet Meter, Model 3D, Solar Light Company, Philadelphia, PA). Although excised mouse skin is not an ideal substrate, use of this approach could permit direct measurement of the total erythema effective UV dose applied and the total erythema effective UV dose transmitted by the substrate and the sunscreen/ substrate combination. From those parameters, the sunscreen SPF may be

calculated as described above. A UVA protection factor could also be computed using measurements of transmitted UVA dose.

3.0 RECOMMENDATIONS

3.1 Apparatus

Essential components of a system for *in vitro* measurements of sunscreen performance include the UV source, the substrate and a spectroradiometer equipped with an integrating sphere. Alternatively, the spectroradiometer could be replaced by an integrating radiometer with full spectrum and UVA detectors, which have a response curve approximating that of the human erythema response over the range from 290 to 400 nm and the range from 320 to 400 nm, respectively.

The UV source must be stable over time and comply with Colipa Sun Protection Factor Test Method requirements [11].

The substrate must fulfill the following requirements:

1. Topography similar to human skin of the mid-back
2. Penetration characteristics and surface chemistry similar to skin.
3. UV transparent

The sunscreen will be applied at 1-2 mg/cm^2, with a goal of duplicating the SPF value measured in the human *in vivo* test. Although the SPF should be within the same product category designation (SPF 2 to under 12, 12 to under 30 and 30 and above) [12], it is not essential to match the human SPF value exactly, since proposed photostability and UVA protection labeling may be based on spectral ratios rather than absolute values.

The spectroradiometer must be equipped with an integrating sphere or other appropriate input optics to ensure collection of essentially all forward scattered UV radiation. The scan speed must permit scans of the complete solar UV spectrum (290 to 400 nm) at 1 or 2 nm intervals within the time required for the UV source to deliver 2-3 MEDs.

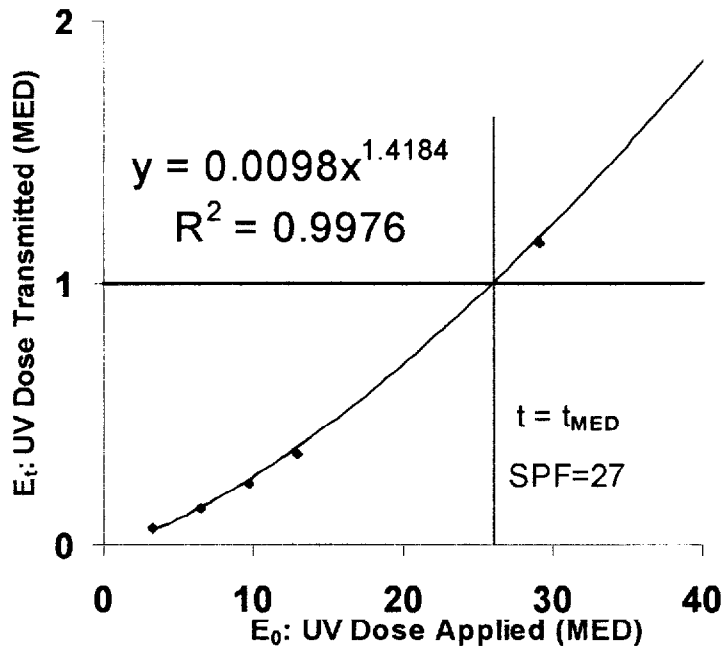
3.2 Photostability

The values of $\mathbf{E_t}$ and $\mathbf{E_0}$ will be measured or computed from spectral irradiance values at intervals no longer than the time required for the UV source to deliver 2-3 MEDs to the sunscreen/substrate, using equations (1) through (6). $\mathbf{E_t}$ vs. $\mathbf{E_0}$ will be plotted in units of MED, and a power curve fit of the form shown in equation (8) will be computed.

(8) $\mathbf{E_x = \alpha E_0^{\beta}}$

The value of r^2 for the curve fit should be at least 0.9. See Figure 3.

Figure 3. Example of E_t vs. E_0 for a Typical Sunscreen With Power Curve Fit Equation



3.3 UVA Protection

The UVA protection factor, $\mathbf{APF_t}$, may be calculated using equations (5), (6) and (7) and calculating $\mathbf{E_{SS}}$ and $\mathbf{E_t}$ for a wavelength range of 320 to 400 nm at $\mathbf{t = t_{MED}}$. $\mathbf{APF_t}$ represents the UVA component of $\mathbf{SPF_t}$, and is not analogous to a UVA protection factor measured in a human *in vivo* test, because it is measured at $\mathbf{t = t_{MED}}$ (full spectrum), rather than the time corresponding to 1 MED of transmitted UVA.

4.0 PROPOSED PRODUCT LABELING BASED ON *IN VITRO* PHOTOSTABILITY, SPF AND APF

Since a value of 1 for β in equation (8) represents a linear relationship between $\mathbf{E_t}$ and $\mathbf{E_0}$, and a constant sunscreen SPF, a sunscreen may be considered photostable if the value of β is near 1. Therefore an arbitrary limit of 1.1 has been set for β. Thus, if $\beta < 1.1$, a sunscreen may be labeled as photostable. In the example shown in Figure 3., $\beta = 1.42$, and the sunscreen is not considered photostable.

There is general agreement that the contribution of UVA to acute effects of sunlight is about 20% [28, 29]. Therefore, if the ratio of $\mathbf{APF_t}$ to $\mathbf{SPF_t}$ (when $\mathbf{E_t}$ = 1 MED) is at least 20 percent, the sunscreen may be labeled "Broad Spectrum" or "protects against UVA".

Although the above computations require a large number of mathematical operations, they may be accomplished easily, using a computerized spreadsheet, such as Excel® (Microsoft, Renton, WA) See sample calculations in Appendix 1.

5.0 CONCLUSIONS

Sunscreen SPF is a useful benchmark of sunscreen protection under the most potentially damaging conditions of sun exposure. However the actual SPF in sunlight depends on the solar spectrum, which changes with sun angle during the day. A product with a high degree of UVA protection would provide a more constant SPF at different sun angles.

The integrity of a sunscreen product depends on its degree of photostability and the spectral energy of the UV source. A photostable product would maintain its degree of protection over a wider range of UV spectra, including xenon arc lamps and solar spectra.

Thus a photostable sunscreen product with high UVA protection would maintain the degree of photoprotection measured *in vivo,* using a xenon arc lamp to a greater extent than a product with low UVA protection that is not photostable.

The above *in vitro* method and proposed labeling requirements provide a reliable and informative approach to assessing and describing sunscreen protection. Although the value of β and the ratio of $\mathbf{APF_t}$ to $\mathbf{SPF_t}$ cannot be directly extrapolated to human sun exposure, they can provide, like SPF, a useful benchmark of sunscreen performance.

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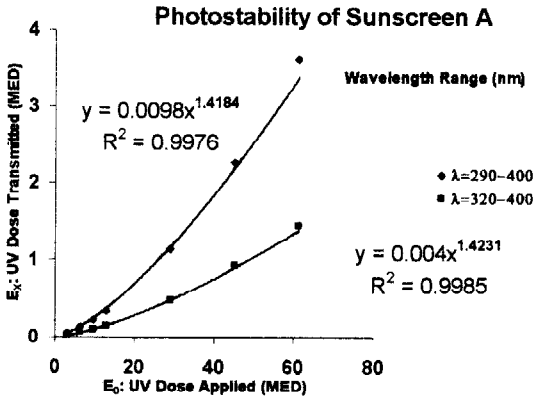
Appendix 1. Sample Calculations

Spectral Irradiance			Time (sec)								
Sunscreen A	Lamp	Substrate	0	60	120	180	240	540	840	1140	CIE Erythemal Effectiveness
λ = 290	3.71E-08	8.18E-09	3.38E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.67E-10	1.12E-09	1.44E-09	1.00E+00
291	4.05E-08	9.39E-09	1.07E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.47E-10	7.32E-10	1.13E-09	1.00E+00
292	5.17E-08	1.27E-08	2.48E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.34E-10	1.03E-09	1.07E-09	1.00E+00
293	8.14E-08	1.82E-08	3.53E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.90E-10	1.63E-09	9.95E-10	1.00E+00
294	3.85E-07	4.10E-08	1.15E-10	8.55E-12	0.00E+00	0.00E+00	0.00E+00	1.24E-09	2.41E-09	2.12E-09	1.00E+00
295	7.24E-07	1.02E-07	2.55E-10	4.18E-10	1.01E-10	6.75E-10	4.58E-10	3.43E-09	3.42E-09	3.50E-09	1.00E+00
296	1.56E-06	7.05E-07	2.06E-09	1.46E-09	1.66E-09	2.00E-09	2.98E-09	7.89E-09	8.43E-09	8.65E-09	1.00E+00
297	5.33E-06	1.26E-06	5.23E-09	5.00E-09	5.97E-09	5.32E-09	7.72E-09	1.91E-08	1.54E-08	2.35E-08	1.00E+00
298	9.47E-06	4.11E-06	1.06E-08	1.28E-08	1.50E-08	1.74E-08	2.12E-08	3.86E-08	4.03E-08	5.47E-08	1.00E+00
299	1.73E-05	6.55E-06	2.36E-08	2.76E-08	3.56E-08	4.19E-08	4.90E-08	8.47E-08	9.94E-08	1.25E-07	8.05E-01
300	4.61E-05	1.12E-05	4.94E-08	5.87E-08	7.23E-08	8.75E-08	1.03E-07	4.58E-07	5.88E-07	6.18E-07	6.49E-01
301	8.71E-05	2.12E-05	9.30E-08	1.18E-07	4.33E-07	4.36E-07	4.85E-07	6.26E-07	8.23E-07	9.31E-07	5.22E-01
302	9.79E-05	4.20E-05	3.96E-07	4.39E-07	5.21E-07	5.68E-07	6.62E-07	9.32E-07	1.24E-06	1.41E-06	4.21E-01
303	1.39E-04	5.64E-05	4.96E-07	5.95E-07	6.95E-07	8.01E-07	9.26E-07	1.35E-06	2.84E-06	3.15E-06	3.39E-01
304	2.94E-04	7.46E-05	6.58E-07	7.92E-07	9.37E-07	1.07E-06	1.26E-06	2.94E-06	3.39E-06	3.87E-06	2.73E-01
305	3.34E-04	9.73E-05	8.48E-07	1.04E-06	1.22E-06	1.41E-06	2.55E-06	3.45E-06	4.25E-06	4.95E-06	2.20E-01
306	3.95E-04	1.23E-04	1.08E-06	1.31E-06	1.55E-06	2.65E-06	2.84E-06	4.21E-06	5.32E-06	6.30E-06	1.77E-01
307	4.70E-04	1.54E-04	1.33E-06	2.51E-06	2.70E-06	3.01E-06	3.35E-06	5.17E-06	6.67E-06	7.88E-06	1.43E-01
308	5.51E-04	2.50E-04	2.33E-06	2.66E-06	3.07E-06	3.48E-06	3.91E-06	6.24E-06	8.10E-06	9.64E-06	1.15E-01
309	6.35E-04	2.77E-04	2.52E-06	2.99E-06	3.54E-06	4.05E-06	4.57E-06	7.38E-06	9.68E-06	1.16E-05	9.25E-02
310	7.24E-04	3.12E-04	2.79E-06	3.40E-06	4.03E-06	4.66E-06	5.31E-06	8.63E-06	1.14E-05	1.37E-05	7.45E-02
311	8.10E-04	3.46E-04	3.11E-06	3.80E-06	4.57E-06	5.33E-06	6.04E-06	9.90E-06	1.32E-05	2.20E-05	6.00E-02
312	9.04E-04	3.84E-04	3.50E-06	4.27E-06	5.16E-06	6.01E-06	6.86E-06	1.13E-05	2.09E-05	2.34E-05	4.83E-02
313	9.90E-04	4.22E-04	3.88E-06	4.74E-06	5.73E-06	6.67E-06	7.65E-06	1.28E-05	2.20E-05	2.55E-05	3.89E-02
314	1.08E-03	4.60E-04	4.25E-06	5.25E-06	6.30E-06	7.41E-06	8.54E-06	1.43E-05	2.37E-05	2.78E-05	3.13E-02
315	1.16E-03	4.97E-04	4.65E-06	5.77E-06	6.93E-06	8.18E-06	9.44E-06	2.06E-05	2.57E-05	3.02E-05	2.52E-02
316	1.23E-03	5.30E-04	5.02E-06	6.25E-06	7.54E-06	8.91E-06	1.03E-05	2.17E-05	2.75E-05	3.27E-05	2.03E-02
317	1.31E-03	5.65E-04	5.41E-06	6.79E-06	8.22E-06	9.71E-06	1.13E-05	2.31E-05	2.97E-05	3.53E-05	1.64E-02
318	1.65E-03	5.97E-04	5.79E-06	7.31E-06	8.88E-06	1.05E-05	1.23E-05	2.46E-05	3.18E-05	3.80E-05	1.32E-02
319	1.66E-03	6.29E-04	6.18E-06	7.87E-06	9.60E-06	1.14E-05	1.80E-05	2.63E-05	3.42E-05	4.08E-05	1.06E-02
320	1.69E-03	6.62E-04	6.69E-06	8.53E-06	1.04E-05	1.25E-05	1.85E-05	2.83E-05	3.68E-05	4.39E-05	8.55E-03
321	1.72E-03	6.96E-04	7.26E-06	9.24E-06	1.13E-05	1.76E-05	1.95E-05	3.05E-05	3.97E-05	4.73E-05	6.89E-03
322	1.75E-03	7.29E-04	7.82E-06	1.00E-05	1.67E-05	1.85E-05	2.09E-05	3.30E-05	4.28E-05	5.11E-05	5.55E-03
323	1.78E-03	7.62E-04	8.46E-06	1.09E-05	1.73E-05	1.97E-05	2.24E-05	3.57E-05	4.64E-05	5.53E-05	4.47E-03
324	1.78E-03	7.86E-04	9.10E-06	1.55E-05	1.81E-05	2.09E-05	2.40E-05	3.83E-05	5.00E-05	5.95E-05	3.60E-03
325	1.81E-03	8.20E-04	9.92E-06	1.63E-05	1.94E-05	2.26E-05	2.60E-05	4.19E-05	5.50E-05	6.53E-05	2.90E-03
326	1.83E-03	8.51E-04	1.45E-05	1.74E-05	2.09E-05	2.45E-05	2.83E-05	4.60E-05	6.03E-05	7.15E-05	2.33E-03
327	1.86E-03	8.84E-04	1.53E-05	1.87E-05	2.26E-05	2.67E-05	3.10E-05	5.07E-05	6.65E-05	7.84E-05	1.88E-03
328	1.88E-03	9.54E-04	1.63E-05	2.02E-05	2.47E-05	2.93E-05	3.40E-05	5.61E-05	7.34E-05	8.60E-05	1.46E-03
329	1.91E-03	1.12E-03	1.75E-05	2.19E-05	2.70E-05	3.22E-05	3.74E-05	6.21E-05	8.09E-05	1.25E-04	1.41E-03
330	1.94E-03	1.12E-03	1.89E-05	2.41E-05	2.97E-05	3.54E-05	4.13E-05	6.90E-05	1.21E-04	1.29E-04	1.36E-03
331	1.97E-03	1.14E-03	2.06E-05	2.65E-05	3.28E-05	3.92E-05	4.59E-05	7.67E-05	1.24E-04	1.36E-04	1.32E-03
332	2.01E-03	1.16E-03	2.26E-05	2.93E-05	3.64E-05	4.37E-05	5.14E-05	1.13E-04	1.31E-04	1.45E-04	1.27E-03
333	2.05E-03	1.19E-03	2.48E-05	3.22E-05	4.04E-05	4.89E-05	5.76E-05	1.18E-04	1.40E-04	1.54E-04	1.23E-03
334	2.10E-03	1.22E-03	2.74E-05	3.56E-05	4.50E-05	5.48E-05	6.46E-05	1.25E-04	1.49E-04	1.64E-04	1.19E-03
335	2.14E-03	1.25E-03	3.01E-05	3.95E-05	5.01E-05	6.12E-05	7.22E-05	1.34E-04	1.59E-04	1.75E-04	1.15E-03
336	2.19E-03	1.28E-03	3.31E-05	4.40E-05	5.57E-05	6.82E-05	1.02E-04	1.44E-04	1.71E-04	1.87E-04	1.11E-03
337	2.23E-03	1.31E-03	3.63E-05	4.86E-05	6.16E-05	7.53E-05	1.07E-04	1.53E-04	1.82E-04	2.00E-04	1.07E-03
338	2.27E-03	1.34E-03	3.98E-05	5.34E-05	6.80E-05	1.01E-04	1.13E-04	1.64E-04	1.94E-04	2.12E-04	1.04E-03
339	2.31E-03	1.37E-03	4.35E-05	5.87E-05	7.48E-05	1.07E-04	1.21E-04	1.75E-04	2.07E-04	2.26E-04	1.00E-03
340	2.34E-03	1.41E-03	4.73E-05	6.39E-05	9.74E-05	1.13E-04	1.29E-04	1.87E-04	2.20E-04	2.41E-04	9.66E-04
341	2.38E-03	1.44E-03	5.10E-05	6.94E-05	1.02E-04	1.19E-04	1.37E-04	2.00E-04	2.35E-04	2.56E-04	9.33E-04
342	2.40E-03	1.47E-03	5.45E-05	7.46E-05	1.07E-04	1.25E-04	1.44E-04	2.12E-04	2.50E-04	2.72E-04	9.02E-04
343	2.43E-03	1.50E-03	5.81E-05	7.97E-05	1.13E-04	1.34E-04	1.54E-04	2.26E-04	2.67E-04	2.90E-04	8.71E-04
344	2.45E-03	1.53E-03	6.17E-05	9.71E-05	1.19E-04	1.42E-04	1.63E-04	2.40E-04	2.84E-04	3.09E-04	8.41E-04
345	2.43E-03	1.56E-03	7.08E-05	9.98E-05	1.29E-04	1.57E-04	1.84E-04	2.77E-04	3.26E-04	3.52E-04	8.13E-04
346	2.44E-03	1.58E-03	7.31E-05	1.04E-04	1.34E-04	1.64E-04	1.92E-04	2.89E-04	3.41E-04	3.69E-04	7.85E-04
347	2.44E-03	1.60E-03	7.56E-05	1.08E-04	1.40E-04	1.72E-04	2.01E-04	3.05E-04	3.58E-04	3.88E-04	7.59E-04
348	2.43E-03	1.61E-03	7.80E-05	1.12E-04	1.46E-04	1.79E-04	2.10E-04	3.19E-04	3.75E-04	4.06E-04	7.33E-04
349	2.44E-03	1.63E-03	8.85E-05	1.16E-04	1.52E-04	1.87E-04	2.20E-04	3.36E-04	3.95E-04	4.28E-04	7.08E-04
350	2.44E-03	1.64E-03	9.00E-05	1.20E-04	1.58E-04	1.96E-04	2.30E-04	3.54E-04	4.18E-04	4.51E-04	6.84E-04
351	2.44E-03	1.65E-03	9.23E-05	1.24E-04	1.64E-04	2.04E-04	2.41E-04	3.73E-04	4.40E-04	4.75E-04	6.61E-04
352	2.44E-03	1.67E-03	9.50E-05	1.29E-04	1.71E-04	2.13E-04	2.53E-04	3.93E-04	4.63E-04	5.01E-04	6.38E-04
353	2.43E-03	1.68E-03	9.72E-05	1.34E-04	1.77E-04	2.22E-04	2.64E-04	4.13E-04	4.88E-04	5.27E-04	6.17E-04
354	2.43E-03	1.69E-03	9.99E-05	1.39E-04	1.85E-04	2.31E-04	2.76E-04	4.35E-04	5.16E-04	5.57E-04	5.96E-04
355	2.44E-03	1.71E-03	1.03E-04	1.44E-04	1.93E-04	2.43E-04	2.90E-04	4.61E-04	5.47E-04	5.91E-04	5.75E-04
356	2.44E-03	1.73E-03	1.06E-04	1.50E-04	2.01E-04	2.54E-04	3.05E-04	4.88E-04	5.79E-04	6.27E-04	5.56E-04
357	2.46E-03	1.76E-03	1.10E-04	1.56E-04	2.12E-04	2.68E-04	3.23E-04	5.20E-04	6.18E-04	6.69E-04	5.37E-04
358	2.48E-03	1.79E-03	1.14E-04	1.63E-04	2.23E-04	2.83E-04	3.42E-04	5.54E-04	6.59E-04	7.13E-04	5.19E-04
359	2.51E-03	1.82E-03	1.18E-04	1.71E-04	2.35E-04	2.98E-04	3.62E-04	5.90E-04	7.05E-04	7.62E-04	5.01E-04

Effective Spectral Irradiance		Time (sec)							
Lamp	Substrate	0	60	120	180	240	540	840	1140
3.71E-08	8.18E-09	3.38E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.67E-10	1.12E-09	1.44E-09
4.05E-08	9.39E-09	1.07E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.47E-10	7.32E-10	1.13E-09
5.17E-08	1.27E-08	2.48E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.34E-10	1.03E-09	1.07E-09
8.14E-08	1.82E-08	3.53E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.90E-10	1.63E-09	9.95E-10
3.85E-07	4.10E-08	1.15E-10	8.55E-12	0.00E+00	0.00E+00	0.00E+00	1.24E-09	2.41E-09	2.12E-09
7.24E-07	1.02E-07	2.55E-10	4.18E-10	1.01E-10	6.75E-10	4.58E-10	3.43E-09	3.42E-09	3.50E-09
1.56E-06	7.05E-07	2.06E-09	1.46E-09	1.66E-09	2.00E-09	2.98E-09	7.89E-09	8.43E-09	8.65E-09
5.33E-06	1.26E-06	5.23E-09	5.00E-09	5.97E-09	5.32E-09	7.72E-09	1.91E-08	1.54E-08	2.35E-08
9.47E-06	4.11E-06	1.06E-08	1.28E-08	1.50E-08	1.74E-08	2.12E-08	3.86E-08	4.03E-08	5.47E-08
1.39E-05	5.28E-06	1.90E-08	2.22E-08	2.87E-08	3.37E-08	3.95E-08	6.82E-08	8.01E-08	1.01E-07
2.99E-05	7.24E-06	3.21E-08	3.81E-08	4.69E-08	5.68E-08	6.70E-08	2.97E-07	3.81E-07	4.01E-07
3.51E-05	1.11E-05	4.86E-08	6.17E-08	2.26E-07	2.28E-07	2.54E-07	3.27E-07	4.30E-07	4.88E-07
4.12E-05	1.77E-05	1.67E-07	1.85E-07	2.19E-07	2.39E-07	2.79E-07	3.92E-07	5.20E-07	5.92E-07
4.71E-05	1.91E-05	1.68E-07	2.02E-07	2.35E-07	2.71E-07	3.14E-07	4.56E-07	9.62E-07	1.07E-06
8.02E-05	2.04E-05	1.80E-07	2.16E-07	2.56E-07	2.93E-07	3.44E-07	8.03E-07	9.26E-07	1.06E-06
7.33E-05	2.14E-05	1.86E-07	2.29E-07	2.67E-07	3.09E-07	5.61E-07	7.59E-07	9.35E-07	1.09E-06
6.99E-05	2.19E-05	1.90E-07	2.32E-07	2.75E-07	4.69E-07	5.03E-07	7.45E-07	9.42E-07	1.11E-06
6.70E-05	2.19E-05	1.90E-07	3.58E-07	3.85E-07	4.29E-07	4.77E-07	7.37E-07	9.50E-07	1.12E-06
6.32E-05	2.87E-05	2.67E-07	3.05E-07	3.52E-07	4.00E-07	4.49E-07	7.16E-07	9.31E-07	1.11E-06
5.87E-05	2.56E-05	2.33E-07	2.77E-07	3.28E-07	3.74E-07	4.22E-07	6.82E-07	8.95E-07	1.07E-06
5.39E-05	2.32E-05	2.07E-07	2.53E-07	3.00E-07	3.47E-07	3.96E-07	6.43E-07	8.51E-07	1.02E-06
4.86E-05	2.07E-05	1.88E-07	2.28E-07	2.74E-07	3.19E-07	3.62E-07	5.94E-07	7.95E-07	1.32E-06
4.37E-05	1.85E-05	1.69E-07	2.06E-07	2.49E-07	2.90E-07	3.32E-07	5.48E-07	1.01E-06	1.13E-06
3.85E-05	1.64E-05	1.51E-07	1.84E-07	2.23E-07	2.60E-07	2.98E-07	4.97E-07	8.56E-07	9.93E-07
3.37E-05	1.44E-05	1.33E-07	1.65E-07	1.97E-07	2.32E-07	2.67E-07	4.49E-07	7.41E-07	8.72E-07
2.92E-05	1.25E-05	1.17E-07	1.46E-07	1.75E-07	2.06E-07	2.38E-07	5.21E-07	6.48E-07	7.63E-07
2.50E-05	1.08E-05	1.02E-07	1.27E-07	1.53E-07	1.81E-07	2.10E-07	4.41E-07	5.59E-07	6.64E-07
2.14E-05	9.25E-06	8.86E-08	1.11E-07	1.35E-07	1.59E-07	1.85E-07	3.78E-07	4.86E-07	5.78E-07
2.17E-05	7.87E-06	7.63E-08	9.64E-08	1.17E-07	1.39E-07	1.62E-07	3.25E-07	4.20E-07	5.01E-07
1.76E-05	6.68E-06	6.57E-08	8.36E-08	1.02E-07	1.22E-07	1.91E-07	2.79E-07	3.63E-07	4.33E-07
1.44E-05	5.66E-06	5.72E-08	7.30E-08	8.90E-08	1.07E-07	1.58E-07	2.42E-07	3.15E-07	3.78E-07
1.18E-05	4.79E-06	5.00E-08	6.36E-08	7.81E-08	1.21E-07	1.35E-07	2.10E-07	2.73E-07	3.26E-07
9.69E-06	4.04E-06	4.34E-08	5.56E-08	9.29E-08	1.03E-07	1.16E-07	1.83E-07	2.37E-07	2.83E-07
7.94E-06	3.40E-06	3.78E-08	4.86E-08	7.71E-08	8.79E-08	1.00E-07	1.59E-07	2.07E-07	2.47E-07
6.42E-06	2.83E-06	3.28E-08	5.59E-08	6.51E-08	7.51E-08	8.64E-08	1.38E-07	1.80E-07	2.14E-07
5.25E-06	2.36E-06	2.88E-08	4.71E-08	5.62E-08	6.55E-08	7.54E-08	1.22E-07	1.59E-07	1.89E-07
4.28E-06	1.99E-06	3.38E-08	4.06E-08	4.87E-08	5.73E-08	6.60E-08	1.07E-07	1.41E-07	1.67E-07
3.49E-06	1.66E-06	2.87E-08	3.51E-08	4.25E-08	5.02E-08	5.82E-08	9.53E-08	1.25E-07	1.47E-07
2.75E-06	1.39E-06	2.38E-08	2.95E-08	3.61E-08	4.28E-08	4.97E-08	8.21E-08	1.07E-07	1.26E-07
2.69E-06	1.58E-06	2.47E-08	3.10E-08	3.81E-08	4.55E-08	5.29E-08	8.78E-08	1.14E-07	1.77E-07
2.64E-06	1.53E-06	2.58E-08	3.28E-08	4.05E-08	4.83E-08	5.64E-08	9.41E-08	1.65E-07	1.76E-07
2.60E-06	1.50E-06	2.72E-08	3.50E-08	4.32E-08	5.17E-08	6.05E-08	1.01E-07	1.64E-07	1.79E-07
2.56E-06	1.48E-06	2.88E-08	3.73E-08	4.63E-08	5.57E-08	6.55E-08	1.44E-07	1.67E-07	1.84E-07
2.53E-06	1.46E-06	3.05E-08	3.97E-08	4.97E-08	6.02E-08	7.09E-08	1.45E-07	1.72E-07	1.89E-07
2.50E-06	1.45E-06	3.25E-08	4.24E-08	5.35E-08	6.51E-08	7.68E-08	1.49E-07	1.77E-07	1.95E-07
2.46E-06	1.43E-06	3.46E-08	4.54E-08	5.76E-08	7.03E-08	8.29E-08	1.54E-07	1.83E-07	2.01E-07
2.43E-06	1.42E-06	3.67E-08	4.88E-08	6.18E-08	7.56E-08	1.13E-07	1.59E-07	1.89E-07	2.08E-07
2.39E-06	1.40E-06	3.89E-08	5.21E-08	6.61E-08	8.07E-08	1.14E-07	1.64E-07	1.95E-07	2.14E-07
2.35E-06	1.39E-06	4.12E-08	5.53E-08	7.04E-08	1.05E-07	1.17E-07	1.69E-07	2.01E-07	2.20E-07
2.31E-06	1.37E-06	4.35E-08	5.87E-08	7.48E-08	1.07E-07	1.21E-07	1.75E-07	2.07E-07	2.26E-07
2.26E-06	1.36E-06	4.56E-08	6.17E-08	9.41E-08	1.09E-07	1.24E-07	1.81E-07	2.13E-07	2.33E-07
2.22E-06	1.35E-06	4.76E-08	6.48E-08	9.51E-08	1.11E-07	1.28E-07	1.86E-07	2.19E-07	2.39E-07
2.17E-06	1.33E-06	4.91E-08	6.72E-08	9.61E-08	1.14E-07	1.30E-07	1.91E-07	2.25E-07	2.46E-07
2.12E-06	1.31E-06	5.06E-08	6.94E-08	9.81E-08	1.17E-07	1.34E-07	1.97E-07	2.32E-07	2.53E-07
2.07E-06	1.29E-06	5.19E-08	8.17E-08	9.98E-08	1.20E-07	1.37E-07	2.02E-07	2.39E-07	2.60E-07
1.97E-06	1.27E-06	5.75E-08	8.11E-08	1.05E-07	1.28E-07	1.49E-07	2.25E-07	2.65E-07	2.86E-07
1.91E-06	1.24E-06	5.74E-08	8.15E-08	1.05E-07	1.29E-07	1.51E-07	2.27E-07	2.67E-07	2.90E-07
1.85E-06	1.22E-06	5.74E-08	8.21E-08	1.06E-07	1.30E-07	1.52E-07	2.31E-07	2.71E-07	2.94E-07
1.78E-06	1.18E-06	5.72E-08	8.19E-08	1.07E-07	1.31E-07	1.54E-07	2.34E-07	2.75E-07	2.98E-07
1.73E-06	1.15E-06	6.26E-08	8.19E-08	1.08E-07	1.32E-07	1.56E-07	2.38E-07	2.80E-07	3.03E-07
1.67E-06	1.12E-06	6.15E-08	8.22E-08	1.08E-07	1.34E-07	1.58E-07	2.42E-07	2.86E-07	3.08E-07
1.61E-06	1.09E-06	6.10E-08	8.22E-08	1.08E-07	1.35E-07	1.59E-07	2.46E-07	2.90E-07	3.14E-07
1.56E-06	1.07E-06	6.06E-08	8.24E-08	1.09E-07	1.36E-07	1.61E-07	2.51E-07	2.96E-07	3.19E-07
1.50E-06	1.03E-06	5.99E-08	8.24E-08	1.09E-07	1.37E-07	1.63E-07	2.55E-07	3.01E-07	3.25E-07
1.45E-06	1.01E-06	5.95E-08	8.26E-08	1.10E-07	1.38E-07	1.64E-07	2.59E-07	3.07E-07	3.32E-07
1.40E-06	9.85E-07	5.93E-08	8.31E-08	1.11E-07	1.40E-07	1.67E-07	2.65E-07	3.15E-07	3.40E-07
1.36E-06	9.61E-07	5.89E-08	8.33E-08	1.12E-07	1.41E-07	1.70E-07	2.71E-07	3.22E-07	3.48E-07
1.32E-06	9.44E-07	5.91E-08	8.40E-08	1.14E-07	1.44E-07	1.73E-07	2.79E-07	3.32E-07	3.59E-07
1.29E-06	9.27E-07	5.91E-08	8.47E-08	1.16E-07	1.47E-07	1.77E-07	2.87E-07	3.42E-07	3.70E-07
1.26E-06	9.13E-07	5.93E-08	8.58E-08	1.18E-07	1.49E-07	1.81E-07	2.96E-07	3.53E-07	3.82E-07

360	2.53E-03	1.85E-03	1.23E-04	1.80E-04	2.45E-04	3.14E-04	3.81E-04	6.26E-04	7.50E-04	9.13E-04	4.84E-04	1.23E-06	8.97E-07	5.94E-08	8.70E-08	1.19E-07	1.52E-07	1.85E-07	3.03E-07	3.63E-07	4.42E-07
361	2.55E-03	1.88E-03	1.27E-04	1.88E-04	2.57E-04	3.30E-04	4.02E-04	6.64E-04	7.96E-04	9.40E-04	4.68E-04	1.19E-06	8.81E-07	5.96E-08	8.80E-08	1.20E-07	1.55E-07	1.88E-07	3.10E-07	3.72E-07	4.39E-07
362	2.57E-03	1.91E-03	1.32E-04	1.97E-04	2.69E-04	3.47E-04	4.22E-04	7.01E-04	9.20E-04	9.75E-04	4.52E-04	1.16E-06	8.62E-07	5.98E-08	8.90E-08	1.22E-07	1.57E-07	1.91E-07	3.17E-07	4.16E-07	4.41E-07
363	2.57E-03	1.93E-03	1.38E-04	2.06E-04	2.83E-04	3.64E-04	4.43E-04	7.40E-04	9.49E-04	1.01E-03	4.37E-04	1.12E-06	8.43E-07	6.03E-08	8.97E-08	1.24E-07	1.59E-07	1.93E-07	3.23E-07	4.14E-07	4.43E-07
364	2.59E-03	1.95E-03	1.45E-04	2.15E-04	2.97E-04	3.82E-04	4.66E-04	7.79E-04	9.85E-04	1.06E-03	4.22E-04	1.09E-06	8.23E-07	6.11E-08	9.06E-08	1.25E-07	1.61E-07	1.97E-07	3.28E-07	4.15E-07	4.45E-07
365	2.61E-03	1.98E-03	1.52E-04	2.26E-04	3.13E-04	4.02E-04	4.91E-04	8.20E-04	1.03E-03	1.10E-03	4.07E-04	1.06E-06	8.05E-07	6.19E-08	9.19E-08	1.27E-07	1.64E-07	2.00E-07	3.34E-07	4.18E-07	4.47E-07
366	2.62E-03	2.00E-03	1.60E-04	2.38E-04	3.29E-04	4.24E-04	5.18E-04	8.62E-04	1.07E-03	1.15E-03	3.94E-04	1.03E-06	7.88E-07	6.31E-08	9.36E-08	1.29E-07	1.67E-07	2.04E-07	3.39E-07	4.20E-07	4.51E-07
367	2.64E-03	2.03E-03	1.69E-04	2.51E-04	3.46E-04	4.47E-04	5.45E-04	9.06E-04	1.11E-03	1.19E-03	3.80E-04	1.00E-06	7.71E-07	6.44E-08	9.56E-08	1.32E-07	1.70E-07	2.07E-07	3.44E-07	4.22E-07	4.54E-07
368	2.64E-03	2.05E-03	1.79E-04	2.66E-04	3.65E-04	4.70E-04	5.72E-04	9.48E-04	1.15E-03	1.24E-03	3.67E-04	9.70E-07	7.52E-07	6.57E-08	9.76E-08	1.34E-07	1.73E-07	2.10E-07	3.48E-07	4.23E-07	4.55E-07
369	2.63E-03	2.05E-03	1.88E-04	2.79E-04	3.82E-04	4.90E-04	5.96E-04	9.83E-04	1.19E-03	1.28E-03	3.55E-04	9.33E-07	7.27E-07	6.68E-08	9.90E-08	1.36E-07	1.74E-07	2.11E-07	3.49E-07	4.21E-07	4.52E-07
370	2.60E-03	2.04E-03	1.97E-04	2.91E-04	3.97E-04	5.08E-04	6.15E-04	1.01E-03	1.21E-03	1.30E-03	3.43E-04	8.92E-07	6.98E-07	6.75E-08	9.97E-08	1.36E-07	1.74E-07	2.11E-07	3.48E-07	4.15E-07	4.46E-07
371	2.54E-03	2.00E-03	2.04E-04	2.99E-04	4.06E-04	5.17E-04	6.26E-04	1.02E-03	1.22E-03	1.31E-03	3.31E-04	8.40E-07	6.61E-07	6.75E-08	9.90E-08	1.35E-07	1.71E-07	2.07E-07	3.38E-07	4.04E-07	4.34E-07
372	2.45E-03	1.94E-03	2.09E-04	3.04E-04	4.12E-04	5.23E-04	6.30E-04	1.02E-03	1.21E-03	1.30E-03	3.20E-04	7.82E-07	6.19E-07	6.67E-08	9.72E-08	1.32E-07	1.67E-07	2.02E-07	3.26E-07	3.89E-07	4.16E-07
373	2.33E-03	1.86E-03	2.11E-04	3.04E-04	4.12E-04	5.22E-04	6.27E-04	1.01E-03	1.19E-03	1.28E-03	3.09E-04	7.20E-07	5.73E-07	6.51E-08	9.40E-08	1.27E-07	1.61E-07	1.94E-07	3.11E-07	3.69E-07	3.95E-07
374	2.21E-03	1.77E-03	2.11E-04	3.03E-04	4.10E-04	5.17E-04	6.20E-04	9.87E-04	1.17E-03	1.25E-03	2.99E-04	6.59E-07	5.28E-07	6.30E-08	9.06E-08	1.22E-07	1.54E-07	1.85E-07	2.95E-07	3.49E-07	3.72E-07
375	2.09E-03	1.68E-03	2.10E-04	3.02E-04	4.05E-04	5.08E-04	6.09E-04	9.62E-04	1.13E-03	1.21E-03	2.88E-04	6.03E-07	4.85E-07	6.07E-08	8.70E-08	1.17E-07	1.47E-07	1.76E-07	2.77E-07	3.27E-07	3.49E-07
376	1.98E-03	1.60E-03	2.09E-04	3.00E-04	3.99E-04	4.99E-04	5.98E-04	9.36E-04	1.10E-03	1.17E-03	2.79E-04	5.52E-07	4.45E-07	5.83E-08	8.35E-08	1.11E-07	1.39E-07	1.66E-07	2.61E-07	3.07E-07	3.26E-07
377	1.87E-03	1.52E-03	2.09E-04	2.98E-04	3.93E-04	4.90E-04	5.85E-04	9.10E-04	1.07E-03	1.13E-03	2.69E-04	5.04E-07	4.09E-07	5.62E-08	8.01E-08	1.06E-07	1.32E-07	1.57E-07	2.45E-07	2.87E-07	3.05E-07
378	1.78E-03	1.45E-03	2.09E-04	2.95E-04	3.88E-04	4.83E-04	5.74E-04	8.87E-04	1.04E-03	1.10E-03	2.60E-04	4.62E-07	3.77E-07	5.43E-08	7.68E-08	1.01E-07	1.26E-07	1.49E-07	2.31E-07	2.70E-07	2.86E-07
379	1.68E-03	1.38E-03	2.08E-04	2.92E-04	3.83E-04	4.74E-04	5.62E-04	8.62E-04	1.00E-03	1.06E-03	2.51E-04	4.23E-07	3.46E-07	5.22E-08	7.34E-08	9.62E-08	1.19E-07	1.41E-07	2.16E-07	2.52E-07	2.67E-07
380	1.59E-03	1.31E-03	2.06E-04	2.88E-04	3.76E-04	4.64E-04	5.47E-04	8.32E-04	9.67E-04	1.02E-03	2.43E-04	3.85E-07	3.17E-07	5.01E-08	6.98E-08	9.13E-08	1.13E-07	1.33E-07	2.02E-07	2.35E-07	2.46E-07
381	1.50E-03	1.23E-03	2.05E-04	2.84E-04	3.70E-04	4.53E-04	5.33E-04	8.01E-04	9.27E-04	9.80E-04	2.34E-04	3.51E-07	2.89E-07	4.82E-08	6.66E-08	8.67E-08	1.06E-07	1.25E-07	1.88E-07	2.17E-07	2.30E-07
382	1.40E-03	1.16E-03	2.05E-04	2.81E-04	3.63E-04	4.43E-04	5.18E-04	7.68E-04	8.87E-04	9.34E-04	2.26E-04	3.18E-07	2.63E-07	4.63E-08	6.36E-08	8.21E-08	1.00E-07	1.17E-07	1.74E-07	2.01E-07	2.12E-07
383	1.31E-03	1.09E-03	2.05E-04	2.78E-04	3.55E-04	4.31E-04	5.02E-04	7.35E-04	8.44E-04	8.89E-04	2.19E-04	2.87E-07	2.38E-07	4.47E-08	6.07E-08	7.77E-08	9.44E-08	1.10E-07	1.61E-07	1.85E-07	1.95E-07
384	1.22E-03	1.01E-03	2.05E-04	2.75E-04	3.48E-04	4.20E-04	4.85E-04	7.01E-04	7.99E-04	8.40E-04	2.11E-04	2.57E-07	2.14E-07	4.33E-08	5.82E-08	7.35E-08	8.88E-08	1.03E-07	1.48E-07	1.69E-07	1.78E-07
385	1.12E-03	9.39E-04	2.06E-04	2.73E-04	3.41E-04	4.07E-04	4.68E-04	6.64E-04	7.52E-04	7.89E-04	2.04E-04	2.29E-07	1.92E-07	4.21E-08	5.57E-08	6.96E-08	8.32E-08	9.55E-08	1.36E-07	1.54E-07	1.61E-07
386	1.02E-03	8.61E-04	2.07E-04	2.70E-04	3.32E-04	3.92E-04	4.47E-04	6.23E-04	7.00E-04	7.34E-04	1.97E-04	2.02E-07	1.70E-07	4.09E-08	5.32E-08	6.56E-08	7.73E-08	8.81E-08	1.23E-07	1.38E-07	1.45E-07
387	9.29E-04	7.85E-04	2.08E-04	2.66E-04	3.22E-04	3.76E-04	4.25E-04	5.79E-04	6.48E-04	6.74E-04	1.91E-04	1.77E-07	1.50E-07	3.97E-08	5.06E-08	6.14E-08	7.17E-08	8.10E-08	1.10E-07	1.23E-07	1.28E-07
388	8.31E-04	7.04E-04	2.07E-04	2.58E-04	3.09E-04	3.57E-04	3.99E-04	5.31E-04	5.88E-04	6.10E-04	1.84E-04	1.53E-07	1.30E-07	3.82E-08	4.76E-08	5.69E-08	6.57E-08	7.35E-08	9.77E-08	1.08E-07	1.12E-07
389	7.35E-04	6.27E-04	2.04E-04	2.49E-04	2.93E-04	3.35E-04	3.71E-04	4.81E-04	3.79E-04	3.72E-04	1.78E-04	1.31E-07	1.11E-07	3.63E-08	4.42E-08	5.21E-08	5.95E-08	6.59E-08	8.56E-08	6.74E-08	6.61E-08
390	6.40E-04	4.27E-04	1.97E-04	2.35E-04	2.74E-04	3.09E-04	3.38E-04	4.30E-04	3.45E-04	3.48E-04	1.72E-04	1.10E-07	7.34E-08	3.39E-08	4.04E-08	4.70E-08	5.30E-08	5.81E-08	7.38E-08	5.93E-08	5.95E-08
391	3.51E-04	3.08E-04	1.88E-04	2.19E-04	2.51E-04	2.80E-04	3.04E-04	3.78E-04	3.05E-04	3.06E-04	1.66E-04	5.83E-08	5.12E-08	3.11E-08	3.64E-08	4.17E-08	4.65E-08	5.05E-08	6.27E-08	5.06E-08	5.08E-08
392	2.83E-04	2.68E-04	1.75E-04	2.01E-04	2.26E-04	2.49E-04	2.69E-04	3.27E-04	2.64E-04	2.65E-04	1.60E-04	4.53E-08	4.29E-08	2.80E-08	3.22E-08	3.62E-08	3.99E-08	4.31E-08	5.24E-08	4.23E-08	4.24E-08
393	2.43E-04	2.28E-04	1.59E-04	1.80E-04	1.99E-04	2.17E-04	2.33E-04	2.78E-04	2.25E-04	2.26E-04	1.55E-04	3.76E-08	3.53E-08	2.47E-08	2.79E-08	3.09E-08	3.37E-08	3.61E-08	4.31E-08	3.48E-08	3.49E-08
394	2.04E-04	1.91E-04	1.42E-04	1.58E-04	1.73E-04	1.87E-04	1.99E-04	2.34E-04	1.89E-04	1.89E-04	1.50E-04	3.05E-08	2.86E-08	2.13E-08	2.36E-08	2.58E-08	2.79E-08	2.97E-08	3.50E-08	2.83E-08	2.83E-08
395	1.68E-04	1.57E-04	1.24E-04	1.36E-04	1.47E-04	1.57E-04	1.67E-04	1.93E-04	1.57E-04	1.57E-04	1.45E-04	2.43E-08	2.27E-08	1.80E-08	1.96E-08	2.12E-08	2.28E-08	2.41E-08	2.79E-08	2.27E-08	2.27E-08
396	1.36E-04	1.28E-04	1.06E-04	1.14E-04	1.23E-04	1.30E-04	1.37E-04	1.57E-04	1.29E-04	1.29E-04	1.40E-04	1.90E-08	1.79E-08	1.48E-08	1.59E-08	1.71E-08	1.82E-08	1.92E-08	2.19E-08	1.80E-08	1.80E-08
397	1.10E-04	1.04E-04	8.81E-05	9.40E-05	1.00E-04	1.06E-04	1.11E-04	1.26E-04	1.04E-04	1.04E-04	1.35E-04	1.48E-08	1.40E-08	1.19E-08	1.27E-08	1.35E-08	1.43E-08	1.50E-08	1.70E-08	1.41E-08	1.41E-08
398	8.69E-05	8.26E-05	7.19E-05	7.59E-05	8.03E-05	8.47E-05	8.84E-05	9.92E-05	8.36E-05	8.33E-05	1.30E-04	1.13E-08	1.08E-08	9.37E-09	9.89E-09	1.05E-08	1.10E-08	1.15E-08	1.29E-08	1.09E-08	1.09E-08
399	6.80E-05	6.52E-05	5.74E-05	6.01E-05	6.32E-05	6.64E-05	6.91E-05	7.68E-05	6.63E-05	6.59E-05	1.26E-04	8.56E-09	8.21E-09	7.22E-09	7.57E-09	7.96E-09	8.36E-09	8.70E-09	9.67E-09	8.35E-09	8.30E-09
400	1.92E-05	1.90E-05	1.67E-05	1.65E-05	1.55E-05	2.53E-05	1.83E-05	5.88E-05	1.60E-05	1.63E-05	1.22E-04	2.33E-09	2.31E-09	2.04E-09	2.00E-09	1.89E-09	3.08E-09	2.23E-09	7.15E-09	1.95E-09	1.99E-09
												Lamp	Substrate				Sunscreen/Substrate				



UVA/UVB	**λ=290-400**									
	$\Delta\lambda$=1 nm; 1 MED = 0.02 J/cm^2									
	$I_0=\Sigma V_\lambda I_{\lambda 0}\Delta\lambda$ (MED/sec)	5.39E-02								
	$I_s=\Sigma V_\lambda I_{\lambda s}\Delta\lambda$ (MED/sec)		2.15E-02							
	$I_{ss}=\Sigma V_\lambda I_{\lambda ss}\Delta\lambda$ (MED/sec)			3.35E-04	4.43E-04	5.65E-04	6.87E-04	8.18E-04	1.32E-03	1.67E-03	1.90E-03
	t (sec)			0	60	120	180	240	540	840	1140
	Δt=60 sec										
	$E_0=\Sigma I_0\Delta t$ (MED)			0.00E+00	3.24E+00	6.47E+00	9.71E+00	1.29E+01	2.91E+01	4.53E+01	6.15E+01
	$E_{SS}=\Sigma I_{SS}\Delta t$ (MED)			0.00E+00	2.33E-02	5.36E-02	9.11E-02	1.36E-01	4.58E-01	9.04E-01	1.44E+00
	$SPFs=I_0/I_S$			2.51							
	$E_t=SPF_SE_{SS}$ (MED)			0.00E+00	5.86E-02	1.35E-01	2.29E-01	3.42E-01	1.14E+00	2.27E+00	3.61E+00
	$SPF_t=E_0/E_t$				55.20	48.08	42.40	37.83	25.44	19.96	17.01
UVA	**λ=320-400**										
	$\Delta\lambda$=1 nm										
	$I_0=\Sigma V_\lambda I_{\lambda 0}\Delta\lambda$ (MED/sec)	7.04E-03									
	$I_s=\Sigma V_\lambda I_{\lambda s}\Delta\lambda$ (MED/sec)		3.99E-03								
	$I_{ss}=\Sigma V_\lambda I_{\lambda ss}\Delta\lambda$ (MED/sec)			1.84E-04	2.54E-04	3.35E-04	4.15E-04	4.92E-04	7.73E-04	9.25E-04	1.01E-03
	t (sec)			0	60	120	180	240	540 t_{MED}	840	1140
	Δt=60 sec										
	$E_0=\Sigma I_0\Delta t$ (MED)			0.00E+00	4.23E-01	8.45E-01	1.27E+00	1.69E+00	3.80E+00	5.92E+00	8.03E+00
	$E_{SS}=\Sigma I_{SS}\Delta t$ (MED)			0.00E+00	1.31E-02	3.08E-02	5.33E-02	8.05E-02	2.70E-01	5.25E-01	8.15E-01
	$APFs=I_0/I_S$			1.77							
	$E_t=SPF_SE_{SS}$ (MED)			0.00E+00	2.32E-02	5.44E-02	9.41E-02	1.42E-01	4.77E-01	9.27E-01	1.44E+00
	$APF_t=E_0/E_t$				18.22	15.54	13.47	11.89	7.97	6.38	5.58
	APF_t/SPF_t								0.31		
	β	1.4184									

β>1.1 and APF_t/SPF_t Therefore the sunscreen is not photostable, but provides "Broad Spectrum" protection.

FedEx USA Airbill FedEx Tracking Number 817991737529

Form I.D. No. 0200

1 From

Date 07/05/00 [redacted]

Sender's Name Joseph W. Stanfield Phone 901 761-2782

Company Juncare Research Laboratories, LLC

Address 740 East Brookhaven Circle

Dept./Floor/Suite/Room

City Memphis, State TN ZIP 38117

2 Your Internal Billing Reference

3 To

Recipient's Name Dockets Management Branch Phone 301 827-2222

Company Food and Drug Administration (HFA305)

Address 5630 Fishers Lane Rm 1061

We cannot deliver to P.O. boxes or P.O. ZIP codes.

Dept./Floor/Suite/Room

To "HOLD" at FedEx location, print FedEx address here.

City Rockville State MD ZIP 20852

817991737529

4a Express Package Service — *Packages up to 150 lbs.* Delivery commitment may be later in some areas.

- [x] FedEx Priority Overnight — Next business morning
- [ ] FedEx Standard Overnight — Next business afternoon
- [ ] FedEx First Overnight — Earliest next business morning delivery to select locations
- [ ] FedEx 2Day* — Second business day
- [ ] FedEx Express Saver* — Third business day

* FedEx Letter Rate not available. Minimum charge: One-pound rate

4b Express Freight Service — *Packages over 150 lbs.* Delivery commitment may be later in some areas.

- [ ] FedEx 1Day Freight* — Next business day
- [ ] FedEx 2Day Freight — Second business day
- [ ] FedEx 3Day Freight — Third business day

* Call for Confirmation: _____

5 Packaging — * Declared value limit $500

- [x] FedEx Letter*
- [ ] FedEx Pak*
- [ ] Other Pkg. — Includes FedEx Box, FedEx Tube, and customer pkg.

6 Special Handling

- [ ] **Saturday Delivery** — Available for FedEx Priority Overnight and FedEx 2Day to select ZIP codes
- [ ] **Sunday Delivery** — Available for FedEx Priority Overnight to select ZIP codes
- [x] **HOLD Weekday** at FedEx Location — Not available with FedEx First Overnight
- [ ] **HOLD Saturday** at FedEx Location — Available for FedEx Priority Overnight and FedEx 2Day to select locations

Does this shipment contain dangerous goods? One box must be checked.

- [ ] No
- [ ] Yes — As per attached Shipper's Declaration
- [ ] Yes — Shipper's Declaration not required
- [ ] Dry Ice — Dry Ice, 9, UN 1845 ____ x ____ kg
- [ ] Cargo Aircraft Only

Dangerous Goods cannot be shipped in FedEx packaging.

7 Payment *Bill to:* Enter FedEx Acct. No. or Credit Card No. below. [ ] Obtain Recip. Acct. No.

- [x] Sender — Acct. No. in Section 1 will be billed.
- [ ] Recipient
- [ ] Third Party
- [ ] Credit Card
- [ ] Cash/Check

[redacted]

Total Packages	Total Weight	Total Declared Value†	Total Charges
		$ .00	Credit Card Auth.

†Our liability is limited to $100 unless you declare a higher value. See back for details.

8 Release Signature *Sign to authorize delivery without obtaining signature.*

By signing you authorize us to deliver this shipment without obtaining a signature and agree to indemnify and hold us harmless from any resulting claims.

Questions? Call 1·800·Go·FedEx* (800-463-3339)

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