Application Note (A5)

Discrepancies Associated with Using UVA and UVB Meters to Measure Output of Sunlight, Solar Simulators, etc.

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Abstract: Comparison of UVA and UVB irradiance measurements made on solar simulators using spectroradiometric and broadband meter instrumentation indicates that wide discrepancies can occur between the two methods of measurement. With a xenon arc lamp filtered as a solar simulator producing UVA and UVB radiation, the meter can either over or under estimate the irradiance of the source when different cut-off filters are used. The most severe discrepancies occurred with the UVB meters although the UVA meters also had significant errors.

Optronic Laboratories has been advising customers for many years now that significant errors can be made when using the small, portable, inexpensive meters to measure ultraviolet irradiance. The use of a **double** monochromator spectroradiometer is strongly recommended to:

1. Measure the spectral irradiance over the wavelength range of interest.

2. Integrate the spectral irradiance (watts/cm5nm) over the appropriate wavelength range to get the actual "broadband" irradiance (watts/cm5).

However, many people continue to use the inexpensive meters with "direct readouts" in watts/cm5. Some of these meters are called UVA and UVB meters. The UVA is defined as the 320 to 400 nm spectral region and the UVB is defined as the 280 to 320 nm spectral region.

A paper by Dr. Robert Sayre, a well known researcher in the solar simulator field, and Dr. Lorraine Kligman (1991) gives specific examples of the errors associated with the use of these "direct reading" meters. In summary, Sayre and Kligman set up a solar simulator with filters to obtain four different spectral distributions (see Figure 1). The authors then measured the spectral irradiance of each simulator using an OL 742 Spectroradiometer (Sayre now owns an OL 752 Spectroradiometer) and integrated the irradiance over the UVA and UVB regions. Measurements were then made using the UVA and UVB meters.

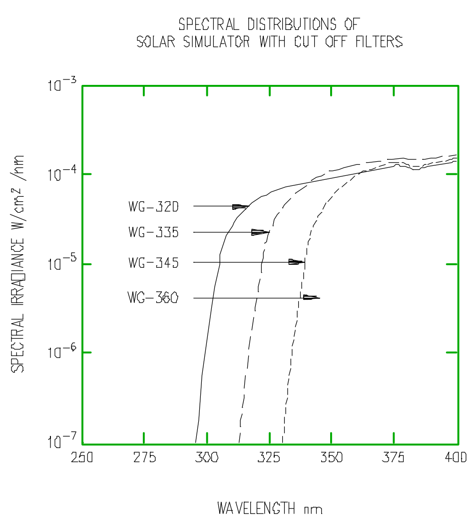

FIGURE 1

Tables 1 and 2 give the results of the measurements. For the UVA meter, errors ranging from 18 to 42% were observed. For the UVB meter, the errors were extremely large. The correction factors were 16, 1.03, 0.054, and 0.040.

TABLE 1
SPECTRORADIOMETER vs UVA METER
(UVA = 320 to 400 nm)

FILTER	INTEGRATED SPECTRORADIOMETRIC IRRADIANCE	UVA METER READING	CORRECTION FACTOR
WG-320	9.0×10^{-3} W/cm^2	7.5×10^{-3} W/cm^2	1.20
WG-335	9.6×10^{-3} W/cm^2	8.1×10^{-3} W/cm^2	1.18
WG-345	6.7×10^{-3} W/cm^2	5.5×10^{-3} W/cm^2	1.21
WG-360	7.3×10^{-3} W/cm^2	5.1×10^{-3} W/cm^2	1.42

TABLE 2
SPECTRORADIOMETER vs UVB METER
(UVB = 290 to 320 nm)

FILTER	INTEGRATED SPECTRORADIOMETRIC IRRADIANCE	UVB METER READING	CORRECTION FACTOR
WG-320	6.0×10^{-4} W/cm^2	3.8×10^{-5} W/cm^2	16.0
WG-335	1.2×10^{-5} W/cm^2	1.2×10^{-5} W/cm^2	1.03
WG-345	2.7×10^{-7} W/cm^2	4.9×10^{-6} W/cm^2	.054
WG-360	1.6×10^{-7} W/cm^2	4.1×10^{-6} W/cm^2	.040

It is clear that these broadband UVA and UVB meters can yield very severe discrepancies as compared to actual integrated spectroradiometric irradiance. However, there are circumstances where these meters can be used. These are:

1. Applications having extremely poor accuracy requirements.

2. Certain monitoring applications requiring relatively low (poor) levels of accuracy.

3. Measuring the output of sources having the same spectral distribution as the source used to calibrate the meter. Note: this does not compensate for any spectrally dependent changes which may and probably will occur in the source to be measured. A prime example is sunlight where the UV spectrum can change significantly over a period of minutes. The xenon lamps commonly used in solar simulators also change as a function of wavelength. However, this is a slower process.

In conclusion, a high quality, double monochromator based spectroradiometer should be used if accurate measurements over the UV spectral wavelength region is required.

References

Sayre, R. M. and L. H. Kligman, 1991, *Discrepancies in the Measurement of Spectral Sources*