National Renewable Energy Laboratory

Memo

To: Daryl Myers and Thomas Stoffel

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Date: 18 April 2008

Subject: Calibration of SRRL AOCS Direct Quantum Sensors
Instruments: Licor LI-190 s/n Q8434 (AOCS Direct Normal).

NREL PV Radiometric Measurements Task monitored the count output of one (1) SRRL LI-190 Quantum Sensors while measuring the spectral distribution of natural sunlight in direct normal incidence mode on 14 April 2008 from 14 April 2008 from 300 nm to 1100 nm at 2nm intervals using a LICOR LI-1800 Spectroradiometer w/LICOR Direct limiting tube. The count output from the AOCS sensors were recorded by the AOCS tattletale data logger.

The LI-1800 S/N PRS-158 spectrometer was calibrated against NREL's National Institute of Standards and Technology (NIST) Standard of spectral irradiance F571 on 7 April 2008.

The LI-1800 has a command ("PP") to automatically integrate the data between 400 and 700nm and display the result in the Quantum (PAR) units of µmol/s/m^2/nm. All data were used to compute the calibration factors shown in Table 1.

Table 1. April 14, 2008 NREL Quantum LI-190 Calibration Summary

Time (MST)	**LI-1800 PP µmol/s/m^2**	**Q8434 counts**	**µmol/s/m^2/count CF**
13:07	2020	491	4.1141
13:08	2022	491	4.1181
13:10	2022	489	4.1350
13:11	2020	491	4.1141
13:12	2019	489	4.1288
13:14	2021	491	4.1161
		Avg.	**4.121**
		Sigma	**0.0088**
	AOCS CF requires:	**Photons/s/ m^2/count**	**2.482E+18**

Note: 1 micromole = 6.022e17 photons.

UNCERTAINTY

The estimated uncertainty in the LI-1800 spectral irradiance calibration is ±4.0% from 400 nm to 700nm. The accuracy of the CR23X data logger was about 0.8%. Estimated uncertainty in the derived calibration factor is ±4.8% (limit of error). Spectral data is plotted below.

Figure 1. Measured Spectral Distributions indicated by LI-1800 Spectroradiometer 14 April 2008