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REVIEW OF TERRESTRIAL PHOTOVOLTAIC MEASUREMENTS WORKSHOP

by Henry W. Brandhorst, Jr.

NASA-Lewis Research Center
Cleveland, Ohio

Abstract

A Terrestrial Photovoltaic Measurements Workshop was held at the NASA-Lewis Research Center, March 19-21, 1975. The purpose of this meeting (figure 1) was to make recommendations on measurement methods and the terrestrial solar intensity and spectrum to be used by investigators in the Solar Photovoltaic Energy Conversion Program.

The workshop was divided into three major areas, each with a chairman, as shown in figure 2. Approximately 95 people from 45 different organizations (Federal Government, universities, and companies) attended. About 25 papers covering these three areas were presented. The proceedings of this meeting will be available shortly.

Broad agreement was obtained on an interim method for making terrestrial solar cell measurements. The major recommendations of the workshop are shown in figure 3. These recommendations have been translated into an interim test procedure to be used by all photovoltaic investigators. The session chairmen and workshop coordinator together developed this document which is now available to all investigators.

The key aspects of this procedure are summarized in figures 4 and 5. Figure 4 shows the only acceptable measurement techniques: three to be used with natural sunlight measurements, and one with artificial light sources. Pyranometers or pyrheliometers are to be used in a well-defined manner and are not to be used with artificial light sources.

The use of standard solar cells to set simulator irradiance levels or to monitor solar irradiance in outdoor measurements is a proven, reliable method developed in the space program. It is necessary that the standard cells be made from the same material and have essentially the same spectral response as the test cells. Such cells must either be supplied by, or traceable to, the NASA-Lewis Research Center, which is serving the ERDA as the national testing laboratory. These cells should become available no later than October 1975. Figure 5 shows the recommended standard test conditions and definitions to be used in reporting cell performance data. Figure 6 shows the Air Mass Two spectral distribution to be used for all theoretical calculations. Integrated intensity for this curve is 75 mW/cm^2.

With this basis, it is hoped that uniform measurements and calculations can be made by all investigators. However, these recommended procedures are interim procedures. It is planned that another workshop be held in April 1976 so that new results can be presented and modifications made to these interim test conditions as required.

In summary (figure 7), a Terrestrial Photovoltaic Measurements Workshop was held in March 1975. The recommendations of this workshop have been translated into an interim terrestrial solar cell test procedure to be used by all investigators. A second workshop is planned in April 1976 to modify this interim test procedure as required.

TERRESTRIAL PHOTOVOLTAIC MEASUREMENTS WORKSHOP

MARCH 19-21, 1975

NASA-LEWIS RESEARCH CENTER

PURPOSE: TO MAKE RECOMMENDATIONS ON MEASUREMENT METHODS AND TERRESTRIAL SOLAR INTENSITY AND SPECTRUM TO BE USED BY INVESTIGATORS IN THE SOLAR PHOTOVOLTAIC CONVERSION PROGRAM

TERRESTRIAL PHOTOVOLTAIC MEASUREMENTS WORKSHOP

TECHNICAL ORGANIZATION

SESSION I - SOLAR INTENSITY AND SPECTRUM CONDITIONS FOR TERRESTRIAL PHOTOVOLTAICS

JOHN HICKEY/EPPLEY LABORATORIES, CHAIRMAN

SESSION II - TERRESTRIAL SUNLIGHT SIMULATION

HENRY CURTIS/NASA-LEWIS RESEARCH CENTER, CHAIRMAN

SESSION III - METHODOLOGY FOR MEASUREMENT AND CALIBRATION OF SOLAR CELLS

EUGENE RALPH/SPECTROLAB, CHAIRMAN

RECOMMENDATIONS OF THE TERRESTRIAL PHOTOVOLTAIC MEASUREMENTS WORKSHOP

- MEASUREMENTS OF SOLAR CELL PERFORMANCE IN TERRESTRIAL SUNLIGHT ARE THE MOST ACCEPTABLE.
- AN ARTIFICIAL LIGHT SOURCE SUCH AS A FILTERED Xe ARC LAMP IS TO BE USED FOR LABORATORY MEASUREMENTS.
- CALIBRATED SOLAR CELLS ARE TO BE USED TO ADJUST THE ARTIFICIAL LIGHT SOURCE INTENSITY.
- AN ABSOLUTE SPECTRAL RESPONSE MEASUREMENT TECHNIQUE IS NEEDED.
- A SINGLE AIR MASS TWO SOLAR SPECTRAL DISTRIBUTION CURVE SHOULD BE USED IN ALL THEORETICAL CALCULATIONS.
- A CENTRALIZED NATIONAL LABORATORY SHOULD BE ESTABLISHED TO PERFORM REFERENCE PHOTOVOLTAIC MEASUREMENTS, TO ISSUE CALIBRATED SOLAR CELLS, AND TO SUPPORT NECESSARY R&D.

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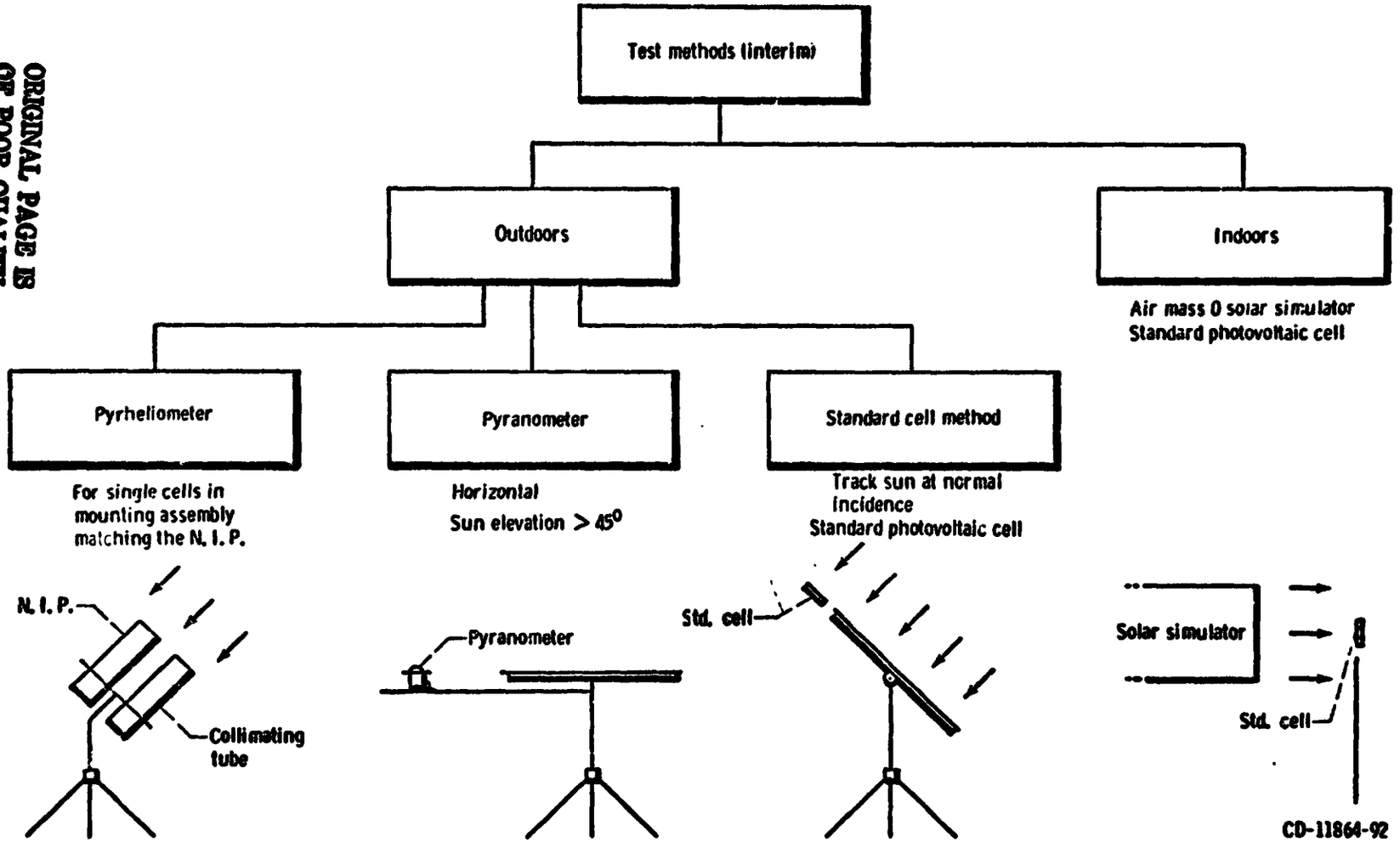


Figure 1.

STANDARD TEST CONDITIONS AND DEFINITIONS

TEMPERATURE - $28 \pm 2°C$

INTENSITY - $100\ mW/cm^2$ FOR SUNLIGHT SIMULATOR AS SET WITH STANDARD CELL

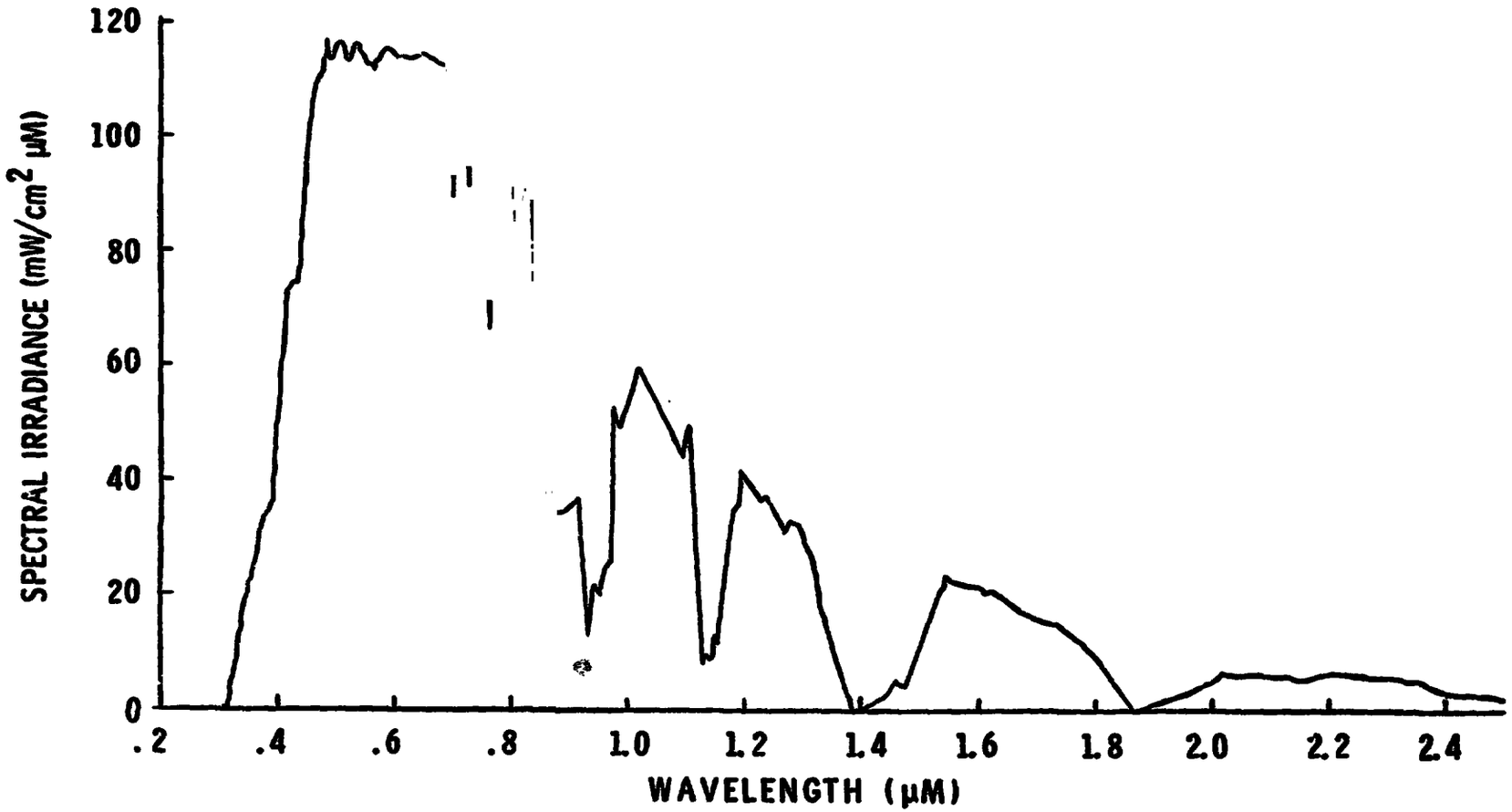
TEST CELL AREA - TOTAL CELL AREA

SHORT CIRCUIT CURRENT - $V_{LOAD} < 20\ mV$

OPEN CIRCUIT VOLTAGE - $R_{LOAD} > 10^4\ \Omega$

FILL FACTOR - $\dfrac{P_{max}}{V_{oc} \times I_{sc}}$

EFFICIENCY (%) - $\dfrac{P_{max}}{A_{Total} \times \text{IRRADIANCE}} \times 100$


SPECTRAL IRRADIANCE (mW/cm² μM)
120
100
80
60
40
20
0
.2
.4
.6
.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
WAVELENGTH (μM)

SUMMARY

- FIRST TERRESTRIAL PHOTOVOLTAIC MEASUREMENTS WORKSHOP HELD IN MARCH 1975
- INTERIM TERRESTRIAL SOLAR CELL TESTING PROCEDURES HAVE BEEN DOCUMENTED FOR USE BY ALL INVESTIGATORS
- A SECOND WORKSHOP IS PLANNED FOR APRIL 1976 TO MODIFY INTERIM TEST PROCEDURES AS REQUIRED