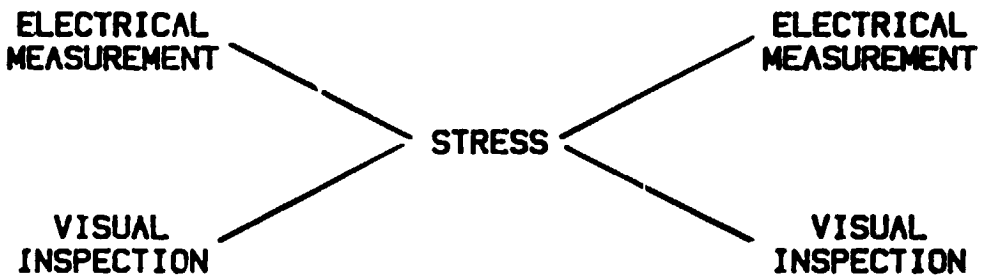
N86-29404

AMORPHOUS-SILICON CELL RELIABILITY TESTING

CLEMSON UNIVERSITY

J. W. Lathrop

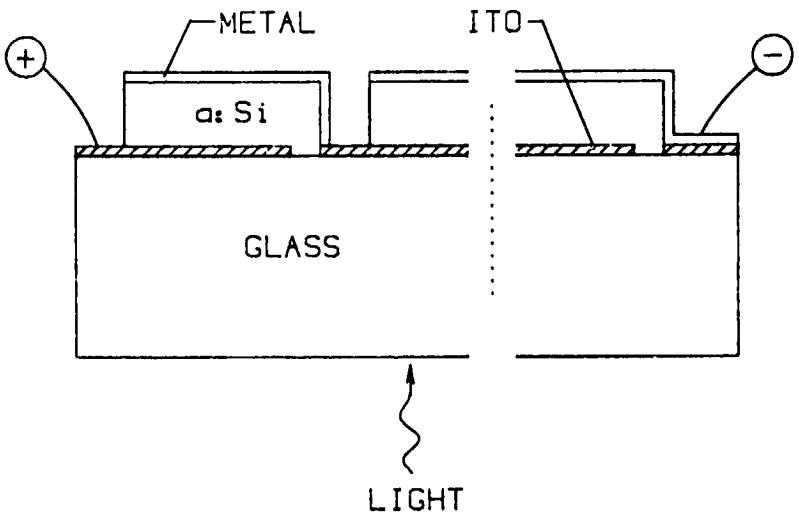
Accelerated Stress Test Methodology



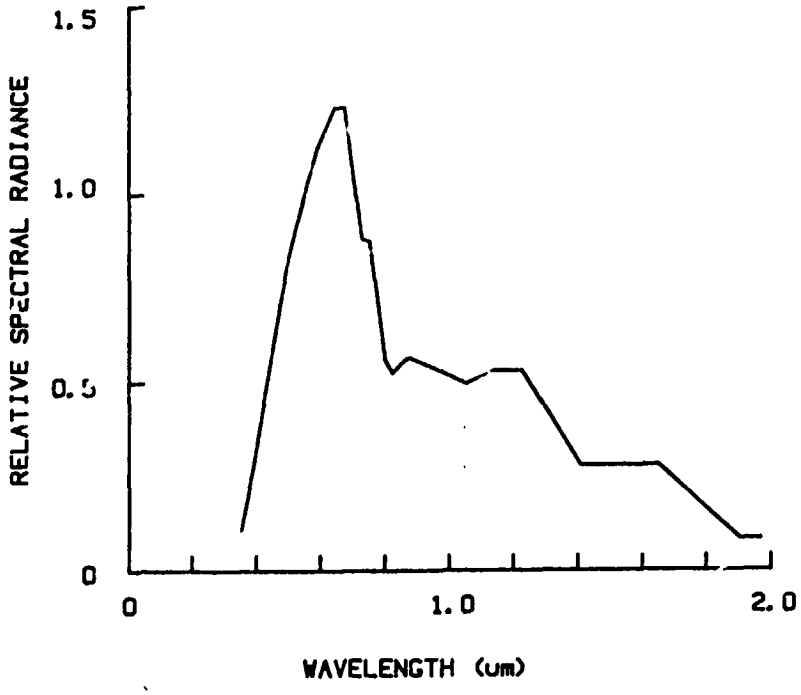
Amorphous-Silicon Problem Areas

MEASUREMENT -- REFERENCE CELL
INSPECTION -- SURFACE ANALYSIS METHODS
STRESS -- TEST SCHEDULE

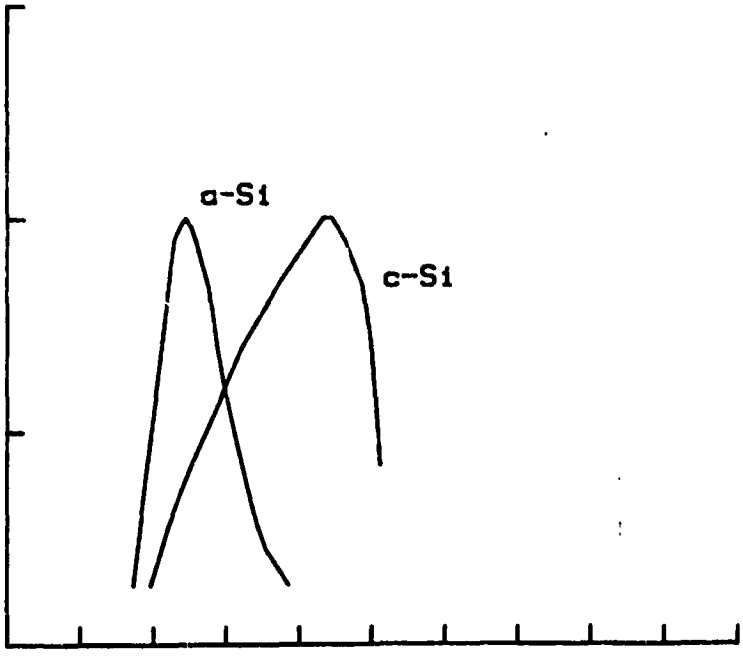
Schematic Diagram of Amorphous-Silicon Monolithic Solar Panel



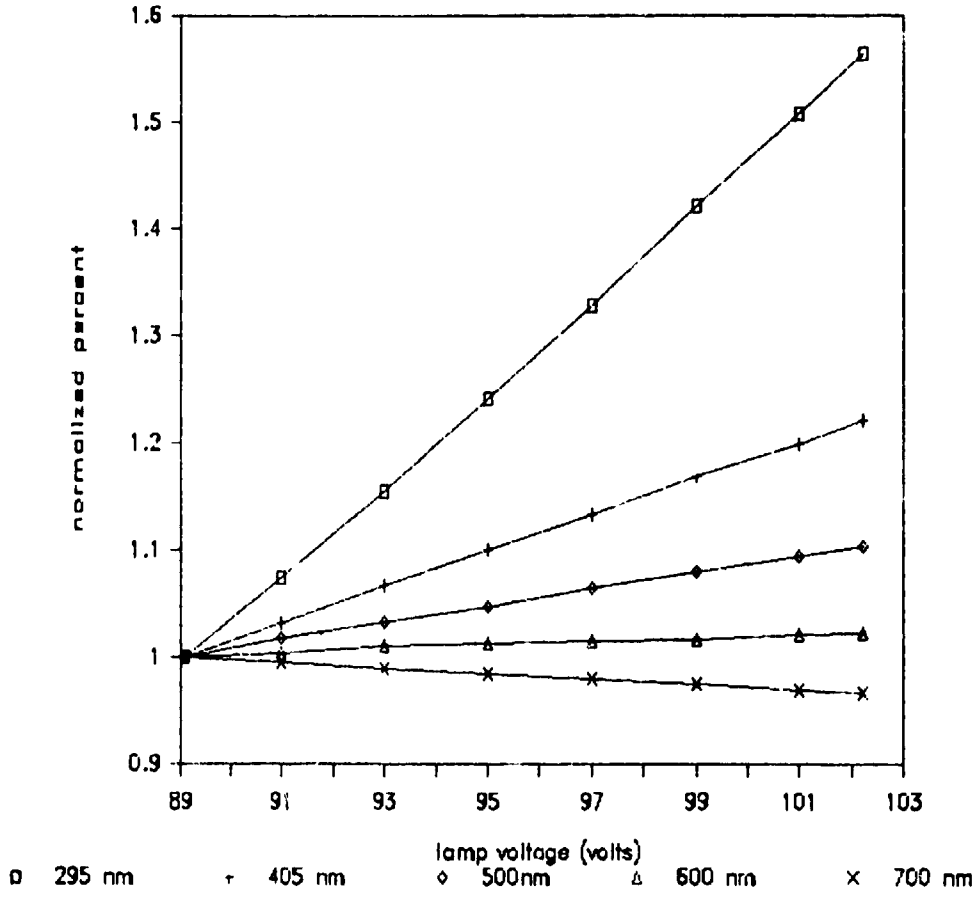
Relative Spectral Distribution of ELH Lamp



Relative Spectral Response



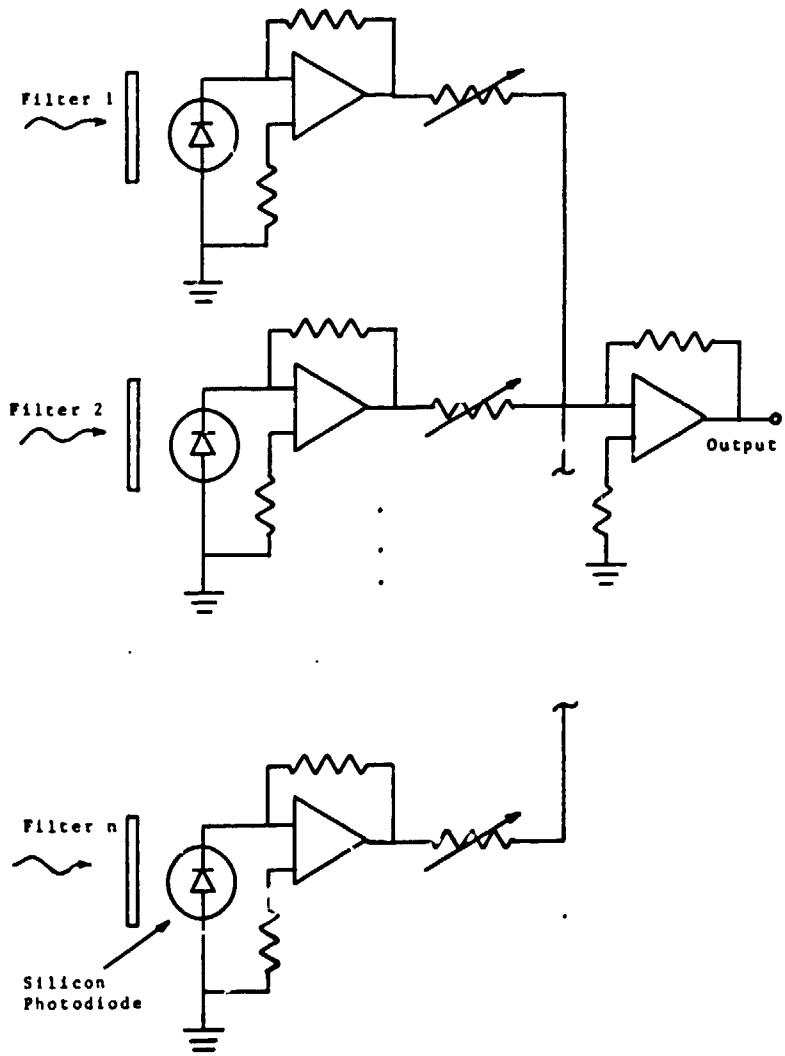
ELH Spectral Content Versus Lamp Voltage



Calibration and Measurement Procedures for Crystalline Cells

	RADIATION TYPE	SOURCE INTENSITY	SOURCE SPECTRAL DIST.	CELL	I(out)
CALIBRATION	NATURAL	1-SUN	1-SUN	SMALL REFERENCE	Io
	ELH	A	B	SMALL REFERENCE	Io
	ELH	A	B	FULL STANDARD	Is
MEASUREMENT	ELH	A'	B'	FULL STANDARD	Is

Simulated Amorphous Reference Cell



Calibration and Measurement Procedures for Crystalline Cells

	RADIATION TYPE	SOURCE INTENSITY	SOURCE SPECTRAL DIST.	CELL	I(out)
CALIBRATION	NATURAL	1-SUN	1-SUN	SMALL REFERENCE	Io
	ELH	A	B	SMALL REFERENCE	Io
	ELH	A	B	FULL STANDARD	Is
MEASUREMENT	ELH	A'	B'	FULL STANDARD	Is

Calibration and Measurement Procedures for Amorphous Cells

	RADIATION TYPE	SOURCE INTENSITY	SOURCE SPECTRAL DIST.	CELL	I(out)
SPECTRAL CALIBRATION	ELH	A	B	MFG SAMPLE	I(1)...I(n)
	ELH	A	B	Si DIODE REF	I(1)...I(n)
INTENSITY CALIBRATION	NATURAL	1-SUN	1-SUN	MFG SAMPLE	Io
	ELH	A'	B'	MFG SAMPLE	Io
	ELH	A'	B'	Si DIODE REF	Is
MEASUREMENT	ELH	A''	B''	Si DIODE REF	Is

IN GENERAL,

$$j = \int_{\text{spectrum}} I(\lambda) \cdot R(\lambda)\, d\lambda$$

where j = short circuit current density (A/cm^2)
$I(\lambda)$ = illumination intensity ($W/cm^2/um$)
$R(\lambda)$ = solar cell response (A/W)

FOR AN a-Si CELL

$$j(a) = I(\lambda_1)\, Ra(\lambda_1)\Delta\lambda + I(\lambda_2)\, Ra(\lambda_2)\Delta\lambda + \ldots + I(\lambda n)\, Ra(\lambda n)\Delta\lambda$$

FOR A c-Si CELL

$$j(c) = I(\lambda_1)\, Rc(\lambda_1)\Delta\lambda + I(\lambda_2)\, Rc(\lambda_2)\Delta\lambda + \ldots + I(\lambda n)\, Rc(\lambda n)\Delta\lambda$$

THE PROGRAMMABLE REFERENCE CELL CONSISTS OF n BAND PASS ($\Delta\lambda$) FILTERED DIODES, EACH HAVING A SEPARATE AMPLIFIER (GAIN = A). THE SHORT CIRCUIT CURRENT FROM EACH DIODE IS ADDED TO GIVE A TOTAL CURRENT VALUE OF:

$$i(P) = A_1 I(\lambda_1)\, Rc(\lambda_1)\Delta\lambda + A\, I(\lambda_2)\, Rc(\lambda_2)\Delta\lambda + \ldots + An I(\lambda n)\, Rc(\lambda n)\Delta\lambda$$

IF THE AMPLIFIER GAINS ARE ADJUSTED IN THE COMPUTER SUCH THAT

$$An = C \cdot Ra(\lambda n)/Rc(\lambda n)$$

WHERE C IS A CONSTANT SUCH THAT $i(P)$ = CURRENT UNDER 1-SUN ILLUMINATION. THEN

$$i(P) = C \cdot j(a)$$

AND THE FILTERED DIODE ARRAY WILL ACT AS A SIMULATED REFERENCE CELL.

CALIBRATION REQUIRES DETERMING:

1) SPECTRAL RESPONSE RATIOS OF FILTERED SILICON DIODES AND UNKNOWN CELL

2) VALUE OF CONSTANT, C.

ACCURACY OF CALIBRATION WILL DEPEND ON THE NUMBER OF DIODES USED AND THE WIDTH OF THE BAND PASS FILTERS.

BECAUSE OF ITS SMALL AREA, THE SIMULATED REFERENCE CELL DOES NOT PERFORM SPATIAL AVERAGING. HENCE UNIFORM ILLUMINATION IS REQUIRED.

Initial and After 140°C Step for Amorphous-Silicon Cells

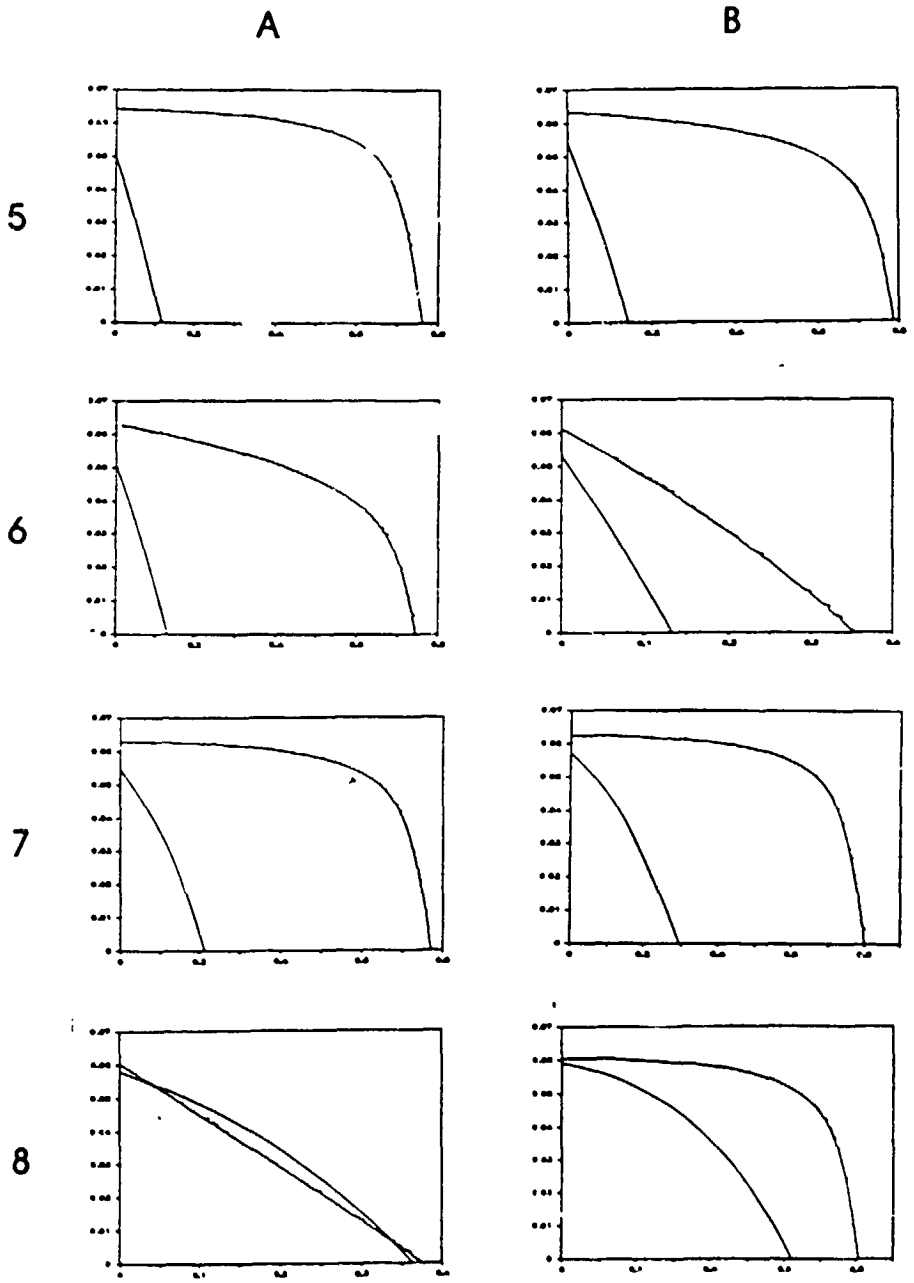
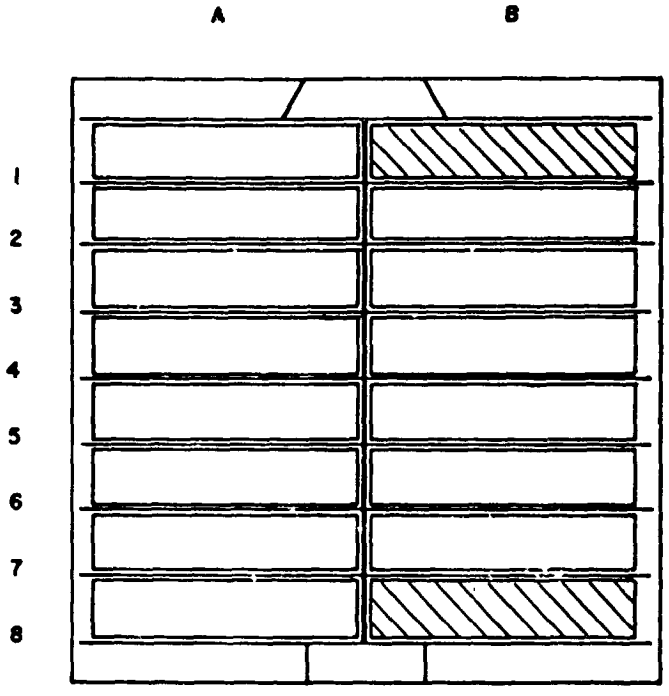
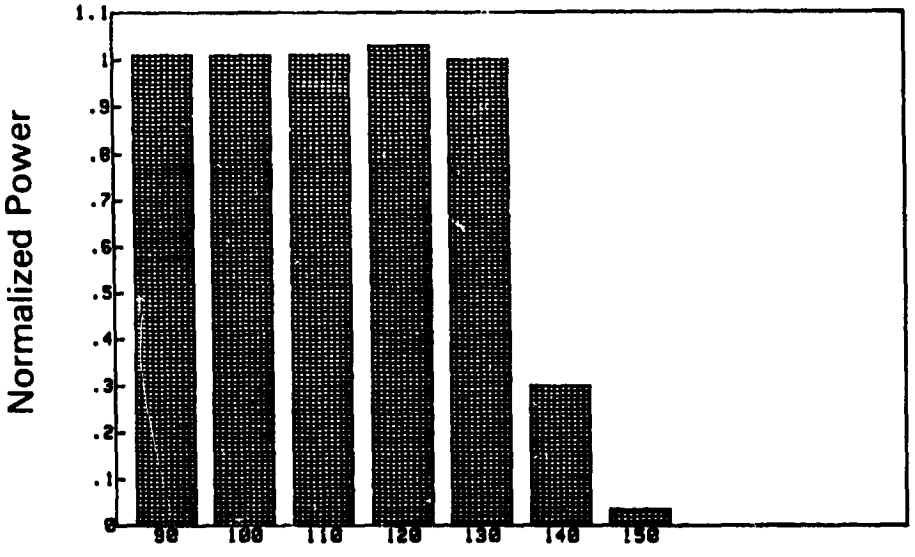


Diagram of Step Stress Submodule Showing
Location of Two "Bad" Cells

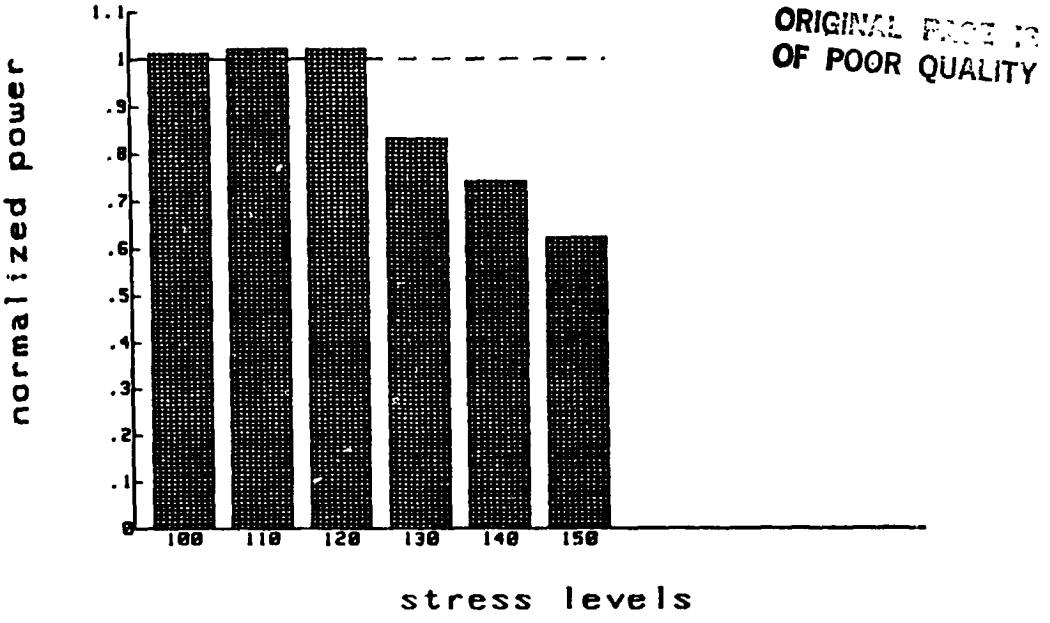


Temperature Step Stress

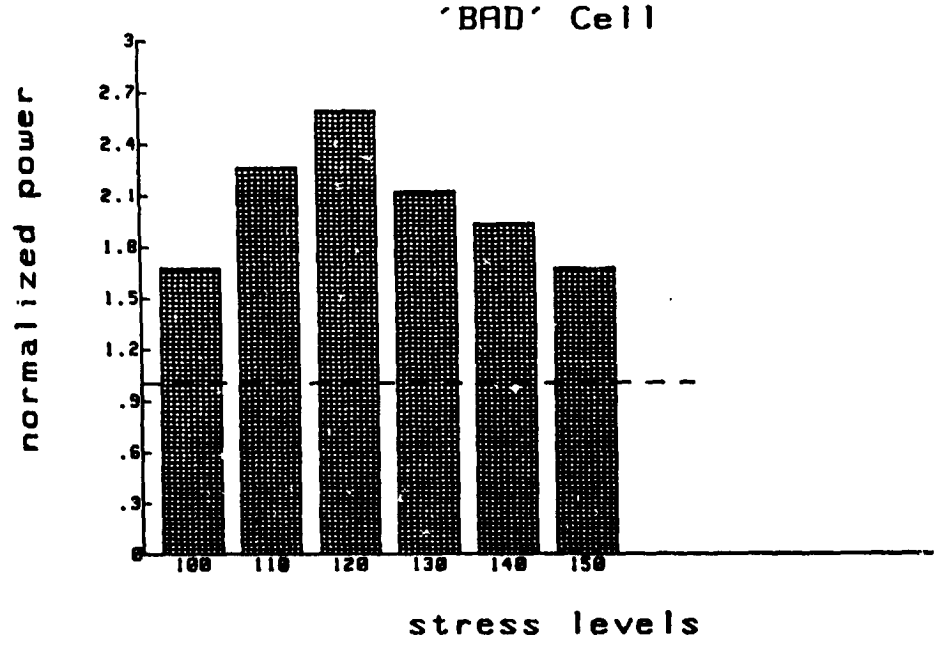


Stress levels (20 hrs. at temp in deg C)

Temperature Step Stress: "Good" Cell
(20 h at Temperature in Degree C)



Temperature Step Stress: "Bad" Cell
(20 h at Temperature in Degree C)



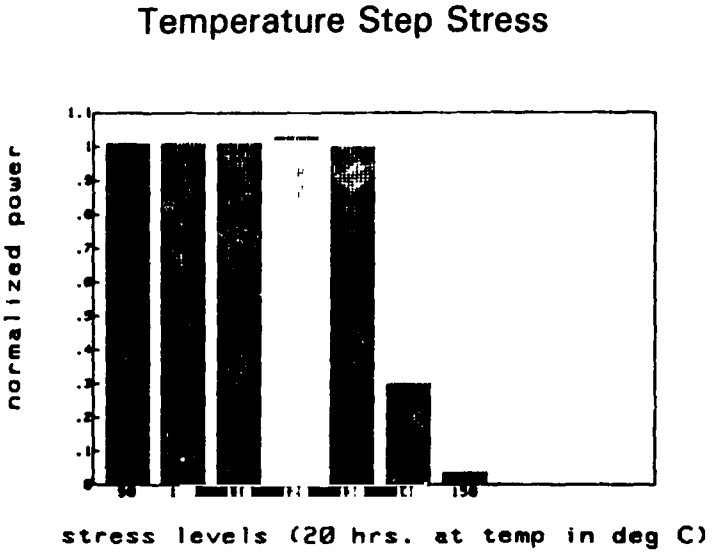


Figure 1. Average Normalized Power Output as a Function of Stress Level Temperature for 16 Amorphous Silicon Solar Cells.

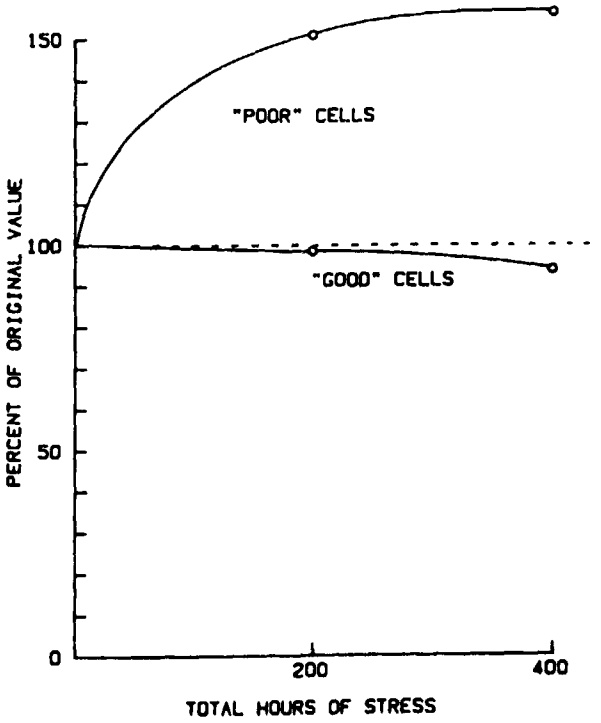


Figure 2. Average Normalized Power Output of Amorphous Silicon Solar Cells as a Function of 85/85 Stress Time.