25

INDUSTRIAL STEAM GENERATION BY NON–IMAGING FOCUSING

FINAL REPORT

FEBRUARY, 1979

PREPARED BY:

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CENTER FOR ENERGY AND ENVIRONMENT RESEARCH

UNIVERSITY OF PUERTO RICO — U.S. DEPARTMENT OF ENERGY

CEER -S-25

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1. Introduction

An innovative solar collector for industrial steam generation has been designed, developed and built by CEER with cooperation and funding from the University of Chicago and Bacardí Corporation. The collector is a linearly segmented compound parabolic concentrator (CPC) with a cylindrical evacuated tube as the receiver. As part of the project, a solar radiation measuring station was installed on the premises of the Bacardí Rum Distillation Plant in Cataño, Puerto Rico.

This report emphasizes that portion of the project carried out after the First Progress Report of August, 1978. We refer the reader to that report for details of the initial phases of the project. In general, that report dealt with the general design ideas and the preliminary analytical studies of these ideas. Some work with an experimental model was also included. This report covers mainly the final design and construction of the collector.

The main design elements that are incorporated in this collector are now summarized. First, it is a CPC collector with a concentration ratio of 5.25. This means it can make use of diffuse as well as direct sunlight. This also means it does not require continuous or even daily tracking of the sun's position. Second, it has an evacuated tubular receiver of a new design. This receiver is expected to perform better than other receivers for high temperature collectors. Third, the CPC mirror surface is segmented and encapsulated in glass tubes. The tubes provide

lightweight, low cost structural suport as well as protection for the mirror surface.

II. Design and Fabrication of Collector Components

The major system components of the linearly segmented compound parabolic collector under consideration are shown in schematic form in Figs. 1, 2, and 3 which show the evacuated tubular receiver, the segmented encapsulated mirrors and the collector frame. Dimensions given in these drawings were original design and some were changed in the final design.

A. Evacuated Tubular Receiver

Fig. 4 shows the schematic of the single wall evacuated receiver tube designed specifically for this project. A detailed description of this receiver was given in the First Progress Report.

One of the three receiver tubes received from the manufacturer was tested under stagnation conditions and one sun radiation density. The temperature inside the copper tubing was found to be 240°C attesting to the excellent heat absorption and retention qualities of this receiver design.

B. Segmented Mirror

A major part of our effort since August has gone into developing and building the segmented mirror. Figure 5 illustrates the final design of the mirror units.

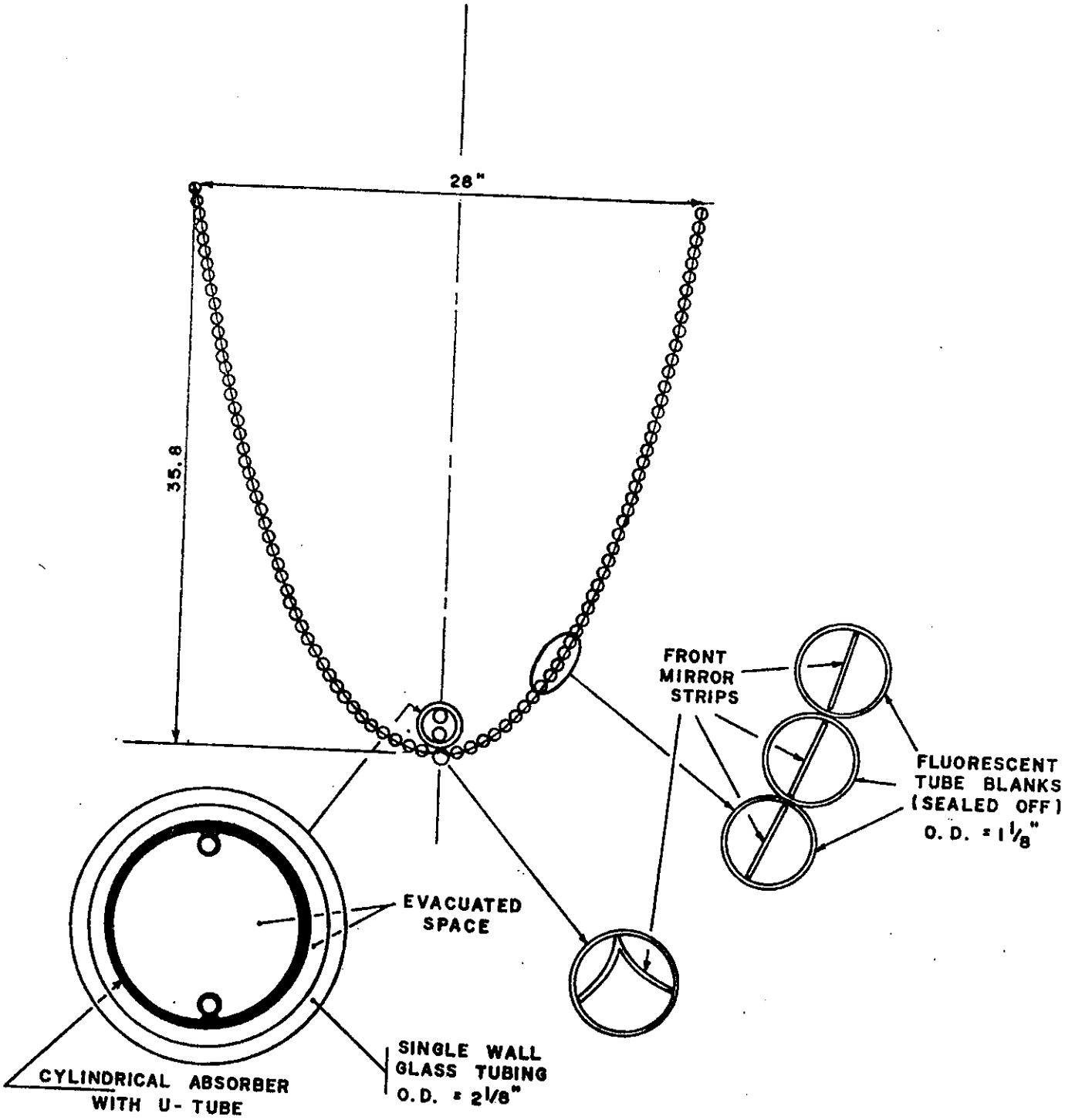
Plexiglas plastic (1/8" thick) was chosen as the material for the mirror substrate. Major considerations in this decision were ease of handling, cutting, and machining, and

FIGURE -1-

UNIVERSITY OF PUERTO RICO / CEER

FACETED CPC COLLECTOR (EFF. CR ≥ 5)

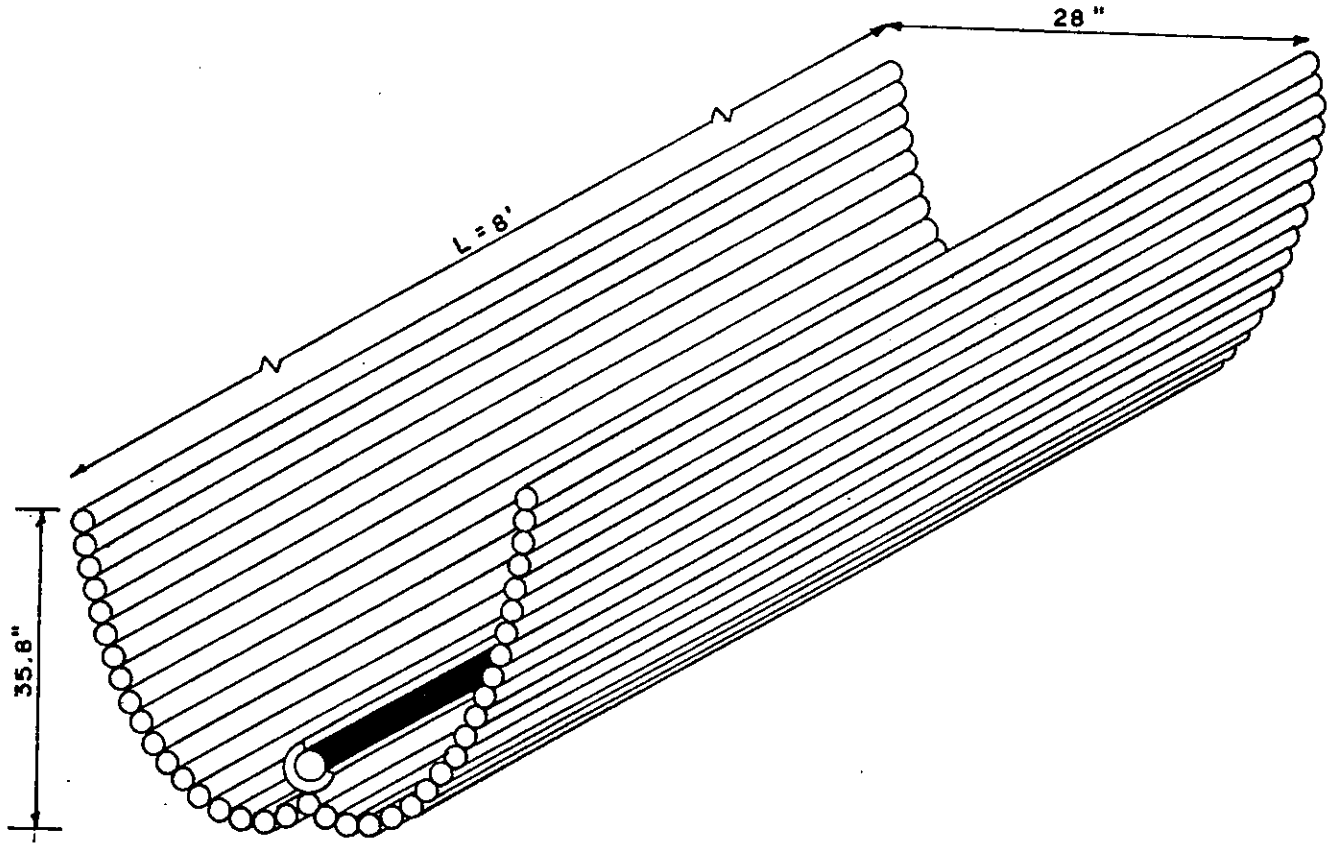
(SUPPORT FRAME FOR TUBES NOT SHOWN)



DRAWING
NOT TO SCALE

FIGURE -2-

PHYSICAL DIMENSIONS OF THE PROTOTYPE CONCENTRATOR SYSTEM



NOT TO SCALE

FIGURE -3-

DUAL AXIS COLLECTOR FRAME

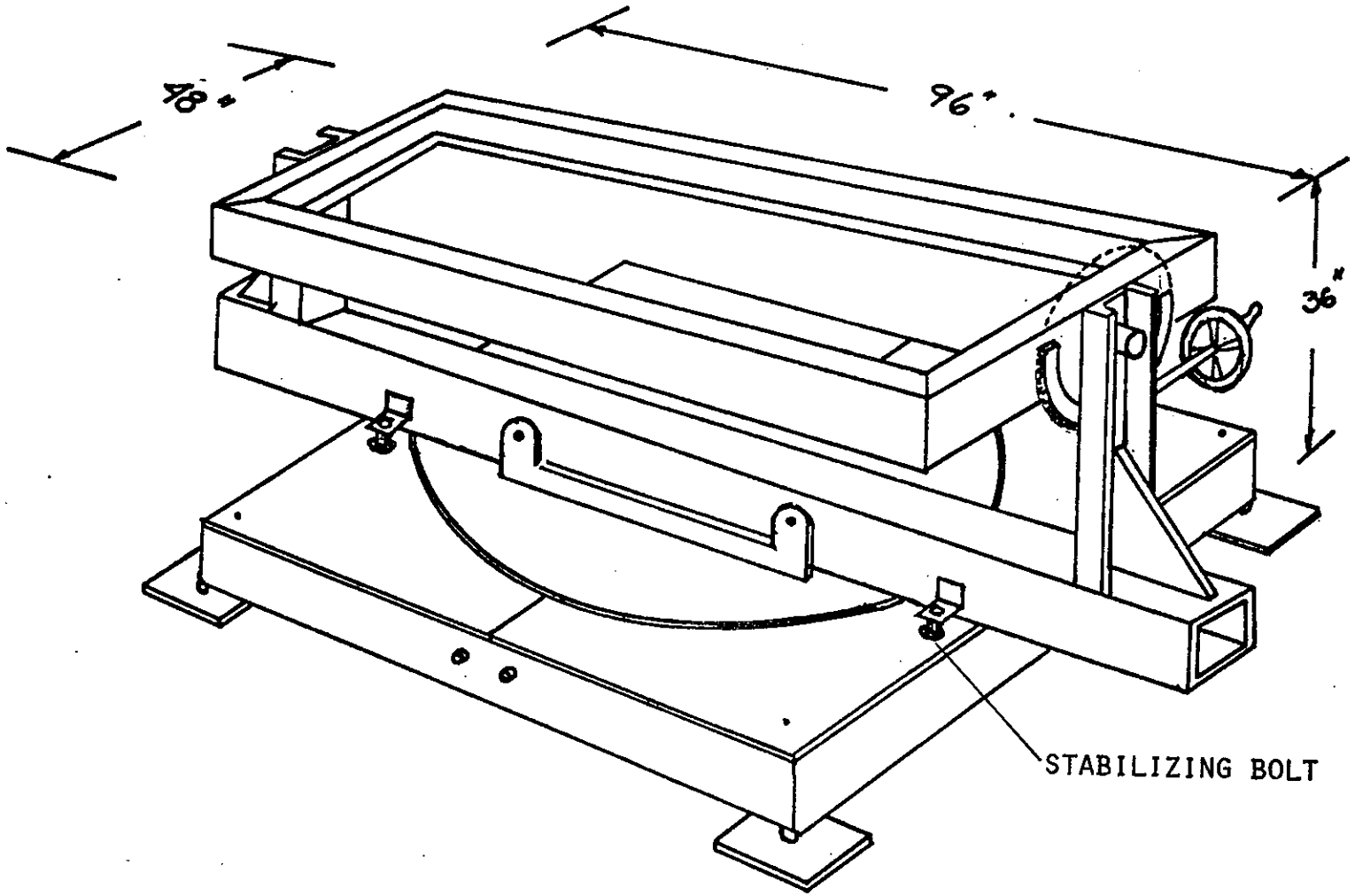


FIGURE -4-

EVACUATED RECEIVER TUBE TO BE UTILIZED WITH THE LINEAR SEGMENTED COMPOUND PARABOLIC CONCENTRATOR

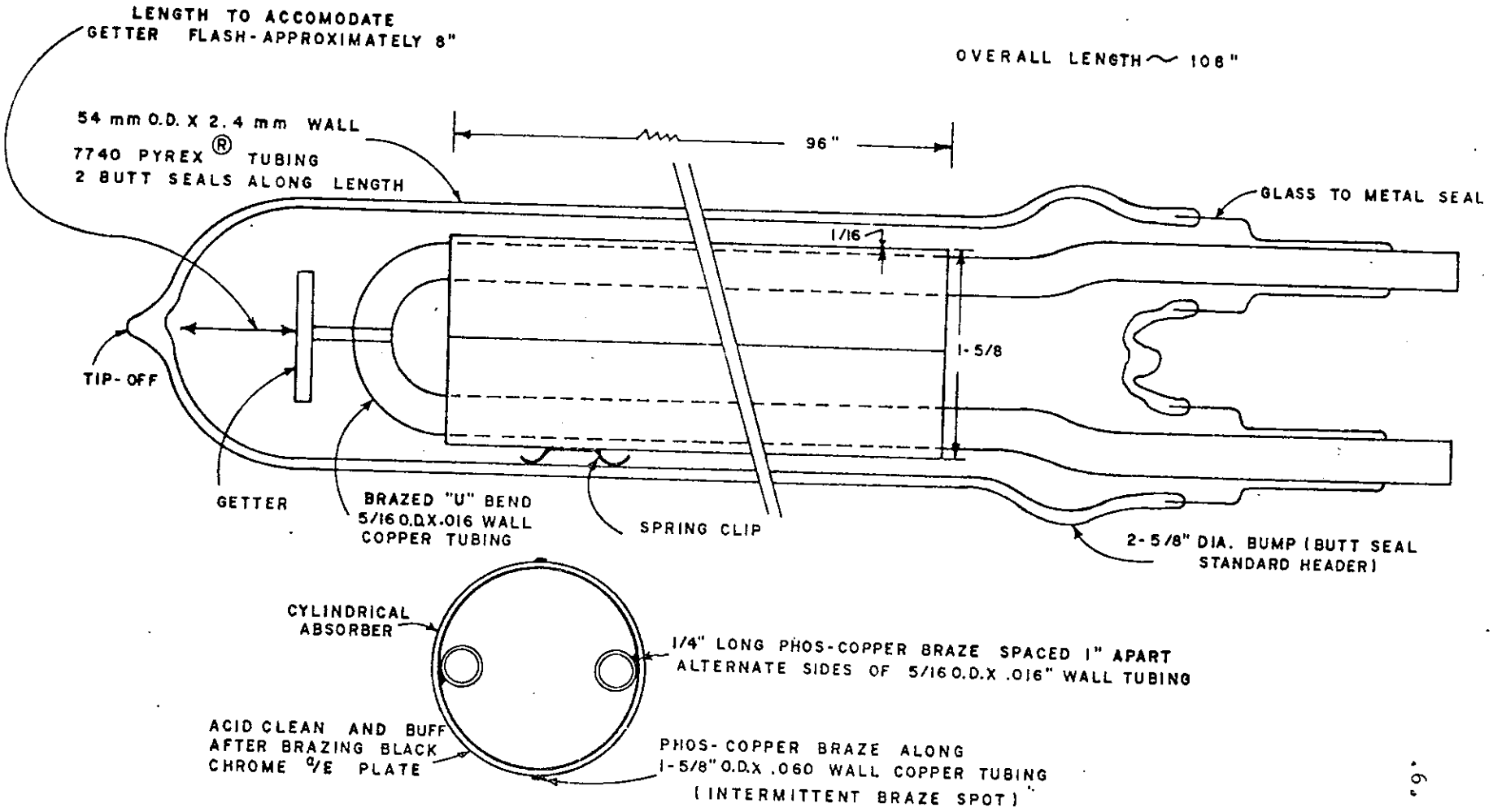
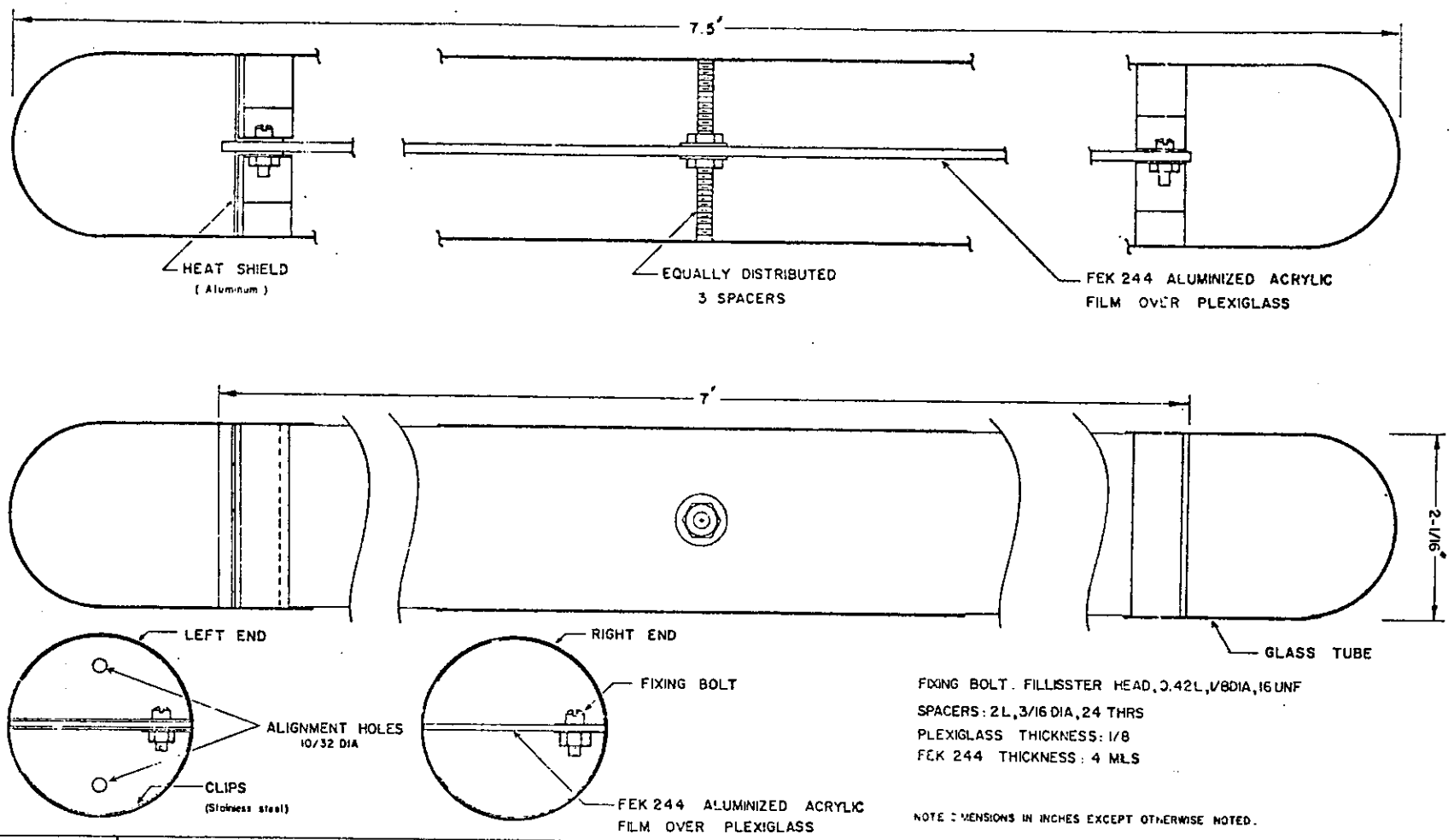


FIGURE -5-



FIXING BOLT. FILLISSTER HEAD, 0.42L, 1/8DIA, 16 UNF
SPACERS: 2L, 3/16 DIA, 24 THRS
PLEXIGLASS THICKNESS: 1/8
FEK 244 THICKNESS: 4 MLS

NOTE: DIMENSIONS IN INCHES EXCEPT OTHERWISE NOTED.

MATL: As shown above	DESCRIPTION:	DR: J.F.Gamarra	SCALE: 2"=1"	CEER _ CENTER FOR ENERGY AND ENVIRONMENT RESEARCH	DWG NO:
PART NO: __	ENCAPSULATED MIRROR SEGMENT	CK: __	DATE: February 1979		
PCS/UNIT: 38		TCR: __	APP __		

smoothness of surface. The plexiglas was cut into strips 7' long and 1 15/16" wide.

Finding a suitable reflective film and a method of bonding to the plexiglas was a major problem. Much effort was spent in trying to bond 200 Dun-Chrome ®, DL-50 metallized polyester film (Dunmore Corp., Newtown, Penn.) to the plexiglas with unsatisfactory results. Many different types of bonding agents were tried. Finally we learned of a new product manufactured by the 3M Company. This is their "Scothcal" Brand Film FEK-244, a 0.004" thick aluminum-on-acrylic film with 86% spectral reflectance. This film has pressure-sensitive adhesive backing and satisfactory results were obtained in applying it to the plexiglas substrate.

The encapsulation tubes are fluorescent tube blanks obtained from Corning Glass Works (Fig. 6). These have an outside diameter of 2.08" and a wall thickness of 0.035". We estimate the diameter tolerance to be $\pm$ 0.01".

The mirror segments are held inside the glass tubes by spring clips at the ends. In order to prevent undue sagging of the mirror, it was found necessary to attach three screw spacers at equal intervals along its length. A metal heat shield was also attached to prevent damage to the mirror when the glass tube was being closed off.

After attaching clips, spacers and shields to the mirror, the assembly was inserted inside a glass tube (Fig. 7). The mirror was then checked todetermine whether there was any twist

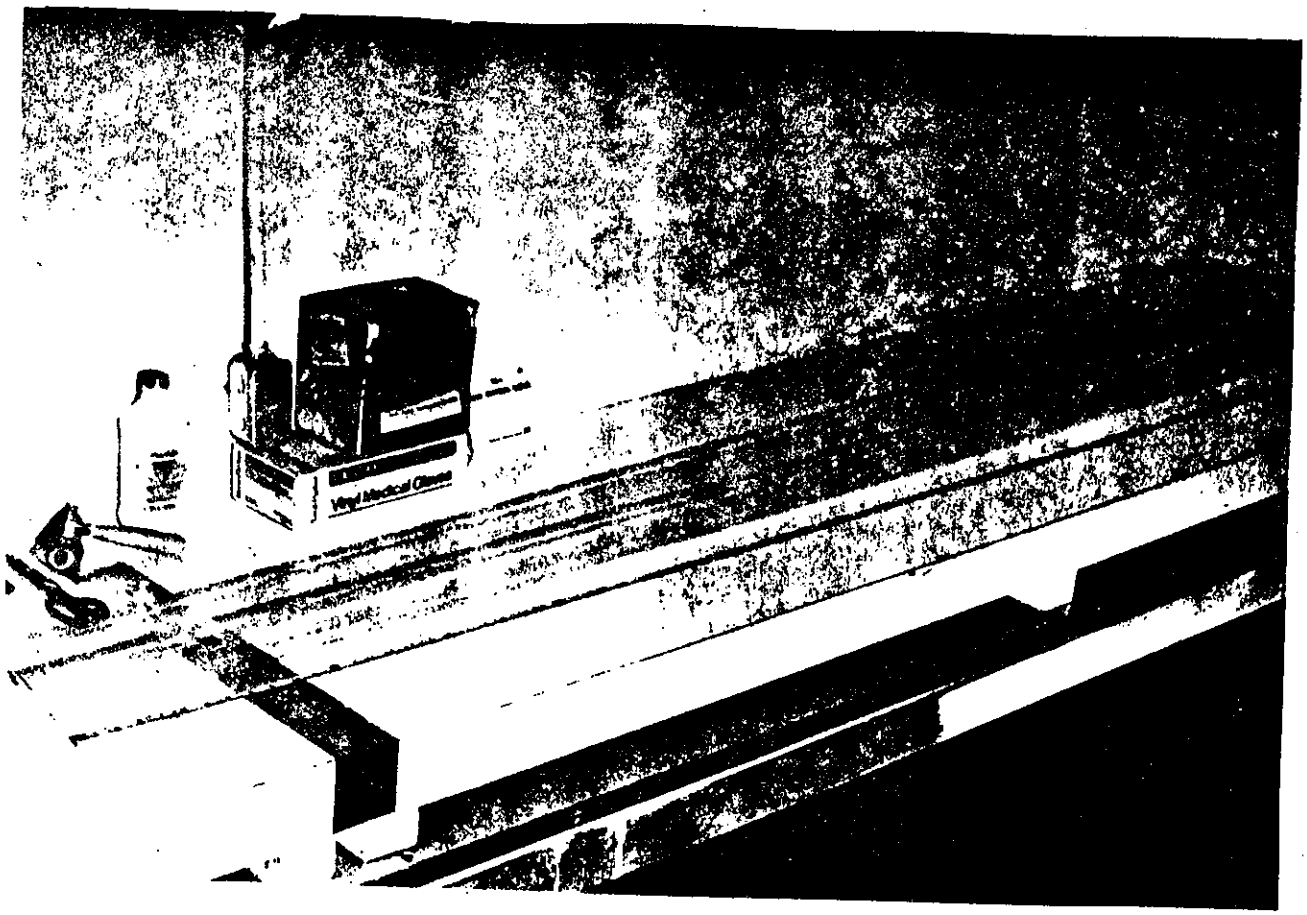


FIG. 6 FLUORESCENT TUBE BLANKS FROM CORNING GLASS WORKS.

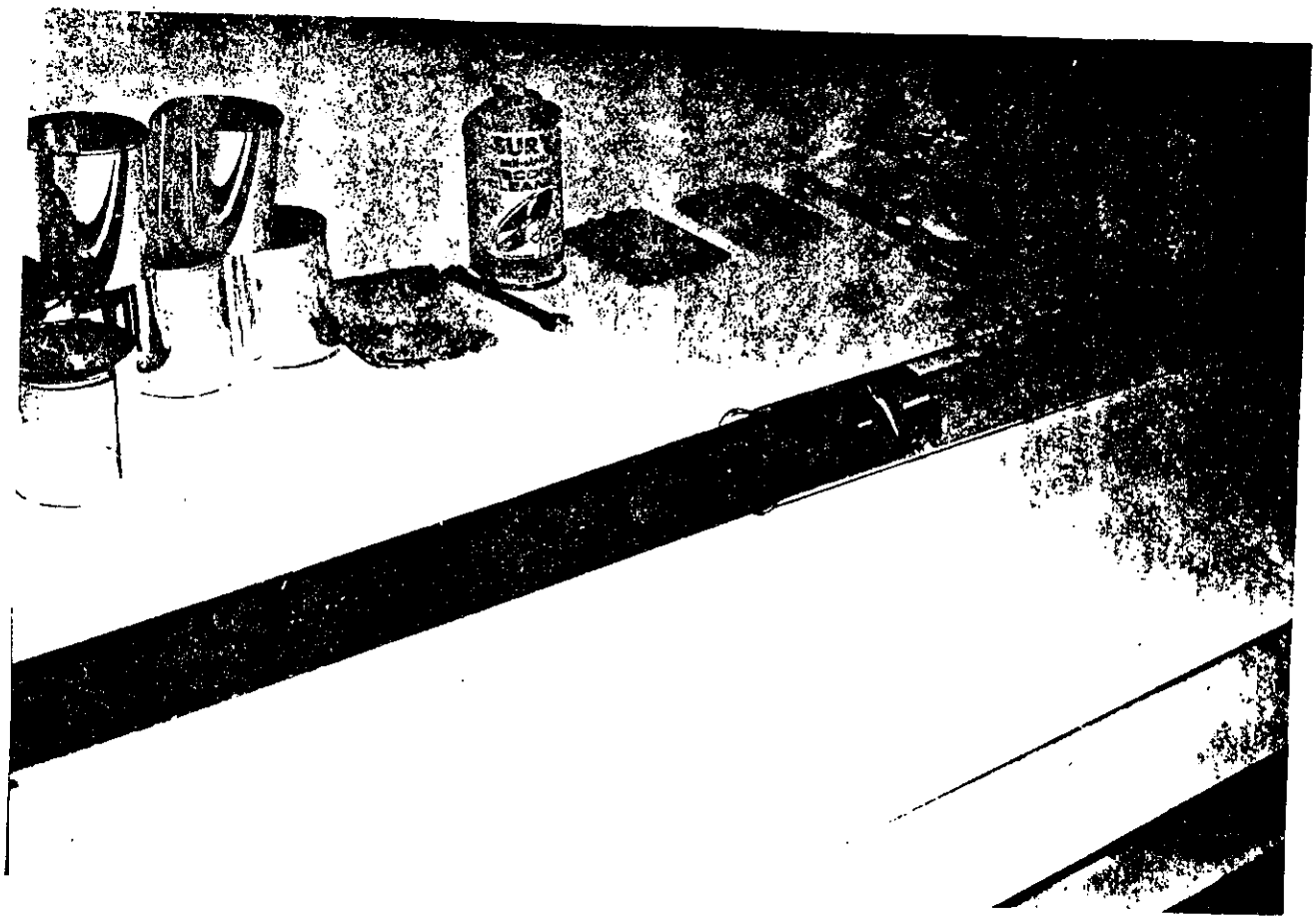


FIG. 7 INSERTION OF MIRROR ASSEMBLY INTO GLASS TUBE.

of one end with respect to the other. This was done by looking at the reflection of a laser beam from the mirror at different points along its length (Fig. 8). Since one end of the mirror was accessible and since the spacers were not attached to the tubes, any large twists could be removed. The largest allowable amount of twist of one part of the mirror with respect to another was 1°.

Originally it had been planned to close off the glass tubes after they had been evacuated at an elevated temperature and filled with a dry gas. The idea was to eliminate as much moisture as possible from the inside of the tubes. An oven was built and it was determined that the mirrors could withstand 100°C without apparent damage. However, when the tubes were evacuated to a pressure of 500 microns of Hg. at 100°C, immediate damage to the adhesive bond resulted. Evacuation alone did not appear to damage the bond and several tubes were made using this procedure. After being connected to a vacuum pump for 30 minutes, they were filled with dry nitrogen at a pressure of $\sim$ 1 atm.. Damage to the adhesive bond of these mirrors did not become apparent until they had been exposed to sunlight for 2 or 3 weeks. Finally it was decided to abandon the evacuation procedure. Tubes were closed off in an air conditioned room. A room dehumidifier brought the relative humidity down to 50% at 75°C which corresponds to a ratio of moisture to dry air of 1.0% by weight.

Another important problem encountered in the construction of the tubes was the frequent breakage and craking

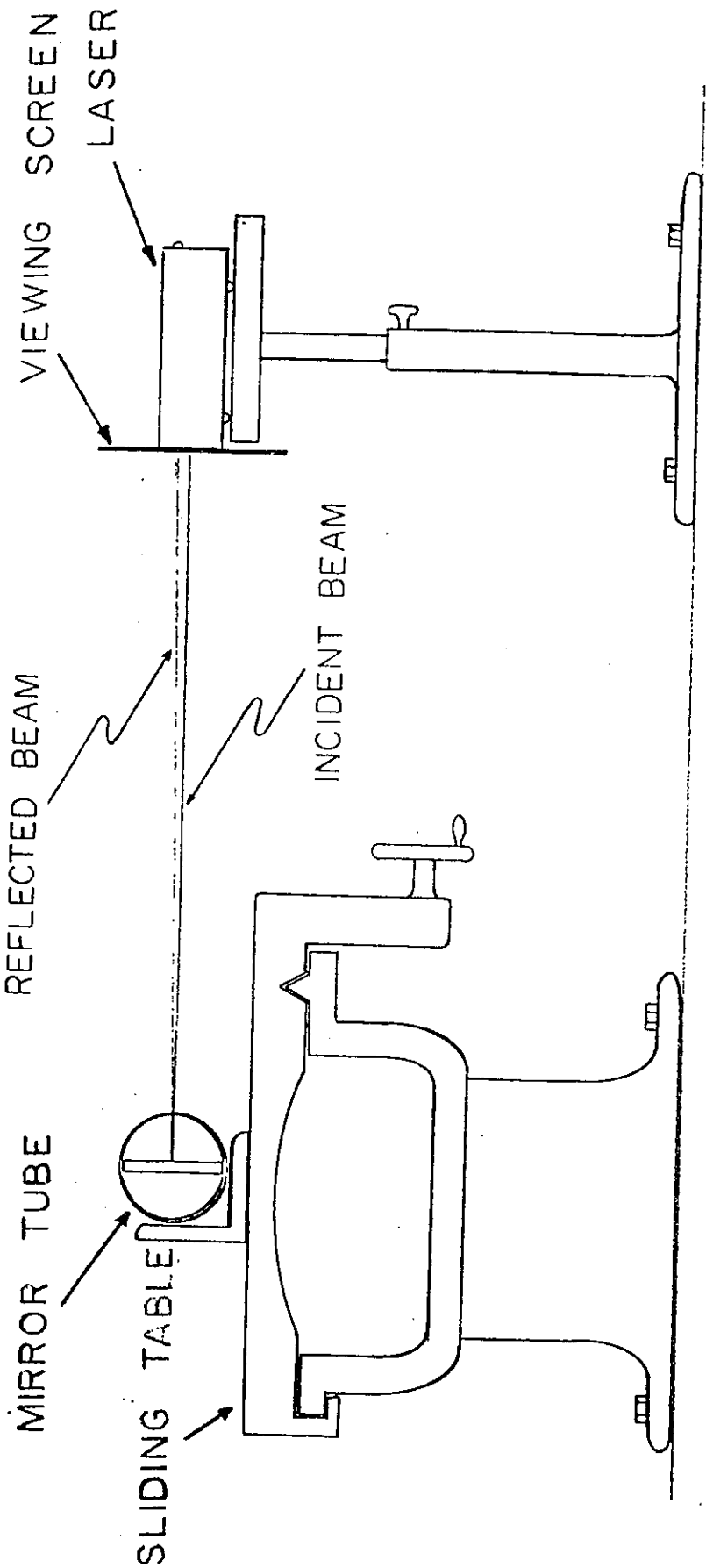


FIG. 8 SCHEMATIC OF THE METHOD FOR MEASURING TWISTS IN MIRROR SURFACE, THE SLIDING TABLE MOVES THE MIRROR TUBE ALONG ITS LENGTH (I.E, PERPENDICULAR TO THE VIEW SHOWN). ANY CHANGE IN THE POSITION OF THE REFLECTED BEAM AS THE SLIDING TABLE MOVES IS AN INDICATION OF TWIST.

of the glass at stress points where it had been worked. Since the temperature of the mirrors could not be raised, it was not possible to do oven annealing to relieve these stresses. This problem was alleviated considerably when the evacuation procedure was abandoned. It seems that a large part of the problem was due to differences between the nitrogen pressure inside and atmospheric pressure outside. This resulted in uneven tips which eventually cracked.

C. Collector Frame

Figs 3 and 9 show the collector frame including the tube wells which actually hold the glass tubes.

The basic dual axis tracking frame design developed by the University of Chicago was altered in some important ways. The main beam of the frame which in the Chicago design was an I-beam was found to be too unstable to torsional forces such as would be exerted on it by the collector weight when tilted. The I-beam was replaced by a rectangular cross section hollow beam which also allowed a simpler design for fixing the beam to the circular platform.

Four bolts were added to the sides of the main beam. These prevent movement of the circular platform (and thus of the collector) after it has been set at a particular position.

In order to measure the collector's tilt angle, two bubble level with protactor assemblies were installed at each end of the collector frame. These permit angle measurements with an accuracy of $\sim 1/4°$.

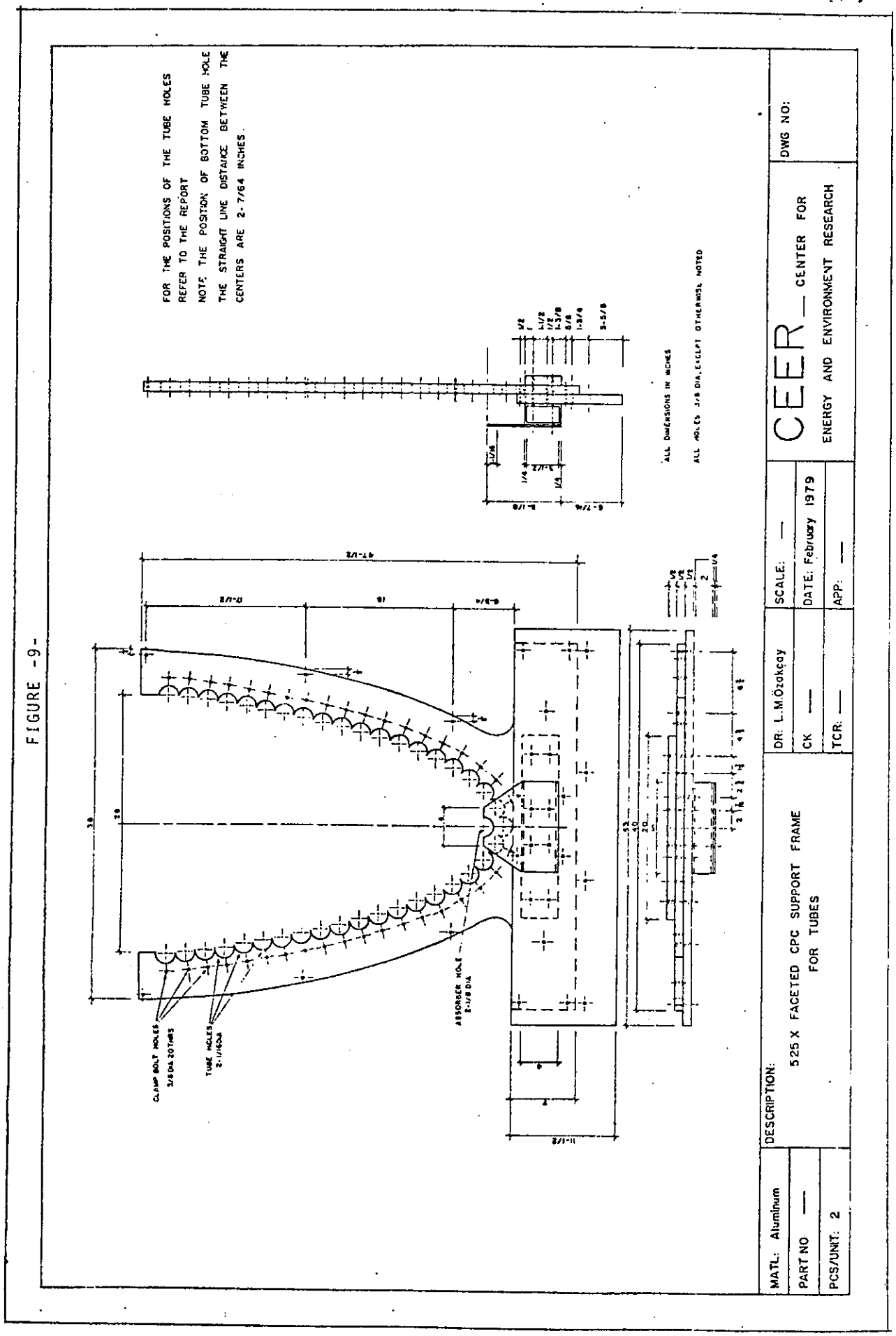

FOR THE POSITIONS OF THE TUBE HOLES
REFER TO THE REPORT
NOTE: THE POSITION OF BOTTOM TUBE HOLE
THE STRAIGHT LINE DISTANCE BETWEEN THE
CENTERS ARE 2-7/64 INCHES.
ALL DIMENSIONS IN INCHES
ALL HOLES 3/8 DIA. EXCEPT OTHERWISE NOTED
CLAMP BOLT HOLES
3/8 DIA 20 THRS
TUBE HOLES
2-1/16DIA
ABSORBER HOLE
2-1/8 DIA
MATL: Aluminum
PART NO —
PCS/UNIT: 2
DESCRIPTION:
525 X FACETED CPC SUPPORT FRAME
FOR TUBES
DR: L.M.Özakçay
CK —
TCR: —
SCALE: —
DATE: February 1979
APP: —
CEER — CENTER FOR
ENERGY AND ENVIRONMENT RESEARCH
DWG NO:

FIGURE -9-

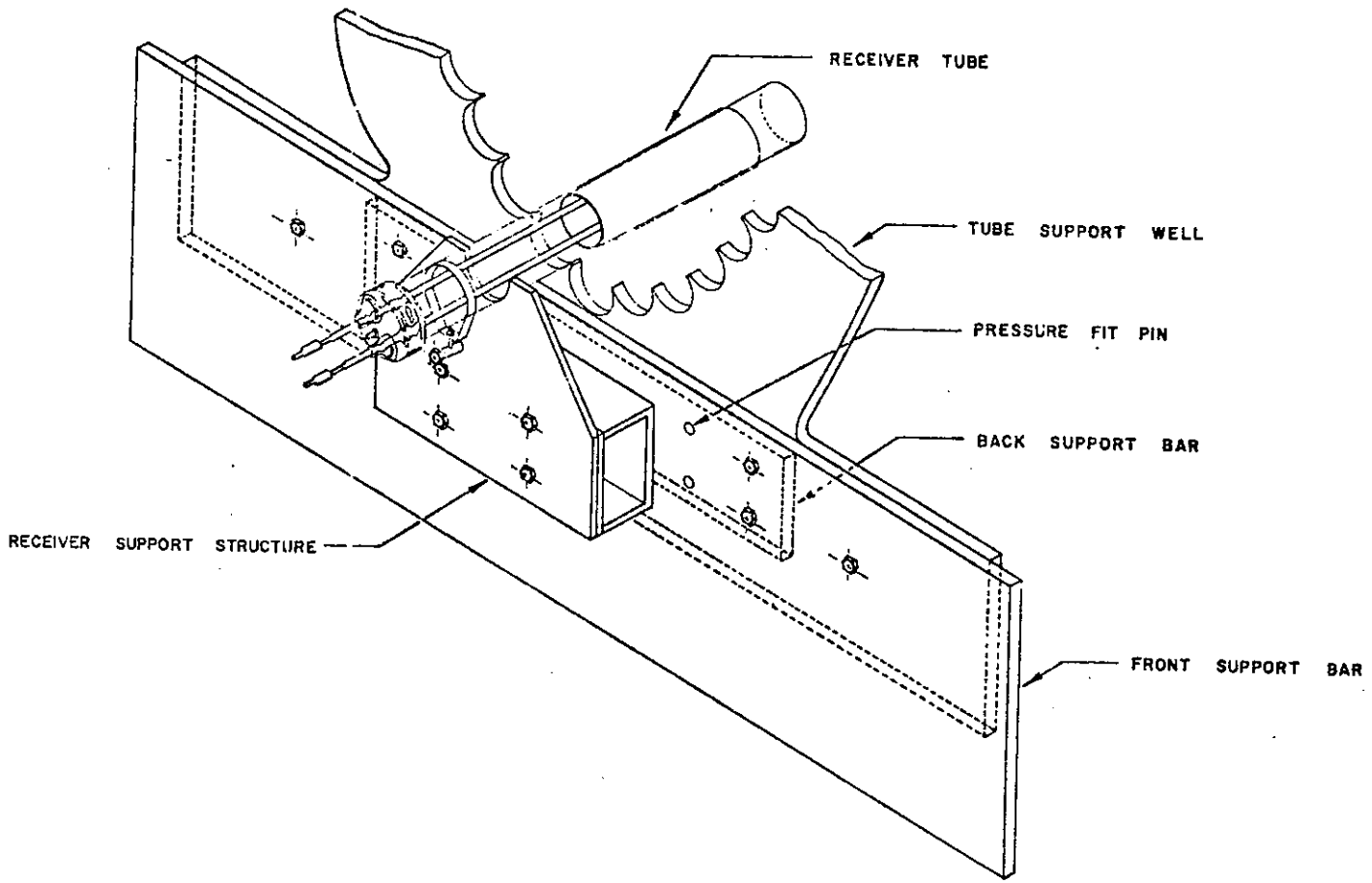
Major efforts on the collector frame went into designing and building the tube wells which are shown in detail in Fig. 9.

A computer program was developed to calculate the theoretical shape of the reflector surface (See First Progress Report, Appendix A). Using the results from the program, the tube wells were precisely machined. Four identical pieces (each was one-half a well) were machined simultaneously by stacking them. The raw material for the wells were four pieces of 1/2" aluminum, 20" wide and 48" long. The circular holes that hold the tubes have a diameter of 2.09". The straight line distance between circles is 2.11" to allow for the metal bands that grip the tubes. After the tube holes had been machined, excess material was removed to make the structure lighter. The tube holes thus became open semicircles.

Fig. 10 is a depiction of the support bar and the structure which holds the receiver tube. These can also be seen in Fig. 9. Two halves of a well were held together by precisely machined pressure fit pins and by screws and nuts which joined them to the support bar. The pressure fit pins assured alignment to a high degree of precision. The receiver tube is supported by a structure that allows space for the mirror tubes that are close to the receiver.

The mirror tube wells are fastened to cross support members of the frame. Six aluminum tubes join the tube wells to each other. These add much rigidity to the structure

FIGURE -10-



MATL: As shown above	DESCRIPTION:	DR: J.F. Gamarra	SCALE: 1" = 2"	CEER — CENTER FOR ENERGY AND ENVIRONMENT RESEARCH	DWG NO:
PART NO: —	RECEIVER SUPPORT STRUCTURE	CK: —	DATE: February 1979		
PCS / UNIT : —		TCR: —	APP: —		

and very little weight.

The structure for fastening the glass tubes to the wells is shown in Fig. 11. It consists of a stainless steel band which is pulled tight by a screw which runs through a bolt fastened to the frame. The bands are placed so that bands from neighboring tubes do not touch thus reducing the distance between mirror segments.

III. Analytical Studies of Collector Orientation

One of the main advantages of a CPC design is the possibility of doing away with continuous tracking of the sun thus reducing complexity and cost. This is because a CPC can collect radiation incident over an extended range of angles as is shown in Fig. 12. Our CPC design is an ideal 6.30 X concentrator truncated to 5.25X. The theoretical half acceptance angle (θ_c) of the ideal concentrator is 9°. An actual device never has a perfect theoretical shape due to random deviations of its surface from the "ideal" surface. This changes its acceptance characteristics (see Fig. 12) but this change can be approximated as a reduction in the acceptance angle.

The idea, then, is to orient the collector so that the radiation is incident at an angle less than or equal to the acceptance angle. Yet we want to do this with a minimum amount of tracking. The optimum collection to tracking ratio is achieved by orienting the long axis of the collector along the east-west direction. The angle of interest is then the projected incidence angle on the plane defined by the zenith and the

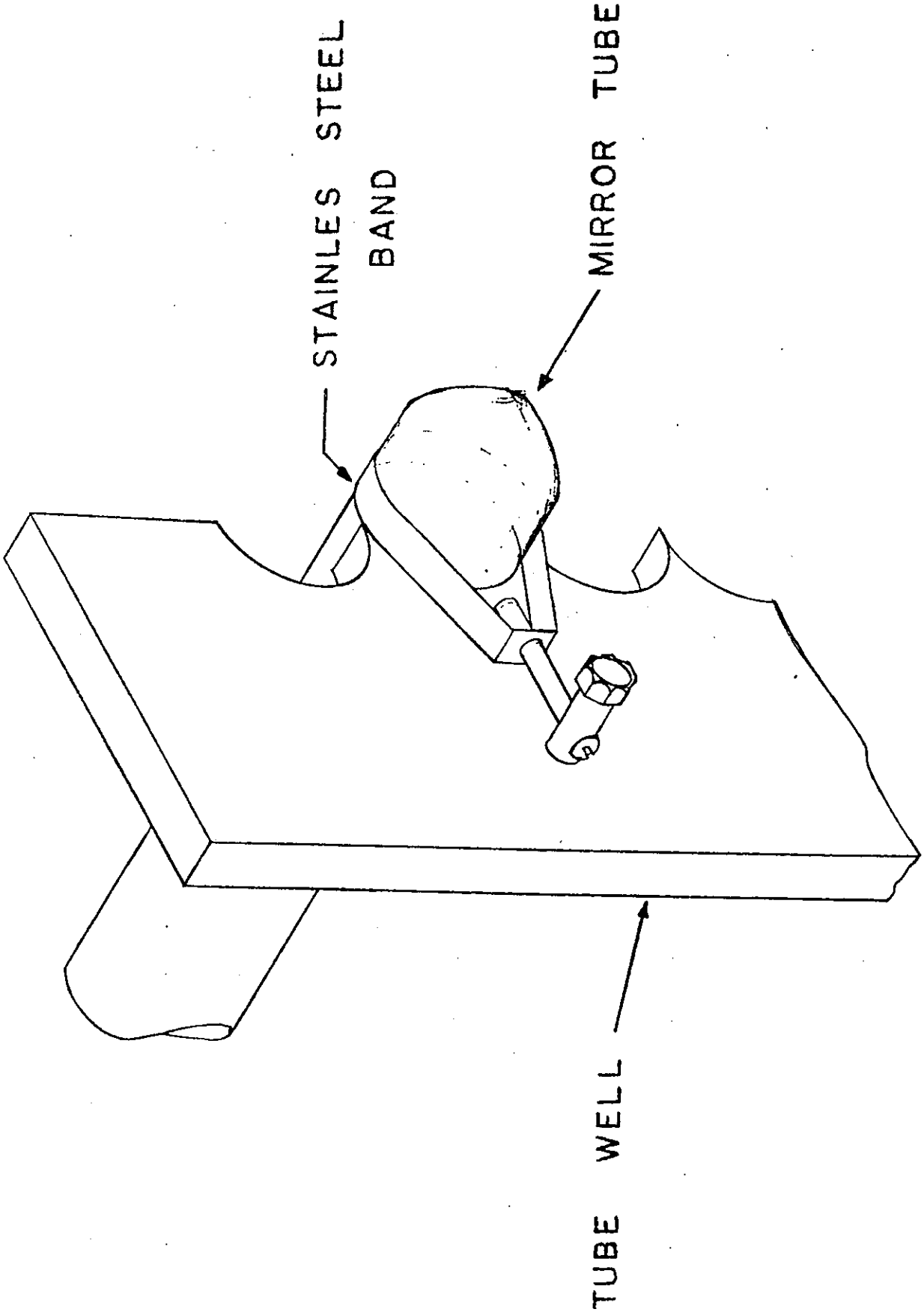


FIG. 11 ATTACHMENT OF MIRROR TUBES TO TUBE WELL.

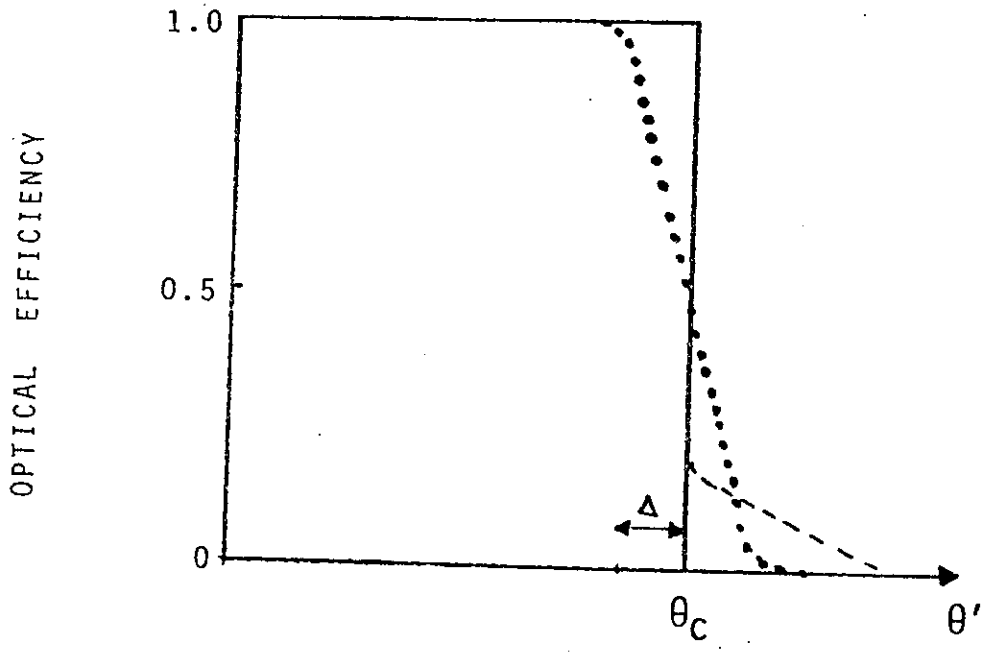


Fig. 12 Fraction of the radiation incident on the aperture of a CPC at angle θ' which reaches absorber. All curves refer to a concentrator in two dimensions with acceptance half angle θ_c, assuming perfect reflectivity.

———————— untruncated ideal concentrator

- - - - - - - truncated ideal concentrator

•••••••••••• untruncated concentrator with average surface error Δ.

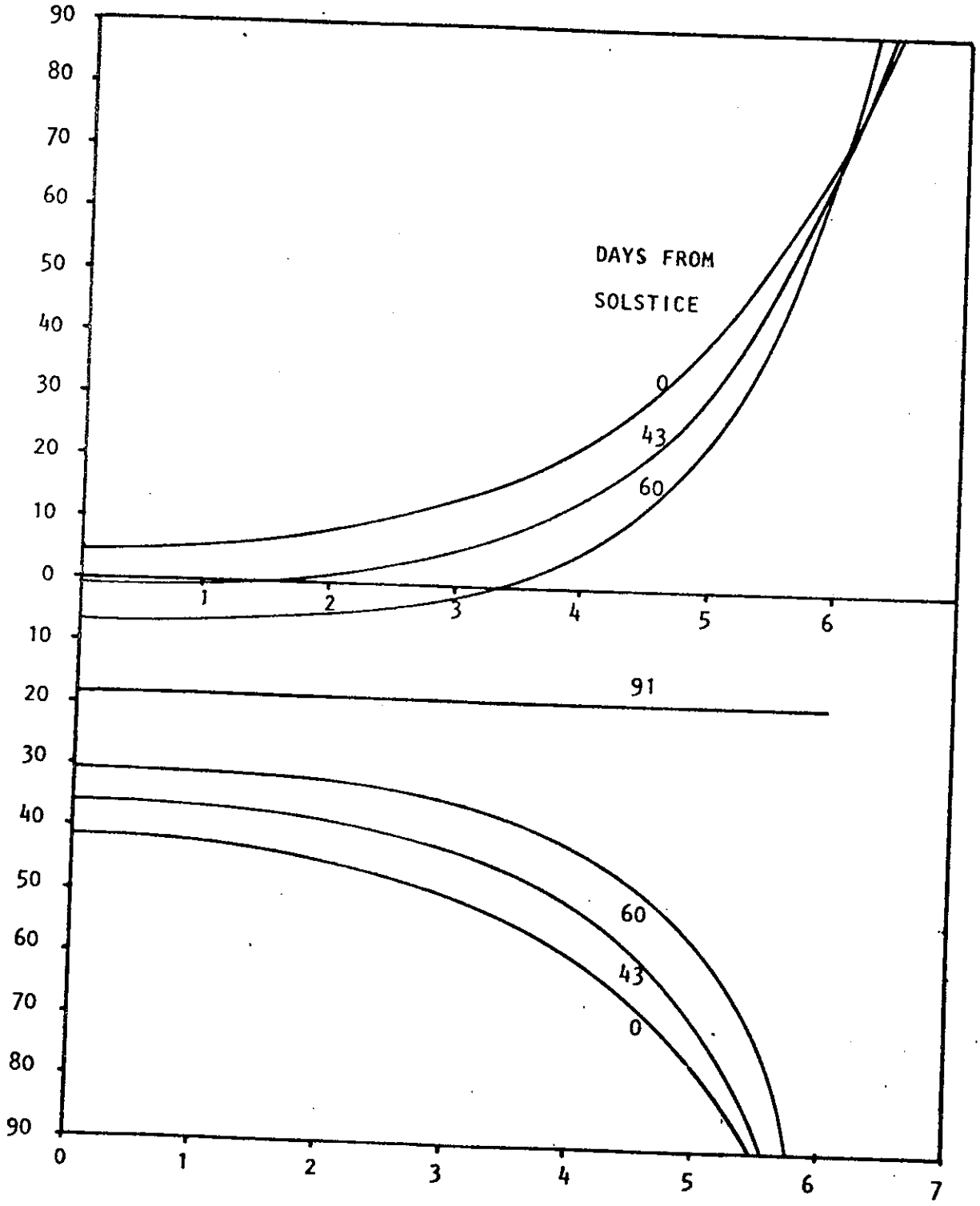
north-south direction. This angle (θ_{sp}, measured from the zenith) can be calculated for a particular day and hour by the following formula

$$\tan (\theta_{sp} + \alpha) = \tan \delta \; / \; \cos \omega$$

where α is the latitude, δ is the declination and ω is the angular time from noon ($\omega = 2\pi t/24$, t in hours). Fig. 13 is the graph of θ_{sp} for different days during the year and for Puerto Rico's latitude.

A scheme for orienting the collector can be derived from this graph. One first chooses a half acceptance angle (θ_c) and a minimum daily collection time (e.g. 7 hours/day). Starting at the summer solstice, one determines the value of θ_{sp} at the extremes of the minimum collection time (time=3.5). Call this angle θ_e. Before and after the solstice the collector would be oriented at an angle $\theta_e - \theta_c$. For this configuration, the collector would have a high optical efficiency at any hour of the day that $\theta_e - 2\theta_c < \theta_{sp} < \theta_e$. For several days after the solstice this condition will hold more than 7 hours a day. But there comes a day when it will hold for less than the required 7 hours because it will not hold in the period around noon time. On this day, the collector orientation should be changed. Suppose that the value of θ_{sp} at the extremes of the minimum collection time on this day is θ'_e. The collector is then pointed at an angle $\theta'_e - \theta_c$. This procedure for determining the collector orientation and the dates for changing it is repeated until a full year is mapped out. The result is a chart such as the one

FIG. 13
PROJECTED
SOLAR ELEVATION
(FOR LATITUDE 18.5)



shown in Table 1. For a half acceptance angle of 9° and a minimum required collection time of 7 hrs./day the collector has to be reoriented only 10 times a year.

IV. Insolation Measurements

Solar radiation has been recorded at the Bacardí plant in Cataño since July, 1978. Diffuse as well as total insolation have been recorded. Details of the measuring process were given in the First Progress Report.

Results of the computer analysis of data for the months of July, August and September are given in Appendix A. Data for the months of October, November and December shows certain irregularities which are not understood at present. These months are not included in the Appendix.

V. Conclusion

The completion of construction of an innovative experimental solar collector designed for industrial steam generation is the main achievement of our work this year. In addition, much analytical study of the design has been made and a solar radiation measuring program has been implemented at the proposed industrial site. The analytical studies indicate the possibility of a high efficiency to cost ratio for this collector. Figures 14, 15, 16 and 17 are views of the finished Bacardí solar collector.

TABLE 1

$\theta_c = 9°$

*START DATE	*END DATE	TILT S=south N=north	LENGHT OF PERIOD	DECLINATION AT END OF PERIOD
Jan. 30	Feb. 24	37°S	25 days	-10°
Feb. 24	Mar. 22	25.0°S	26 days	0
Mar. 22	Apr. 17	11°S	26 days	10°
Apr. 17	May 12	1°S	25 days	18°
May 12	Jul. 31	11°N	80 days	18°
Jul. 31	Aug. 26	1°N	26 days	10°
Aug. 26	Sep. 20	11°S	25 days	0
Sep. 20	Oct. 16	25°S	26 days	-10°
Oct. 16	Nov. 11	37°S	26 days	-18°
Nov. 11	Jan. 30	45°S	80 days	-18°

No. of adjustments/year = 10

*In a leap year, add one day to dates after Feb. 28.

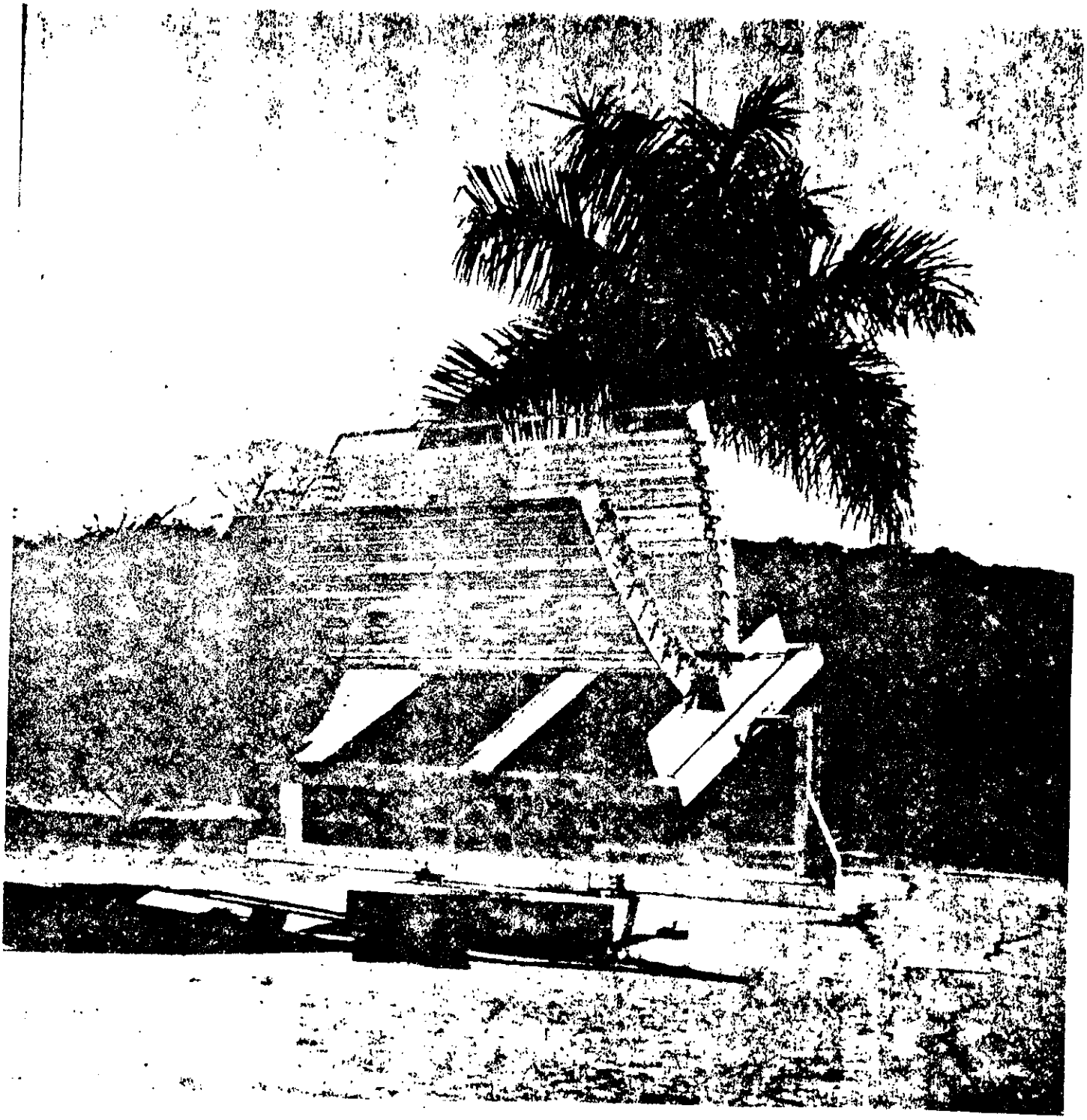


FIG. 14 COMPLETED BACARDÍ COLLECTOR

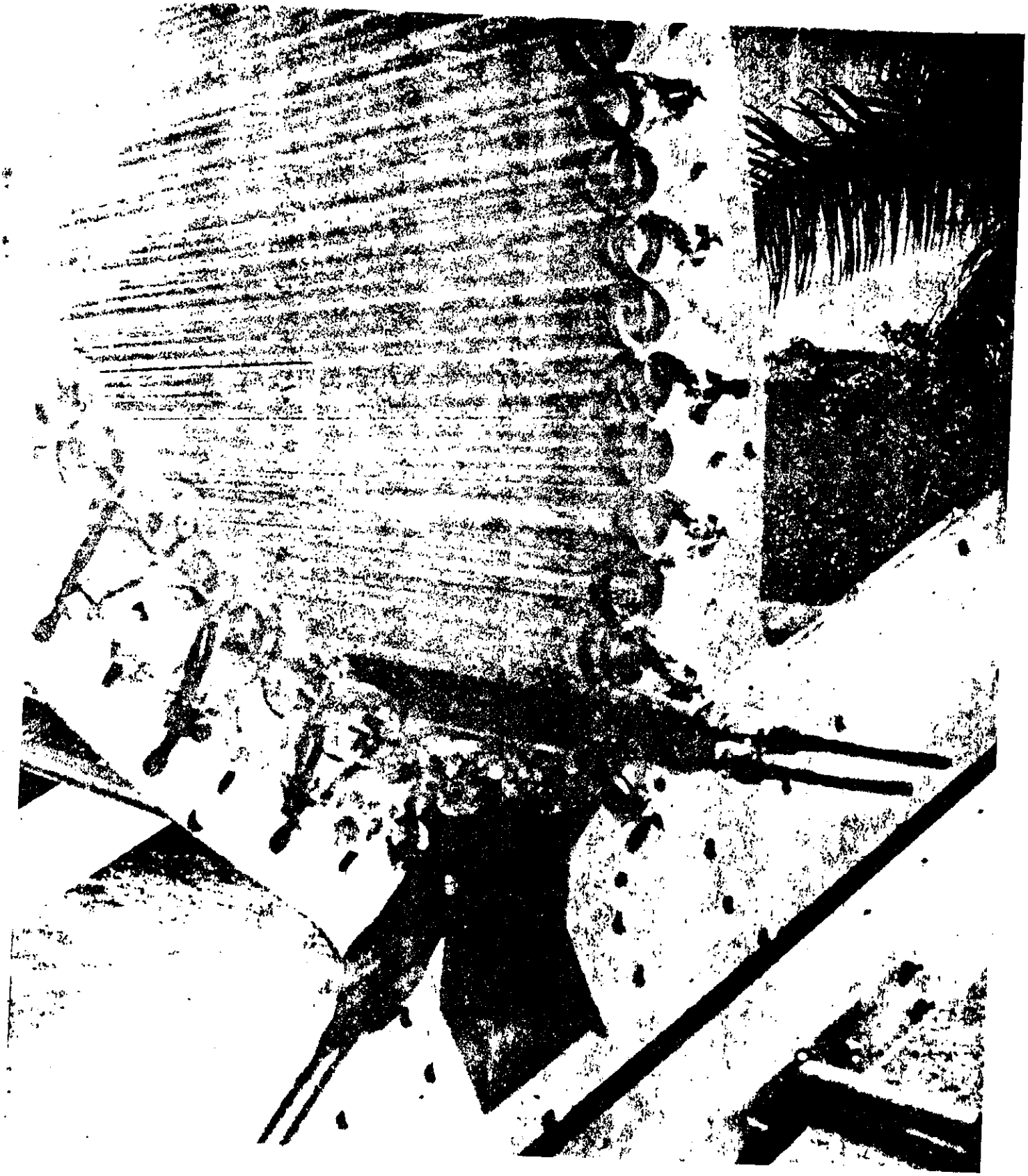


FIG. 15 COMPLETED BACARDÍ COLLECTOR. CLOSE-UP VIEW OF ONE TUBE WELL AND RELATED SUPPORT STRUCTURE.

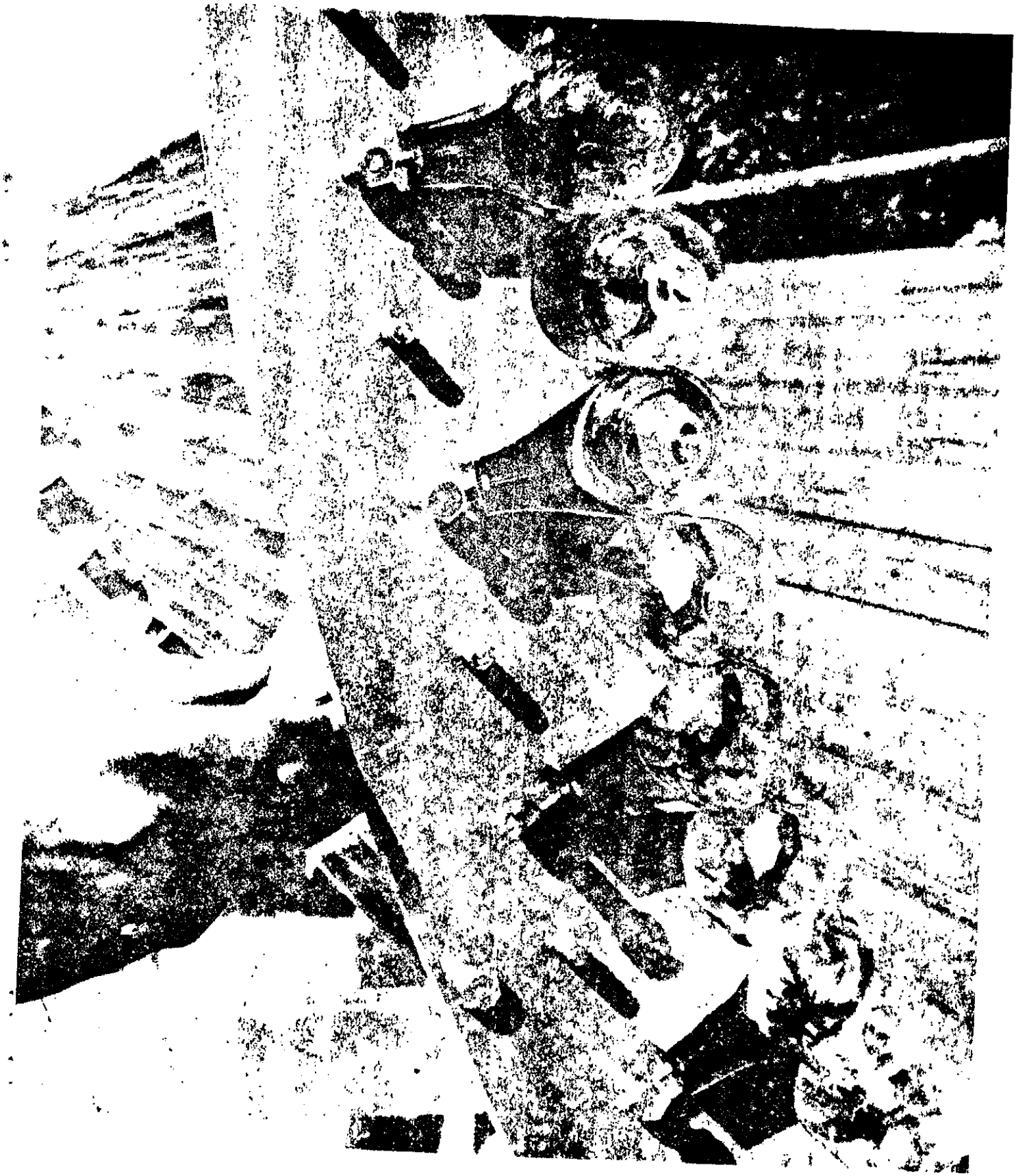


FIG. 16 COMPLETED BACARDÍ COLLECTOR. CLOSE-UP VIEW OF ATTACHMENT OF MIRROR TUBES TO TUBE WELL.

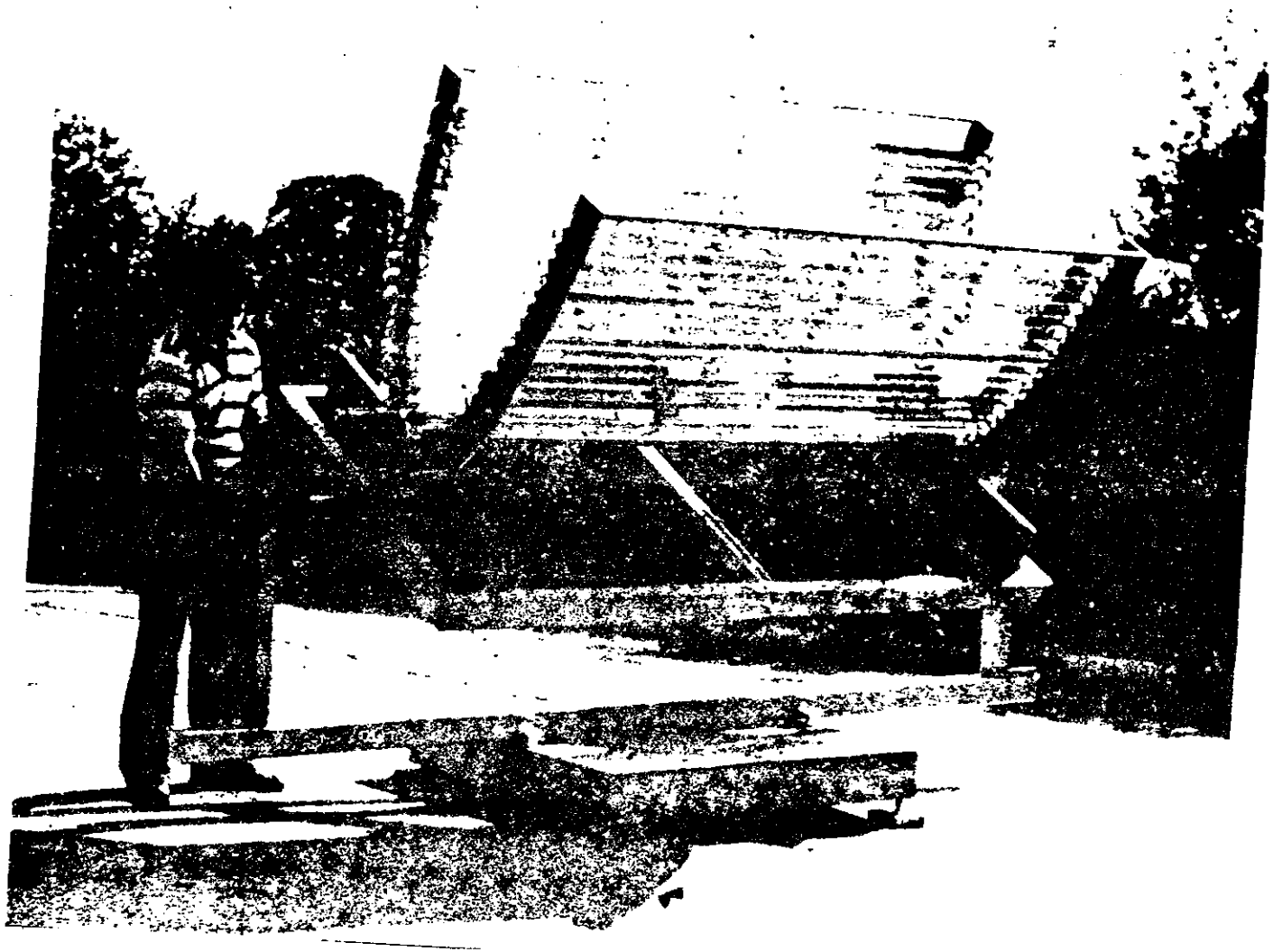


FIG. 17 COMPLETED BACARDÍ COLLECTOR. COLLECTOR TILT IS ADJUSTED MANUALLY.

APPENDIX A

START USER SODERSTROM K [240300,240311] JOB FOR10 SEQ. 31085 DATE 28-FEB-79 14:02:28 MONITOR SYSTEM RUN 507B W/RJE *START*

```
FFFFFFFFFFFFFFF      000000000       RRRRRRRRRRRRR         111        000000000
FFFFFFFFFFFFFFF      000000000       RRRRRRRRRRRRR         111        000000000
FFFFFFFFFFFFFFF      000000000       RRRRRRRRRRRRR         111        000000000
FFF               000         000    RRR          RRR   111111     000         000
FFF               000         000    RRR          RRR   111111     000         000
FFF               000         000    RRR          RRR   111111     000         000
FFF               000         000    RRR          RRR      111     000      000000
FFF               000         000    RRR          RRR      111     000      000000
FFF               000         000    RRR          RRR      111     000      000000
FFFFFFFFFFFF      000         000    RRRRRRRRRRRRR         111     000   000   000
FFFFFFFFFFFF      000         000    RRRRRRRRRRRRR         111     000   000   000
FFFFFFFFFFFF      000         000    RRRRRRRRRRRRR         111     000   000   000
FFF               000         000    RRR    RRR            111     000000      000
FFF               000         000    RRR    RRR            111     000000      000
FFF               000         000    RRR    RRR            111     000000      000
FFF               000         000    RRR       RRR         111     000         000
FFF               000         000    RRR       RRR         111     000         000
FFF               000         000    RRR       RRR         111     000         000
FFF                  000000000       RRR          RRR   111111111     000000000
FFF                  000000000       RRR          RRR   111111111     000000000
FFF                  000000000       RRR          RRR   111111111     000000000
```

START USER SODERSTROM K [240300,240311] JOB FOR10 SEQ. 31085 DATE 28-FEB-79 14:02:28 MONITOR SYSTEM RUN 507B W/RJE *START*

START USER SODERSTROM K [240300,240311] JOB FOR10 SEQ. 31085 DATE 28-FEB-79 14:02:28 MONITOR SYSTEM RUN 507B W/RJE *START*

START USER SODERSTROM K [240300,240311] JOB FOR10 SEQ. 31085 DATE 28-FEB-79 14:02:28 MONITOR SYSTEM RUN 507B W/RJE *START*

START USER SODERSTROM K [240300,240311] JOB FOR10 SEQ. 31085 DATE 28-FEB-79 14:02:28 MONITOR SYSTEM RUN 507B W/RJE *START*

START USER SODERSTROM K [240300,240311] JOB FOR10 SEQ. 31085 DATE 28-FEB-79 14:02:28 MONITOR SYSTEM RUN 507B W/RJE *START*

START USER SODERSTROM K [240300,240311] JOB FOR10 SEQ. 31085 DATE 28-FEB-79 14:02:28 MONITOR SYSTEM RUN 507B W/RJE *START*

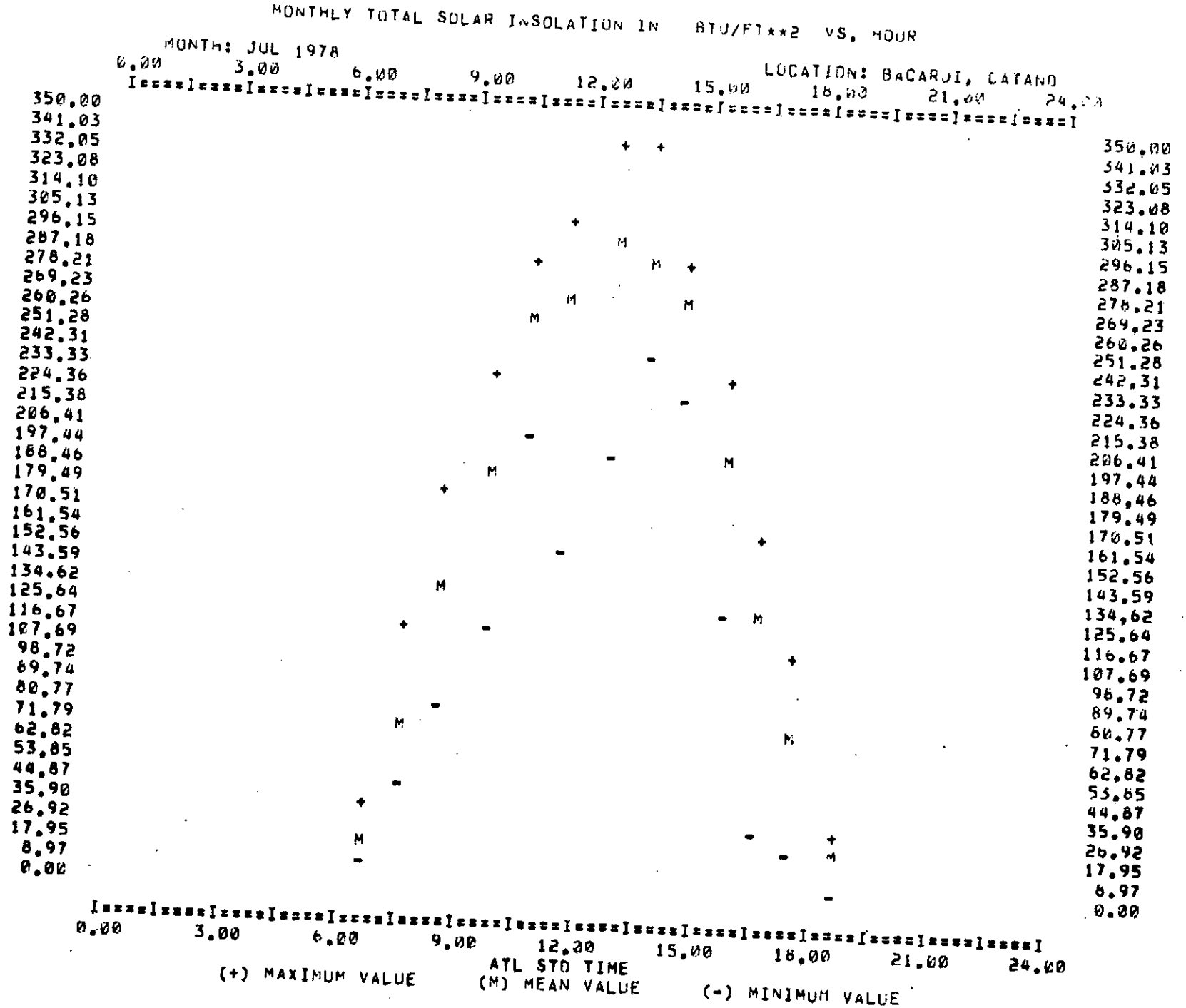
MONTHLY WEATHER DATA

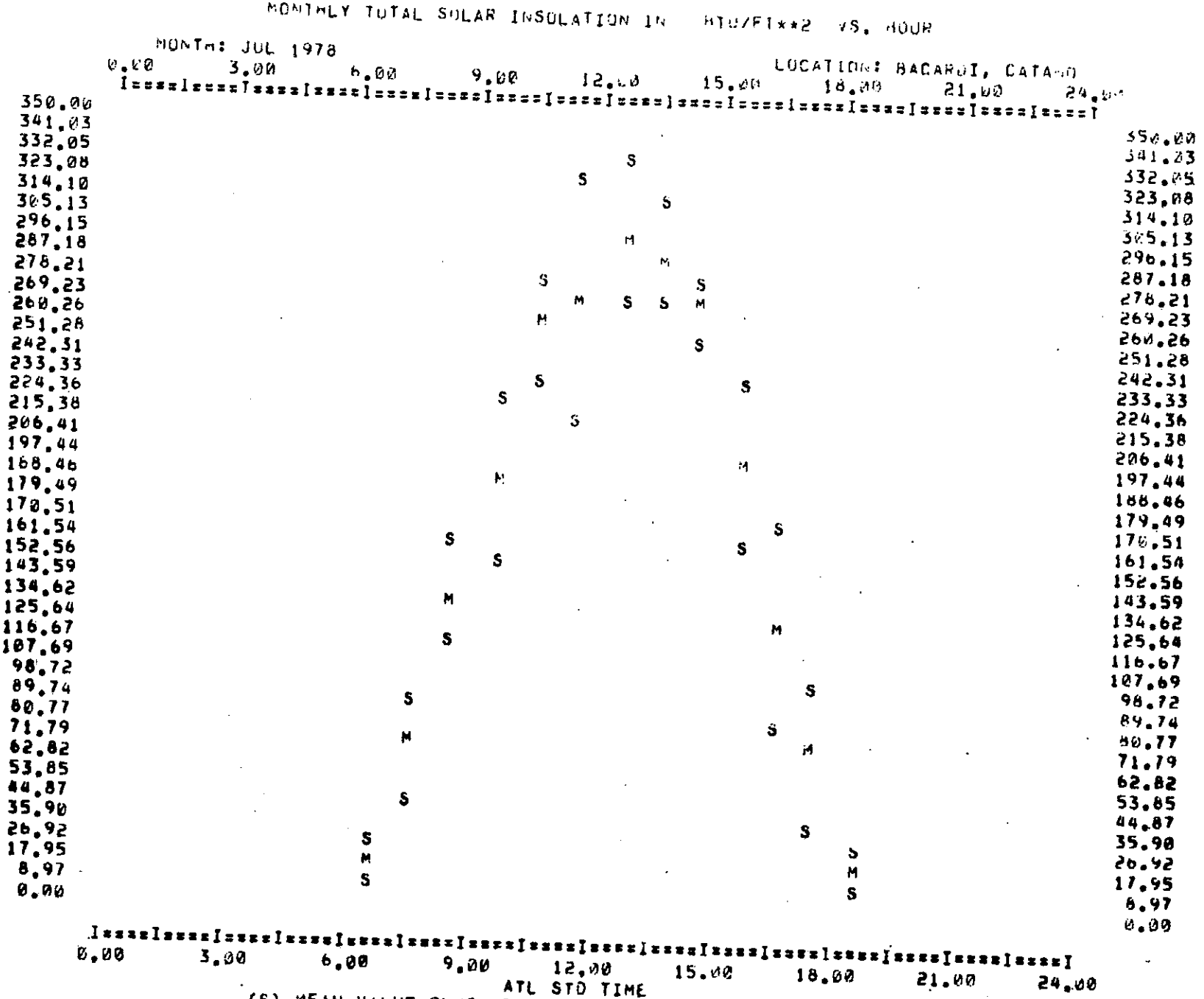
MONTH: JUL 1978

LOCATION: MACARGI, CATANDUANES

TOTAL INSOLATION IN BTU/FT**2

DAY	HOUR 6-7	7-8	8-9	9-10	10-11	11-12	12-1	1-2	2-3	3-4	4-5	5-6	6-7	TOTAL
1	27.90	92.20	152.80	216.00	266.80	300.90	307.90	291.60	244.20	222.30	187.90	96.30	******	******
2	33.70	116.50	176.30	188.80	286.20	308.30	342.60	359.00	290.40	234.00	158.20	110.90	29.20	2614.7
3	40.70	100.40	156.50	186.80	293.80	******	244.80	213.90	99.40	138.00	164.70	81.80	******	******
4	37.70	96.40	156.60	203.50	273.20	318.20	320.00	309.10	273.60	219.20	150.60	******	31.90	******
5	42.00	105.20	164.00	217.50	285.20	316.50	186.10	166.40	118.90	144.00	138.40	76.40	******	******
6	30.50	80.20	124.80	148.40	******	188.40	153.80	131.90	280.40	113.60	******	49.70	14.20	******
7	12.90	62.30	133.60	128.20	205.60	151.60	288.60	268.00	251.90	122.00	45.50	28.90	10.40	1709.5
8	25.20	47.40	79.10	146.20	217.90	186.10	197.30	272.80	225.50	142.50	50.70	16.10	9.60	1596.4
9	20.10	76.30	156.40	213.60	267.80	294.00	290.40	301.20	268.10	157.90	52.40	14.80	4.00	2117.0
10	18.30	83.70	146.10	227.10	277.00	301.00	310.60	293.40	232.00	230.70	157.40	64.80	20.30	2440.4
11	9.20	83.00	161.80	231.40	283.70	271.90	282.90	274.00	261.50	146.30	151.40	74.80	10.30	2242.2
12	31.50	76.80	124.40	131.30	273.20	294.90	286.10	253.60	261.30	******	******	******	******	******
13	******	******	******	******	******	******	******	******	******	******	125.10	65.30	12.20	******
14	18.60	45.30	169.80	226.10	272.00	302.10	314.70	300.10	267.20	216.70	149.00	94.00	10.00	2385.6
15	24.50	85.60	129.70	172.30	******	******	******	******	******	******	******	******	******	******
16	******	******	******	******	******	******	******	******	******	******	******	******	******	******
17	******	******	******	******	******	******	******	******	******	******	******	******	******	******
18	******	******	******	******	******	******	******	******	******	******	******	******	******	******
19	******	******	******	******	******	******	******	******	******	******	******	******	******	******
20	******	******	******	******	******	******	******	******	******	******	******	******	******	******
21	******	******	******	******	******	******	******	******	******	******	******	******	******	******
22	******	******	******	******	******	******	******	******	******	******	******	******	******	******
23	******	******	******	******	******	******	******	******	******	******	******	******	******	******
24	******	******	******	******	******	******	******	******	******	******	******	******	******	******
25	12.90	67.80	134.20	156.00	270.20	295.00	311.60	303.30	268.20	222.30	145.60	77.10	19.80	2284.2
26	34.30	69.60	124.20	113.30	248.90	307.90	312.90	301.90	276.50	215.70	146.00	64.90	17.10	2254.3
27	9.90	50.40	150.50	216.20	277.40	300.30	313.60	296.80	267.60	212.80	153.90	65.20	21.00	2355.6
28	13.50	56.80	116.30	180.10	236.00	292.20	300.80	301.00	259.20	205.30	137.50	68.90	15.10	2182.7
29	25.60	60.00	137.40	202.70	257.40	290.70	304.00	287.10	253.30	209.00	131.10	56.90	16.40	2231.6
30	13.70	63.70	119.70	213.80	264.40	303.20	305.70	238.70	260.10	205.80	135.90	72.60	29.00	2226.1
31	15.40	65.10	131.80	177.30	235.40	183.60	286.10	293.90	275.00	217.50	160.70	75.20	16.40	2133.4
MEAN	18.81	67.71	136.37	187.20	257.14	270.55	297.86	290.80	264.89	195.65	125.58	67.44	16.33	2198.1
STD D	6.12	18.38	25.02	38.52	24.96	53.74	32.94	22.88	15.66	36.75	45.74	28.72	7.27	110.5
MIN	9.20	45.30	79.10	113.30	205.60	151.60	197.30	238.70	225.50	122.00	30.70	14.80	4.00	1437.1
MAX	34.30	116.50	176.30	231.40	286.20	308.30	342.60	339.00	290.40	234.00	164.70	110.90	29.20	2660.4


MONTHLY TOTAL SOLAR INSOLATION IN BTU/FT**2 VS. HOUR
MONTH: JUL 1978
LOCATION: BACARJI, CATANO
0.00 3.00 6.00 9.00 12.00 15.00 18.00 21.00 24.00
350.00
341.03
332.05
323.08
314.10
305.13
296.15
287.18
278.21
269.23
260.26
251.28
242.31
233.33
224.36
215.38
206.41
197.44
188.46
179.49
170.51
161.54
152.56
143.59
134.62
125.64
116.67
107.69
98.72
89.74
80.77
71.79
62.82
53.85
44.87
35.90
26.92
17.95
8.97
0.00
ATL STD TIME
(+) MAXIMUM VALUE
(M) MEAN VALUE
(-) MINIMUM VALUE


MONTHLY TOTAL SOLAR INSULATION IN BTU/FT**2 VS. HOUR
MONTH: JUL 1978
LOCATION: BACARDI, CATANO
0.00 3.00 6.00 9.00 12.00 15.00 18.00 21.00 24.00
350.00
341.03
332.05
323.08
314.10
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0.00 3.00 6.00 9.00 12.00 15.00 18.00 21.00 24.00
ATL STD TIME
(S) MEAN VALUE PLUS OR MINUS STD D
(M) MEAN VALUE

FREQUENCY CHARTS FOR TOTAL / EXTRATERRESTIAL INSOLATION

MONTH: JUL 1978 LOCATION: BACARDI, CATANO

BASED ON HOURLY VALUES

REGULAR

RANGE	0	20	40	60	80	100	120	NO. OF VALUES	% OF TOTAL
0-.1								1	0.39
.1-.2	XX							5	1.94
.2-.3	XXXXX							11	4.26
.3-.4	XXXXXXXXXXX							22	8.53
.4-.5	XXXXXXXXXXXXXXXX							32	12.40
.5-.6	XXXXXXXXXXXXXXXXXX							37	14.34
.6-.7	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX							58	22.48
.7-.8	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX							87	33.72
.8-.9	XX							5	1.94
.9-1.								0	0.00

CUMULATIVE

RANGE	0	80	160	240	320	400	480	NO. OF VALUES	% OF TOTAL
0-.1								1	0.39
.1-.2								6	2.33
.2-.3	XX							17	6.59
.3-.4	XXXX							39	15.12
.4-.5	XXXXXXXX							71	27.52
.5-.6	XXXXXXXXXXXXX							108	41.86
.6-.7	XXXXXXXXXXXXXXXXXXXX							166	64.34
.7-.8	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX							253	98.06
.8-.9	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX							258	100.00
.9-1.	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX							258	100.00

BASED ON DAILY VALUES

REGULAR

RANGE	0	5	10	15	NO. OF VALUES	% OF TOTAL
0-.1					0	0.00
.1-.2					0	0.00
.2-.3					0	0.00
.3-.4					0	0.00
.4-.5	X				1	7.14
.5-.6	X				1	7.14
.6-.7	XXXXXXXXX				9	64.29
.7-.8	XXX				3	21.43
.8-.9					0	0.00
.9-1.					0	0.00

CUMULATIVE

0	10	20	30	NO. OF VALUES	% OF TOTAL
				0	0.00
				0	0.00
				0	0.00
				0	0.00
X				1	7.14
XX				2	14.29
XXXXXXXXXX				11	78.57
XXXXXXXXXXXXX				14	100.00
XXXXXXXXXXXXX				14	100.00
XXXXXXXXXXXXX				14	100.00

MONTHLY WEATHER DATA

MONTH: JUL 1978

LOCATION: MACAHAI, DATA 0

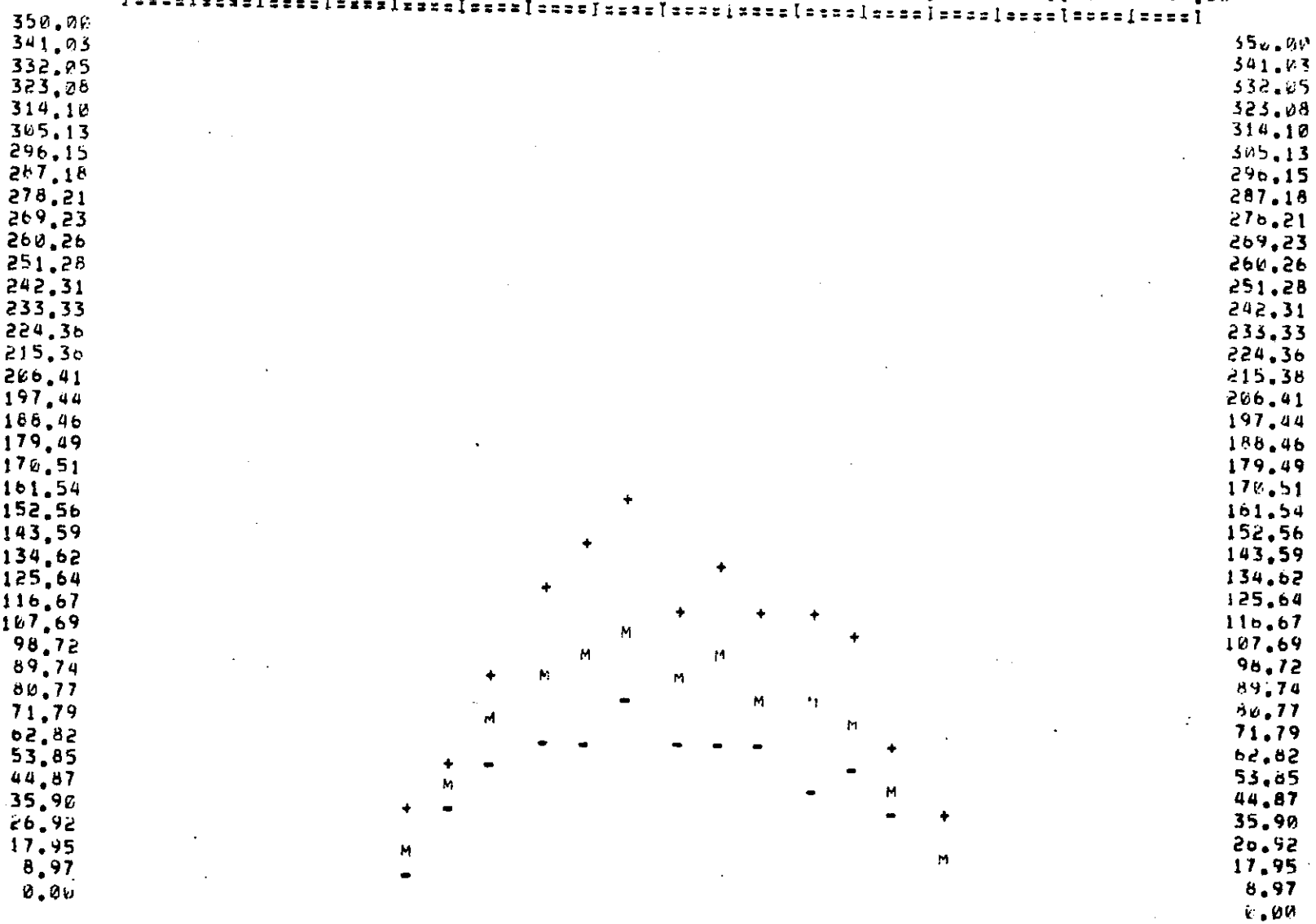
DIFFUSE INSOLATION IN BTU/FT**2

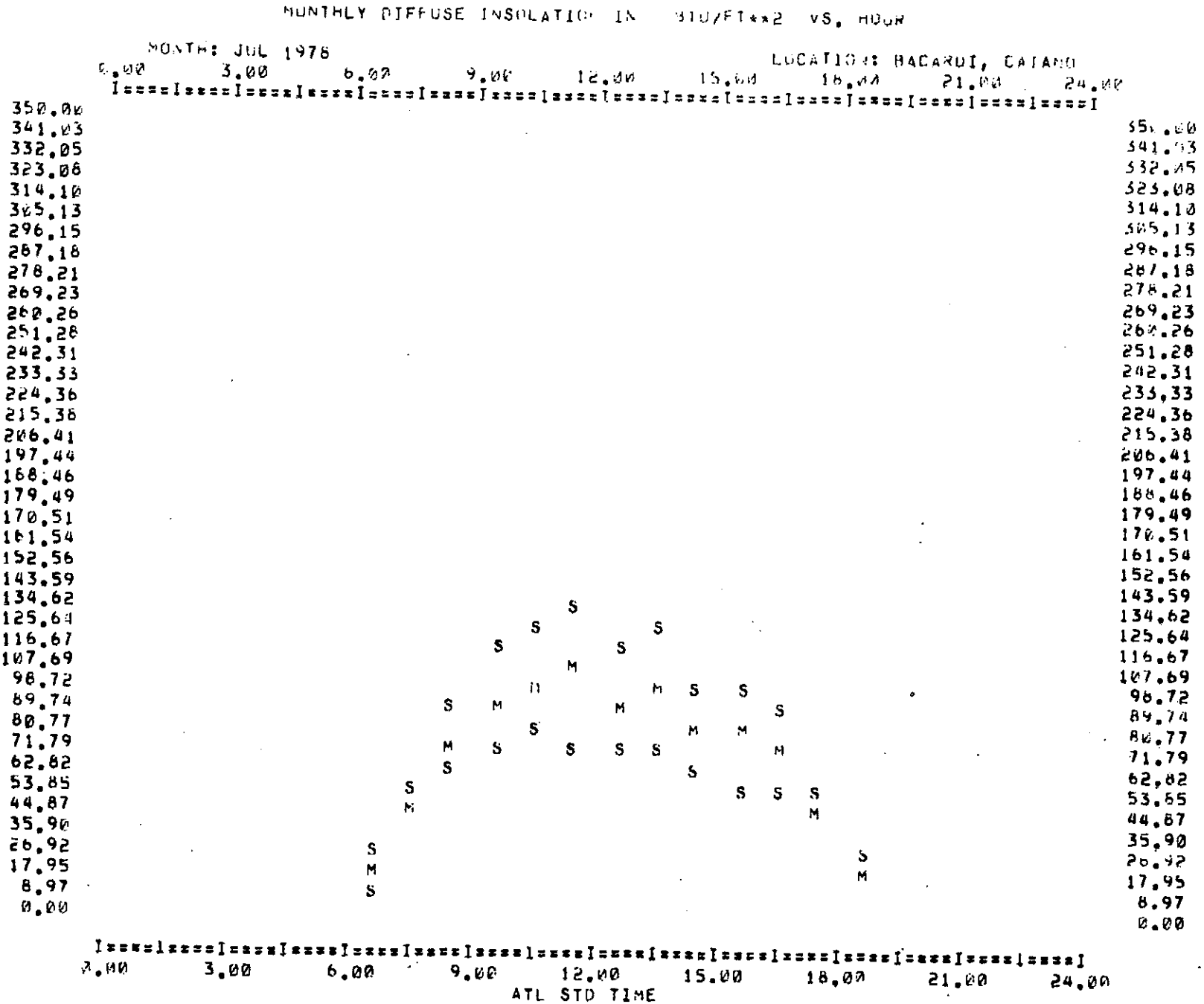
DAY	HOUR 6-7	7-8	8-9	9-10	10-11	11-12	12-1	1-2	2-3	3-4	4-5	5-6	6-7	TOTAL
1	24.48	50.76	55.20	60.48	63.84	76.44	115.52	138.12	113.40	116.88	106.80	59.04	37.20	1019.2
2	27.60	41.16	41.28	58.08	67.92	52.44	67.44	******	50.04	46.92	77.16	57.72	27.84	******
3	29.88	67.80	102.72	97.80	******	72.48	179.28	161.40	92.04	92.76	90.24	65.64	60.36	******
4	******	77.64	90.00	99.00	132.00	113.04	108.72	119.28	110.08	111.30	81.72	80.40	33.36	******
5	30.84	78.36	69.12	87.48	81.96	125.04	125.64	******	******	******	******	******	******	******
6	******	******	******	******	******	******	******	******	******	******	******	******	14.88	******
7	12.60	49.68	60.64	91.32	116.16	112.32	102.24	71.40	******	******	******	******	12.24	******
8	48.24	52.32	85.92	140.76	144.48	150.48	155.88	173.16	******	55.56	50.16	31.68	******	******
9	15.12	45.60	85.92	77.52	87.60	79.32	103.80	95.64	******	88.92	35.88	18.60	******	******
10	15.24	53.40	46.68	75.00	56.20	68.04	56.76	62.16	******	63.24	56.76	57.24	21.00	******
11	******	44.40	42.60	46.44	48.12	141.24	160.92	98.88	******	64.68	70.32	46.20	******	******
12	32.76	46.92	68.40	88.92	97.08	92.40	118.44	103.44	96.24	******	******	******	******	******
13	******	******	******	******	******	******	******	******	******	******	77.28	57.84	******	******
14	16.32	41.28	86.88	65.52	******	46.44	54.00	50.40	56.16	62.52	73.44	57.96	11.88	******
15	19.56	51.60	75.24	86.64	******	******	******	******	******	******	******	******	******	******
16	******	******	******	******	******	******	******	******	******	******	******	******	******	******
17	******	******	******	******	******	******	******	******	******	******	******	******	******	******
18	******	******	******	******	******	******	******	******	******	******	******	******	******	******
19	******	******	******	******	******	******	******	******	******	******	******	******	******	******
20	******	******	******	******	******	******	******	******	******	******	******	******	******	******
21	******	******	******	******	******	******	******	******	******	******	******	******	******	******
22	******	******	******	******	******	******	******	******	******	******	******	******	******	******
23	******	******	******	******	******	******	******	******	******	******	******	******	******	******
24	******	******	******	******	******	******	******	******	******	******	******	******	******	******
25	10.80	56.28	85.92	72.60	94.44	88.20	68.64	65.16	63.36	67.56	60.12	47.52	19.32	799.9
26	33.24	39.84	58.44	84.48	90.60	78.84	65.52	64.32	78.60	66.84	54.60	51.00	15.36	781.7
27	7.92	38.04	84.60	84.36	96.36	91.92	83.40	70.68	65.04	69.84	72.24	45.36	20.52	821.3
28	10.68	53.16	85.08	113.16	143.40	162.84	93.96	116.76	91.08	64.24	76.08	46.92	16.56	1093.9
29	22.32	47.04	81.12	95.40	102.12	100.20	112.92	109.20	106.56	109.92	76.12	50.64	17.40	1033.0
30	11.52	49.20	79.08	102.36	96.12	102.12	91.80	109.32	78.84	75.72	73.56	45.72	33.48	948.8
31	8.04	45.48	72.60	122.16	130.68	135.24	111.72	92.28	71.28	48.36	59.16	34.32	17.28	948.6
MEAN	16.13	47.48	75.26	91.88	102.20	104.48	93.06	95.73	83.52	78.80	72.59	47.57	22.14	930.8
STD D	9.36	6.27	12.18	20.57	24.63	29.86	19.60	27.17	18.61	23.83	16.56	6.94	8.36	68.0
MIN	7.92	38.04	55.20	60.48	63.84	76.44	65.52	64.32	63.36	48.36	54.60	34.32	15.36	647.8
MAX	33.24	56.28	85.92	122.16	143.40	162.84	116.52	138.12	113.40	116.88	106.80	59.04	37.20	1291.8

MONTHLY DIFFUSE INSOLATION IN BTU/FT**2 VS. HOUR

MONTH: JUL 1978

LOCATION: BACARDI, CATANO




MONTHLY DIFFUSE INSOLATION IN BTU/FT**2 VS. HOUR
MONTH: JUL 1978
LOCATION: BACARDI, CAIMAN
0.00 3.00 6.00 9.00 12.00 15.00 18.00 21.00 24.00
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0.00
ATL STD TIME
(S) MEAN VALUE PLUS OR MINUS STD D
(M) MEAN VALUE

MONTHLY WEATHER DATA

MONTH: JUL 1978

LOCATION: BACAROT, LAGUNA

DIFFUSE / TOTAL INSOLATION

DAY	6-7 (A)	7-8 (B)	8-9 (C)	9-10 (D)	10-11 (E)	11-12 (F)	12-1 (N)	1-2 (G)	2-3 (H)	3-4 (I)	4-5 (J)	5-6 (K)	6-7 (L)	DAILY VALUE
	HOUR (CODE)													
1	0.877	0.551	0.361	0.280	0.239	0.254	0.378	0.549	0.464	0.526	0.568	0.621	******	******
2	0.819	0.353	0.234	0.308	0.237	0.170	0.197	******	0.172	0.200	0.488	0.520	0.953	******
3	0.734	0.675	0.656	0.524	******	******	0.732	0.755	0.926	0.672	0.548	0.602	******	******
4	******	0.805	0.567	0.486	0.483	0.355	0.339	0.386	0.405	0.506	0.543	******	1.046	******
5	0.734	0.745	0.376	0.402	0.334	0.395	0.675	******	******	******	******	******	******	******
6	******	******	******	******	******	******	******	******	******	******	******	******	******	******
7	0.977	0.797	0.455	0.712	0.565	0.741	0.354	0.266	******	******	******	******	1.048	******
8	1.914	1.104	1.086	0.963	0.663	0.809	0.790	0.635	******	0.455	1.102	1.096	1.177	******
9	0.752	0.598	0.549	0.363	0.327	0.270	0.357	0.318	******	0.980	1.169	1.155	******	******
10	0.833	0.638	0.320	0.330	0.210	0.226	0.178	0.212	******	0.563	1.163	1.170	******	******
11	******	0.535	0.263	0.201	0.170	0.519	0.569	0.361	******	0.274	0.361	0.675	1.034	******
12	1.040	0.611	0.550	0.677	0.355	0.313	0.414	0.408	0.368	******	0.442	0.464	0.610	******
13	******	******	******	******	******	******	******	******	******	******	******	******	******	******
14	0.877	0.911	0.512	0.290	******	******	******	******	******	******	0.628	0.886	******	******
15	0.798	0.603	0.580	0.503	******	0.154	0.172	0.168	0.210	0.269	0.493	0.617	1.168	******
16	******	******	******	******	******	******	******	******	******	******	******	******	******	******
17	******	******	******	******	******	******	******	******	******	******	******	******	******	******
18	******	******	******	******	******	******	******	******	******	******	******	******	******	******
19	******	******	******	******	******	******	******	******	******	******	******	******	******	******
20	******	******	******	******	******	******	******	******	******	******	******	******	******	******
21	******	******	******	******	******	******	******	******	******	******	******	******	******	******
22	******	******	******	******	******	******	******	******	******	******	******	******	******	******
23	******	******	******	******	******	******	******	******	******	******	******	******	******	******
24	******	******	******	******	******	******	******	******	******	******	******	******	******	******
25	0.837	0.630	0.640	0.465	0.350	0.299	0.220	0.215	0.236	0.304	0.413	0.635	1.015	******
26	0.969	0.572	0.471	0.746	0.364	0.256	0.209	0.213	0.282	0.310	0.374	0.616	0.976	0.350
27	0.800	0.755	0.562	0.390	0.347	0.306	0.266	0.238	0.243	0.246	0.469	0.532	0.898	0.347
28	0.791	0.936	0.732	0.628	0.608	0.557	0.312	0.388	0.351	0.410	0.553	0.681	1.097	0.349
29	0.872	0.784	0.590	0.471	0.397	0.345	0.371	0.380	0.421	0.526	0.596	0.890	1.061	0.501
30	0.841	0.772	0.661	0.479	0.364	0.337	0.320	0.458	0.303	0.368	0.541	0.630	1.154	0.463
31	0.522	0.699	0.551	0.689	0.555	0.737	0.390	0.314	0.259	0.222	0.368	0.456	1.054	0.445
MEAN	0.805	0.764	0.661	0.553	0.426	0.405	0.296	0.315	0.299	0.347	0.474	0.630	1.031	0.412
STD D	0.138	0.112	0.085	0.134	0.108	0.175	0.070	0.097	0.066	0.099	0.092	0.136	0.066	0.065
MIN	0.522	0.572	0.471	0.390	0.347	0.256	0.209	0.213	0.236	0.222	0.368	0.456	0.898	0.347
MAX	0.969	0.936	0.732	0.746	0.608	0.737	0.390	0.458	0.421	0.526	0.596	0.890	1.154	0.501

FREQUENCY CHARTS FOR DIFFUSE / TOTAL INSOLATION

MONTH: JUL 1978 LOCATION: BACAROI, CATANDUANES

BASED ON HOURLY VALUES

REGULAR

RANGE	0	20	40	60	80	100	120	NO. OF VALUES	% OF TOTAL
0-.1								0	0.00
.1-.2	XXXX							9	3.93
.2-.3	XXXXXXXXXXXXXXX							30	13.10
.3-.4	XXXXXXXXXXXXXXXXXXXXXXX							45	19.65
.4-.5	XXXXXXXXXXX							23	10.04
.5-.6	XXXXXXXXXXXXXXXX							33	14.41
.6-.7	XXXXXXXXXXXXX							26	11.35
.7-.8	XXXXXXXXX							18	7.86
.8-.9	XXXXXXX							15	6.55
.9-1.	XXXXX							10	4.37

THERE ARE 20 VALUES ABOVE 1.0 (8.73%)

CUMULATIVE

RANGE	0	80	160	240	320	400	480	NO. OF VALUES	% OF TOTAL
0-.1								0	0.00
.1-.2	X							9	3.93
.2-.3	XXXX							39	17.03
.3-.4	XXXXXXXXXX							84	36.68
.4-.5	XXXXXXXXXXXXX							107	46.72
.5-.6	XXXXXXXXXXXXXXXXX							140	61.14
.6-.7	XXXXXXXXXXXXXXXXXXXXX							166	72.49
.7-.8	XXXXXXXXXXXXXXXXXXXXXXXX							184	80.35
.8-.9	XXXXXXXXXXXXXXXXXXXXXXXXXX							199	86.90
.9-1.	XXXXXXXXXXXXXXXXXXXXXXXXXXX							209	91.27

BASED ON DAILY VALUES

REGULAR

RANGE	0	5	10	15	NO. OF VALUES	% OF TOTAL
0-.1					0	0.00
.1-.2					0	0.00
.2-.3					0	0.00
.3-.4	XXX				3	42.86
.4-.5	XXX				3	42.86
.5-.6	X				1	14.29
.6-.7					0	0.00
.7-.8					0	0.00
.8-.9					0	0.00
.9-1.					0	0.00

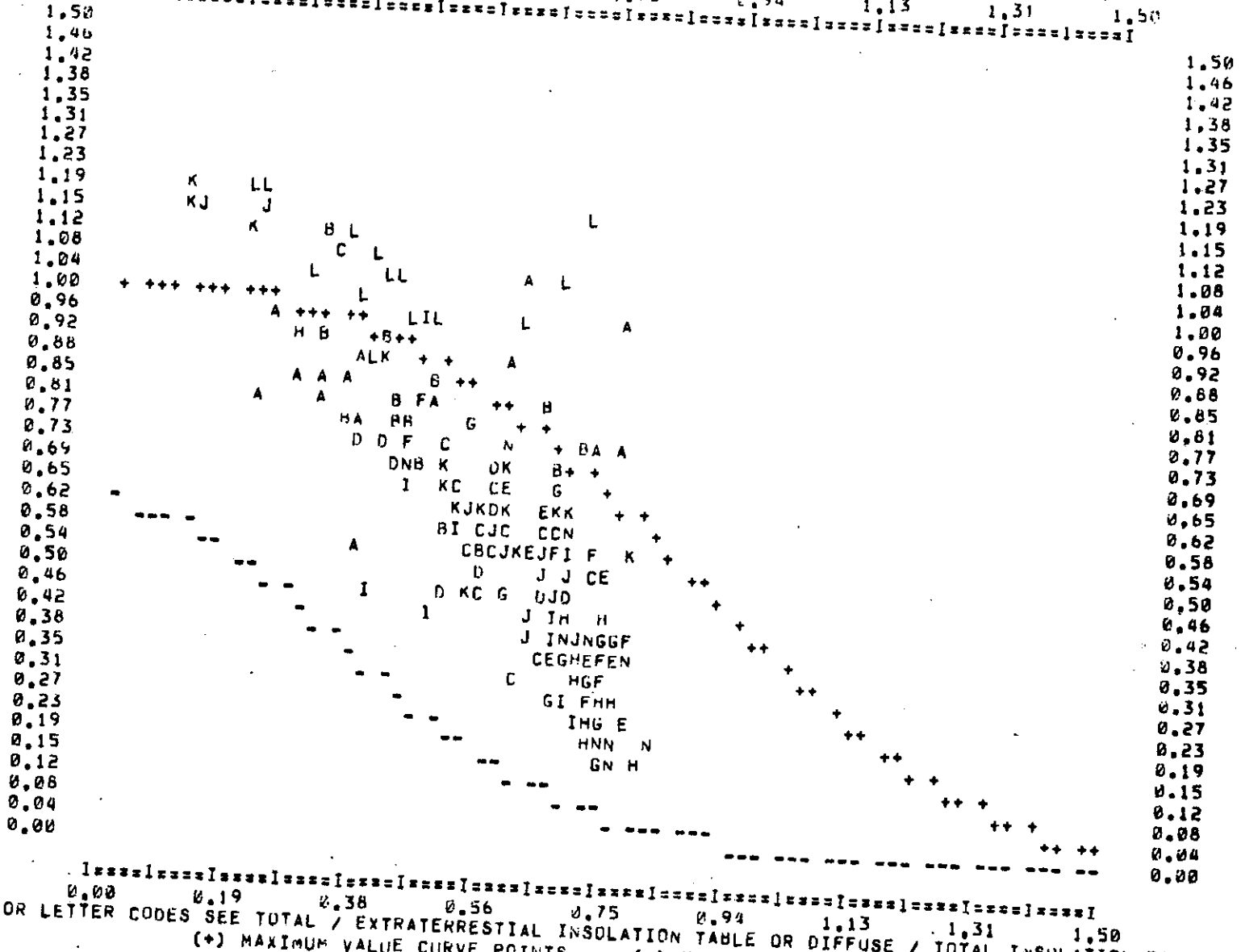
CUMULATIVE

0	10	20	30	NO. OF VALUES	% OF TOTAL
				0	0.00
				0	0.00
				0	0.00
XXX				3	42.86
XXXXXX				6	85.71
XXXXXXX				7	100.00
XXXXXXX				7	100.00
XXXXXXX				7	100.00
XXXXXXX				7	100.00
XXXXXXX				7	100.00

TOTAL / EXTRATERRESTIAL INSOLATION (HORIZONTAL AXIS)
VS. DIFFUSE / TOTAL INSOLATION (VERTICAL AXIS)

MONTH: JUL 1978

LOCATION: BACARDI, CATANO

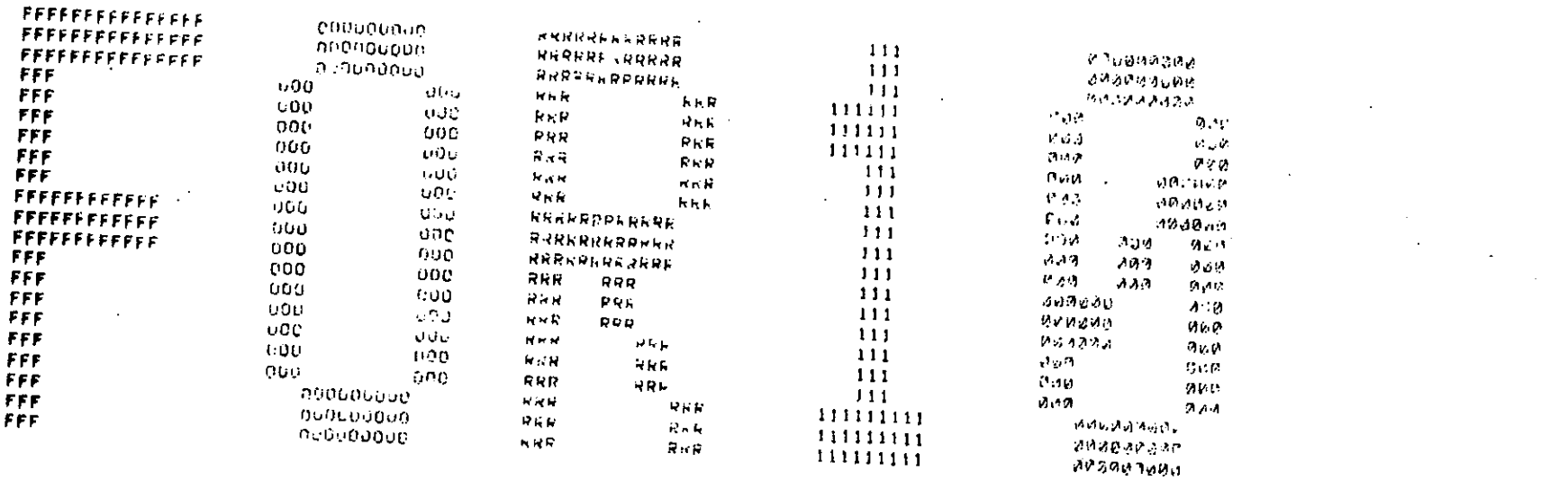


FOR LETTER CODES SEE TOTAL / EXTRATERRESTIAL INSOLATION TABLE OR DIFFUSE / TOTAL INSOLATION TABLE

(+) MAXIMUM VALUE CURVE POINTS (-) MINIMUM VALUE CURVE POINTS

KT: TOTAL / EXTRATERRESTIAL *** 145 VALUES ABOVE 1.5 *** 145 VALUES WITHOUT DATA
KD: DIFFUSE / TOTAL *** 175 VALUES ABOVE 1.5 *** 174 VALUES WITHOUT DATA

LPTSPL VERSION 5(344) RUNNING ON LPT2
START USER SODERSTROM K [240[illegible],240312] JOB FOR10 SEQ. 31107 DATE 28-FEB-79 14:20:16 MONITOR SYSTEM NUM 5.7B #/RJE *START*



START USER SODERSTROM K [240302,240312] JOB FOR10 SEQ. 31107 DATE 28-FEB-79 14:20:16 MONITOR SYSTEM NUM 5.7B #/RJE *START*

START USER SODERSTROM K [240304,240312] JOB FOR10 SEQ. 31107 DATE 28-FEB-79 14:20:16 MONITOR SYSTEM NUM 5.7B #/RJE *START*

START USER SODERSTROM K [240306,240312] JOB FOR10 SEQ. 31107 DATE 28-FEB-79 14:20:16 MONITOR SYSTEM NUM 5.7B #/RJE *START*

START USER SODERSTROM K [240308,240312] JOB FOR10 SEQ. 31107 DATE 28-FEB-79 14:20:16 MONITOR SYSTEM NUM 5.7B #/RJE *START*

START USER SODERSTROM K [240310,240312] JOB FOR10 SEQ. 31107 DATE 28-FEB-79 14:20:16 MONITOR SYSTEM NUM 5.7B #/RJE *START*

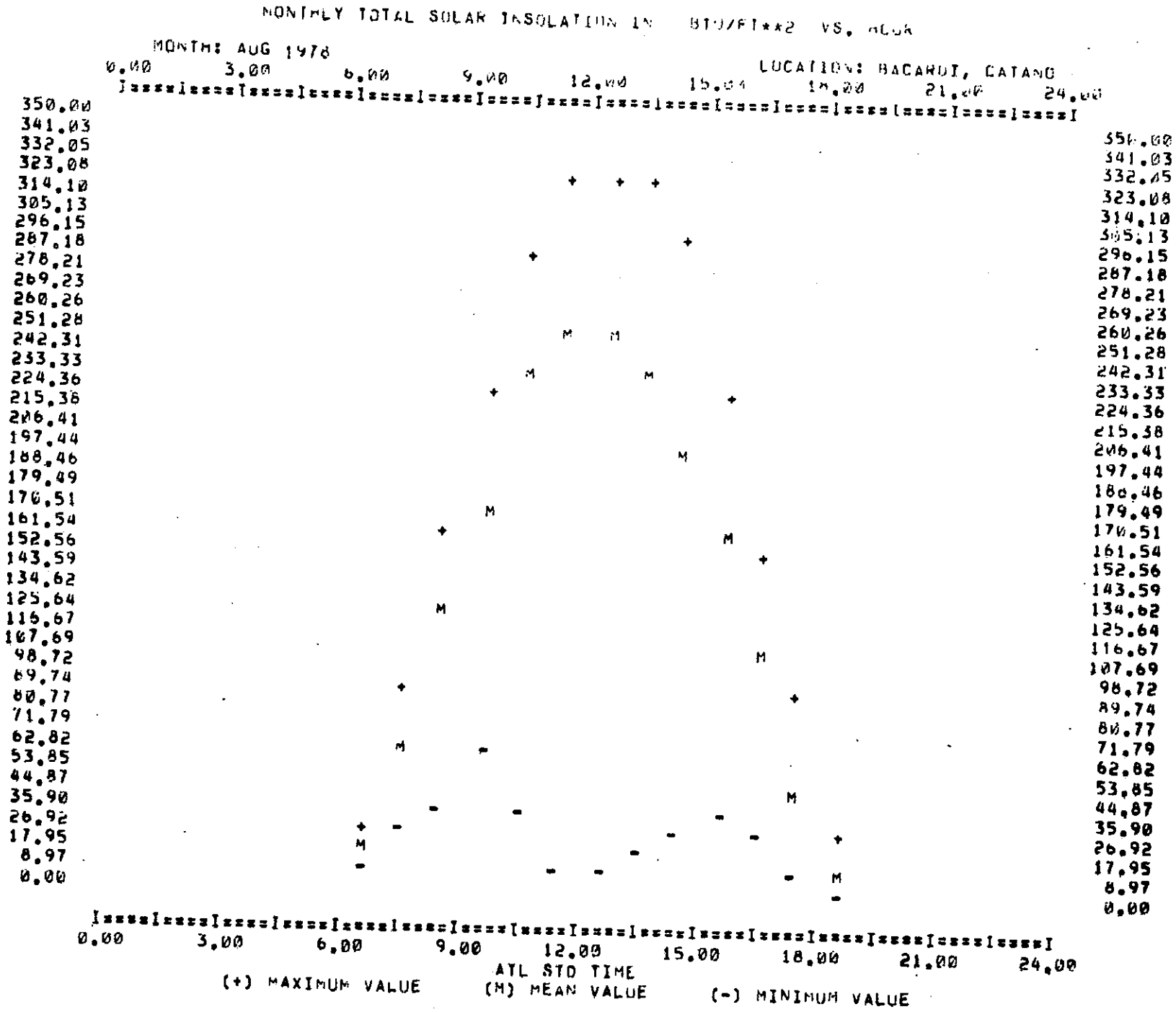
MONTHLY WEATHER DATA

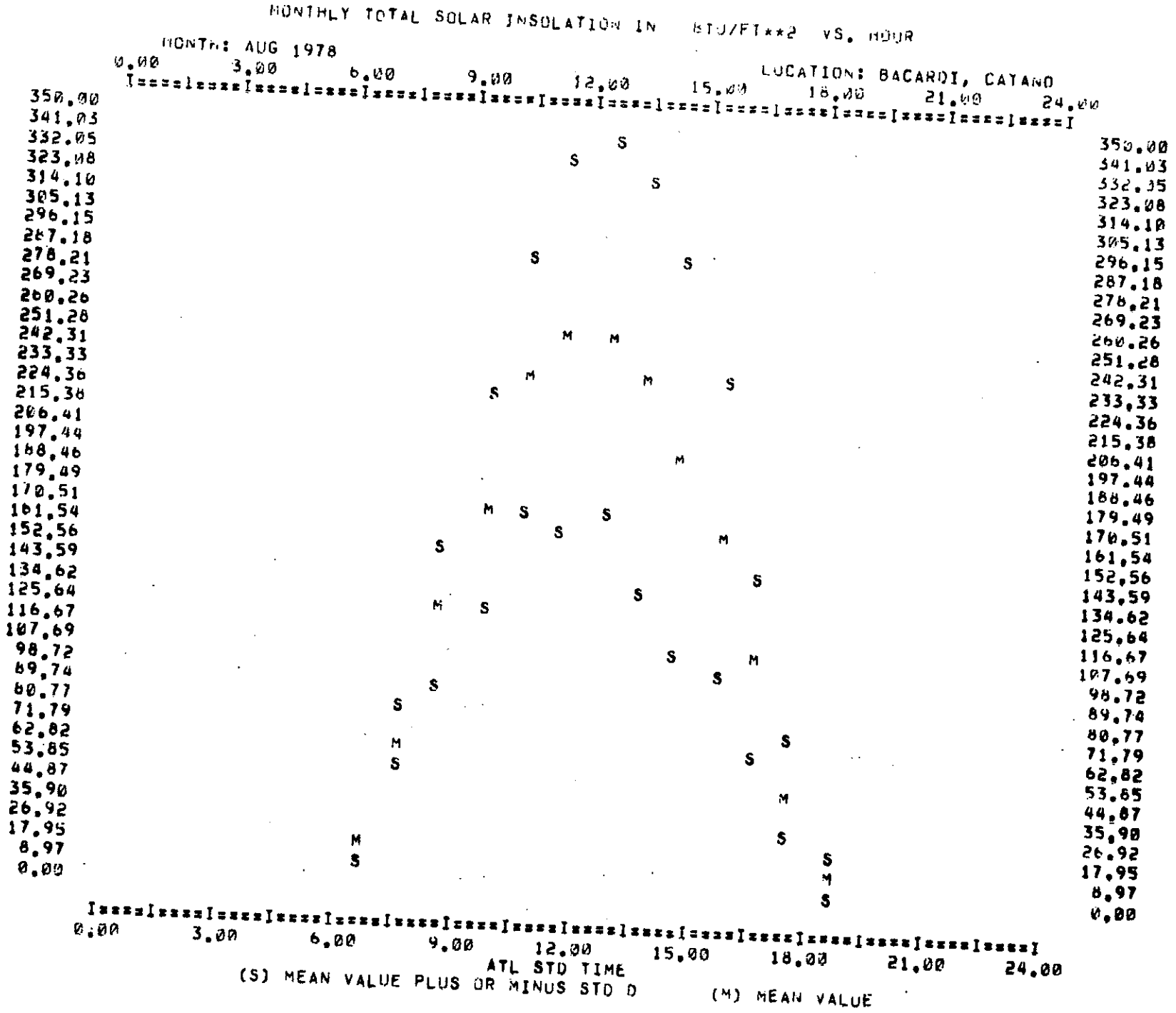
MONTH: AUG 1978

LOCATION: BACARDI, CATANO

TOTAL INSOLATION IN BTU/FT**2

DAY	HOUR 6-7	7-8	8-9	9-10	10-11	11-12	12-1	1-2	2-3	3-4	4-5	5-6	6-7	TOTAL
1	18.10	58.10	88.40	116.80	161.10	246.50	207.80	104.50	99.60	68.00	63.30	47.20	21.40	1301.0
2	19.70	69.80	120.60	210.80	267.30	302.00	314.40	301.70	270.10	219.40	104.40	33.10	20.40	2249.7
3	8.00	23.40	64.50	127.70	228.50	277.40	208.20	161.00	155.50	98.50	61.20	46.20	34.10	1490.2
4	11.10	57.40	113.10	143.30	141.50	194.10	213.30	231.20	242.50	181.80	147.70	42.60	12.50	1731.9
5	14.40	70.10	149.90	188.10	272.80	268.00	305.20	259.40	273.90	224.30	138.00	60.40	15.00	2259.5
6	26.70	72.20	155.30	226.60	266.40	319.50	322.60	307.50	294.10	216.40	155.60	90.50	15.10	2468.7
7	18.80	86.50	103.40	205.40	251.80	73.40	104.20	52.00	24.00	48.10	72.10	51.10	11.00	1101.8
8	29.40	80.30	162.50	152.50	285.30	309.70	322.40	323.70	259.90	180.30	76.50	71.60	14.20	2268.3
9	19.60	74.70	159.90	192.30	273.30	308.80	187.20	72.50	******	******	******	******	******	******
10	******	******	******	******	******	******	******	******	******	******	149.10	77.20	12.60	******
11	14.00	65.80	126.00	208.00	257.30	301.00	316.20	306.10	272.40	216.80	154.10	79.20	15.90	2332.8
12	23.60	66.90	97.10	214.00	270.80	304.70	319.80	314.40	279.10	222.50	155.80	86.50	14.30	2369.5
13	14.60	73.30	136.60	219.70	266.60	310.90	300.90	321.50	274.90	222.40	156.50	93.10	13.20	2406.2
14	9.70	44.50	56.40	102.40	224.50	173.00	143.60	125.50	88.30	55.50	32.60	27.60	4.70	1090.3
15	13.90	61.60	87.20	181.70	250.40	290.40	307.80	299.90	251.40	202.90	121.60	26.20	9.00	2124.6
16	12.70	43.70	37.80	64.90	32.90	10.80	9.10	20.00	29.70	32.30	24.70	8.50	2.60	329.9
17	17.70	25.30	48.50	93.40	106.50	126.60	127.10	126.50	******	39.10	41.50	34.80	10.50	******
18	17.60	72.90	124.70	133.00	181.10	229.00	243.80	157.30	74.30	47.60	43.80	24.80	6.40	1356.3
19	12.70	89.40	142.50	156.30	225.80	261.40	125.20	184.80	192.50	200.50	126.40	45.80	6.90	1770.2
20	20.60	69.20	135.70	129.50	275.60	299.50	307.70	307.70	279.10	213.30	115.10	45.20	11.10	2209.3
21	10.60	71.10	110.40	127.10	149.30	175.40	290.70	302.40	264.60	******	******	******	******	******
22	14.00	68.80	138.30	203.50	147.40	75.00	214.80	114.30	91.60	166.30	121.50	45.30	7.40	1408.2
23	******	66.80	130.40	154.70	262.60	281.70	269.10	231.80	255.50	194.30	106.60	36.90	9.00	******
24	22.20	60.50	130.70	204.00	267.50	300.70	310.30	293.10	255.30	195.90	132.20	57.60	6.10	2236.1
25	14.40	70.50	130.10	217.10	275.50	306.70	318.50	302.90	265.00	203.00	69.40	73.40	7.20	2255.7
26	21.50	53.80	126.00	221.40	275.30	304.10	311.20	296.30	259.00	202.00	117.60	22.60	3.00	2213.8
27	15.20	68.60	151.00	92.90	158.10	146.50	171.30	163.60	173.20	184.10	112.00	44.60	4.20	1485.3
28	13.20	67.20	140.40	177.00	211.50	297.80	306.00	286.50	247.70	191.20	122.00	50.80	5.50	2116.8
29	12.80	66.90	146.20	205.10	264.00	296.50	305.40	289.10	251.50	195.10	126.70	52.50	5.90	2211.7
30	13.30	68.90	148.90	217.70	268.20	303.00	315.40	158.90	41.30	49.60	35.10	18.80	3.10	1642.2
31	15.30	74.70	150.00	219.10	272.60	295.60	319.60	300.20	262.30	181.10	109.70	31.10	3.90	2235.4
MEAN	16.44	66.35	121.51	174.56	230.85	250.66	255.42	239.12	200.32	162.27	103.68	49.17	10.42	1871.7
STD D	5.14	13.86	32.02	47.07	60.21	85.81	85.07	92.89	91.25	67.51	41.50	22.73	6.68	213.3
MIN	8.00	23.40	37.80	64.90	32.90	10.80	9.10	20.00	24.00	32.30	24.70	8.50	2.80	299.2
MAX	29.40	89.40	162.50	226.60	285.30	319.50	322.80	323.70	294.10	224.30	156.50	93.10	30.10	2557.3


MONTHLY TOTAL SOLAR INSOLATION IN BTU/FT**2 VS. HOUR
MONTH: AUG 1978
LOCATION: BACARDI, CATANO
0.00 3.00 6.00 9.00 12.00 15.00 18.00 21.00 24.00
350.00
341.03
332.05
323.08
314.10
305.13
296.15
287.18
278.21
269.23
260.26
251.28
242.31
233.33
224.36
215.38
206.41
197.44
188.46
179.49
170.51
161.54
152.56
143.59
134.62
125.64
116.67
107.69
98.72
89.74
80.77
71.79
62.82
53.85
44.87
35.90
26.92
17.95
8.97
0.00
ATL STD TIME
(+) MAXIMUM VALUE
(M) MEAN VALUE
(-) MINIMUM VALUE


MONTHLY TOTAL SOLAR INSOLATION IN BTU/FT**2 VS. HOUR
MONTH: AUG 1978
LOCATION: BACARDI, CATANO
0.00
3.00
6.00
9.00
12.00
15.00
18.00
21.00
24.00
350.00
341.03
332.05
323.08
314.10
305.13
296.15
287.18
278.21
269.23
260.26
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233.33
224.36
215.38
206.41
197.44
188.46
179.49
170.51
161.54
152.56
143.59
134.62
125.64
116.67
107.69
98.72
89.74
80.77
71.79
62.82
53.85
44.87
35.90
26.92
17.95
8.97
0.00
ATL STD TIME
(S) MEAN VALUE PLUS OR MINUS STD D
(M) MEAN VALUE

MONTHLY WEATHER DATA

MONTH: AUG 1978

LOCATION: BACARDI, CATANO

TOTAL / EXTRATERRESTIAL INSOLATION

DAY	6-7 (A)	7-8 (B)	8-9 (C)	9-10 (D)	10-11 (E)	11-12 (F)	HOUR (CODE) 12-1 (N)	1-2 (G)	2-3 (H)	3-4 (I)	4-5 (J)	5-6 (K)	6-7 (L)	DAILY VALUE
1	0.435	0.420	0.387	0.382	0.441	0.613	0.501	0.260	0.274	0.223	0.279	0.346	0.537	0.386
2	0.478	0.506	0.528	0.689	0.732	0.751	0.748	0.751	0.742	0.721	0.461	0.244	0.520	0.668
3	0.196	0.170	0.283	0.418	0.626	0.689	0.502	0.401	0.427	0.324	0.271	0.342	0.779	0.443
4	0.274	0.418	0.496	0.469	0.387	0.482	0.514	0.575	0.666	0.598	0.655	0.316	0.329	0.515
5	0.359	0.511	0.658	0.615	0.747	0.715	0.735	0.646	0.753	0.739	0.613	0.450	0.402	0.673
6	0.673	0.528	0.682	0.741	0.729	0.793	0.778	0.765	0.809	0.713	0.692	0.678	0.412	0.735
7	0.478	0.633	0.454	0.672	0.689	0.182	0.251	0.129	0.066	0.159	0.321	0.384	0.306	0.328
8	0.755	0.589	0.714	0.499	0.781	0.769	0.776	0.806	0.715	0.596	0.342	0.541	0.402	0.677
9	0.508	0.549	0.703	0.629	0.748	0.766	0.451	0.180	******	******	******	******	******	******
10	******	******	******	******	******	******	******	******	******	******	0.669	0.590	0.372	******
11	0.370	0.485	0.555	0.680	0.704	0.747	0.761	0.762	0.751	0.718	0.693	0.608	0.480	0.698
12	0.630	0.494	0.428	0.700	0.740	0.756	0.770	0.783	0.770	0.738	0.702	0.668	0.441	0.710
13	0.393	0.543	0.602	0.719	0.734	0.771	0.724	0.801	0.758	0.739	0.707	0.724	0.417	0.721
14	0.264	0.330	0.257	0.335	0.614	0.429	0.346	0.313	0.244	0.185	0.148	0.216	0.152	0.327
15	0.382	0.606	0.385	0.594	0.684	0.720	0.741	0.747	0.695	0.676	0.553	0.206	0.319	0.636
16	0.352	0.325	0.167	0.212	0.090	0.027	0.022	0.050	0.082	0.108	0.113	0.067	0.095	0.099
17	0.495	0.189	0.214	0.306	0.291	0.314	0.306	0.315	******	0.131	0.190	0.278	0.368	******
18	0.497	0.545	0.551	0.435	0.495	0.568	0.587	0.392	0.206	0.159	0.201	0.199	0.230	0.409
19	0.362	0.670	0.630	0.512	0.617	0.648	0.302	0.461	0.534	0.672	0.582	0.371	0.256	0.534
20	0.593	0.519	0.600	0.424	0.753	0.743	0.741	0.768	0.774	0.717	0.531	0.369	0.423	0.668
21	0.308	0.535	0.488	0.416	0.408	0.435	0.701	0.756	0.735	******	******	******	******	******
22	0.411	0.518	0.612	0.666	0.403	0.186	0.518	0.286	0.255	0.561	0.565	0.375	0.300	0.427
23	******	0.504	0.578	0.507	0.718	0.699	0.649	0.580	0.711	0.656	0.497	0.308	0.377	******
24	0.665	0.458	0.579	0.668	0.731	0.746	0.749	0.734	0.712	0.663	0.619	0.485	0.264	0.680
25	0.436	0.534	0.577	0.712	0.753	0.761	0.769	0.759	0.740	0.689	0.326	0.640	0.323	0.687
26	0.657	0.409	0.559	0.726	0.753	0.755	0.751	0.743	0.724	0.687	0.555	0.194	0.139	0.675
27	0.469	0.522	0.671	0.305	0.433	0.364	0.414	0.411	0.485	0.627	0.531	0.386	0.202	0.454
28	0.412	0.513	0.624	0.581	0.579	0.740	0.740	0.720	0.694	0.653	0.581	0.443	0.274	0.646
29	0.404	0.512	0.624	0.673	0.723	0.737	0.739	0.727	0.706	0.668	0.606	0.462	0.306	0.676
30	0.424	0.526	0.664	0.715	0.735	0.753	0.763	0.400	0.116	0.170	0.168	0.167	0.167	0.505
31	0.509	0.580	0.672	0.722	0.749	0.736	0.774	0.756	0.737	0.621	0.526	0.276	0.212	0.686
MEAN	0.457	0.495	0.537	0.572	0.632	0.622	0.616	0.575	0.555	0.543	0.475	0.391	0.334	0.564
STD D	0.137	0.104	0.142	0.154	0.165	0.213	0.205	0.232	0.253	0.226	0.189	0.175	0.149	0.162
MIN	0.196	0.170	0.167	0.212	0.090	0.027	0.022	0.050	0.066	0.108	0.113	0.067	0.095	0.099
MAX	0.755	0.670	0.714	0.741	0.781	0.793	0.778	0.806	0.809	0.739	0.707	0.724	0.779	0.735

FREQUENCY CHARTS FOR TOTAL / EXTRATE-RESTIAL INSULATION

```
MONTH: AUG 1976
                                        BASED ON HOURLY VALUES          LOCATION: BACARDI, CATANO
--------------------------------------------REGULAR--------------------------------------------------
RANGE  0        20        40        60        80        100       120   NO. OF    % OF
                                                                        VALUES    TOTAL
 0-.1   XXXX
 .1-.2  XXXXXXXXXXXX                                                         8     2.09
 .2-.3  XXXXXXXXXXXXXX                                                      25     6.54
 .3-.4  XXXXXXXXXXXXXXXXXXXXXXX                                             29     7.59
 .4-.5  XXXXXXXXXXXXXXXXXXXXXXXXXXX                                         47    12.30
 .5-.6  XXXXXXXXXXXXXXXXXXXXXXXXXXXX                                        55    14.40
 .6-.7  XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX                                      56    14.66
 .7-.8  XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX                  61    15.97
 .8-.9  X                                                                   98    25.65
 .9-1.                                                                       3     0.79
                                                                             0     0.00
------------------------------------------CUMULATIVE------------------------------------------------
RANGE  0        80        160       240       320       400       480   NO. OF    % OF
                                                                        VALUES    TOTAL
 0-.1   X
 .1-.2  XXXX                                                                 8     2.09
 .2-.3  XXXXXXX                                                             33     8.64
 .3-.4  XXXXXXXXXXXXX                                                       62    16.23
 .4-.5  XXXXXXXXXXXXXXXXXXXX                                               109    28.53
 .5-.6  XXXXXXXXXXXXXXXXXXXXXXXXXXX                                        164    42.93
 .6-.7  XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX                                220    57.59
 .7-.8  XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX                   281    73.56
 .8-.9  XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX                   379    99.21
 .9-1.  XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX                   382   100.00
                                                                           382   100.00

                                        BASED ON DAILY VALUES
================REGULAR-----------------         ------------------CUMULATIVE------------------
RANGE  0   5   10   15   NO. OF   % OF           0        10        20        30   NO. OF   % OF
                         VALUES   TOTAL                                            VALUES   TOTAL
 0-.1   X                   1      3.85
 .1-.2                      0      0.00          X                                    1      3.85
 .2-.3                      0      0.00          X                                    1      3.85
 .3-.4  XXX                 3     11.54          X                                    1      3.85
 .4-.5  XXXX                4     15.38          XXXX                                 4     15.38
 .5-.6  XXX                 3     11.54          XXXXXXXX                             8     30.77
 .6-.7  XXXXXXXXXXXX       12     46.15          XXXXXXXXXXX                         11     42.31
 .7-.8  XXX                 3     11.54          XXXXXXXXXXXXXXXXXXXXXXX             23     88.46
 .8-.9                      0      0.00          XXXXXXXXXXXXXXXXXXXXXXXXXX          26    100.00
 .9-1.                      0      0.00          XXXXXXXXXXXXXXXXXXXXXXXXXX          26    100.00
                                                 XXXXXXXXXXXXXXXXXXXXXXXXXX          26    100.00
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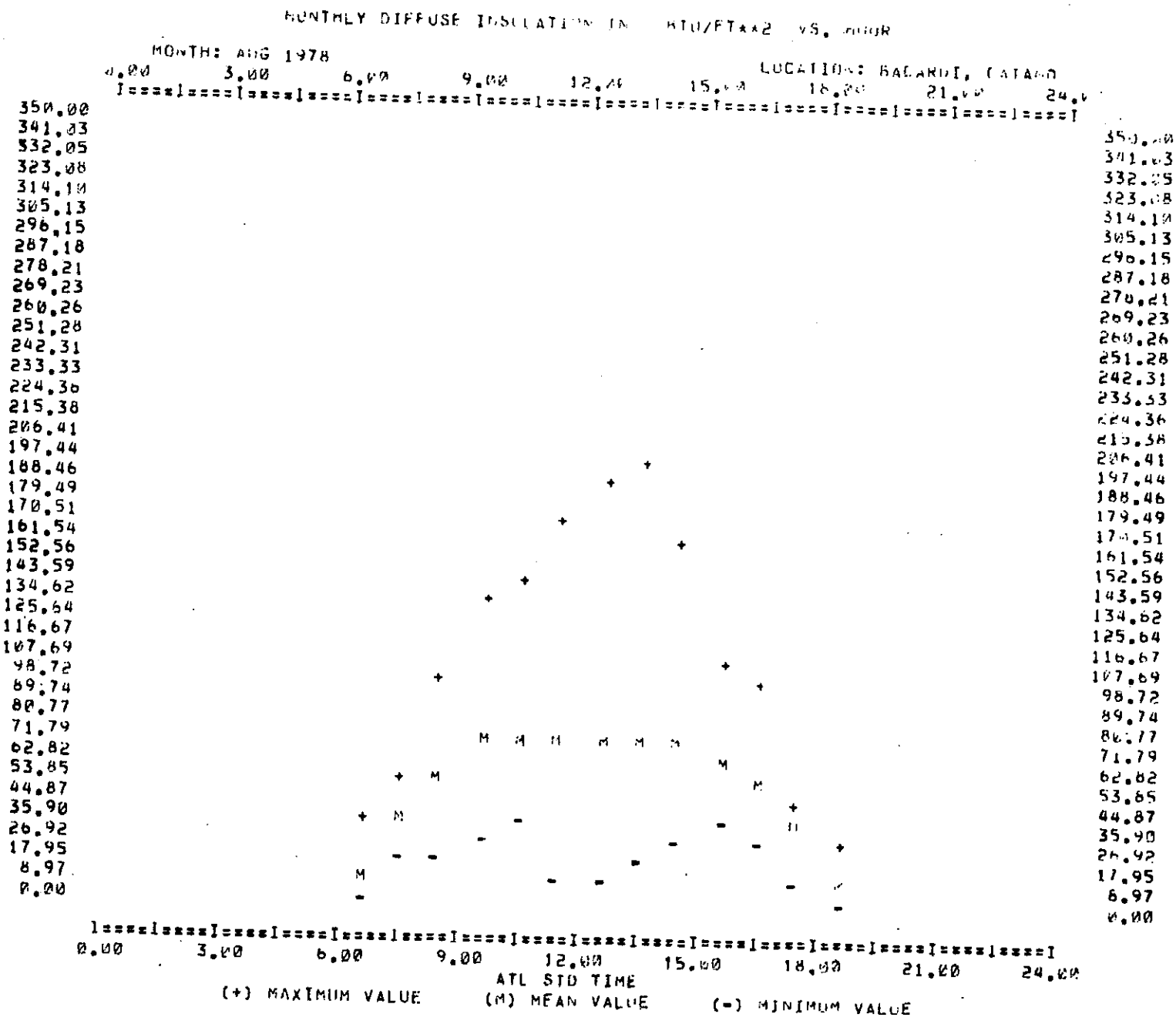
MONTHLY WEATHER DATA

MONTH: AUG 1978

LOCATION: MACARDI, CATARO

DIFFUSE INSOLATION IN BTU/FT**2

DAY	HOUR 6-7	7-8	8-9	9-10	10-11	11-12	12-1	1-2	2-3	3-4	4-5	5-6	6-7	TOTAL
1	******	42.83	83.01	87.60	105.63	178.23	116.28	93.65	98.61	72.24	61.71	49.13	19.48	******
2	15.25	32.67	57.23	66.19	66.43	68.97	65.70	62.68	62.07	60.14	58.34	34.61	23.47	665.7
3	2.66	22.63	53.60	78.41	101.52	132.13	166.74	147.74	138.30	104.06	63.64	47.92	26.02	1065.4
4	6.95	53.84	95.71	130.80	139.15	174.48	185.86	194.57	163.83	109.75	100.07	44.16	16.77	1411.9
5	11.62	34.85	67.88	85.06	89.06	99.46	85.55	106.60	90.27	82.04	64.73	42.95	17.18	677.3
6	25.05	47.79	75.87	82.88	65.10	73.57	63.89	72.96	75.02	35.57	39.69	44.29	13.19	714.9
7	11.74	30.85	32.79	48.52	57.60	52.86	102.49	56.08	25.77	49.61	84.34	45.86	******	******
8	24.68	54.00	53.36	88.57	52.03	51.42	43.08	60.02	54.69	98.61	72.96	59.17	******	******
9	14.88	24.44	57.96	98.37	62.92	52.15	56.14	74.17	******	******	******	******	******	******
10	******	******	******	******	******	******	******	******	******	******	43.20	32.19	10.77	******
11	12.10	37.75	52.03	56.51	62.19	55.30	51.67	49.13	47.79	48.04	47.55	38.11	13.91	572.1
12	24.68	37.03	54.33	50.34	45.74	44.89	43.80	40.90	39.81	34.24	32.67	32.43	12.22	493.1
13	6.78	17.54	43.20	39.81	40.05	72.84	50.94	41.02	31.82	33.64	26.01	39.08	13.67	456.4
14	8.23	28.92	37.51	59.41	89.54	113.98	107.45	109.02	89.90	53.48	33.52	25.65	******	******
15	10.89	54.21	79.38	92.93	86.15	79.38	69.82	67.76	76.84	66.91	67.76	22.99	11.49	786.5
16	12.95	34.73	35.82	63.77	34.73	11.25	9.56	19.24	30.85	31.46	26.26	9.07	2.66	322.3
17	20.93	21.90	44.77	87.24	105.15	120.23	120.23	118.34	******	39.06	41.02	35.45	******	******
18	11.62	27.35	37.99	70.91	110.35	121.24	159.36	144.23	84.09	48.88	48.28	26.74	******	******
19	9.68	37.63	29.16	57.23	83.01	78.04	50.70	83.49	85.30	64.25	71.27	31.94	7.38	689.1
20	14.64	24.32	35.33	67.15	53.60	51.67	52.39	58.82	51.67	40.90	49.85	44.65	12.95	549.9
21	5.01	37.51	41.14	104.42	112.77	153.19	164.80	92.93	128.38	******	******	******	******	******
22	10.77	36.30	54.09	91.60	111.68	64.37	125.11	99.46	79.13	88.57	73.57	38.46	6.53	879.7
23	37.51	35.57	57.35	94.50	93.29	91.96	96.32	101.03	94.26	81.67	58.44	28.43	9.32	879.7
24	21.30	32.79	52.15	58.20	60.86	59.77	60.14	59.17	55.90	50.21	43.56	28.07	6.05	568.2
25	8.11	20.93	36.78	44.29	38.72	35.09	34.36	31.74	29.52	32.91	43.92	39.61	7.06	404.0
26	14.04	27.47	50.34	47.79	47.79	46.83	50.82	48.44	44.77	38.11	30.25	18.63	3.51	468.4
27	8.47	23.84	50.09	91.35	115.55	132.74	148.10	134.79	131.28	104.79	63.28	33.40	4.64	1042.5
28	9.68	34.36	52.03	69.45	79.74	71.87	76.11	77.20	74.66	65.10	51.67	32.19	6.05	700.1
29	6.95	32.91	53.84	65.34	67.64	70.06	71.15	69.09	61.35	54.21	47.07	29.77	6.41	637.7
30	8.71	27.10	49.25	54.93	54.45	54.21	59.77	54.57	40.41	49.73	35.33	18.75	3.63	510.9
31	6.78	15.37	21.30	25.29	50.94	51.91	37.27	34.97	30.98	38.48	36.60	18.75	4.11	374.7
MEAN	13.16	32.80	52.58	66.81	72.15	73.67	75.26	74.66	69.81	59.76	51.13	32.66	10.18	686.8
STD D	7.79	10.27	16.72	23.32	27.76	35.89	44.17	42.15	36.76	25.35	18.41	10.22	6.29	96.1
MIN	2.66	15.37	21.30	25.29	34.73	11.25	9.56	19.24	29.52	31.46	26.01	9.07	2.66	236.1
MAX	37.51	54.21	95.71	130.80	139.15	174.48	185.86	194.57	163.83	109.75	100.07	47.92	26.02	1460.5


MONTHLY DIFFUSE INSOLATION IN BTU/FT**2 VS. HOUR
MONTH: AUG 1978
LOCATION: BACARDI, CATANO
0.00
3.00
6.00
9.00
12.00
15.00
18.00
21.00
24.00
350.00
341.03
332.05
323.08
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269.23
260.26
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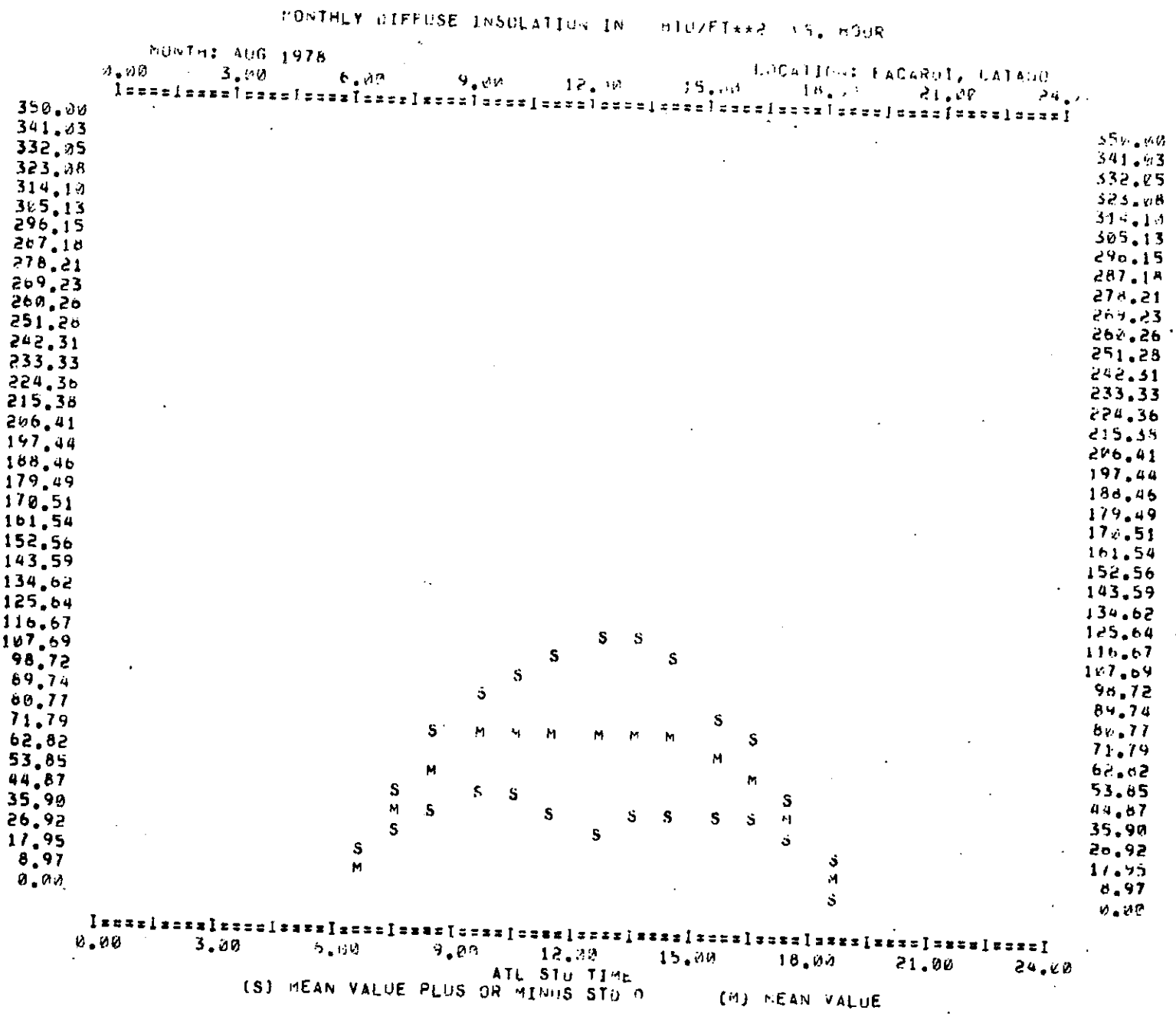
233.33
224.36
215.38
206.41
197.44
188.46
179.49
170.51
161.54
152.56
143.59
134.62
125.64
116.67
107.69
98.72
89.74
80.77
71.79
62.82
53.85
44.87
35.90
26.92
17.95
8.97
0.00
ATL STD TIME
(+) MAXIMUM VALUE
(M) MEAN VALUE
(-) MINIMUM VALUE


MONTHLY DIFFUSE INSULATION IN BTU/FT**2 VS. HOUR
MONTH: AUG 1978
LOCATION: MACAPUI, CATADO
0.00 3.00 6.00 9.00 12.00 15.00 18.00 21.00 24.00
350.00
341.03
332.05
323.08
314.10
305.13
296.15
287.18
278.21
269.23
260.26
251.28
242.31
233.33
224.36
215.38
206.41
197.44
188.46
179.49
170.51
161.54
152.56
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80.77
71.79
62.82
53.85
44.87
35.90
26.92
17.95
8.97
0.00
ATL STD TIME
(S) MEAN VALUE PLUS OR MINUS STD D
(M) MEAN VALUE

MONTHLY WEATHER DATA

MONTH: AUG 1976

LOCATION: MACAPA, BRAZIL

DIFFUSE / TOTAL INSOLATION

DAY	6-7 (A)	7-8 (B)	8-9 (C)	9-10 (D)	10-11 (E)	11-12 (F)	HOUR (CODE) 12-1 (N)	1-2 (G)	2-3 (H)	3-4 (I)	4-5 (J)	5-6 (K)	6-7 (L)	DAILY VALUE
1	******	0.737	0.939	0.750	0.656	0.723	0.560	0.696	0.988	1.062	0.975	1.041	0.910	******
2	0.774	0.468	0.475	0.314	0.249	0.228	0.212	0.238	0.234	0.274	0.482	1.045	1.151	0.290
3	0.333	0.967	0.831	0.614	0.444	0.476	0.801	0.916	0.889	1.056	1.030	1.037	0.864	0.720
4	0.807	0.938	0.846	0.913	0.983	0.899	0.871	0.842	0.676	0.624	0.678	1.037	0.862	0.615
5	0.807	0.497	0.453	0.452	0.326	0.345	0.280	0.411	0.330	0.366	0.469	0.711	1.145	0.380
6	0.938	0.662	0.489	0.366	0.244	0.230	0.198	0.237	0.255	0.164	0.255	0.489	0.873	0.290
7	0.624	0.357	0.317	0.236	0.229	0.720	0.984	1.117	1.074	1.031	1.170	0.697	******	******
8	0.840	0.423	0.328	0.581	0.182	0.166	0.134	0.185	0.210	0.547	0.954	0.626	******	******
9	0.759	0.327	0.362	0.512	0.230	0.169	0.340	1.023	******	******	******	******	******	******
10	******	******	******	******	******	******	******	******	******	******	******	******	******	******
11	0.864	0.574	0.413	0.272	0.242	0.184	0.163	0.160	0.175	0.222	0.290	0.417	0.855	******
12	1.046	0.553	0.560	0.235	0.169	0.147	0.137	0.130	0.143	0.154	0.210	0.375	0.655	0.200
13	0.464	0.239	0.316	0.181	0.149	0.234	0.169	0.128	0.116	0.151	0.166	0.420	1.036	0.190
14	0.848	0.650	0.642	0.580	0.399	0.659	0.748	0.869	1.018	0.964	1.028	0.929	******	******
15	0.783	0.664	0.910	0.511	0.344	0.273	0.227	0.226	0.306	0.330	0.557	0.877	1.197	0.370
16	1.019	0.795	0.948	0.983	1.056	1.042	1.050	0.962	1.039	0.974	1.063	1.066	0.951	0.977
17	1.183	0.866	0.923	0.934	0.987	0.948	0.944	0.935	******	1.000	0.988	1.019	******	******
18	0.660	0.375	0.305	0.533	0.609	0.529	0.654	0.917	1.132	1.027	1.102	1.078	******	******
19	0.762	0.421	0.205	0.366	0.366	0.299	0.405	0.452	0.443	0.320	0.564	0.697	1.070	0.384
20	0.711	0.351	0.260	0.519	0.194	0.173	0.170	0.165	0.185	0.192	0.433	0.988	1.106	0.249
21	0.548	0.528	0.373	0.822	0.755	0.873	0.567	0.307	0.485	******	******	******	******	******
22	0.769	0.528	0.391	0.450	0.758	0.856	0.582	0.670	0.864	0.533	0.605	0.849	0.685	0.625
23	******	0.533	0.440	0.611	0.355	0.326	0.358	0.436	0.369	0.420	0.548	0.771	1.035	******
24	0.959	0.542	0.399	0.285	0.228	0.199	0.194	0.202	0.219	0.256	0.330	0.487	0.992	0.265
25	0.563	0.297	0.283	0.204	0.141	0.114	0.108	0.105	0.111	0.102	0.633	0.528	1.092	0.175
26	0.653	0.511	0.399	0.216	0.174	0.154	0.103	0.162	0.173	0.189	0.257	0.525	1.170	0.216
27	0.557	0.347	0.332	0.983	0.731	0.906	0.865	0.824	0.758	0.569	0.565	0.749	1.152	0.702
28	0.733	0.511	0.371	0.392	0.377	0.241	0.249	0.269	0.301	0.346	0.423	0.634	1.1.2	0.331
29	0.700	0.492	0.384	0.319	0.256	0.236	0.233	0.239	0.244	0.278	0.371	0.567	1.087	0.280
30	0.655	0.393	0.331	0.252	0.203	0.179	0.190	0.343	0.979	1.003	1.047	0.996	1.171	0.311
31	0.445	0.206	0.142	0.115	0.187	0.176	0.117	0.116	0.118	0.212	0.352	0.883	1.055	0.169
MEAN	0.731	0.522	0.464	0.426	0.372	0.362	0.352	0.379	0.407	0.398	0.512	0.736	1.037	0.392
STD D	0.187	0.201	0.230	0.255	0.273	0.293	0.293	0.303	0.316	0.289	0.260	0.232	0.123	0.235
MIN	0.333	0.206	0.142	0.115	0.141	0.114	0.108	0.105	0.111	0.151	0.166	0.375	0.855	0.169
MAX	1.046	0.967	0.948	0.983	1.056	1.042	1.050	0.962	1.039	1.056	1.063	1.066	1.197	0.977

FREQUENCY CHARTS FOR DIFFUSE / TOTAL INSOLATION

MONTH: AUG 1978 LOCATION: ALAMOSA, COLO.

BASED ON HOURLY VALUES

REGULAR

RANGE	0 20 40 60 80 1.0 120	NO. OF VALUES	% OF TOTAL
0-.1		0	0.00
.1-.2	XXXXXXXXXXXXXXXXXXXXXXXXX	53	14.10
.2-.3	XXXXXXXXXXXXXXXXXXXXXXXXX	54	14.36
.3-.4	XXXXXXXXXXXXXXXXXXXXXXXXX	49	13.03
.4-.5	XXXXXXXXXXXXXXX	32	8.51
.5-.6	XXXXXXXXXXXXXXX	31	8.24
.6-.7	XXXXXXXXXXX	23	6.12
.7-.8	XXXXXXXXXX	20	5.32
.8-.9	XXXXXXXXXXXXXXXX	34	9.04
.9-1.	XXXXXXXXXXXXXXXXX	36	9.57
THERE ARE 44 VALUES ABOVE 1.0 (11.70%)			

CUMULATIVE

RANGE	0 80 160 240 320 400 480	NO. OF VALUES	% OF TOTAL
0-.1		0	0.00
.1-.2	XXXXXX	53	14.10
.2-.3	XXXXXXXXXXXXX	107	28.46
.3-.4	XXXXXXXXXXXXXXXXXXXX	156	41.49
.4-.5	XXXXXXXXXXXXXXXXXXXXXXXX	188	50.00
.5-.6	XXXXXXXXXXXXXXXXXXXXXXXXXXX	219	58.24
.6-.7	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	242	64.36
.7-.8	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	262	69.68
.8-.9	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	296	78.72
.9-1.	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	332	88.30

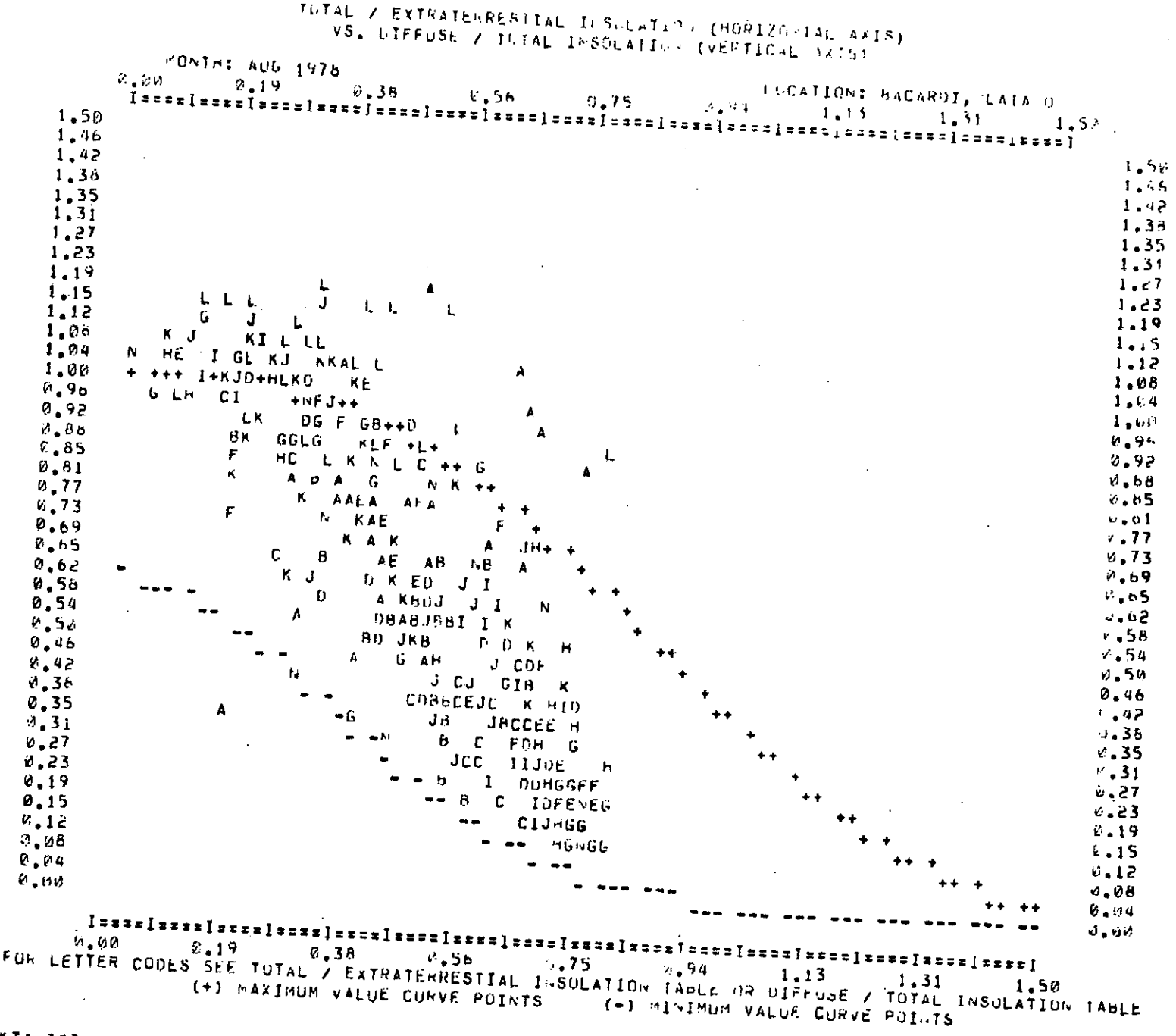
BASED ON DAILY VALUES

REGULAR

RANGE	0 5 10 15	NO. OF VALUES	% OF TOTAL
0-.1		0	0.00
.1-.2	XXX	3	14.29
.2-.3	XXXXXXXX	8	38.10
.3-.4	XXXXX	5	23.81
.4-.5		0	0.00
.5-.6		0	0.00
.6-.7	X	1	4.76
.7-.8	XX	2	9.52
.8-.9	X	1	4.76
.9-1.	X	1	4.76

CUMULATIVE

0 10 20 30	NO. OF VALUES	% OF TOTAL
	0	0.00
XXX	3	14.29
XXXXXXXXXXX	11	52.38
XXXXXXXXXXXXXXXX	16	76.19
XXXXXXXXXXXXXXXX	16	76.19
XXXXXXXXXXXXXXXX	16	76.19
XXXXXXXXXXXXXXXXXX	17	80.95
XXXXXXXXXXXXXXXXXXX	19	90.48
XXXXXXXXXXXXXXXXXXXX	20	95.24
XXXXXXXXXXXXXXXXXXXXX	21	100.00



KT: TOTAL / EXTRATERRESTIAL *** 21 VALUES ABOVE 1.5 *** 21 VALUES WITHOUT DATA
KD: DIFFUSE / TOTAL *** 27 VALUES ABOVE

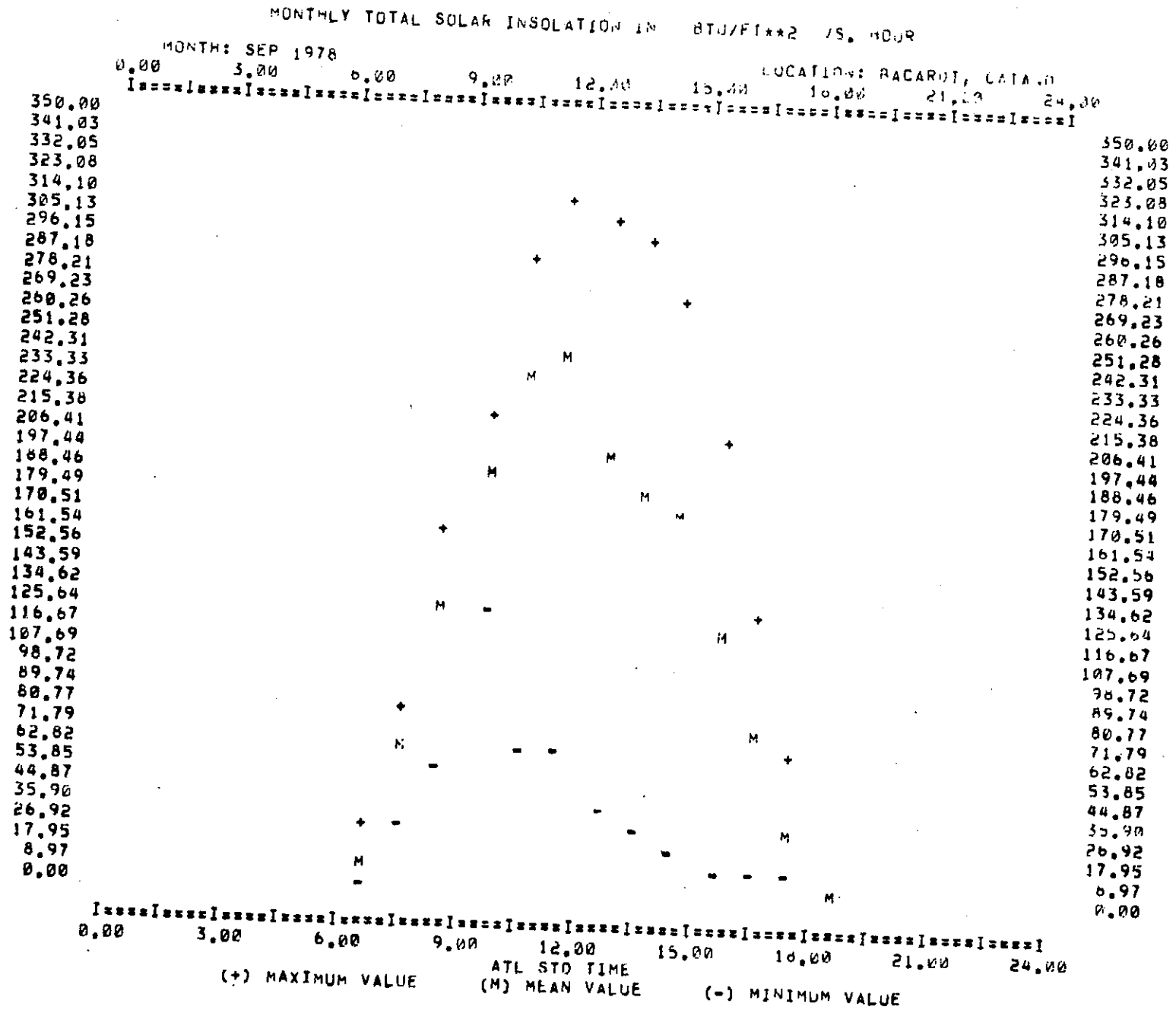
MONTHLY WEATHER DATA

MONTH: SEP 1978

LOCATION: BACABAL, CATARINA

TOTAL INSOLATION IN BTU/FT**2

DAY	HOUR 0-7	7-8	8-9	9-10	10-11	11-12	12-1	1-2	2-3	3-4	4-5	5-6	6-7	TOTAL
1	5.20	67.90	143.60	156.00	283.60	312.10	306.40	283.90	269.10	208.90	109.50	61.50	2.70	2210.4
2	13.50	71.80	95.50	114.60	195.40	77.90	31.40	69.40	156.70	64.40	******	******	******	******
3	******	******	******	******	******	******	******	******	******	******	******	******	******	******
4	******	******	******	******	******	******	******	******	******	******	******	******	******	******
5	******	******	******	******	******	******	******	******	******	******	******	******	******	******
6	******	******	******	******	******	******	******	******	******	******	******	******	******	******
7	******	******	******	******	******	******	******	******	******	******	******	******	******	******
8	******	******	******	******	******	******	******	******	******	******	******	******	******	******
9	13.20	72.90	146.40	214.30	263.00	300.90	306.70	269.30	246.20	188.40	14.80	2.90	3.70	1.50
10	14.20	73.80	148.70	215.90	267.20	302.90	307.60	268.30	247.90	156.50	113.30	17.50	1.10	2175.2
11	14.60	71.00	90.70	193.20	62.00	219.20	308.30	118.10	76.90	37.20	96.70	14.70	1.60	2154.2
12	10.70	28.90	122.00	168.40	240.00	269.60	38.50	34.70	104.10	101.00	26.40	20.00	2.20	1234.6
13	26.20	69.40	152.30	210.50	261.20	297.60	302.90	265.60	244.20	195.50	59.70	26.50	2.20	1206.3
14	13.00	54.80	117.60	204.70	181.60	254.10	241.90	224.30	197.70	95.70	126.70	29.70	1.10	2202.3
15	15.70	78.10	134.20	209.10	177.70	300.20	304.30	294.20	248.00	188.70	34.00	21.60	2.00	1549.0
16	6.90	40.80	158.60	185.00	274.00	200.00	244.10	119.30	252.70	66.50	106.60	34.00	2.30	2093.1
17	14.10	69.90	157.60	207.00	196.30	61.60	165.30	245.80	237.60	188.80	93.40	47.60	3.70	1592.6
18	14.80	74.60	149.30	212.90	254.60	144.90	69.80	162.60	110.20	103.10	115.30	29.70	1.30	1690.3
19	6.50	47.40	152.90	127.30	230.30	272.00	116.60	244.50	81.00	131.80	99.10	33.10	2.10	1439.1
20	21.10	******	******	******	******	******	******	******	81.00	131.80	101.30	20.60	1.20	1553.4
21	******	******	******	******	******	******	******	******	******	******	******	******	******	******
22	13.00	59.10	119.10	185.10	281.70	283.10	224.60	47.00	204.90	74.20	54.90	47.60	2.00	******
23	10.70	63.10	140.50	203.70	244.80	97.00	57.90	30.10	15.30	11.50	9.70	8.50	1.20	1548.0
24	3.10	27.40	53.40	177.40	265.60	263.70	44.50	124.90	102.60	55.10	34.20	16.10	1.00	892.9
25	7.70	58.40	136.00	193.70	223.90	198.80	122.60	228.00	64.30	15.30	10.80	8.40	0.10	1276.2
26	9.90	61.10	95.00	190.40	49.20	64.70	186.80	269.30	131.00	73.40	70.40	12.80	******	******
27	3.70	20.50	75.00	192.50	251.30	256.90	267.20	238.60	205.40	81.60	41.00	19.00	******	******
28	8.90	69.10	135.70	170.00	221.20	269.50	295.50	275.70	197.60	44.70	25.30	12.70	******	******
29	14.00	60.90	129.90	206.20	239.10	268.50	304.80	185.80	88.30	76.20	57.20	22.70	******	******
30	13.00	71.70	127.70	193.00	262.10	263.20	253.60	54.50	213.70	153.30	75.60	9.50	0.50	1711.4
MEAN	11.92	60.54	126.51	191.60	233.51	238.72	201.06	160.16	166.85	116.70	73.78	25.97	1.59	1626.9
STD D	5.29	15.80	31.39	23.74	55.01	75.37	135.07	100.00	84.57	65.74	39.57	14.57	0.89	211.7
MIN	3.10	27.40	53.40	127.30	62.00	61.60	36.50	30.10	15.30	11.50	9.70	7.60	0.10	447.6
MAX	26.20	78.10	157.60	215.90	283.60	312.10	306.70	294.20	269.10	208.90	126.70	61.50	3.70	2346.3


MONTHLY TOTAL SOLAR INSOLATION IN BTU/FT**2 /S. HOUR
MONTH: SEP 1978
LOCATION: RACARUI, CATA.D
0,00 3,00 6,00 9,00 12,00 15,00 18,00 21,00 24,00
350,00
341,03
332,05
323,08
314,10
305,13
296,15
287,18
278,21
269,23
260,26
251,28
242,31
233,33
224,36
215,38
206,41
197,44
188,46
179,49
170,51
161,54
152,56
143,59
134,62
125,64
116,67
107,69
98,72
89,74
80,77
71,79
62,82
53,85
44,87
35,90
26,92
17,95
8,97
0,00
0,00 3,00 6,00 9,00 12,00 15,00 18,00 21,00 24,00
ATL STD TIME
(+) MAXIMUM VALUE
(M) MEAN VALUE
(-) MINIMUM VALUE

FREQUENCY CHARTS FOR DIFFUSE / TOTAL INSOLATION

MONTH: SEP 1970 LOCATION: BACARDI, CATA.

BASED ON HOURLY VALUES

REGULAR

RANGE	0	20	40	60	80	100	120	NO. OF VALUES	% OF TOTAL
0-.1								0	0.00
.1-.2	XXXXXXXXXXXXXXXXX							56	14.17
.2-.3	XXXXXXXXXXXXXXXXX							57	14.57
.3-.4	XXXXXXXXXXXXXXXX							53	12.99
.4-.5	XXXXXXXXXXXXX							49	11.02
.5-.6	XXXXXXXXXX							23	9.36
.6-.7	XXXXXXX							15	3.71
.7-.8	XXXXXXXX							16	8.38
.8-.9	XXXXXX							12	4.72
.9-1.	XXXXXXX							14	5.51

THERE ARE 40 VALUES ABOVE 1.0 (15.75%)

CUMULATIVE

RANGE	0	80	160	240	320	400	480	NO. OF VALUES	% OF TOTAL
0-.1								0	0.00
.1-.2	XXXX							36	14.17
.2-.3	XXXXXXXXX							73	28.74
.3-.4	XXXXXXXXXXXX							106	41.73
.4-.5	XXXXXXXXXXXXXXX							134	52.76
.5-.6	XXXXXXXXXXXXXXXXXXX							157	61.81
.6-.7	XXXXXXXXXXXXXXXXXXXXX							172	67.72
.7-.8	XXXXXXXXXXXXXXXXXXXXXXX							188	74.02
.8-.9	XXXXXXXXXXXXXXXXXXXXXXXXX							200	78.74
.9-1.	XXXXXXXXXXXXXXXXXXXXXXXXXX							214	84.25

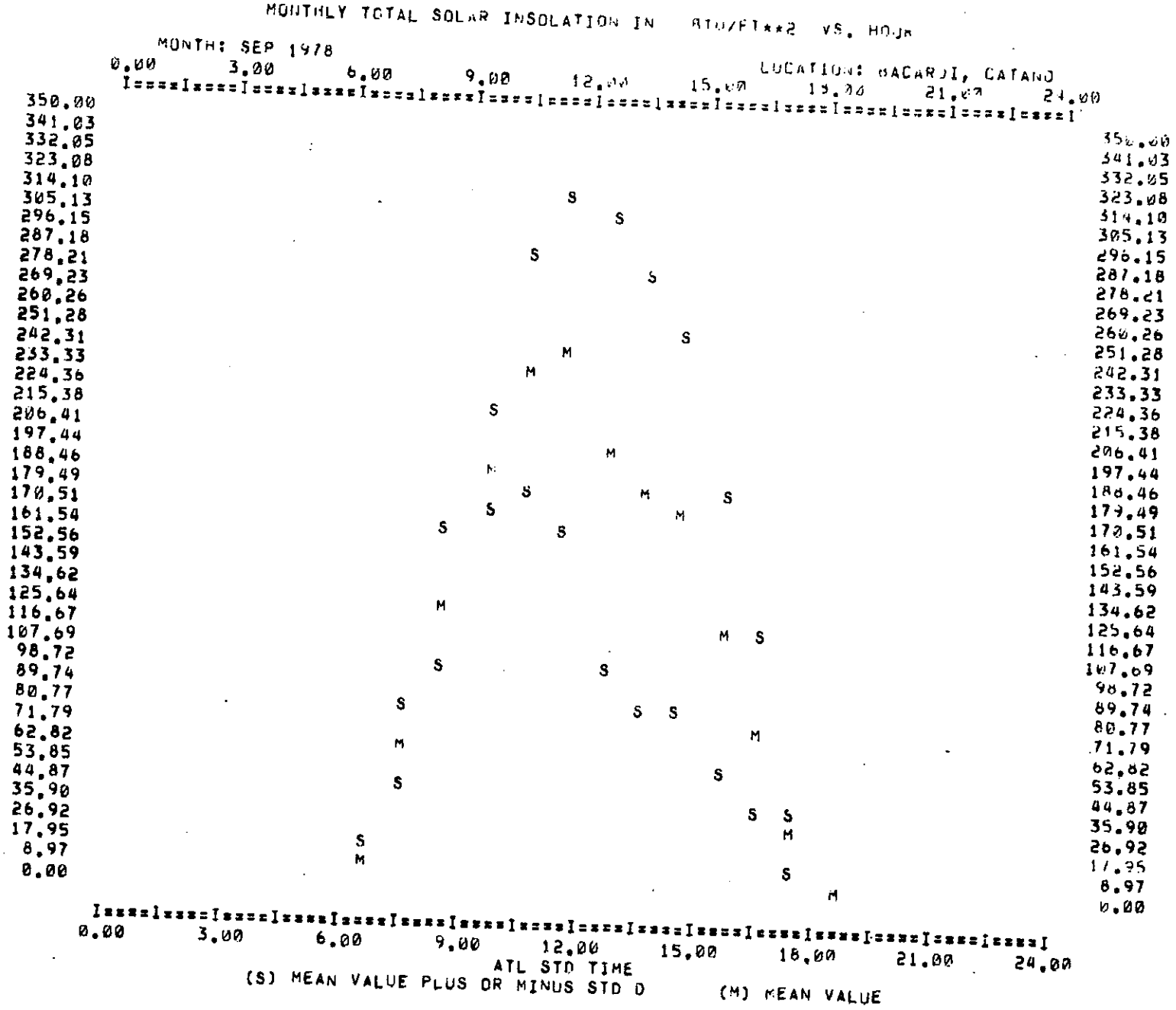
BASED ON DAILY VALUES

REGULAR

RANGE	0	5	10	15	NO. OF VALUES	% OF TOTAL
0-.1					0	0.00
.1-.2	XX				2	40.00
.2-.3	XX				2	40.00
.3-.4					0	0.00
.4-.5	X				1	20.00
.5-.6					0	0.00
.6-.7					0	0.00
.7-.8					0	0.00
.8-.9					0	0.00
.9-1.					0	0.00

CUMULATIVE

0	10	20	30	NO. OF VALUES	% OF TOTAL
				0	0.00
XX				2	40.00
XXXX				4	80.00
XXXX				4	80.00
XXXXX				5	100.00
XXXXX				5	100.00
XXXXX				5	100.00
XXXXX				5	100.00
XXXXX				5	100.00


MONTHLY TOTAL SOLAR INSOLATION IN BTU/FT**2 VS. HOUR
MONTH: SEP 1978
LOCATION: MACARJI, CATANO
0.00 3.00 6.00 9.00 12.00 15.00 18.00 21.00 24.00
350.00
341.03
332.05
323.08
314.10
305.13
296.15
287.18
278.21
269.23
260.26
251.28
242.31
233.33
224.36
215.38
206.41
197.44
188.46
179.49
170.51
161.54
152.56
143.59
134.62
125.64
116.67
107.69
98.72
89.74
80.77
71.79
62.82
53.85
44.87
35.90
26.92
17.95
8.97
0.00
ATL STD TIME
(S) MEAN VALUE PLUS OR MINUS STD D
(M) MEAN VALUE

MONTHLY WEATHER DATA

MONTH: SEP 1978

LOCATION: BACAROI, CATAND

TOTAL / EXTRATERRESTIAL INSOLATION

DAY	6-7 (A)	7-8 (B)	8-9 (C)	9-10 (D)	10-11 (E)	11-12 (F)	HOUR (CODE) 12-1 (N)	1-2 (G)	2-3 (H)	3-4 (I)	4-5 (J)	5-6 (K)	6-7 (L)	DAILY VALUE
1	0.173	0.527	0.643	0.514	0.779	0.777	0.743	0.715	0.758	0.719	0.528	0.553	0.155	0.682
2	0.450	0.557	0.441	0.378	0.536	0.194	0.076	0.175	0.425	0.221	******	******	******	******
3	******	******	******	******	******	******	******	******	******	******	******	******	******	******
4	******	******	******	******	******	******	******	******	******	******	******	******	******	******
5	******	******	******	******	******	******	******	******	******	******	******	******	******	******
6	******	******	******	******	******	******	******	******	******	******	******	******	******	******
7	******	******	******	******	******	******	******	******	******	******	******	******	******	******
8	******	******	******	******	******	******	******	******	******	******	******	******	******	******
9	0.444	0.564	0.655	0.706	0.723	0.753	0.754	0.739	0.708	0.052	0.015	0.037	0.131	******
10	0.479	0.572	0.665	0.711	0.735	0.753	0.753	0.738	0.715	0.670	0.577	0.178	0.103	0.683
11	0.494	0.550	0.406	0.636	0.171	0.549	0.755	0.282	0.228	0.559	0.496	0.152	0.162	0.672
12	0.363	0.224	0.546	0.555	0.661	0.676	0.094	0.089	0.302	0.133	0.137	0.218	0.240	0.396
13	0.891	0.538	0.681	0.694	0.720	0.746	0.744	0.735	0.710	0.364	0.311	0.283	0.260	0.386
14	0.443	0.425	0.526	0.675	0.501	0.639	0.595	0.568	0.314	0.707	0.665	0.322	0.141	0.699
15	0.538	0.606	0.601	0.690	0.490	0.755	0.750	0.761	0.726	0.346	0.180	0.239	0.279	0.495
16	0.237	0.317	0.263	0.611	0.757	0.504	0.603	0.309	0.742	0.689	0.568	0.382	0.351	0.660
17	0.487	0.544	0.707	0.684	0.543	0.155	0.409	0.638	0.700	0.244	0.502	0.545	0.620	0.509
18	0.513	0.581	0.670	0.704	0.705	0.366	0.173	0.423	0.349	0.696	0.624	0.347	0.240	0.542
19	0.226	0.370	0.687	0.421	0.638	0.688	0.269	0.638	0.240	0.382	0.541	0.394	0.430	0.465
20	0.739	******	******	******	******	******	******	******	******	0.491	0.558	0.250	0.273	0.495
21	******	******	******	******	******	0.398	0.701	0.734	0.413	0.279	0.307	0.600	0.573	******
22	0.461	0.463	0.536	0.615	0.783	0.719	0.561	0.124	0.614	0.327	0.192	0.111	0.369	0.504
23	0.381	0.495	0.634	0.677	0.681	0.247	0.145	0.079	0.046	0.044	0.055	0.100	0.370	0.292
24	0.111	0.216	0.241	0.590	0.740	0.672	0.112	0.330	0.309	0.210	0.196	0.216	0.341	0.385
25	0.278	0.460	0.615	0.646	0.625	0.508	0.308	0.604	0.195	0.059	0.109	0.115	0.050	0.426
26	0.360	0.483	0.430	0.635	0.138	0.165	0.470	0.609	0.398	0.302	0.411	0.179	******	******
27	0.136	0.162	0.340	0.643	0.704	0.658	0.674	0.636	0.626	0.316	0.241	0.272	******	******
28	0.329	0.549	0.617	0.569	0.620	0.692	0.747	0.737	0.605	0.174	0.150	0.186	******	******
29	0.523	0.485	0.591	0.691	0.672	0.742	0.772	0.498	0.271	0.299	0.343	0.340	******	******
30	0.498	0.573	0.582	0.648	0.738	0.739	0.644	0.147	0.659	0.604	0.457	0.145	0.642	0.575
MEAN	0.412	0.472	0.568	0.634	0.646	0.602	0.496	0.466	0.489	0.426	0.394	0.268	0.297	0.520
STD D	0.180	0.123	0.141	0.078	0.153	0.189	0.257	0.256	0.245	0.236	0.206	0.141	0.164	0.126
MIN	0.111	0.216	0.241	0.421	0.171	0.155	0.094	0.079	0.046	0.044	0.055	0.100	0.050	0.292
MAX	0.891	0.606	0.707	0.711	0.783	0.777	0.755	0.761	0.758	0.719	0.665	0.555	0.642	0.699

FREQUENCY CHARTS FOR TOTAL / EXTRATERRESTIAL INSOLATION

MONTH: SEP 1978 LOCATION: BACARDI, CATANO

BASED ON HOURLY VALUES

REGULAR

RANGE	0 20 40 60 80 100 120	NO. OF VALUES	% OF TOTAL
0-.1	XXXXXX		
.1-.2	XXXXXXXXXXXXXXXXX	13	4.26
.2-.3	XXXXXXXXXXXXXXXX	36	11.80
.3-.4	XXXXXXXXXXXXXXXXX	32	10.49
.4-.5	XXXXXXXXXXXXXXX	36	11.80
.5-.6	XXXXXXXXXXXXXXXXXXXXX	30	9.84
.6-.7	XXXXXXXXXXXXXXXXXXXXXXXXXXXXX	44	14.43
.7-.8	XXXXXXXXXXXXXXXXXXXXXXXXX	60	19.67
.8-.9		53	17.38
.9-1.		1	0.33
		0	0.00

CUMULATIVE

RANGE	0 80 160 240 320 400 480	NO. OF VALUES	% OF TOTAL
0-.1	X		
.1-.2	XXXXXX	13	4.26
.2-.3	XXXXXXXXXX	49	16.07
.3-.4	XXXXXXXXXXXXXX	81	26.56
.4-.5	XXXXXXXXXXXXXXXXXX	117	38.36
.5-.6	XXXXXXXXXXXXXXXXXXXXXX	147	48.20
.6-.7	XXXXXXXXXXXXXXXXXXXXXXXXXXXXX	191	62.62
.7-.8	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	251	82.30
.8-.9	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	304	99.67
.9-1.	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	305	100.00
		305	100.00

BASED ON DAILY VALUES

REGULAR

RANGE	0 5 10 15	NO. OF VALUES	% OF TOTAL
0-.1		0	0.00
.1-.2		0	0.00
.2-.3	X	1	5.88
.3-.4	XXX	3	17.65
.4-.5	XXXX	4	23.53
.5-.6	XXXX	4	23.53
.6-.7	XXXXX	5	29.41
.7-.8		0	0.00
.8-.9		0	0.00
.9-1.		0	0.00

CUMULATIVE

0 10 20 30	NO. OF VALUES	% OF TOTAL
	0	0.00
	0	0.00
X	1	5.88
XXXX	4	23.53
XXXXXXXX	8	47.06
XXXXXXXXXXXX	12	70.59
XXXXXXXXXXXXXXXXX	17	100.00
XXXXXXXXXXXXXXXXX	17	100.00
XXXXXXXXXXXXXXXXX	17	100.00
XXXXXXXXXXXXXXXXX	17	100.00

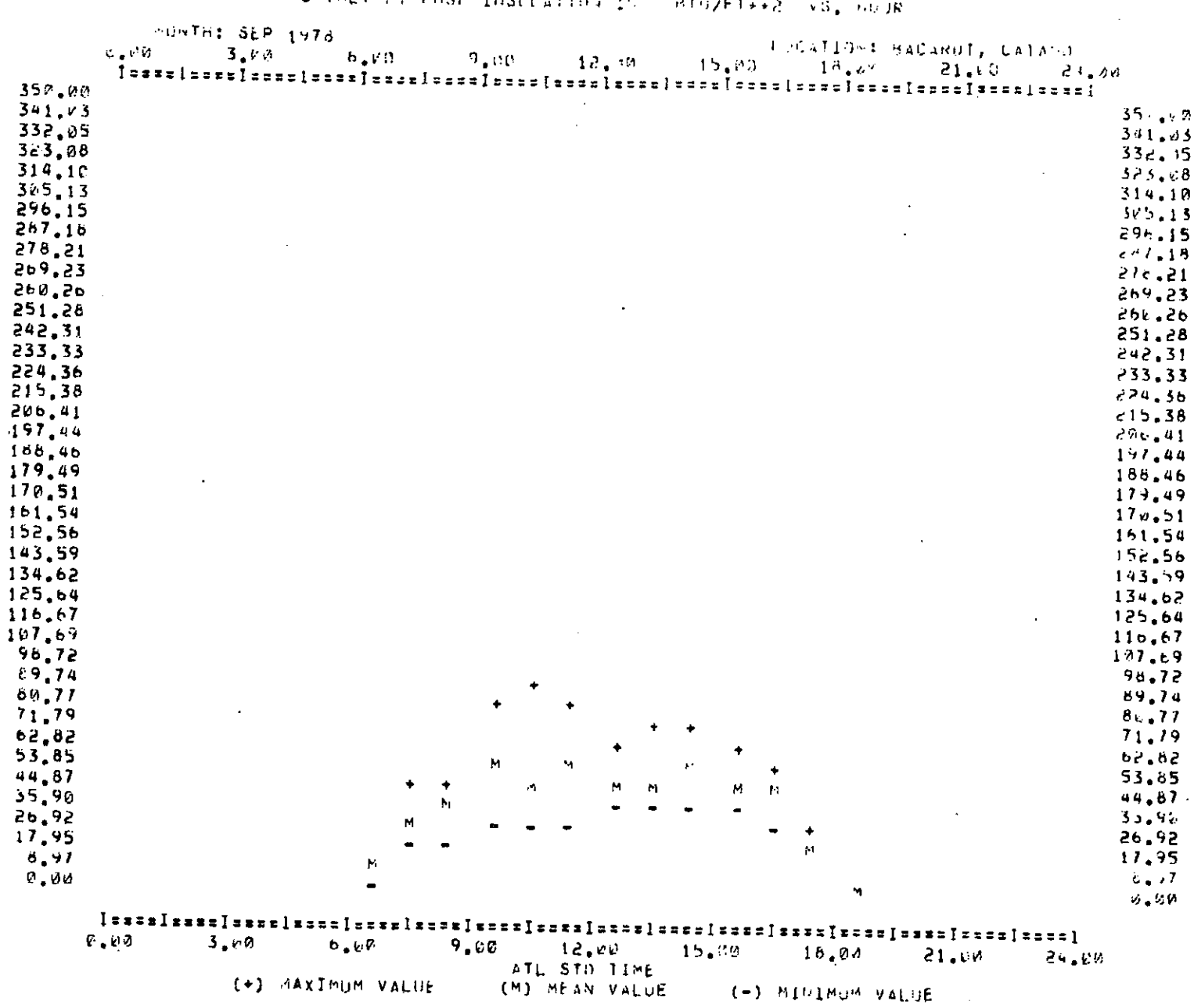
MONTHLY WEATHER DATA

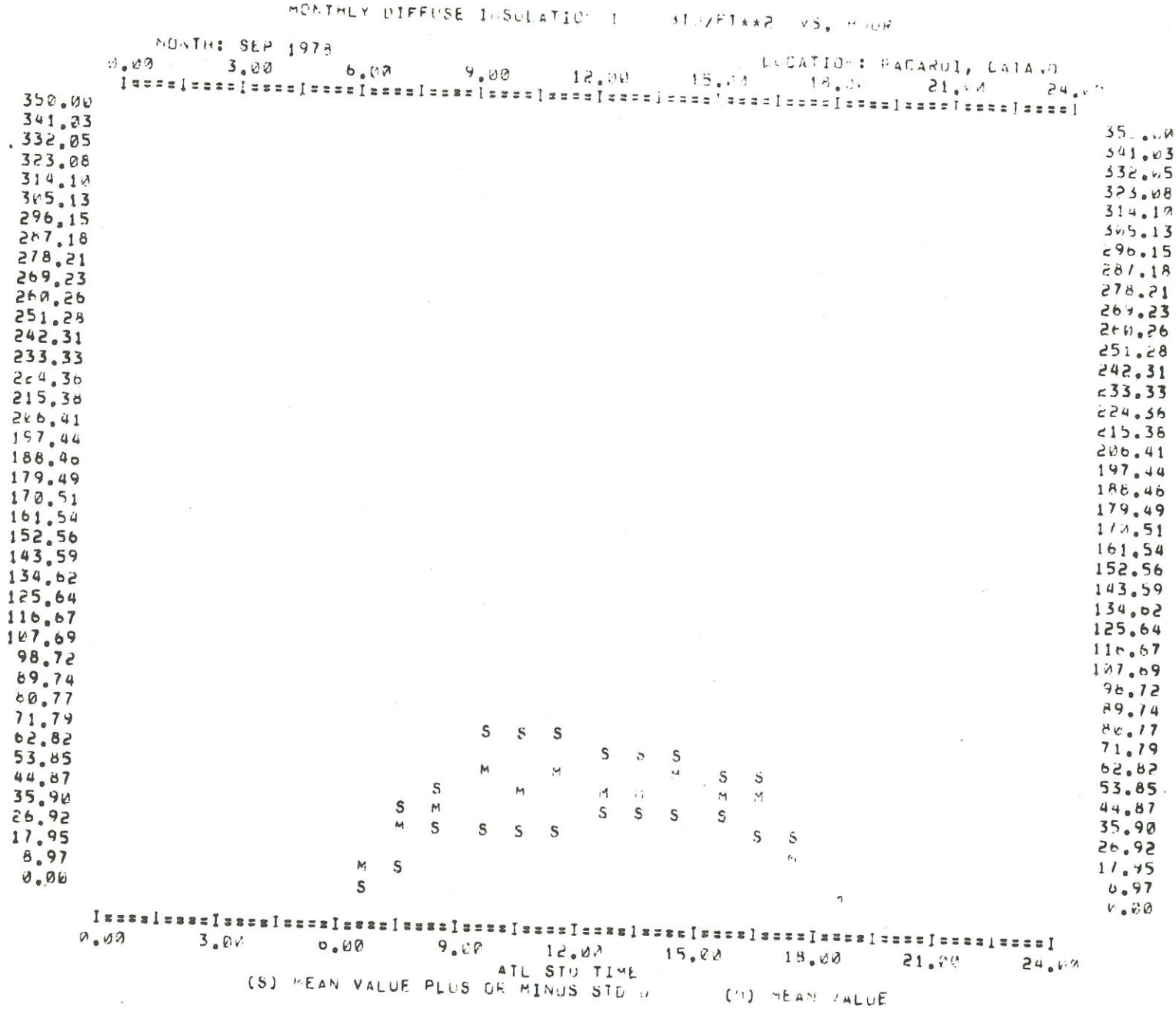
MONTH: SEP 1976

LOCATION: BARCARDI, CATALA

DIFFUSE INSOLATION IN BTU/FT**2

DAY	HOUR 6-7	7-8	8-9	9-10	10-11	11-12	12-1	1-2	2-3	3-4	4-5	5-6	6-7	TOTAL
1	3.78	21.47	32.33	56.49	45.51	45.75	62.34	55.99	41.65	46.85	38.92	26.47	3.29	461.0
2	6.59	19.40	40.02	65.15	57.34	61.24	33.18	63.41	123.34	65.15	******	******	******	******
3	******	******	******	******	******	******	******	******	******	******	******	******	******	******
4	******	******	******	******	******	******	******	******	******	******	******	******	******	******
5	******	******	******	******	******	******	******	******	******	******	******	******	******	******
6	******	******	******	******	******	******	******	******	******	******	******	******	******	******
7	******	******	******	******	******	******	******	******	******	******	******	******	******	******
8	******	******	******	******	******	******	******	******	******	******	******	******	******	******
9	6.10	16.59	23.30	26.84	35.14	38.80	38.92	41.85	46.85	16.47	2.81	3.76	1.71	******
10	5.49	16.35	22.06	27.45	27.33	30.38	32.45	34.53	37.45	43.07	54.78	18.91	1.34	392.5
11	5.73	16.71	43.31	67.22	48.68	84.79	51.61	67.47	74.42	60.15	57.10	16.47	1.95	369.2
12	5.49	16.96	34.16	74.66	84.42	83.81	37.94	34.65	94.31	38.55	25.74	20.37	2.68	547.3
13	******	22.20	39.77	54.66	60.76	53.31	56.49	55.27	50.67	92.64	55.59	27.21	******	******
14	7.08	34.40	54.66	75.27	95.16	103.58	115.41	96.38	81.13	52.34	47.46	16.35	******	******
15	8.91	45.38	42.94	78.08	86.86	60.02	56.30	57.46	47.21	79.79	36.60	23.55	******	******
16	4.76	36.48	43.43	84.42	82.72	63.81	50.39	******	50.14	42.82	33.31	18.42	2.68	580.1
17	5.73	15.98	47.46	60.88	58.44	61.12	82.47	52.34	43.31	51.61	52.22	32.33	******	******
18	6.95	22.20	35.26	55.14	66.12	60.02	58.44	63.94	79.79	30.74	23.79	12.32	******	******
19	4.76	31.84	72.71	74.54	119.32	113.46	101.14	88.57	63.81	67.71	44.65	25.86	******	******
20	******	******	******	******	******	******	******	******	******	62.46	79.30	25.91	******	******
21	******	******	******	******	******	******	******	******	******	******	******	******	******	******
22	9.27	32.70	44.53	62.22	72.59	154.33	166.48	132.25	86.21	80.40	58.68	40.75	******	******
23	6.59	24.52	38.55	49.29	63.20	58.68	85.52	53.56	119.93	64.06	******	10.13	******	******
24	2.32	22.08	47.09	62.46	56.24	61.24	62.95	55.87	******	12.93	10.61	7.93	******	******
25	5.73	32.45	50.51	93.45	69.17	66.12	49.90	130.78	99.67	62.10	39.16	14.79	******	******
26	6.59	32.45	73.08	66.00	54.41	127.61	131.52	117.12	66.25	17.93	21.47	9.39	******	******
27	2.81	18.18	58.68	88.45	91.26	67.95	123.95	116.02	78.81	70.15	62.22	******	******	******
28	9.52	36.97	31.72	63.32	67.95	113.34	112.36	83.08	122.85	69.42	******	******	******	******
29	******	******	******	******	******	56.97	******	******	******	******	******	******	******	******
30	******	******	******	******	******	******	******	******	******	******	******	******	******	******
														******
MEAN	6.00	23.30	32.79	51.22	48.70	51.95	48.26	47.46	49.56	46.29	41.97	20.15	2.39	470.0
STD D	1.85	12.53	10.23	23.26	22.95	21.33	12.51	14.41	14.46	8.29	13.61	3.81	0.76	51.2
MIN	3.78	16.35	22.08	26.84	27.33	30.38	32.45	34.53	37.45	38.55	25.74	16.47	1.34	313.3
MAX	8.91	45.38	43.31	78.08	86.86	84.79	62.34	67.47	74.42	60.15	57.10	26.47	3.29	698.6


MONTHLY DIFFUSE INSOLATION IN BTU/FT**2 VS. HOUR
MONTH: SEP 1976
LOCATION: MACARUT, CAVITE
0.00 3.00 6.00 9.00 12.00 15.00 18.00 21.00 24.00
350.00
341.03
332.05
323.08
314.10
305.13
296.15
287.18
278.21
269.23
260.26
251.28
242.31
233.33
224.36
215.38
206.41
197.44
188.46
179.49
170.51
161.54
152.56
143.59
134.62
125.64
116.67
107.69
98.72
89.74
80.77
71.79
62.82
53.85
44.87
35.90
26.92
17.95
8.97
0.00
ATL STD TIME
(+) MAXIMUM VALUE (M) MEAN VALUE (-) MINIMUM VALUE


MONTHLY DIFFUSE INSOLATION I SIL/FI**2 VS. HOUR
MONTH: SEP 1978
LOCATION: BACABAL, BRAZIL
0.00 3.00 6.00 9.00 12.00 15.00 18.00 21.00 24.00
350.00
341.03
332.05
323.08
314.10
305.13
296.15
287.18
278.21
269.23
260.26
251.28
242.31
233.33
224.36
215.38
206.41
197.44
188.46
179.49
170.51
161.54
152.56
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134.62
125.64
116.67
107.69
98.72
89.74
80.77
71.79
62.82
53.85
44.87
35.90
26.92
17.95
8.97
0.00
ATL STD TIME
(S) MEAN VALUE PLUS OR MINUS STD D
(M) MEAN VALUE

MONTHLY WEATHER DATA

MONTH: SEP 1976

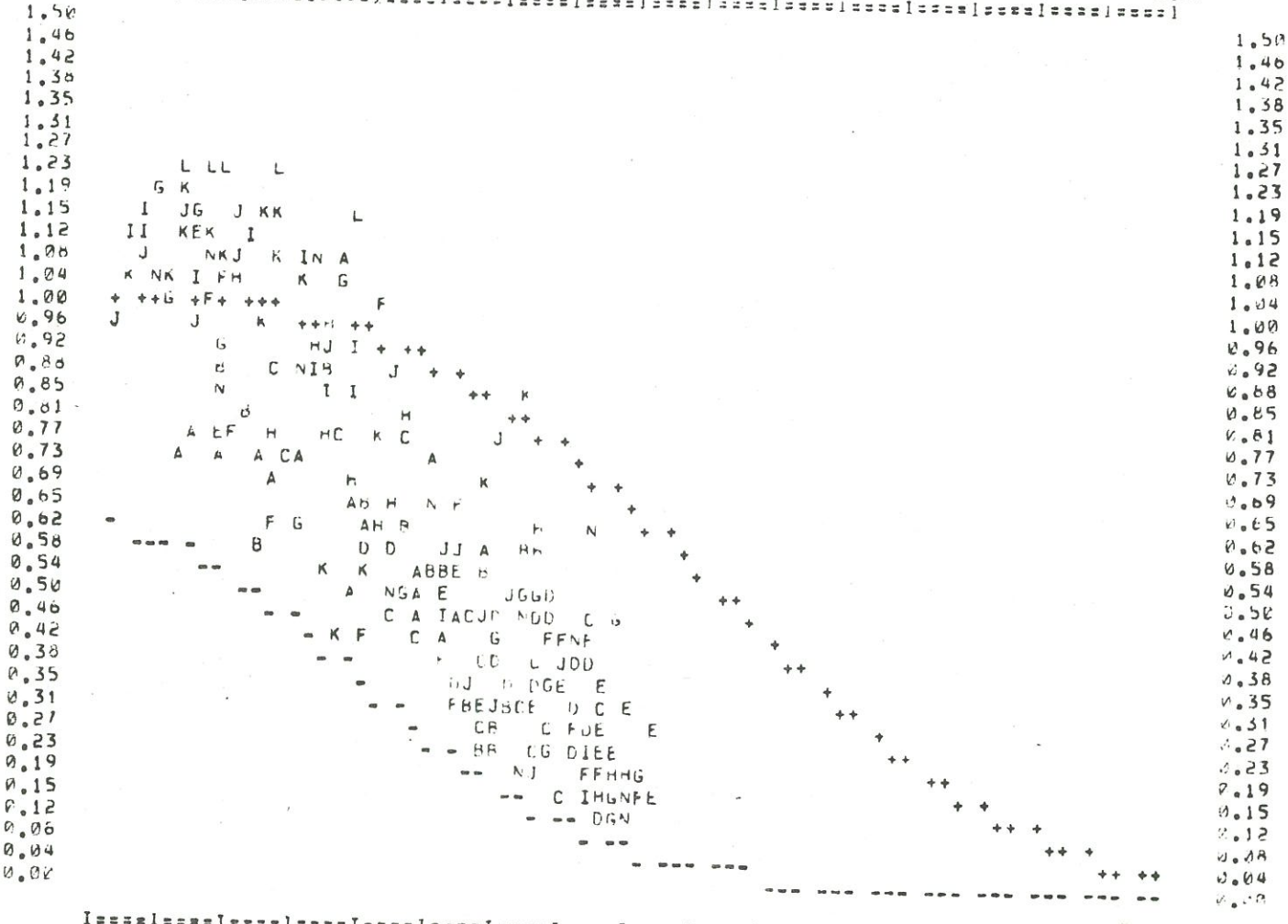
LOCATION: MACAHOI, CATALO

DIFFUSE / TOTAL INSOLATION

DAY	6-7 (A)	7-8 (B)	8-9 (C)	9-10 (D)	10-11 (E)	11-12 (F)	HOUR (CODE) 12-1 (G)	1-2 (H)	2-3 (I)	3-4 (J)	4-5 (K)	5-6 (L)	6-7 (M)	DAILY VALUE
1	0.727	0.316	0.225	0.362	0.160	0.147	0.203	0.127	0.156	0.224	0.355	0.431	1.220	0.209
2	0.488	0.270	0.406	0.568	0.293	0.786	1.057	0.919	0.818	1.018	******	******	******	******
3	******	******	******	******	******	******	******	******	******	******	******	******	******	******
4	******	******	******	******	******	******	******	******	******	******	******	******	******	******
5	******	******	******	******	******	******	******	******	******	******	******	******	******	******
6	******	******	******	******	******	******	******	******	******	******	******	******	******	******
7	******	******	******	******	******	******	******	******	******	******	******	******	******	******
8	******	******	******	******	******	******	******	******	******	******	******	******	******	******
9	0.462	0.228	0.159	0.125	0.134	0.129	0.126	0.145	0.190	0.229	0.483	1.061	1.220	0.180
10	0.387	0.222	0.149	0.127	0.102	0.101	0.105	0.120	0.151	0.384	0.590	1.123	1.220	0.173
11	0.393	0.235	0.478	0.348	0.785	0.387	0.167	0.613	0.943	1.036	0.975	0.980	1.220	0.443
12	0.513	0.587	0.280	0.443	0.352	0.311	0.986	0.999	0.906	0.917	0.928	1.027	******	******
13	******	0.320	0.261	0.260	0.233	0.180	0.186	0.194	0.208	0.266	0.375	0.550	******	******
14	0.544	0.628	0.465	0.368	0.524	0.408	0.477	0.437	0.753	0.834	1.076	1.090	******	******
15	0.567	0.581	0.320	0.373	0.489	0.200	0.184	0.195	0.190	0.227	0.312	0.542	1.167	0.277
16	0.690	0.894	0.741	0.456	0.302	0.319	0.206	******	0.198	0.776	0.559	0.679	******	******
17	0.407	0.229	0.301	0.294	0.298	0.992	0.499	0.213	0.182	0.163	0.206	0.415	******	******
18	0.470	0.298	0.236	0.259	0.260	0.414	0.837	0.516	0.675	0.657	0.451	0.781	******	******
19	0.732	0.672	0.476	0.586	0.518	0.417	0.867	0.362	0.788	0.474	0.703	1.161	******	******
20	******	******	******	******	******	******	******	******	******	******	******	******	******	******
21	******	******	******	******	******	******	******	******	******	******	******	******	******	******
22	0.713	0.553	0.374	0.336	0.258	0.983	0.598	0.472	0.637	1.084	1.069	1.056	******	******
23	0.616	0.589	0.274	0.242	0.258	0.207	0.381	1.140	0.585	0.971	******	1.177	******	******
24	0.748	0.606	0.862	0.352	0.212	0.631	1.487	1.192	******	1.125	1.094	1.043	******	******
25	0.745	0.556	0.371	0.482	0.309	0.251	1.121	1.047	0.971	1.127	1.145	1.167	******	******
26	0.665	0.531	0.769	0.347	1.106	0.642	1.071	0.514	1.030	1.172	1.142	1.116	******	******
27	0.758	0.687	0.782	0.459	0.363	1.050	0.664	0.526	0.602	0.895	0.884	******	******	******
28	1.069	0.535	0.234	0.372	0.307	0.441	0.421	0.348	0.598	0.851	******	******	******	******
29	******	******	******	******	******	0.211	******	******	******	******	******	******	******	******
30	******	******	******	******	******	******	******	******	******	******	******	******	******	******
MEAN	0.507	0.316	0.266	0.267	0.334	0.193	0.157	0.240	0.326	0.420	0.543	0.831	1.269	0.256
STD D	0.143	0.153	0.137	0.129	0.296	0.114	0.041	0.211	0.345	0.351	0.265	0.321	0.024	0.112
MIN	0.387	0.222	0.149	0.125	0.102	0.101	0.105	0.120	0.151	0.224	0.312	0.430	1.167	0.173
MAX	0.727	0.581	0.478	0.373	0.785	0.387	0.203	0.613	0.943	1.036	0.975	1.120	1.220	0.443

TOTAL / EXTRATERRESTIAL INSOLATION (HORIZONTAL AXIS)
VS. DIFFUSE / TOTAL INSOLATION (VERTICAL AXIS)

MONTH: SEP 1976 LOCATION: BACARDI, CATANO



FOR LETTER CODES SEE TOTAL / EXTRATERRESTIAL INSOLATION TABLE OR DIFFUSE / TOTAL INSOLATION TABLE
(+) MAXIMUM VALUE CURVE POINTS (-) MINIMUM VALUE CURVE POINTS

KT: TOTAL / EXTRATERRESTIAL *** 98 VALUES ABOVE 1.5 *** 98 VALUES WITHOUT DATA
KD: DIFFUSE / TOTAL *** 149 VALUES ABOVE 1.5 *** 149 VALUES WITHOUT DATA