GL00858

PRELIMINARY

PART IV SECTION M

ATTACHMENT I

INSOLATION AND WIND RESOURCES

15 July 1980

PRELIMINARY

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PREFACE

The material in this Attachment provides data characterizing potential insolation, wind, and joint insolation-wind resources for use by a broad range of Offerers responding to the MX-RES RFPs for powering shelters, clusters, and operating bases. These characterizations are intended to serve as a consistent data base for Offerer use and interpretations during proposal preparations, and are designed to reduce the complexity of proposal evaluations by the MX-RES Project Office. Accordingly, data are called out in terms of annual hourly resource values (e.g., the Ely, NV Typical Meteorological Year TMY tape) which support Offerer detailed solar system analyses, and summary/statistical charts and tables which support quick-look decisions appropriate to Offerer short RFP response times. Key tradeoffs which could be supported by this data base are considered to be system sizing for individual technologies, sizing for combined technology configurations, and the extent of both storage and backup. The remainder of this Preface serves three purposes: (1) to summarize the content of the attachment; (2) to provide information to the Offerers regarding the possible design uses of the resource data; and (3) to direct Offerers on which data sets are to be used for each RFP (i.e., shelters, clusters, or operating bases).

A summary of the content of this Attachment is shown in Figure 1. Information contained within the three classes of resource data (i.e., insolation, wind, and joint insolation-wind) are identified (Sections 2.0, 3.0, and 4.0, respectively), and these data are supplemented by some data interpretations for the convenience of the Offerer (Section 5.0). The Ely TMY appears in all three resource classes, and is a primary source of data for Offerers (especially insolation). However, Offerer attention should also be given to wind resource data summaries, to data reflecting temporal and spatial variability (via multi-year and multi-location summaries), and to probability data representing the general randomness of the resources (especially wind). Some of these data were previously unpublished.

An overview of the intended purposes of the contained data is provided in Table 1 for the benefit of Offerers. Tables 1-A, 1-B, and 1-C present guidance for data usage relative to designs of solar energy conversion systems, wind energy conversion systems, and combined solar/wind energy conversion systems, respectively.

Offerers are directed to use Table 2 regarding which data sets are to be used for the RFP category of interest. Note that the table addresses their selected options for solar, wind, or combined energy conversion system options. Furthermore, directions are given for both Point Designs and adaptations of those designs to other locations, as indicated in the Proposal Preparation Instructions.

Table 2 is intended to provide a consistent resource data base for Offerer purposes in view of the fact that a paucity of data exists (especially wind and joint insolation/wind data). Insolation data emphasis is placed on the long term Ely measurements of both global and direct insolation. Wind and solar/wind systems Offerers are to use the wind data, appropriately applied, even though there is no guarantee that such a resource will actually exist at the shelter, cluster, or base location; considerable site-to-site resource variation exists.

FIGURE 1

SUMMARY OF ATTACHMENT I CONTENT

INSOLATION (SECTION 2.0)

- TYM TAPE - ELY, NV
- PROFILES AND STATISTICAL SUMMARIES - ELY, NV
  - HOURLY, DAILY, MONTHLY, YEARLY
  - SUCCESSIVE DAY, PROBABILITIES OF INSOLATION LEVELS
- TEMPORAL/SPATIAL VARIATIONS
  - ELY, NV
  - LAS VEGAS, NV
  - YUCCA FLATS, NV
  - CEDAR CITY, UT

WIND (SECTION 3.0)

- CUMULATIVE DISTRIBUTION FUNCTION OF WINDSPEED
  - ELY, NV
  - TONOPAH, NV
  - PEQUOP SUMMIT, NV
  - WHITE MOUNTAINS, CA
- HOURLY AND MONTHLY PROFILES
- PROBABILITY DISTRIBUTION FUNCTIONS OF CALM DURATION (SOME SITES)
- SUCCESSIVE DAY PROBABILITIES OF WINDSPEED LEVELS - ELY, NV
- TMY TAPE - ELY, NV
- PNL ASSESSMENT (CENTRAL NV RIDGECRESTS)
- TEMPORAL/SPATIAL VARIATIONS - ELY & TONAPAH, NV

JOINT INSOLATION-WIND (SECTION 4.0)

- JOINT POWER PROBABILITY - ELY, NV
- CLEAR AND CLOUDY DAY PROFILES - ELY, NV
  - TMY SUMMARY

DATA INTERPRETATIONS (SECTION 5.0)

- KEY DEFINITIONS
- LIMITS AND CONSTRAINTS
- MEASUREMENT PROGRAM PLANS

TABLE 1

RESOURCE DATA PURPOSES

(A) INSOLATION DATA FOR SOLAR ENERGY CONVERSION SYSTEM DESIGN

TIME HISTORIES	INTENDED PURPOSE	DOCUMENT LOCATION
• CLEAR DAY SUMMARY PROFILES	• QUICK LOOK 1-YR SIZING, INCL. AVERAGE STORAGE/BACKUP	• SECTION 2.2.1, FIGURES 2-1 to 2-13
• ELY TMY TAPE (PRIMARY DESIGN (DATA)	• DESIGN DAY SELECTION	
	• DETAILED SIZING, STORAGE, BACKUP	• SECTION 2.1, FIGURE 2-1
	• AVAILABILITY ANALYSIS	
	• METEOROLOGICAL INFLUENCE	
STATISTICAL SUMMARIES		
• MEAN DAILY/MONTHLY/YEARLY ELY DATA	• "RAW" DATA	• SECTIONS 2.2.2,3, TABLES 2-1 to 2-4
	• DEVIATIONS FROM TMY	• SECTION 2.2.3, TABLES 2-3, 2-4
	• TRENDS	• SECTION 2.2.3, FIGURE 2-16, TABLES 2-1 to 2-4
• PROBABILITY OF SUCCESSIVE DAYS ABOVE AN INSOLATION LEVEL	• BACKUP EXTREMES	• SECTION 2.2.4, TABLE 2-5
• COEFFICIENTS OF VARIABILITY (ELY), σ/μ	• TEMPORAL VARIATIONS: ELY, TONOPAH	• SECTION 2.3.1, TABLE 2-6
• ERSATZ ESTIMATES	• SPATIAL VARIATIONS FROM ELY (GLOBAL)	• SECTION 2.3.2, FIGURE 2-17 TABLE 2-7
• NEW NWS MEATUREMENTS	• SPATIAL VARIATIONS ACROSS DEPLOYMENT REGION (GLOBAL/DIRECT)	• SECTION 2.3.2, TABLES 2-8 to 2-10
TILTED SURFACE ALGORITHM		
• THREE COMPONENTS OF FLUX	• CONSISTENT COMBINATIONS OF DIRECT/GLOBAL INSOLATION	• SECTION 2.4, EQUATIONS 2-1, 2-2. TABLE 2-11
• ALBEDO VALUES	• GROUND REFLECTION VLAUES	

TABLE 1 (CONT)

(B) WIND DATA FOR WIND ENERGY CONVERSION SYSTEM DESIGN

WECS SELECTION DATA	INTENDED PURPOSE	DOCUMENT LOCATION
• CUMULATIVE DISTRIBUTION FUNCTION (CDF) OF WINDSPEED - 4 SITES	• SIZING	• SECTIONS 3.2 to 3.5, FIGURES 3-1, 3-5, 3-8, 3-12
• COEFFICIENTS OF VARIABILITY (σ/μ) - ELY AND TONOPAH	• TEMPORAL VARIATIONS (YEARLY)	• SECTION 3.7.1, TABLE 3-4
INTERFACE ANALYSIS DATA		
• HOURLY/MONTHLY WINDSPEED	• AVERAGE STORAGE AND/OR BACKUP • INTEGRATION WITH SOLAR	• SECTION 3.2 to 3.5, FIGURES 3-2, 3-3, 3-6, 3-7, 3-9, 3-10, 3-13, 3-14
• PROBABILITY DISTIRBUTION FUNCTION (PDF) OF CALM DURATION - 3 SITES	• STORAGE/BACKUP EXTREMES	• SECTION 3.2, 3.4, 3.5, FIGURES 3-4, 3-11, 3-15
• PROBABILITY OF SUCCESSIVE DAYS ABOVE A WINDSPEED LEVEL - ELY	• ALTERNATE STORAGE/BACKUP BACKUP CRITERIA	• SECTION 3.6.1, TABLES 3-1 to 3-3
• ELY TMY TAPE	• WINDSPEED, DIRECTION, METEOROLOGICAL (DE-EMPHASIZED WIND)	• SECTION 3.6.2, FIGURE 2-1
• PNL ASSESSMENT - CENTRAL NEVADA	• POTENTIAL HIGH RIDGE WIND RESOURCE	• SECTION 3.6.3

TABLE 1 (CONT)

(C) JOINT INSOLATION WIND DATA FOR HYBRID ENERGY CONVERSION SYSTEM DESIGN

JOINT POWER STATISTICS	INTENDED PURPOSES	DOCUMENT LOCATION
• 1 SUCCESSIVE DAY PROBABILITY VS MONTH - ELY	• QUICK-LOOK INTERFACE SOLAR-WIND ANALYSIS • QUICK-LOOK STORAGE AND BACKUP	• SECTION 4.1, FIGURES 4-1 to 4-3
• MUTLIPLE SUCCESSIVE DAY DAY PROBABILITIES VS MONTH - ELY	• MORE DETAILED INTERFACE ANALYSIS • MORE DETAILED STORAGE AND BACKUP ASSESSMENT	• SECTION 4.1, TABLES 4-1, 4-2
TIME HISTORIES		
• CLEAR/CLOUDY DAY TABULATED	• QUICK-LOOK INSOLATION AND WIND (SPEED/DIRECTION) RELATIONSHIPS • METEROLOGICAL INFLUENCE (CLOUD COVER, TEMPERATURE)	• SECTION 4.2, TABLES 4-3 to 4-16

TABLE 2. RFP DATA STES

ENERGY CONVERSION SYSTEM OFFERED	RESOURCE DATA USE ASSUMPTIONS PER RFP CATEGORY		
	SHELTERS	CLUSTERS	OPERATING BASE(S)
POINT DESIGNS			
• SOLAR	• ASSUME ELY INSOLATION DATA ARE APPLICABLE TO DRY LAKE VALLEY, NV	• SAME AS SHELTERS	• ASSUME ELY DATA ARE APPLICABLE TO BERYL, UT
• WIND	• ASSUME ELY WIND DATA ARE APPLICABLE TO DRY LAKE VALLEY	• SAME AS SHELTERS, AND/OR ASSUME PEQUOP SUMMIT DATA ARE APPLICABLE TO HYPOTHETICAL ADJACENT RIDGES LOCATED 2500 FT ABOVE VALLEY FLOOR AND 7 MILES FROM THE DISTRIBUTION CENTER	• ASSUME ELY WIND DATA APPLICABLE TO BERYL, AND/OR ASSUME PEQUOP SUMMIT DATA ARE APPLICABLE TO ADJACENT RIDGES, AND/OR ASSUME WHITE MOUNTAINS' DATA ARE APPLICABLE TO A HYPOTHETICAL MOUNTAINOUS SITE LOCATED 7000 FT ABOVE AND 35 MILES FROM THE OPERATING BASE
• COMBINED	• ASSUME ELY JOINT DATA, AND/OR ASSUME ABOVE DATA SETS ARE APPLICABLE TO DRY LAKE VALLEY	• SAME AS SHELTERS, AND/OR ASSUME ABOVE DATA SETS ARE APPLICABLE TO DRY LAKE VALLEY	• ASSUME ABOVE DATA SETS ARE APPLICABLE TO BERYL
DESIGN ADAPTATIONS			
• SOLAR	• CONSIDER ABOVE SOLAR POINT DESIGN WITH ERSATZ AND NEW NWS SPATIAL VARIATION DATA	• SAME AS SHELTERS WITH ABOVE DESIGNS	• SAME AS CLUSTERS WITH ABOVE DESIGNS
• WIND	• CONSIDER ABOVE WIND POINT DESIGN WITH TONOPAH AND OFFEROR DATA (IF ANY)	• SAME AS SHELTERS WITH ABOVE DESIGNS, AND/OR WITH PNL RIDGE DATA (IF APPLICABLE) AND OFFEROR DATA (IF ANY)	• SAME AS CLUSTERS WITH ABOVE DESIGNS
• COMBINED	• CONSIDER ABOVE COMBINED POINT DESIGN WITH ABOVE SOLAR/WIND ADAPTATION DATA	• SAME AS SHELTERS WITH ABOVE DESIGNS	• SAME AS CLUSTERS WITH ABOVE DESIGNS

ATTACHMENT I

INSOLATION AND WIND RESOURCES

1.0 INTRODUCTION

This document provides information on insolation and wind which is to be used by all Offerers to MX-RES Request for Proposals (RFPs). The insolation data in Section 2.0 are primarily from an extensive data base for Ely, Nevada, supplemented with data from other locations in the potential MX deployment area. The wind data in Section 3.0 are for two valley sites (i.e., Tonopah and Ely, Nevada), a high ridge site (i.e., Pequop Summit near Wells, Nevada), and a mountain location (i.e., White Mountain at the California/Nevada border). Section 4.0 deals with the joint relations between insolation and wind energy resources as they have been observed at Ely, Nevada. Some interpretations of these data sets are provided in Section 5.0 as a further aid to Offerers.

2.0 INSOLATION

Insolation data are provided in four categories: (1) a typical meteorological year (TMY) for Ely, Nevada; (2) summary data from the TMY and the standard SOLMET data base for Ely; (3) temporal and spatial variability relative to the Ely TMY data; and (4) a simplified algorithm for combining global and direct insolation. Note that Ely has a daily global insolation of approximately 5 kW-hr/m^2 and direct-normal insolation of nearly 7 kW-hr/m^2 when averaged over a year. Definitions of global and direct insolation, as used in this RFP, are provided in Section 5.0. Background leading to the presently available insolation data bases is presented in Reference 6.1.

2.1 TYPICAL METEOROLOGICAL YEAR (TMY)

The TMY for Ely is the current primary source of insolation data relative to MX-RES applications. This TMY is identified as NOAA/NCC* Tape Deck 9734 for Station Number 23154 (see References 6.2, 6.3). The TMY was extracted from the rehabilitated SOLMET (see Reference 6.4) format data base which contains solar radiation and surface meteorological data recorded from January 1953 through December 1975 on an hour basis through 1964 and on a three-hour basis thereafter.

The TMY was defined by Sandia Laboratories (Reference 6.2) to be typical in the sense that the weighted frequency distribution for each month of insolation, wind speed, temperature, and relative humidity were most like the long term monthly distributions for each parameter. The typical meteorological months comprising the Ely TMY are as follows:

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
'74	'71	'71	'71	'56	'75	'58	'73	'66	'66	'63	'65

*NOAA - National Oceanic and Atmospheric Administration.
NCC - National Climatic Center

The TMY provides data at each hour by a merging process applied to the SOLMET data; e.g., linear interpretation to replace missing data and cubic spline fit to ameliorate discontinuities arising at the selected month interfaces. The TMY format is shown in Figure 2-1, which also serves to identify the TMY content.

2.2 SUMMARY OF INSOLATION DATA

The following figures and tables are extracted from both the Ely TMY and the 24 year SOLMET data base that produced the TMY. The data are provided in forms readily accessible to the Offerers without recourse to detailed computer analysis of the basic TMY/SOLMET tapes. Summaries are presented according to various temporal resolutions of insolation values and probabilities of successive day insolations at Ely.

2.2.1 Diurnal/Hourly Values

a. Clear Days: Figures 2-2 through 2-13 provide plots of global and direct insolation for clear days selected from the TMY to be as close to the 21st of each month as possible. The 21st was selected so as to obtain days as close to the solstices and equinoxes as possible. These selections are to be used as typical clear days for Offerer purposes.

b. Cloudy Days: Typical cloudy days are undefinable since cloudy days range from a lack of direct insolation to insolation dropouts; the latter occurrences are demonstrated in Figures 2-14 and 2-15.

2.2.2 Daily Values

The daily direct and daily global insolation values are presented in Tables 2-1 and 2-2, respectively, for each day in the TMY.

2.2.3 Monthly Values

The mean daily values of direct and global insolation by month are provided in Figure 2-16 for the entire 24 year Ely data base. The mean daily values of direct and global insolation for each month during the 24 year period are provided in Tables 2-3 and 2-4. These values are further addressed in Section 2.3, regarding variability of Ely data.

2.2.4 Successive Day Probabilities

Table 2-5 provides probabilities of global insolation exceeding the indicated values over the given number of successive days for each month. The insolation power values are identified at the left as being 60, 120, 180, 240, and 360 watts per square meter (W/m^2), in terms of daily averages. Successive number of days are selected to be 1, 3, 5, and 7. These data are taken from Reference 6.6.

FIGURE 2-1. TAPE DECK 9734 - TYM FORMAT

(TYPICAL METEOROLOGICAL YEAR)

TAPE FIELD #	POSITION	ELEMENT *
001	001-005	WBAN Station Number
002	006-015	Solar Time (Yr, Mo, Day, Hour, Minute)
003	016-019	Local Standard Time (Hr, Minutes)
101	020-023	Extraterrestrial Radiation
102	024-028	Direct Radiation
103	029-033	Diffuse Radiation
104	034-038	Net Radiation
105	039-043	Tilt Radiation
106	044-048	Observed Radiation
107	049-053	Engineering Corrected Radiation
108	054-058	Standard Year Corrected Raidation
109,110	059-068	Additional Radiation (A and B)
111	069-070	Minutes of Sunshine
201	071-072	Time of Surface Observation
202	073-076	Ceiling Height
203	077-081	Sky Condition
204	082-085	Visibility
205	086-093	Weather
206	094-103	Pressure
207	104-111	Temperature
208	112-118	Wind (Direction and Speed)
209	119-122	Cloud (Total Amount Total Opaque)
210	123	Snow Cover Indicator
211	124-132	Black

*Description of elements as contained in SOLMET User's Manual, Vol. 1.

A logical record length is 132 bytes with physical records 3168 bytes (blockes 24).

FIGURE 2-2. ELY INSOLATION DATA - JANUARY CLEAR DAY

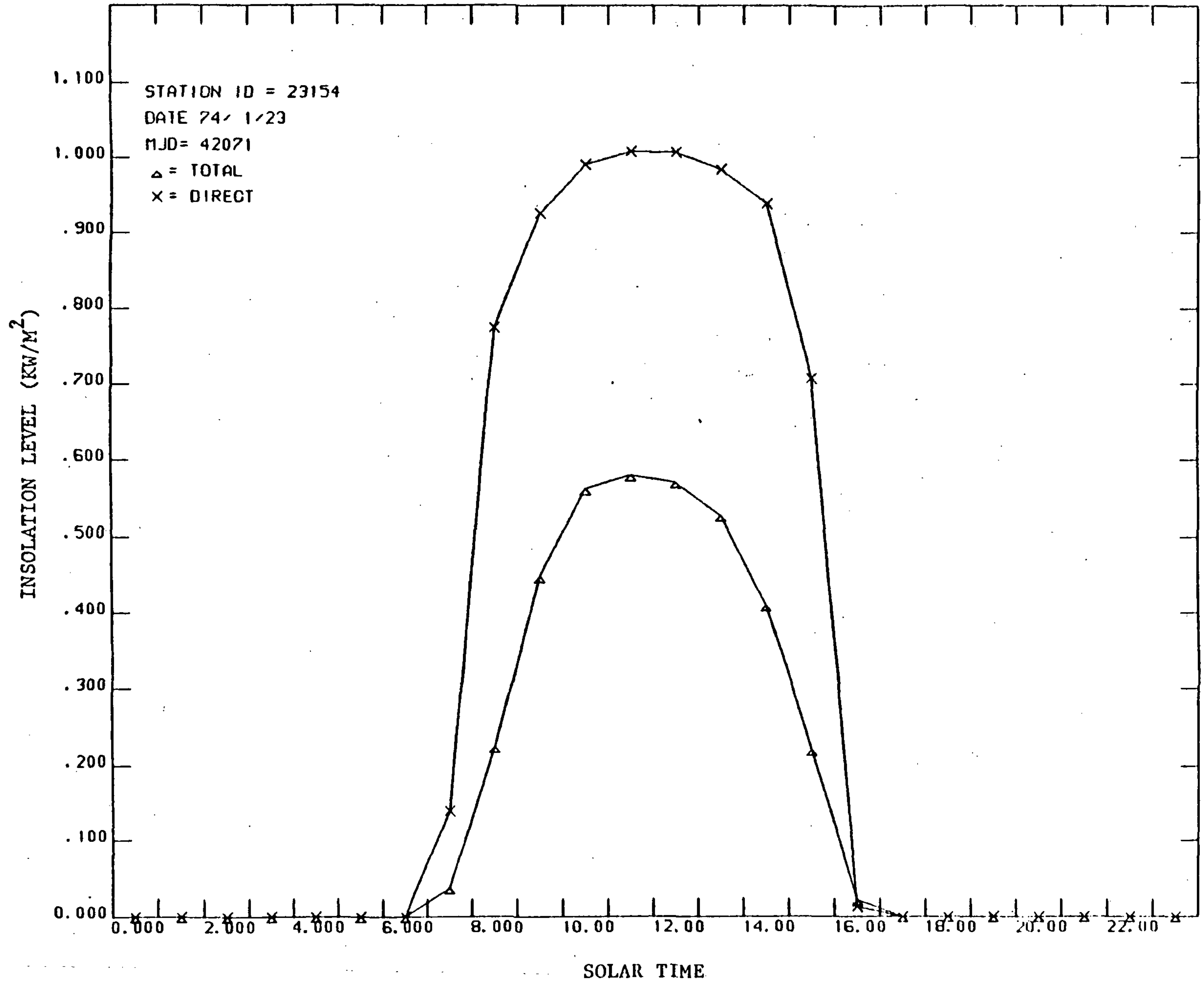
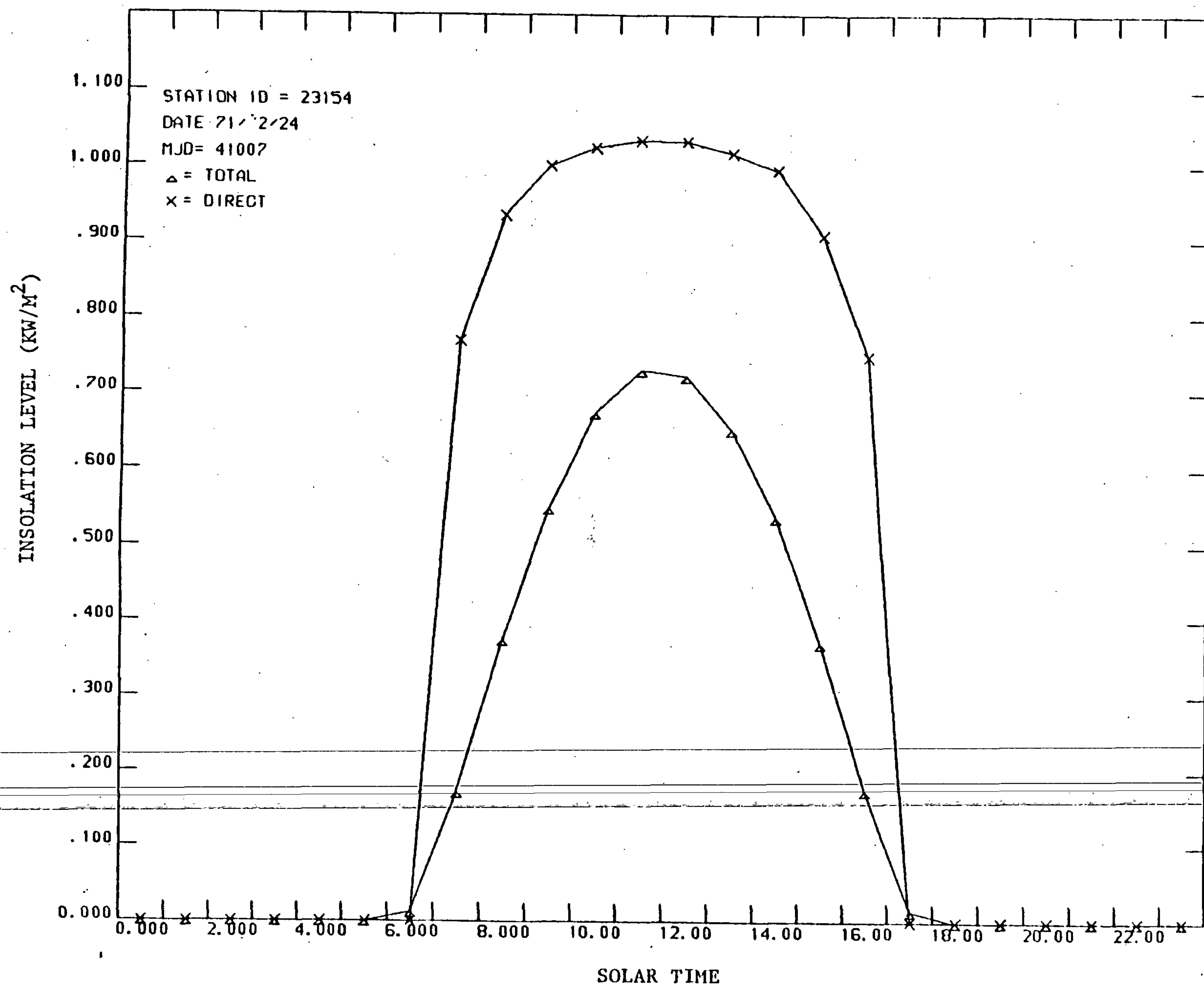


FIGURE 2-3. ELY INSOLATION DATA - FEBRUARY CLEAR DAY



5

FIGURE 2-4. ELY INSOLATION DATA - MARCH CLEAR DAY

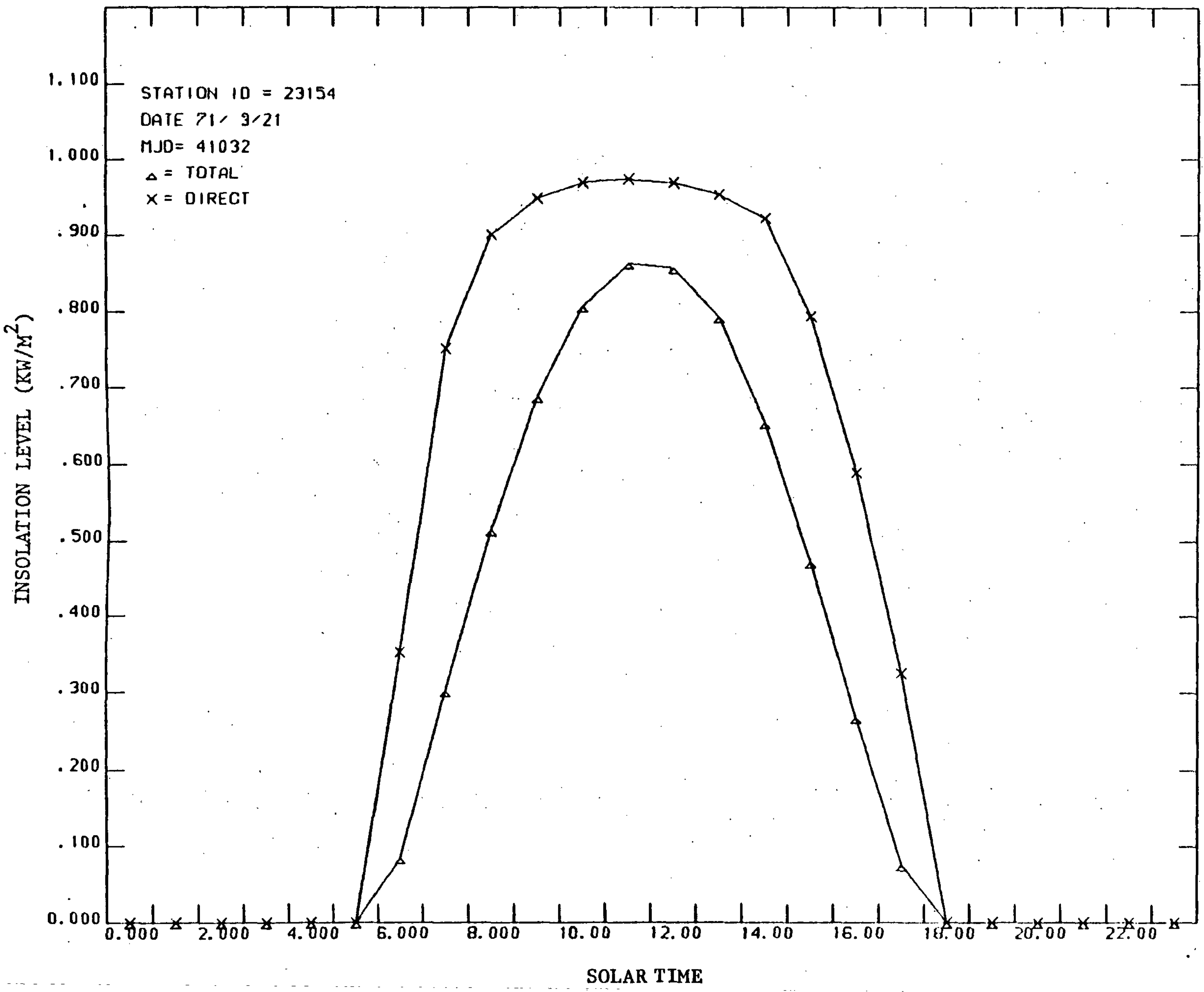


FIGURE 2-5. ELY INSOLATION DATA - APRIL CLEAR DAY

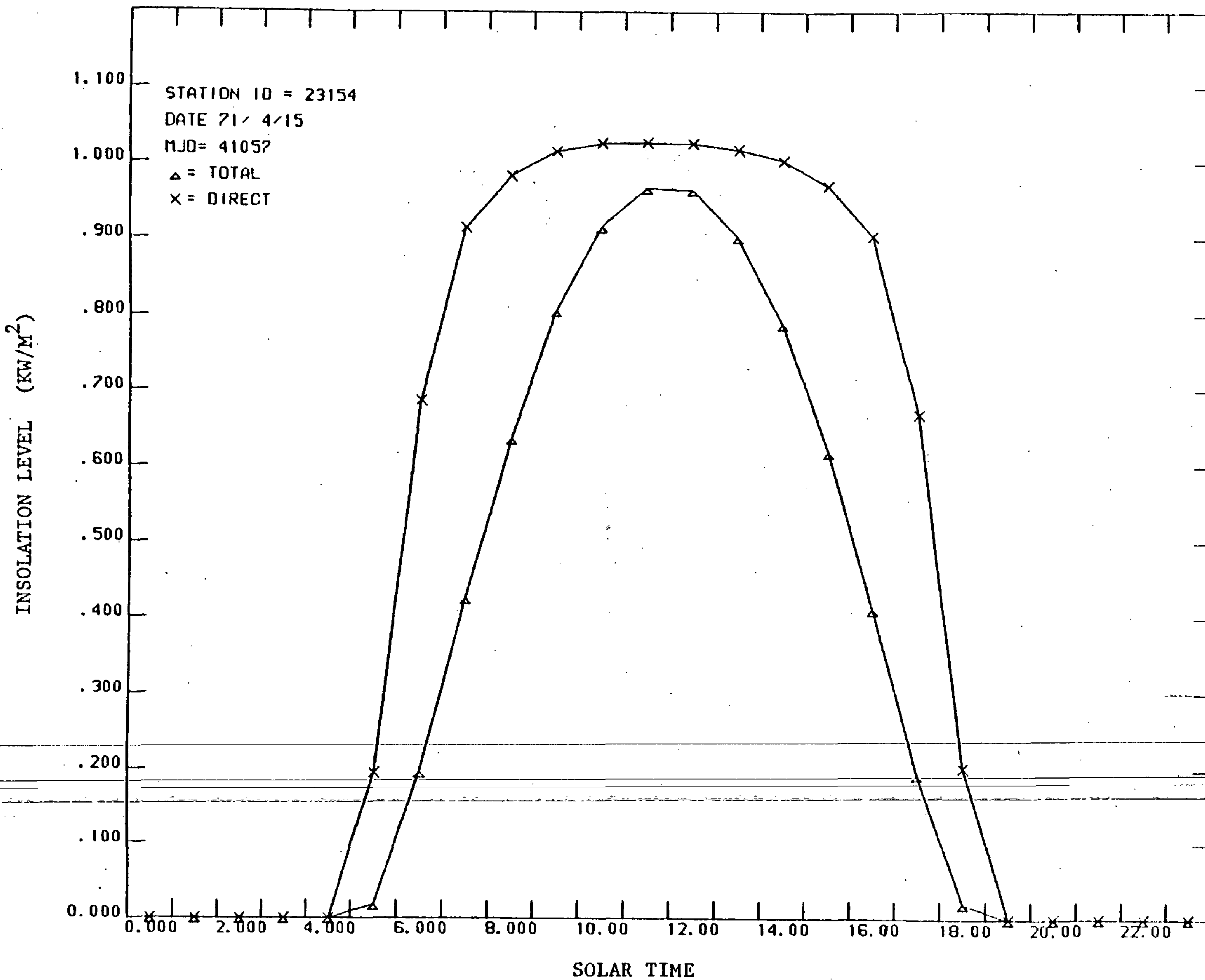


FIGURE 2-6. INSOLATION DATA - MAY CLEAR DAY

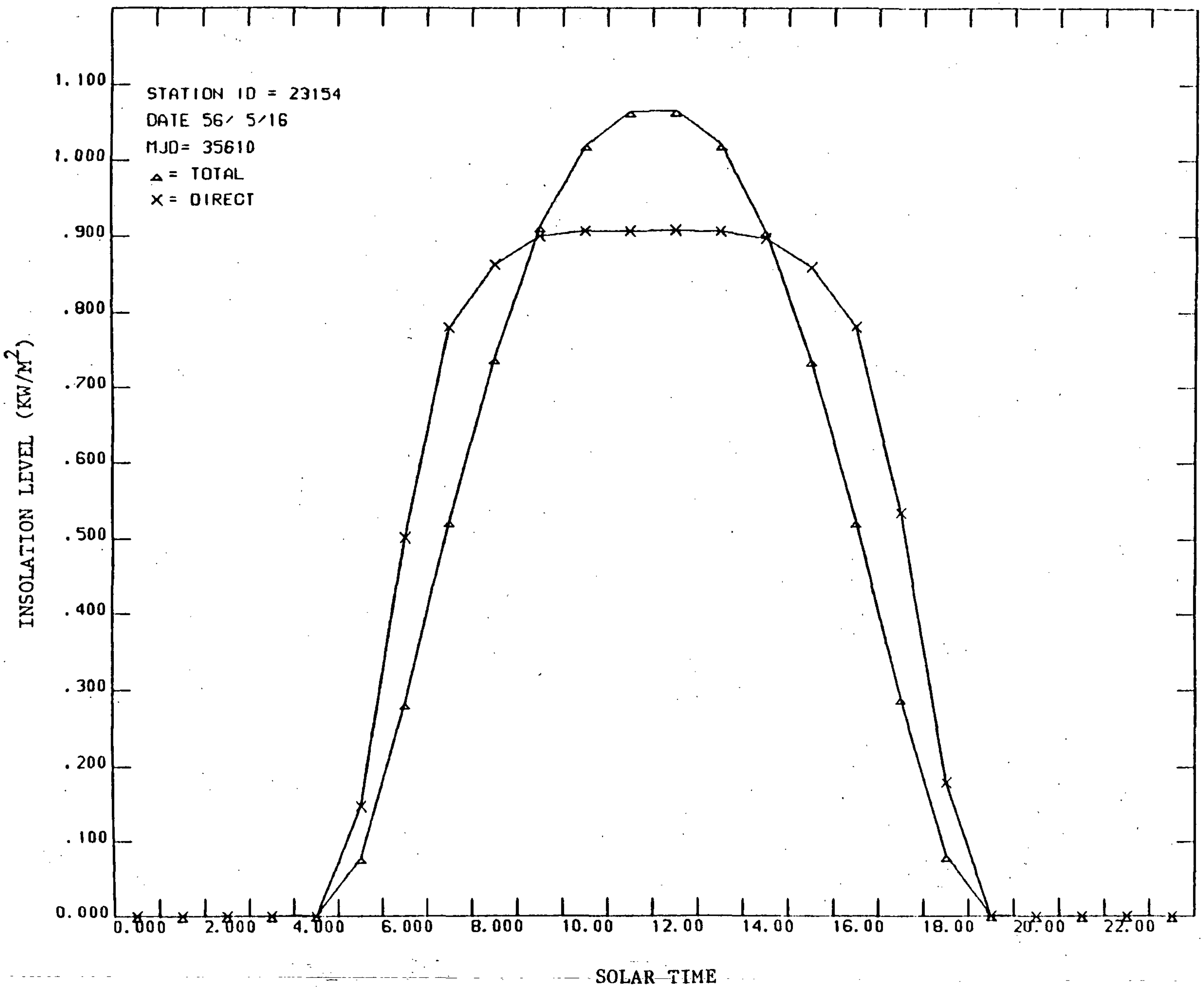


FIGURE 2-7. ELY INSOLATION DATA - JUNE CLEAR DAY

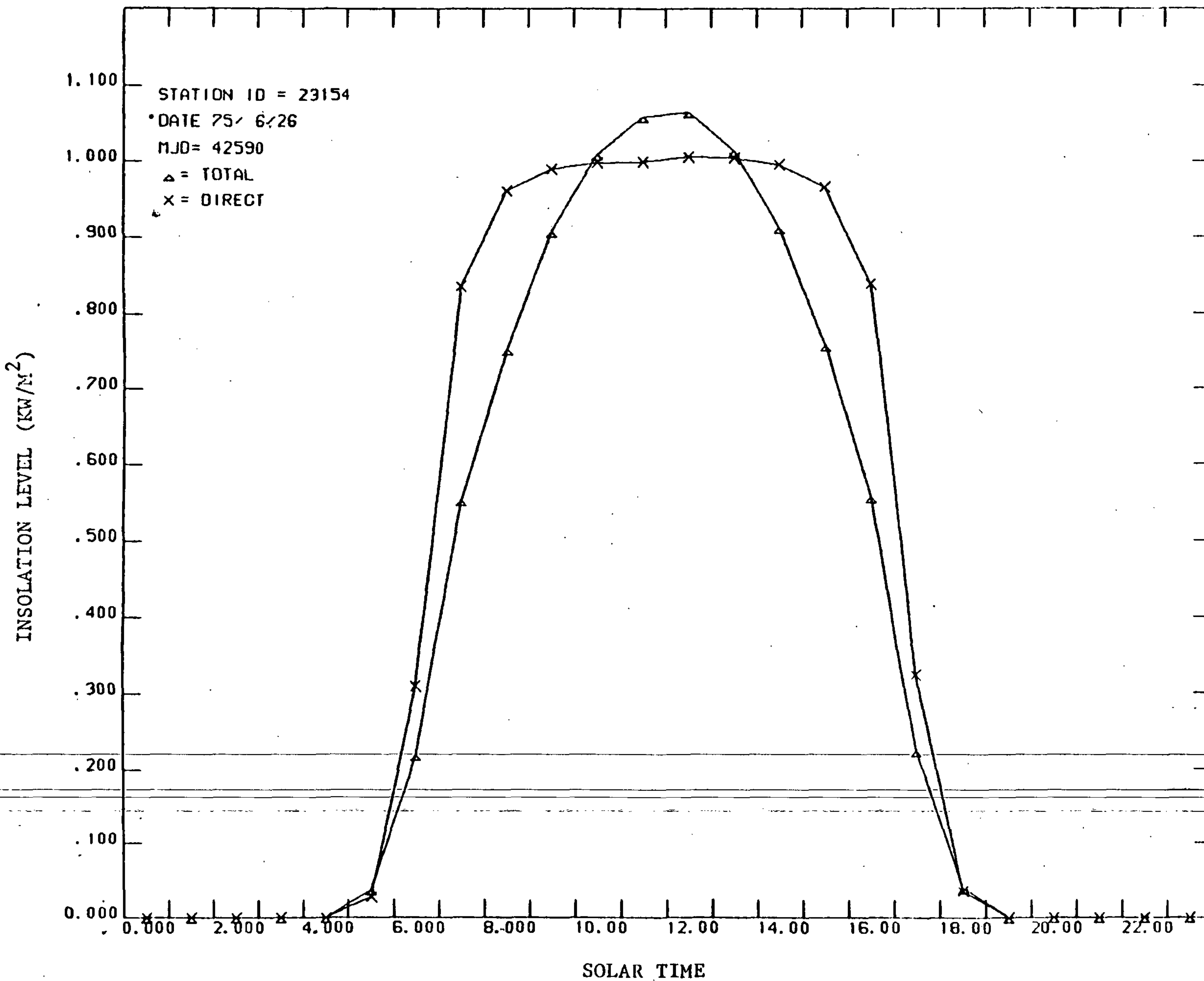


FIGURE 2-8. ELY INSOLATION DATA - JULY CLEAR DAY

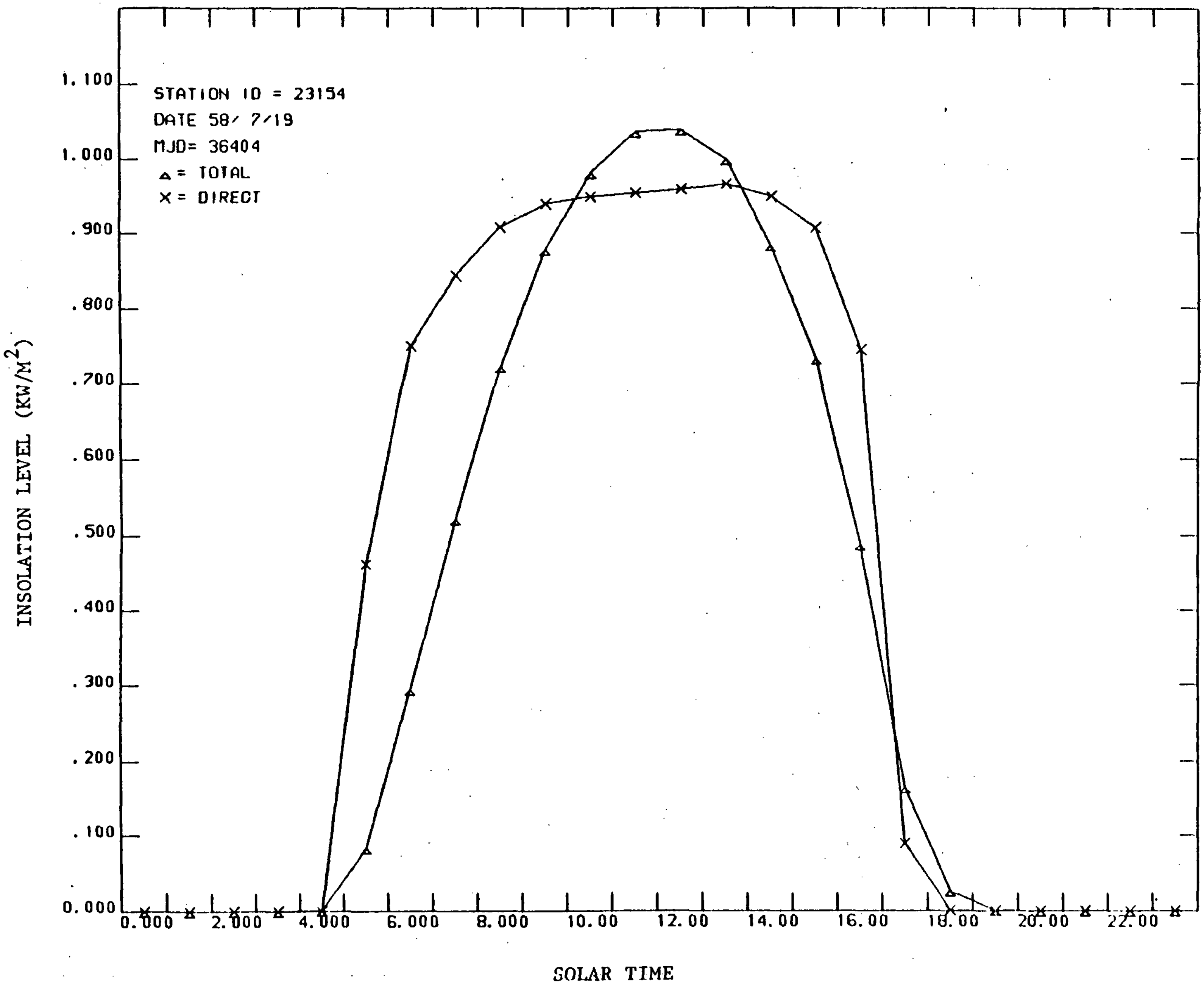


FIGURE 2-9. ELY INSOLATION DATA - AUGUST CLEAR DAY

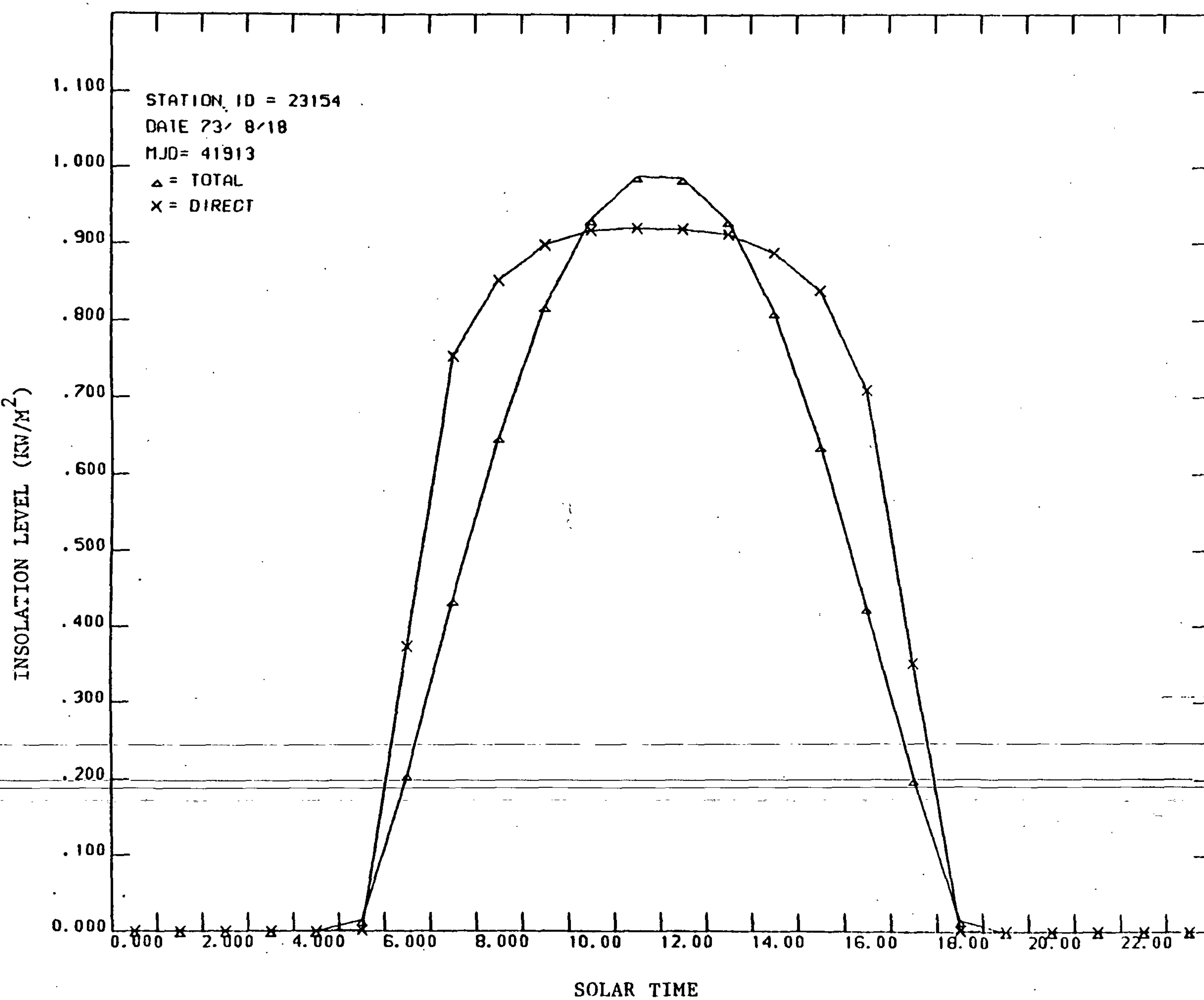


FIGURE 2-10. ELY INSOLATION DATA - SEPTEMBER CLEAR DAY

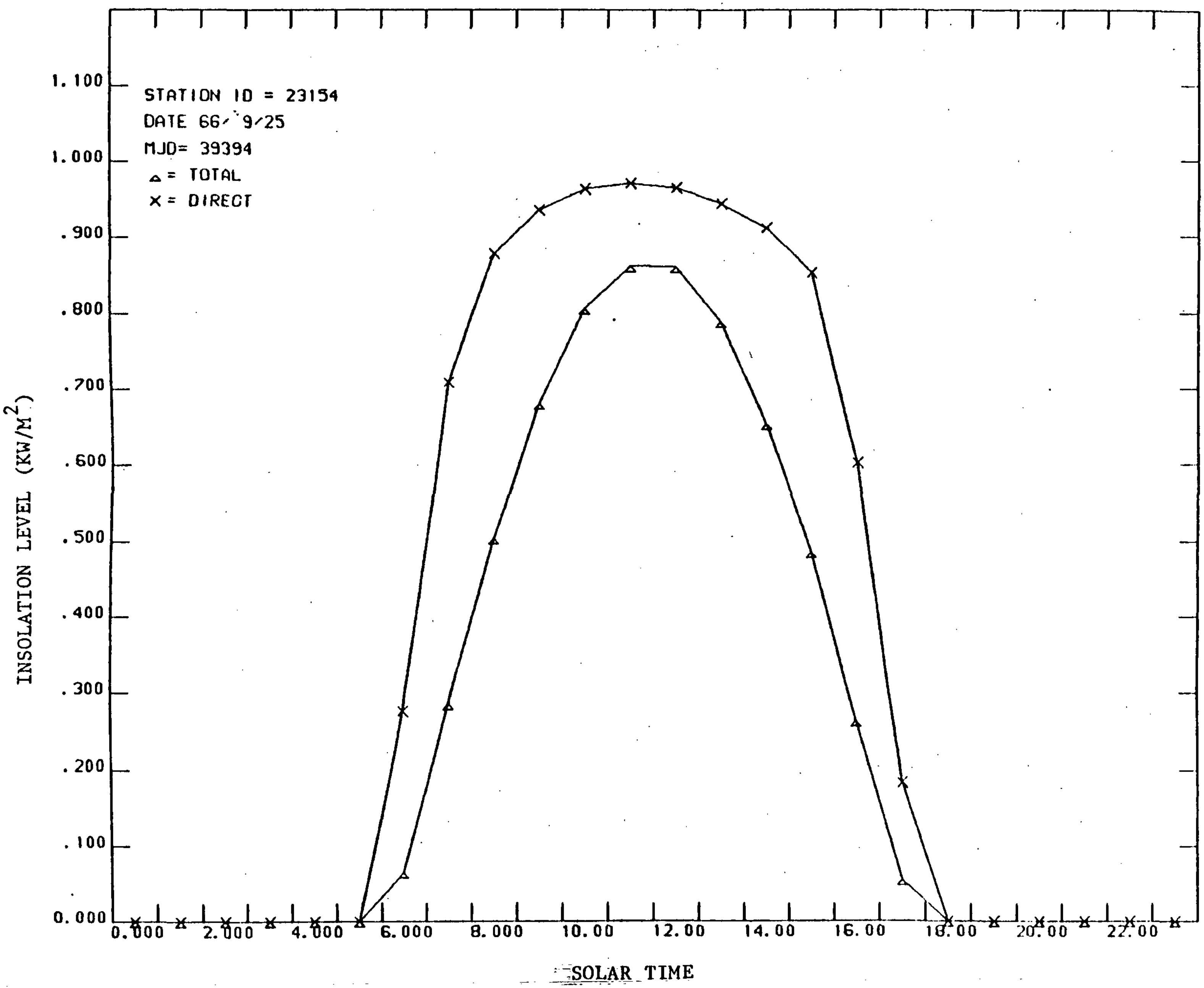


FIGURE 2-11. ELY INSOLATION DATA - OCTOBER CLEAR DAY

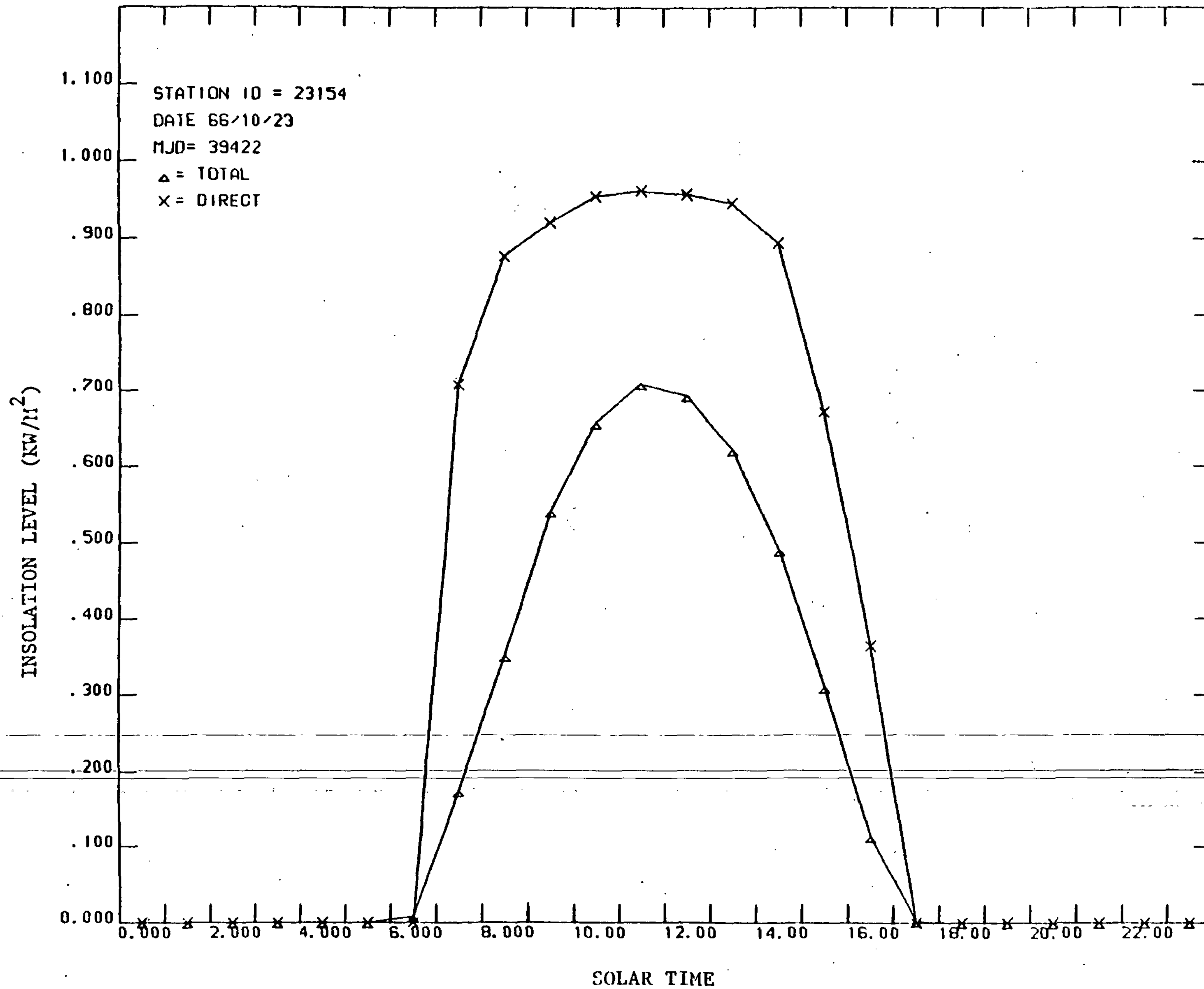


FIGURE 2-12. ELY INSOLATION DATA - NOVEMBER CLEAR DAY

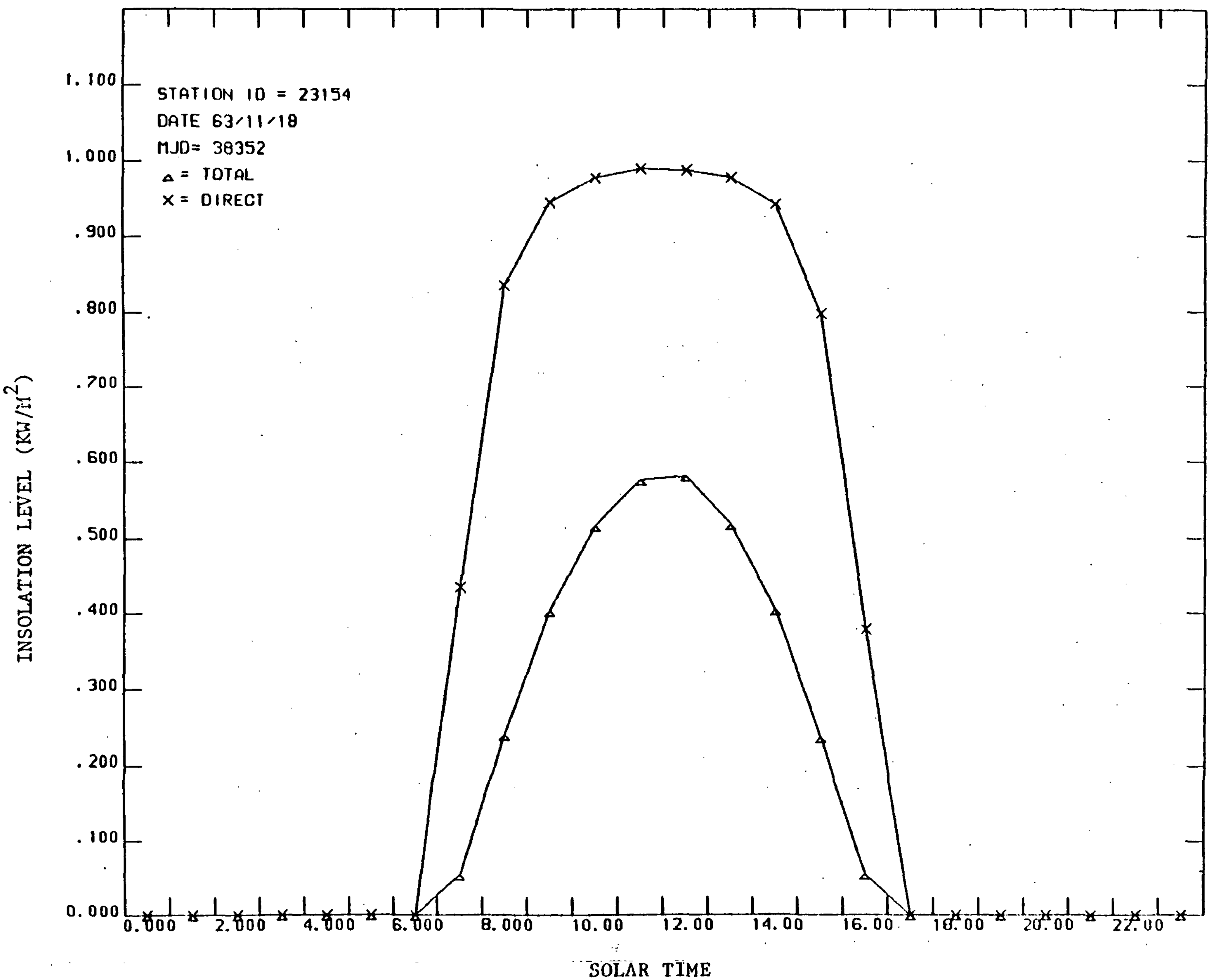


FIGURE 2-13. ELY INSOLATION DATA - DECEMBER CLEAR DAY

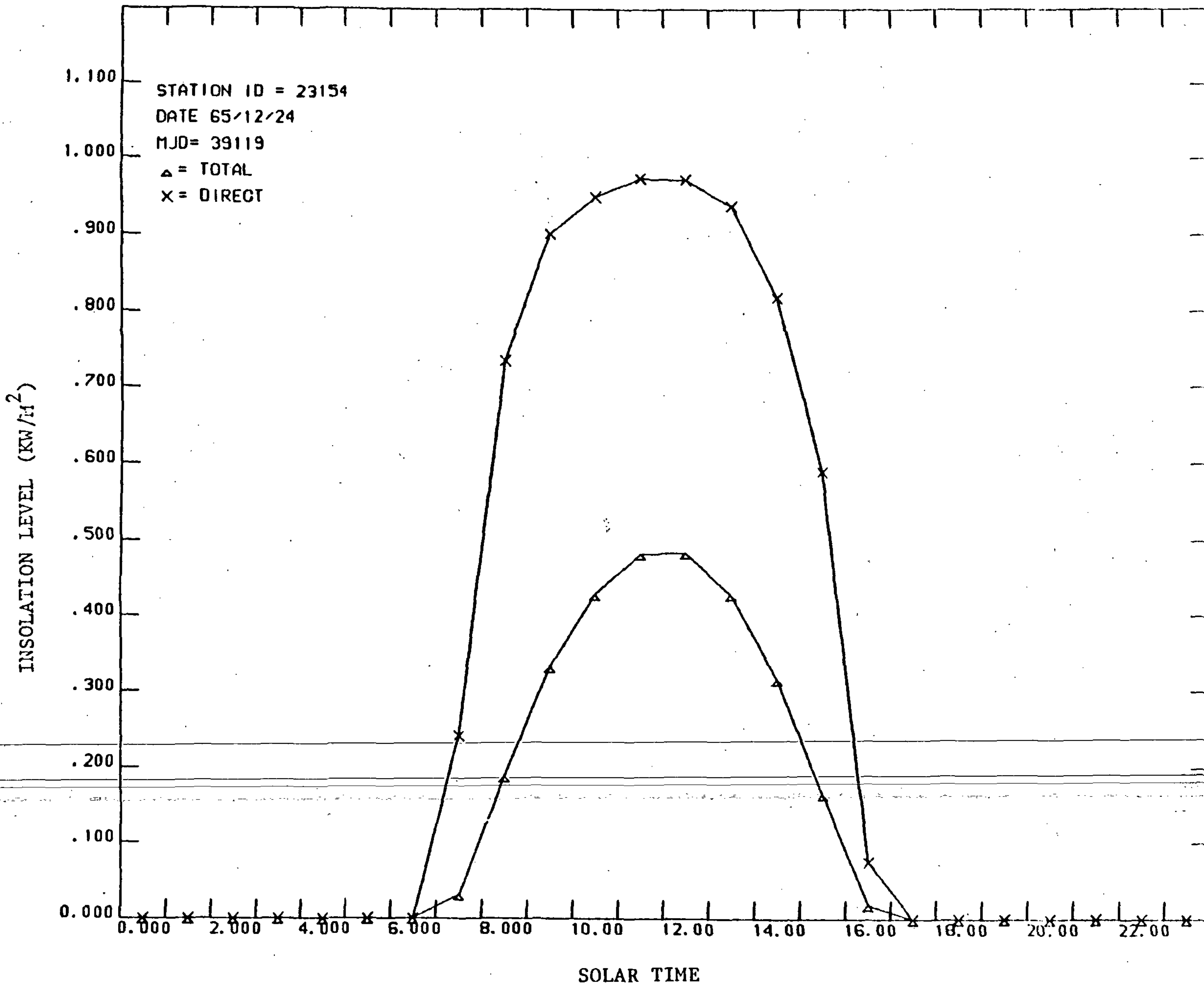


FIGURE 2-14. ELY INSOLATION DATA - APRIL CLOUDY DAY

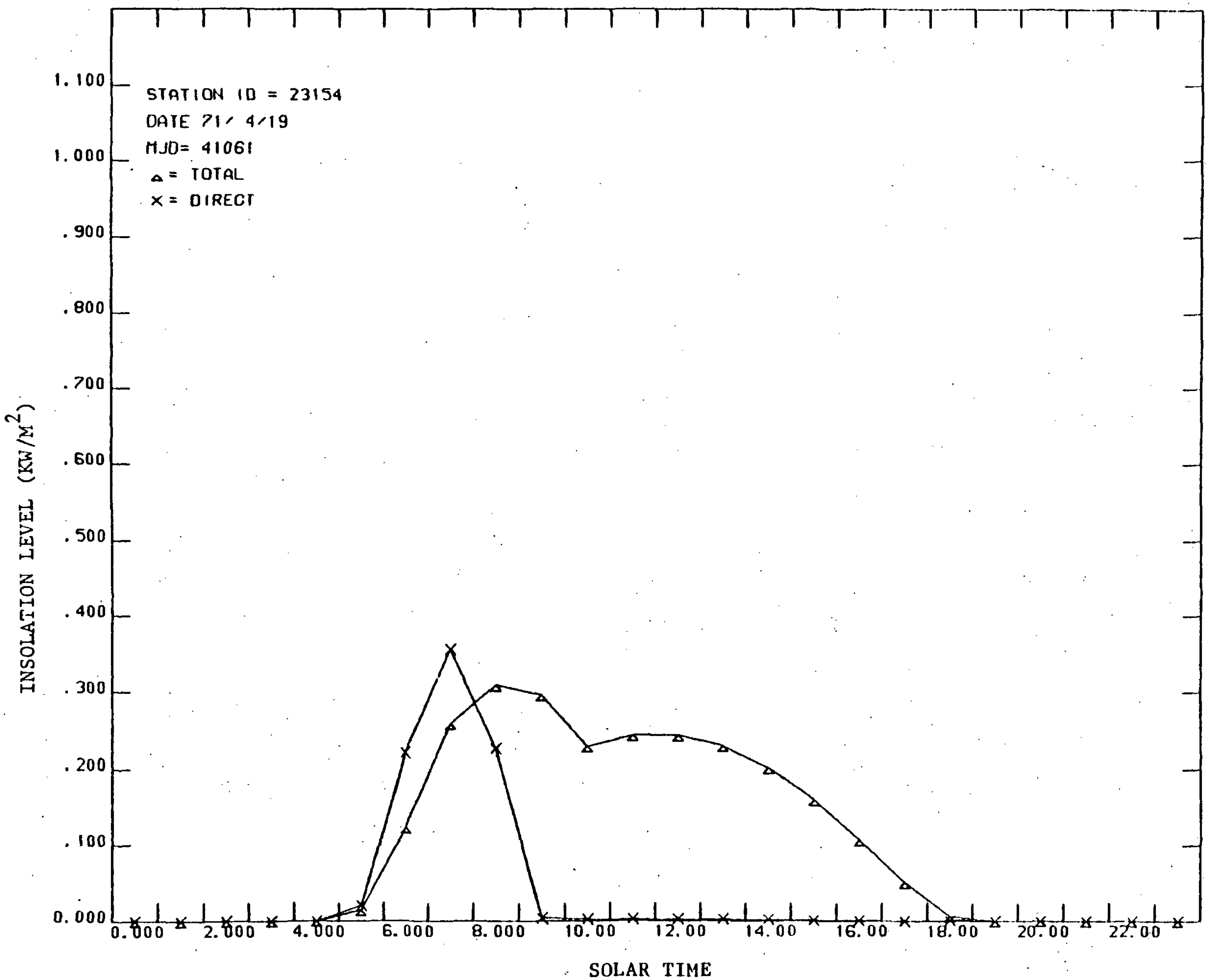


FIGURE 2-15. ELY INSOLATION DATA - MAY CLOUDY DAY

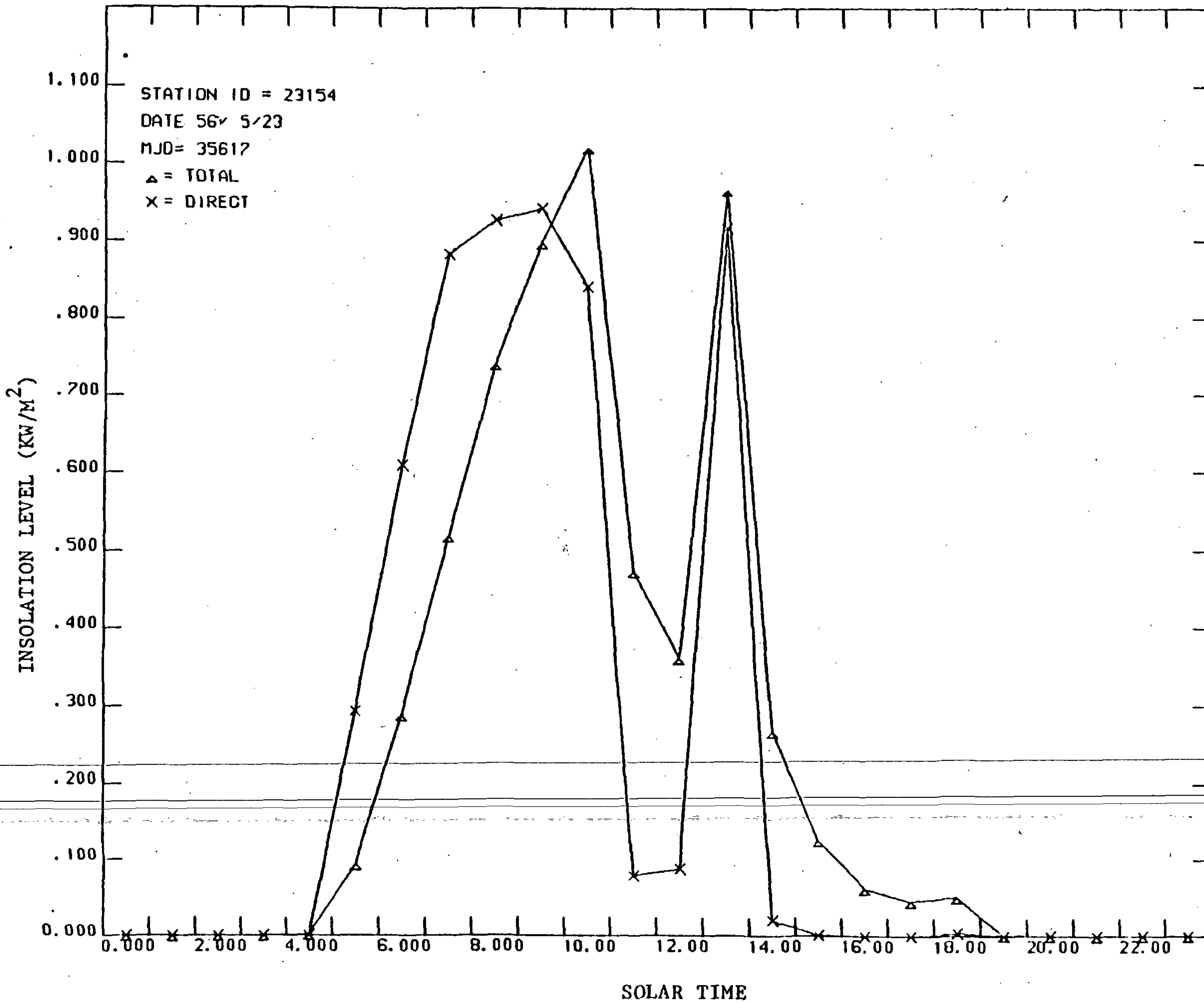


TABLE 2-1. DAILY DIRECT-NORMAL INSOLATION

ELY NEVADA, TYPICAL METEOROLOGICAL YEAR

($KW\text{-}HR/M^2\text{-}Day$)

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	7.58	6.68	1.82	9.65	9.85	9.19	9.42	6.45	2.87	8.07	8.57	7.26
2	5.67	1.93	9.50	8.74	8.53	3.97	9.38	4.40	6.58	5.25	7.65	7.12
3	7.77	7.89	3.61	10.34	6.34	2.05	6.12	3.43	9.22	7.34	5.83	5.93
4	1.72	.70	5.81	11.25	4.30	9.57	6.19	3.39	10.95	8.99	4.47	3.17
5	.40	6.01	4.13	9.85	5.71	10.41	6.79	6.68	8.43	7.51	2.80	1.28
6	2.01	6.03	7.31	10.15	10.77	7.88	8.46	6.28	5.34	4.05	1.39	5.98
7	3.18	8.32	8.20	5.52	8.15	4.62	11.20	9.19	9.60	9.22	6.18	3.30
8	1.91	8.78	5.63	6.82	8.84	9.39	9.56	11.16	10.80	8.81	1.18	4.33
9	7.41	7.81	9.25	10.22	4.93	8.03	11.71	8.24	5.16	8.35	8.01	.15
10	6.72	7.98	4.09	8.64	1.34	9.91	10.72	11.04	3.27	9.87	7.06	.05
11	3.56	8.73	1.36	10.49	.21	9.47	8.87	11.20	10.14	7.36	7.74	5.73
12	2.61	7.82	8.05	11.17	4.06	9.00	8.59	8.49	8.61	5.11	3.92	.67
13	3.30	7.84	2.61	8.89	8.45	9.25	8.68	7.39	7.89	3.21	3.61	3.54
14	4.73	8.28	6.65	4.15	10.21	10.36	3.54	6.27	7.92	7.94	6.44	5.89
15	5.00	3.05	4.66	11.65	10.67	9.10	5.66	8.99	9.54	8.13	.83	5.59
16	3.32	7.64	8.15	8.56	10.07	7.89	11.57	7.98	10.10	9.34	7.37	6.56
17	1.58	.69	10.14	1.84	9.47	4.73	11.80	6.14	9.61	9.09	7.93	7.06
18	2.18	5.02	9.88	1.12	1.39	4.08	11.25	9.34	2.21	8.02	8.27	6.72
19	6.05	.44	9.87	.85	9.73	1.72	10.43	7.87	1.88	7.03	4.25	7.31
20	.03	2.49	7.72	6.53	6.90	4.26	5.76	6.74	8.80	.90	.51	5.32
21	4.28	7.68	9.46	.40	8.14	7.20	6.82	2.25	7.90	5.12	2.58	1.49
22	7.34	1.92	5.50	8.66	5.34	5.83	3.43	9.32	8.91	4.72	5.77	1.79
23	7.49	7.89	.85	.49	5.61	7.46	8.41	10.29	9.53	8.26	3.81	6.87
24	5.46	9.46	8.65	4.84	9.06	8.68	10.83	10.59	10.03	9.13	4.87	7.19
25	5.52	5.13	4.86	4.62	6.51	8.24	10.39	8.03	9.20	9.20	6.67	3.29
26	3.18	2.73	7.27	1.20	7.79	10.30	10.64	9.92	1.07	7.10	7.09	5.41
27	7.73	4.94	5.64	7.03	1.60	10.51	11.85	9.78	8.89	7.19	7.08	2.82
28	4.64	3.43	7.55	3.53	3.89	9.27	9.24	8.77	8.63	8.11	3.04	3.68
29	7.82		10.74	10.56	9.85	10.19	2.39	8.55	10.50	7.93	7.21	.19
30	7.18		8.31	10.45	11.23	9.17	6.50	9.12	10.35	7.95	7.00	5.28
31	.53		8.59		10.95		6.91	3.65		8.82		4.43
MEAN	4.45	5.62	6.64	6.94	7.09	7.72	8.49	7.78	7.80	7.33	5.30	4.37
STD DEV	2.47	2.87	2.75	3.74	3.17	2.58	2.64	2.42	2.88	2.05	2.44	2.38

ANNUAL MEAN = 6.63

TABLE 2-2. DAILY GLOBAL-HEMISPHERIC INSOLATION
ELY NEVADA, TYPICAL METEOROLOGICAL YEAR
(KW-HR/M^2-Day)

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	3.02	3.17	2.77	7.23	8.73	8.21	9.44	7.27	4.43	5.80	4.30	3.04
2	2.68	1.99	5.40	6.49	7.90	6.54	8.63	5.77	6.16	4.29	3.98	2.90
3	3.02	3.75	3.88	7.39	6.84	5.13	6.81	4.77	7.43	5.80	3.61	2.94
4	1.64	1.67	4.38	7.42	5.13	8.81	6.58	5.41	7.37	5.68	2.75	2.13
5	1.22	3.71	4.02	7.39	6.13	8.89	6.92	6.46	6.91	5.42	2.39	1.69
6	1.93	3.93	5.63	6.85	8.74	8.34	8.10	6.11	5.47	3.60	1.61	2.76
7	2.04	4.09	4.82	5.73	7.91	5.54	9.10	7.56	6.95	5.55	3.61	2.14
8	1.88	4.14	4.74	6.41	8.39	8.90	9.23	8.15	7.11	5.65	1.75	2.30
9	3.35	4.12	5.83	7.40	5.69	8.32	9.29	8.29	5.16	5.50	3.80	.84
10	3.19	3.95	4.05	7.71	4.05	9.08	9.34	8.30	4.09	5.51	3.60	.65
11	2.17	4.17	3.56	7.33	2.60	8.60	8.94	8.26	6.87	4.74	3.73	2.84
12	2.15	4.29	5.90	7.85	5.91	8.33	7.80	8.24	6.94	3.99	2.69	1.21
13	2.05	4.07	3.46	7.00	7.76	8.80	7.57	7.45	6.92	3.03	2.43	2.03
14	2.90	4.24	5.18	4.93	9.21	8.98	4.69	6.05	6.03	5.18	3.33	2.73
15	2.60	2.42	3.80	7.87	9.24	8.45	7.27	7.30	6.79	4.81	1.28	2.52
16	2.25	4.22	5.68	7.50	9.25	8.58	9.13	6.76	6.74	5.04	3.89	2.76
17	1.36	2.30	6.13	4.09	8.50	6.19	9.25	6.55	6.83	5.06	3.54	2.79
18	1.99	3.49	6.42	2.33	3.95	5.40	9.11	8.06	3.36	4.98	3.59	3.08
19	3.03	1.86	6.46	2.48	8.49	4.50	8.86	7.20	3.18	4.71	2.77	2.98
20	.42	3.33	6.53	6.39	7.16	5.86	6.58	5.92	6.46	1.76	1.25	2.59
21	2.80	4.84	6.38	3.47	8.19	7.72	7.19	3.98	6.08	3.98	1.88	1.67
22	3.49	3.30	4.82	6.66	6.21	7.43	5.63	7.14	6.02	3.12	2.88	1.60
23	3.60	4.62	2.84	3.12	5.93	7.81	7.96	7.89	6.13	4.68	2.48	2.95
24	3.24	4.98	5.75	6.14	7.83	8.50	8.71	7.77	6.29	4.64	2.71	2.87
25	3.06	4.09	5.17	5.21	6.75	7.88	8.89	7.68	6.31	4.59	3.23	1.99
26	2.43	2.99	6.06	4.35	7.92	9.10	8.67	7.61	2.50	4.18	3.06	2.48
27	3.62	4.06	5.27	6.86	2.53	9.05	8.87	7.39	5.97	3.76	3.04	1.96
28	2.94	3.02	6.67	4.86	6.33	8.99	7.50	7.56	6.07	3.98	1.87	2.14
29	3.79		7.06	8.06	8.62	9.09	4.45	7.65	6.14	4.37	2.95	.79
30	3.79		5.64	8.23	9.55	8.82	6.37	7.41	6.09	4.26	3.05	2.80
31	1.42		6.56		9.63		6.66	4.80		4.11		2.41
MEAN	2.55	3.60	5.19	6.16	7.13	7.87	7.86	6.99	5.96	4.57	2.90	2.28
STD DEV	.84	.89	1.18	1.71	1.96	1.38	1.39	1.15	1.26	.92	.82	.70

ANNUAL MEAN = 5.26

FIGURE 2-16. MEAN DAILY INSOLATION
ELY, NEVADA

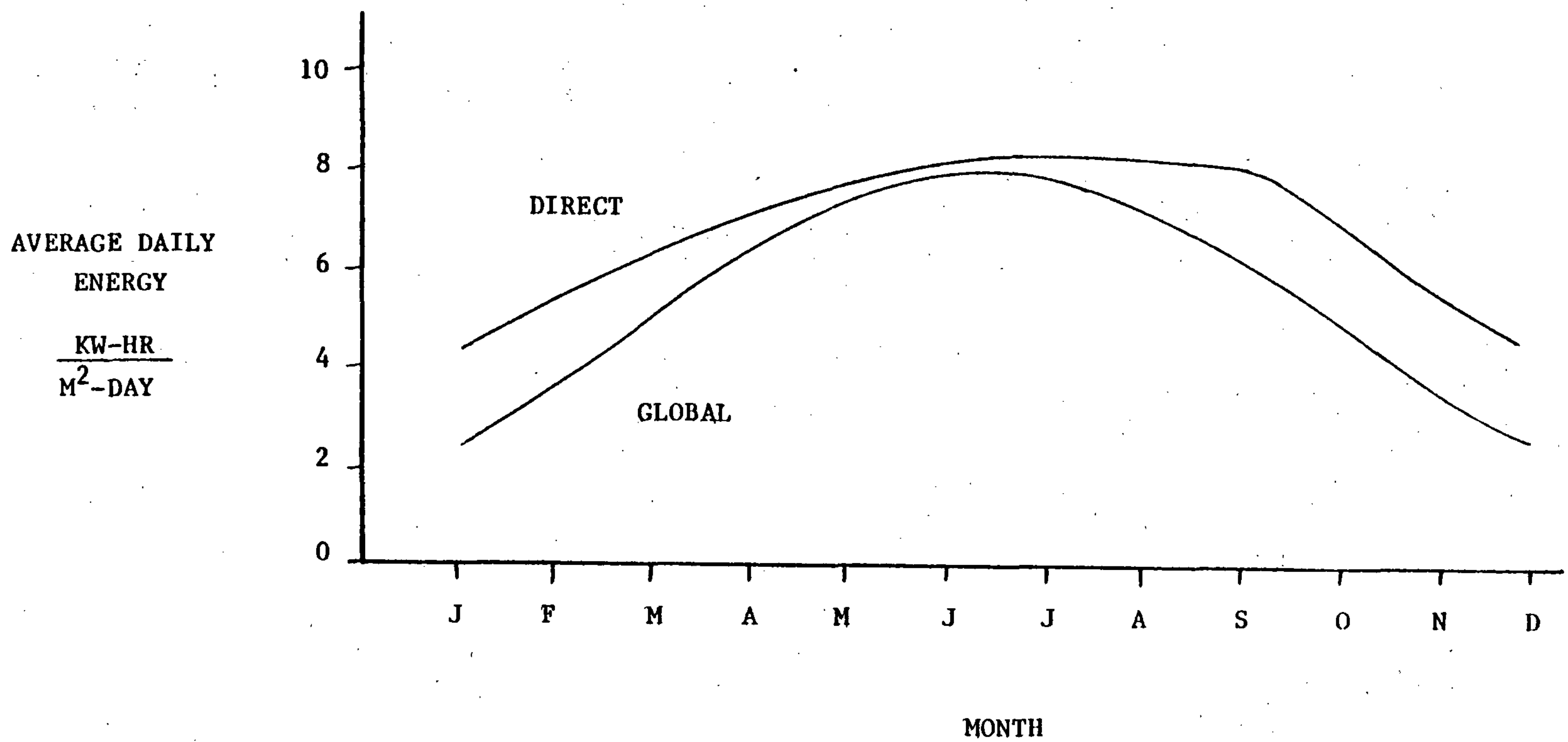


TABLE 2-3. MEAN DAILY DIRECT-NORMAL INSOLATION

ELY NEVADA (KW-HR/M^2-Day)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1951	--	--	--	--	--	--	--	--	--	--	--	3.94	--
1952	4.42	6.19	6.32	7.00	8.70	9.57	8.32	8.85	7.44	7.51	5.58	3.74	6.97
1953	4.28	5.37	6.78	6.83	7.15	9.45	7.55	9.05	7.58	6.34	4.21	4.80	6.62
1954	4.27	6.99	5.99	7.89	8.39	7.80	8.62	8.92	7.73	7.20	5.88	5.07	7.06
1955	5.12	5.75	7.48	6.92	7.18	8.73	8.85	7.05	7.52	7.29	5.23	3.99	6.76
1956	3.49	6.22	8.07	6.26	7.09	9.50	8.03	8.65	8.03	6.20	6.92	4.73	6.93
1957	4.36	4.72	4.26	5.75	5.55	8.73	8.59	8.46	8.40	4.98	4.59	4.65	6.09
1958	4.73	4.58	4.75	7.03	8.78	9.94	8.49	7.26	8.02	7.38	5.50	5.07	6.80
1959	4.14	5.25	7.09	7.95	7.66	8.86	7.36	7.66	6.75	7.48	6.97	4.64	6.82
1960	4.40	4.31	6.51	7.73	8.41	8.78	7.04	8.72	7.37	6.50	4.48	5.19	6.63
1961	5.58	4.81	5.50	7.27	7.37	8.98	8.12	5.88	7.79	6.07	5.34	4.47	6.43
1962	4.98	3.47	6.47	7.87	5.69	8.50	8.15	9.06	8.51	7.64	5.88	5.84	6.86
1963	5.11	5.38	6.40	5.18	7.48	7.19	10.66	8.16	7.43	6.67	5.30	5.13	6.69
1964	4.73	6.99	6.60	6.16	7.10	7.35	9.20	8.61	8.92	6.98	5.18	3.19	6.75
1965	4.25	6.28	6.51	5.92	6.89	7.24	7.67	7.61	7.20	8.08	4.38	4.37	6.37
1966	5.56	5.34	7.01	8.24	8.72	8.47	8.89	7.55	7.80	7.33	4.63	3.99	6.97
1967	4.33	6.50	5.37	5.59	6.24	7.07	8.09	7.93	7.74	7.83	5.36	4.48	6.38
1968	5.85	4.66	6.69	7.99	7.32	7.62	7.73	7.64	8.81	6.88	4.75	3.59	6.63
1969	3.94	3.67	7.51	7.74	8.38	5.96	7.59	8.28	8.40	6.10	5.90	4.19	6.49
1970	3.97	5.90	6.83	6.02	8.23	6.76	7.26	7.68	8.83	7.14	4.50	4.58	6.48
1971	4.75	5.62	6.64	6.54	6.05	7.90	7.61	6.98	8.76	6.52	5.32	3.54	6.38
1972	5.83	6.04	7.85	7.44	7.85	7.11	8.72	8.01	7.31	5.90	4.05	4.04	6.69
1973	4.29	4.30	4.26	6.40	7.31	7.62	7.10	7.78	8.51	7.33	3.69	3.97	6.05
1974	4.45	6.07	5.79	7.47	7.87	8.49	7.23	8.72	9.26	5.21	6.47	3.88	6.74
1975	4.98	5.15	4.90	5.80	7.16	7.72	7.72	8.42	8.50	6.47	5.74	5.04	6.49
MEAN	4.66	5.40	6.32	6.89	7.44	8.14	8.11	8.04	8.03	6.79	5.24	4.40	6.63
STANDARD DEVIATION: (kW hr/m^2-Day)	.61	.95	1.04	.89	.92	1.01	.82	.78	.65	.79	.86	.63	.26
(% of mean)	13.1	17.6	16.5	12.9	12.4	12.4	10.11	9.7	8.1	11.6	14.4	14.3	3.9

MEAN STANDARD DEVIATION IS 12.8%

TABLE 2-4. MEAN DAILY GLOBAL INSOLATION

ELY, NEVADA

(KW-HR/M^2-Day)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1951	--	--	--	--	--	--	--	--	--	--	--	2.20	--
1952	2.63	3.97	5.38	6.47	8.06	8.71	7.88	7.52	6.01	4.74	3.01	2.19	5.55
1953	2.46	3.67	5.42	6.51	7.07	8.52	7.34	7.64	5.03	4.35	2.70	2.36	5.35
1954	2.52	4.09	4.98	6.84	7.83	7.66	7.76	7.44	5.99	4.63	3.16	2.44	5.45
1955	2.83	3.71	5.60	6.54	7.13	8.22	8.04	6.50	5.99	4.69	2.92	2.16	5.37
1956	2.19	3.91	5.84	6.11	7.13	8.79	7.63	7.45	6.18	4.15	3.42	2.39	5.44
1957	2.55	3.47	4.24	5.85	6.18	8.22	7.81	7.30	6.28	3.75	2.71	2.38	5.07
1958	2.63	3.36	4.40	6.46	7.91	8.69	7.85	6.66	6.12	4.73	3.02	2.48	5.37
1959	2.45	3.62	5.41	6.95	7.32	8.28	7.36	6.94	5.46	4.65	3.38	2.30	5.35
1960	2.51	3.32	5.13	6.65	7.72	8.15	7.03	7.39	5.84	4.32	2.60	2.49	5.27
1961	2.81	3.36	4.71	6.51	7.38	8.17	7.56	5.80	6.03	4.17	2.91	2.30	5.15
1962	2.64	2.80	5.15	6.75	6.17	7.98	7.58	7.53*	6.40	4.73	3.15	2.63	5.30
1963	2.59	3.60	5.10	5.55	7.27	7.07	8.84	7.03	5.84	4.47	2.90	2.46	5.24
1964	2.60	4.22	5.27	6.11	7.15	7.51	8.27	7.26	5.62	4.73	3.02	1.96	5.39
1965	2.54	4.00	5.12	5.90	6.91	7.19	7.27	6.67	5.74	4.90	2.66	2.28	5.11
1966	2.81	3.57	5.39	6.98	7.84	8.11	7.99	6.70	5.95	4.57	2.74	2.18	5.41
1967	2.46	3.87	4.62	5.64	6.62	7.04	7.56	6.91	5.86	4.76	2.95	2.28	5.05
1968	2.84	3.31	5.11	6.61	7.29	7.72	7.76	6.75	6.36	4.41	2.84	2.08	5.26
1969	2.34	2.89	5.40	6.58	7.80	6.75	7.57	7.02	6.20	4.19	3.11	2.21	5.18
1970	2.37	3.74	5.15	5.87	7.81	7.29	7.41	6.89	6.34	4.47	2.71	2.28	5.20
1971	2.68	3.59	5.19	6.15	6.51	8.11	7.73	6.58	6.35	4.35	2.94	2.01	5.19
1972	2.90	3.82	5.61	6.51	7.54	7.52	8.18	7.01	5.70	4.04	2.50	2.20	5.30
1973	2.44	3.15	4.08	6.03	7.35	7.89	7.54	6.99	5.20	4.58	2.53	2.14	5.09
1974	2.55	3.69	4.79	6.49	7.61	8.51	7.39	7.46	6.57	3.84	3.16	2.17	5.36
1975	2.66	3.45	4.40	5.79	7.19	7.87	7.69	7.29	6.27	4.24	3.04	2.39	5.20
MEAN	2.58	3.59	5.06	6.33	7.28	7.92	7.71	7.03	5.10	4.43	2.92	2.28	5.28
STD DEV KWHR/M2	.17	.35	.46	.41	.52	.57	.38	.43	.28	.30	.25	.16	.13
PERCENT	6.7	9.8	9.0	6.5	7.2	7.2	4.9	6.1	4.6	6.8	8.4	7.0	2.5

Mean Standard Deviation Percent is 7.0%

Note: Boxed area denotes those months for which more than half the values were obtained from other meteorogical observations.

TABLE 2-5. PROBABILITY OF SUCCESSIVE DAYS

ELY, NEVADA

INSOLATION

INSOLATION (W/M^2) DAILY AVERAGE	JAN				FEB				MAR				APR			
	DAYS				DAYS				DAYS				DAYS			
INT	1	3	5	7	1	3	5	7	1	3	5	7	1	3	5	7
60	90	74	63	54	96	90	85	81	99	99	98	98	100	100	100	100
120	35	12	6	3	74	48	34	24	91	78	68	60	95	87	81	75
180	0	0	0	0	21	8	4	3	70	44	30	21	83	63	50	41
240	0	0	0	0	0	0	0	0	30	12	6	3	64	39	24	15
300	0	0	0	0	0	0	0	0	0	0	0	0	34	11	5	2
	MAY				JUN				JUL				AUG			
	DAYS				DAYS				DAYS				DAYS			
INT	1	3	5	7	1	3	5	7	1	3	5	7	1	3	5	7
60	100	100	100	100	99	99	99	99	100	100	100	100	100	100	100	100
120	98	94	91	87	98	96	93	92	100	100	100	100	99	99	99	98
180	92	79	68	58	94	88	82	78	98	93	89	84	96	88	82	76
240	81	59	45	33	85	72	62	55	88	70	56	45	83	63	48	38
300	59	31	17	8	73	53	42	33	66	41	25	16	53	26	14	7
	SEP				OCT				NOV				DEC			
	DAYS				DAYS				DAYS				DAYS			
INT	1	3	5	7	1	3	5	7	1	3	5	7	1	3	5	7
60	99	99	98	97	97	93	88	84	94	83	73	64	83	62	48	37
120	97	92	86	82	88	71	58	45	58	25	13	7	0	0	0	0
180	91	80	68	58	57	33	19	12	0	0	0	0	0	0	0	0
240	73	47	30	19	0	0	0	0	0	0	0	0	0	0	0	0
300	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

2.3 VARIABILITY RELATIVE TO ELY

The temporal and spatial variability of insolation values across the MX deployment area and relative to Ely may be inferred from the following data.

2.3.1 Temporal Variations

Figure 2-16 depicts the natural variability in insolation that occurs month to month. The mean monthly values corresponding to the figure plus the standard deviation related to each month are also included at the bottom of each column in Tables 2-3 and 2.4. Note the standard deviation value is expressed both in energy units and as a fraction of the mean value; the latter is the percentage form of the coefficient of variability (i.e., the ratio of the standard deviation to the mean). The interannual coefficients of variability on an annual basis are 3.9 percent and 2.5 percent for direct and global insolation, respectively. These data are summarized in Table 2-6 with monthly and daily coefficients of variability for combined seasons for the TMY (i.e., Tables 2-1 and 2-2). Therefore, Table 2-6 indicates the temporal variability of insolation at Ely. Long term interannual averaging produces considerably smaller coefficients of variability than daily averaging.

Table 2-6

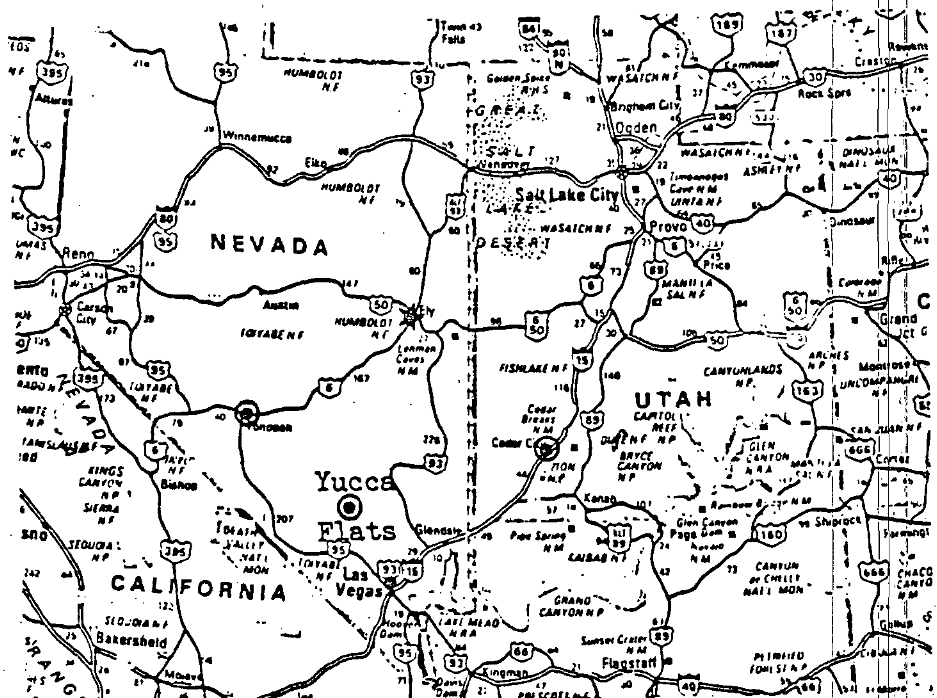
INSOLATION TEMPORAL VARIABILITY

Time Scale	Coefficient of Variability (σ / μ, %) Direct	Global
Yearly (SOLMET)	3.9	2.5
Monthly (Across 24 years-SOLMET)	12.8	7.3
Daily (Across 12 months-TMY)		
Dec-May	50.0	27.8
Jun-Nov:	32.2	20.2

2.3.2 Spatial Variations

Spatial variations of insolation across the MX deployment area may be inferred from the following three sets of data for selected sites shown in Figure 2-17. These sites are either: (1) members of an Ersatz data base group which uses a recently developed algorithm to estimate hourly global insolation in the presence of hourly cloud cover observations, but absence of insolation measurements (Ersatz stations include Tonopah, Yucca Flats, and Las Vegas, Nevada, and Cedar City, Utah); or (2) members of a new National Weather Service (NWS) network of measurement stations established in 1977 (including Ely and Las Vegas, Nevada). The data corresponding to these memberships are described as follows according to a - Ersatz data, b - NWS direct insolation data, and c - NWS global insolation data.

FIGURE 2-17. LOCATIONS OF INSOLATION DATA COMPILATIONS FOR THE MX-RES DEPLOYMENT AREA



NOTE:

Ely, Nevada (★) was a part of the old NWS Network and has had a rehabilitated SOLMET format data tape with estimated direct insolation prepared for it. A TMY tape is also available for Ely. Tonopah, Yucca Flats and Las Vegas, Nevada and Cedar City, Utah (◉) have had ersatz SOLMET Data tapes prepared based on Meteorological observations. Ely and Las Vegas, Nevada are also sites of stations in the New NWS insolation measuring Network started in 1977.

a. Ersatz Data: Mean monthly global insolation values and temperature data are available from the Ersatz data base for the locations pertinent to MX which may be used for comparison with Ely (Reference 6.7). These values are presented in Table 2-7. The insolation values are presented both in terms of actual energy units and as a percent of the daily extraterrestrial (ETR) insolation for the 15th of the month. The daily ETR insolation (Q_o) is the energy incident on a horizontal surface at the latitude of the sensor ignoring all atmospheric effects, i.e., in equation form:

$$Q_o = \int_{\text{sunrise}}^{\text{sunset}} D \cos z(t)\, dt$$

where

z is the angle from the zenith to the sun (i.e., the solar zenith angle).

b. New NWS Network Direct Insolation Data: Table 2-8 lists the geographic characteristics of Ely and Las Vegas, which are the NWS network stations of interest to MX-RES. Hourly data for these two sites are available on computer tapes in a format similar to, but not identical with, SOLMET (Reference 6.6).

The monthly mean direct insolation values of these limited NWS observations are provided in Table 2-9. Table 2-9 lists the available mean daily direct insolation by months for Ely and Las Vegas, subsequent to the first month of measurement, (i.e., subsequent to April 1978). The Las Vegas values are all presented both as energy units and as percent differences from the Ely TMY values.

c. New NWS Network Global Insolation Data: Table 2-10 provides a similar set of data to that of (2) above except for global insolation values (Reference 6.6). The table lists the mean daily global insolation by months for Ely and Las Vegas that became available February 1977.

2.4 SIMPLIFIED ALGORITHM FOR INSOLATION ON TILTED SURFACES

An algorithm follows which models the flux input to a solar energy conservation system, including arbitrarily oriented collectors of a large variety of types. For practical purposes, the primary data for such input are direct and global insolation as functions of time for a climatologically significant time period.

Offerers may assume that both the sky and ground radiation are isotropic so that the flux (Q_s) on an arbitrarily oriented flat surface is comprised of three components, due to direct insolation, sky radiance, and ground reflections, and is given by

$$Q_s = D \cos(\gamma) + d \frac{\cos \beta + 1}{2} + \rho Q \frac{1 - \cos \beta}{2}, \qquad (2\text{-}1)$$

TABLE 2-7. MEAN DAILY GLOBAL INSOLATION BY MONTHS FOR SELECTED NEVADA AND UTAH SITES FROM THE NOAA ERSATZ DATA BASE

($KW-HR/M^2$-Day)

	Tonopah, Nevada			Yucca Flats, Nevada			Las Vegas, Nevada			Cedar City, Utah		
	ETR	Estimated	%	ETR	Estimated	%	ETR	Estimated	%	ETR	Estimated	%
January	4.53	2.89	63.8	4.72	3.01	63.8	4.87	3.08	63.2	4.59	2.78	60.6
February	6.07	4.02	66.2	6.24	4.01	64.3	6.37	4.22	66.3	6.12	3.72	60.8
March	7.93	5.60	70.6	8.06	5.56	69.0	8.17	5.75	70.4	7.97	5.16	64.7
April	9.85	7.10	72.1	9.93	7.08	71.3	9.98	7.31	73.3	9.88	6.60	66.8
May	11.14	8.13	73.0	11.16	8.12	72.8	11.17	8.34	74.7	11.15	7.78	69.8
June	11.70	8.79	75.1	11.68	8.62	73.8	11.67	8.76	75.1	11.69	8.53	73.0
July	11.45	8.52	74.4	11.45	8.36	73.0	11.44	8.16	71.3	11.45	7.89	68.9
August	10.43	7.69	73.7	10.48	7.51	71.7	10.51	7.42	70.6	10.45	7.07	67.7
September	8.77	6.44	73.4	8.88	6.37	71.7	8.96	6.42	71.7	8.81	6.21	70.5
October	6.83	4.79	70.1	6.99	4.78	68.4	7.11	4.85	68.2	6.88	4.60	66.9
November	5.04	3.25	64.5	5.23	3.28	62.7	5.37	3.42	63.7	5.10	3.13	61.4
December	4.16	2.61	62.7	4.35	2.69	61.8	4.50	2.78	61.8	4.22	2.48	58.8
Annual		5.82	70.0		5.78	68.7		5.88	69.2		5.49	65.8

TABLE 2-8. LOCATION OF NEVADA NATIONAL WEATHER SERVICE INSOLATION NETWORK SITES

	Ely	Las Vegas
Altitude (m.)	1912	670
(ft.)	6273	2198
Latitude (deg.)	39.283	36.083
Longtitude (deg.)	114.850	115.167
Station Number	23154	23169

TABLE 2-9. OBSERVED MEAN MONTHLY DIRECT INSOLATION AT ELY AND LAS VEGAS, NEVADA

MONTH	ELY		LAS VEGAS	
	$(KW\text{-}HR/M^2\text{-}DAY)$	(% DIFF FROM TMY)	$(KW\text{-}HR/M^2\text{-}DAY)$	(% DIFF FROM ELY)
May 1978	8.08	+14.0	8.98	+11.1
June 1978	9.18	+18.9	10.25	+11.7
July 1978	----	----	9.54	----
August 1978	9.46	+21.6	9.25	- 2.2
September 1978	7.82	+ 0.3	8.37	+ 7.0
October 1978	6.95	- 5.2	6.54	- 5.9
November 1978	4.38	-17.4	5.41	-23.5
December 1978	4.77	+ 9.2	5.60	+17.4
January 1979	3.14	-29.4	3.15	- 0.3

TABLE 2-10. OBSERVED MEAN DAILY GLOBAL INSOLATION AT ELY AND LAS VEGAS, NEVADA

	Ely			Las Vegas		
	(kW hr/m^2-Day)	(% of ETR)	(% Diff. from TMY)	(kW hr/m^2-Day)	(% of ETR)	(% Diff from Ely)
1977						
February	----	----	----	4.36	68.4	----
March	4.82	62.0	-7.3	----	----	----
April	6.80	69.7	+10.4	7.10	71.1	4.4
May	5.50	49.5	-22.9	7.02	62.8	27.6
June	7.52	64.2	-4.4	----	----	----
July	7.51	65.6	-4.4	7.74	67.7	3.1
August	5.92	57.0	-15.3	6.80	64.7	14.9
September	5.48	63.4	-8.0	5.92	66.1	8.0
October	4.21	63.2	-7.9	4.72	66.4	12.1
November	2.77	57.2	-4.5	3.31	61.6	19.5
December	2.15	54.4	-5.7	2.46	54.7	14.4
Mean		60.6	-7.0		64.8	13.0
1978						
January	2.37	54.9	-7.1	2.63	54.0	11.0
February	3.26	55.5	-9.4	3.61	56.7	10.7
March	4.24	54.6	-18.5	4.75	58.1	12.0
April	5.47	56.0	-11.2	6.69	67.0	22.3
May	7.47	67.2	+4.8	7.73	69.2	3.5
June	8.11	69.3	+3.0	8.49	72.8	4.7
July	----	----	----	7.88	68.9	----
August	7.12	68.6	+1.9	7.17	68.2	0.7
September	5.44	62.9	-8.7	6.01	67.1	10.5
October	4.35	65.3	-4.8	4.39	61.7	0.9
November	2.80	57.8	-3.5	3.09	57.5	10.4
December	2.38	62.2	4.4	2.63	58.4	10.5
Mean		61.1	-4.5		63.3	8.8
1979						
January	2.42	56.0	-5.1	2.13	43.7	-12.0

where

D	is observed direct insolation
Q	is observed global insolation
γ	is the angle between the sun's rays and the normal to the surface of the collector
β	is the angle between the collector surface and the horizontal
ρ	is the albedo of the ground
d	is the integral of diffuse sky radiation which may be computed from

$$d = Q - D \cos(z) \tag{2-2}$$

Representative values of albedo, ρ, from Reference 6.8 are provided in Table 2-11. Formulas for the computation of the angles for surfaces oriented in various ways and for tracking collectors are available in Reference 6.9. (The computed numerical results in Reference 6.9 should not be used, since they are based on a different resolution of insolation into direct and diffuse components than that used in the SOLMET and TMY tapes). More sophisticated models for sky radiance variations with angle are discussed in Reference 6.10.

References 6.11 to 6.15 provide additional data on modeling and measurement interpretations. Section 5.0 provides some insight to these references.

3.0 WIND

A limited summary of wind resource data is provided for use by Offerers. These data should be treated as representative of the Nevada/Utah area and not as actual deployment site/ridge information since the resource may not exist at the site due to considerable site-to-site variability. The data format used is presented, followed by summary data currently available for two valley sites (Ely and Tonopah), a high ridge (Pequop Summit), and a mountain location (White Mountain). Alternate data are then discussed and wind data variability concludes the section.

3.1 DATA FORMAT

A set of four summary plots is presented to describe the wind resource associated with each wind measurement site. The first plot in each set is a Cumulative Distribution Function (CDF) which shows, on an annual basis, what percentage of the time (ordinate) a given windspeed (abscissa) is exceeded. The next plot in each set indicates diurnal variability by displaying the average windspeed (ordinate) occurring each hour of the day (abscissa) for each of the four seasons. The seasons are arbitrarily defined for these data as: 1 January through 31 March; 1 April through 30 June; 1 July through 30 September; 1 October through 31 December. The third plot in each set provides seasonal variability in terms of monthly average windspeed (ordinate) as a function of each of the 12 months (abscissa). The last plot in each

TABLE 2-11. REPRESENTATIVE ALBEDOS FOR VARIOUS NATURAL SURFACES

(Reference 6-7)

Surface	Albedo
Snow, New, Dry	0.88
Snow, New, Wet	0.80
Snow, Old, Wet	0.70
Sand, Calcite*	0.60
Sandy Soil	0.25
Vegetation	0.10 - 0.20

* Based on White Sands, New Mexico

set, except for Tonopah, is a Probability Distribution Function (PDF) for calm durations; Tonopah data are currently unavailable. These PDFs are the average number of times per year (ordinate) that the windspeed remains below the threshold levels of 3.0 to 6.0 meters/second for the duration (abscissa) indicated. Successive day wind probabilities data are also presented in tabular form in Section 3.6 as an alternative to the PDF curves for valley sites only. Section 3.6 also contains a preliminary assessment of wind resources relative to MX-RES by Battelle's Pacific Northwest Laboratory (PNL); see Reference 6.20.

3.2 ELY, NEVADA SUMMARY DATA

Ely, Nevada, is located toward the north central part of the MX deployment area in a valley about 6000 ft above sea level. Summaries of wind observations are presented based on data from 1953-1956 and 1962-1978 standardized to a 10 meter anemometer height. Based on these data the annual average windspeed is 4.4 m/s (~9.8 mph). Specific characteristics of the Ely wind resource are shown in Figure 3-1, 3-2, 3-3, and 3-4. Figures 3-1 to 3-3 are extracted from Reference 6.16 and checked by data constructed from the TMY (Reference 6.3). Figure 3-4 is also constructed from Reference 6.3.

3.3 TONOPAH, NEVADA SUMMARY DATA

Tonopah, Nevada, is located in a valley about 6000 ft above sea level at the western edge of the MX deployment area. Summaries of wind observations are presented based on data from 1952-1958 and 1960-1978 standardized to a 10 meter anemometer height. Based on these data the annual average windspeed is 4.3 m/s (~9.6 mph). The specific characteristics of the Tonopah wind resource are shown in Figure 3-5, 3-6, and 3-7. The figures are extracted from Reference 6.16.

3.4 PEQUOP SUMMIT, NEVADA SUMMARY DATA

Pequop Summit, near Wells, Nevada, is a high ridge about 8700 ft above sea level in north central Nevada. Summaries of wind observations are presented based on data from 1976-1979 obtained by Oregon State University (see Reference 6.17), and standardized to a 10 meter anemometer height. These measurements were made at a location near Pequop Summit at an elevation of 7540 ft above mean sea level. The data have been processed to obtain an annual average windspeed of 6.8 m/s (~15.2 mph). The details of the Pequop wind resource are shown in Figures 3-8, 3-9, 3-10, and 3-11. Figures 3-8 to 3-10 are extracted from Reference 6-16 and checked by data constructed from Reference 6.17. Figure 3-11 is also constructed from Reference 6.17.

3.5 WHITE MOUNTAINS, CALIFORNIA SUMMARY DATA

The White Mountains form a high range (14,240 ft summit) straddling the California/Nevada border. Boundary Peak, the White Mountain shoulder spur on the Nevada boundary, is approximately the same height as Wheeler Peak (13,063 ft) which is within the MX deployment area and considered to be the highest peak in Nevada. There have been a series of high altitude research laboratories on White Mountain since 1950, operated by the University of California (see Reference 6.18). Wind measurements for the year 1954 at an altitude of 12,500 ft have been

FIGURE 3-1. CUMULATIVE DISTRIBUTION FUNCTION FOR ELY WINDS
12/61 - 12/78

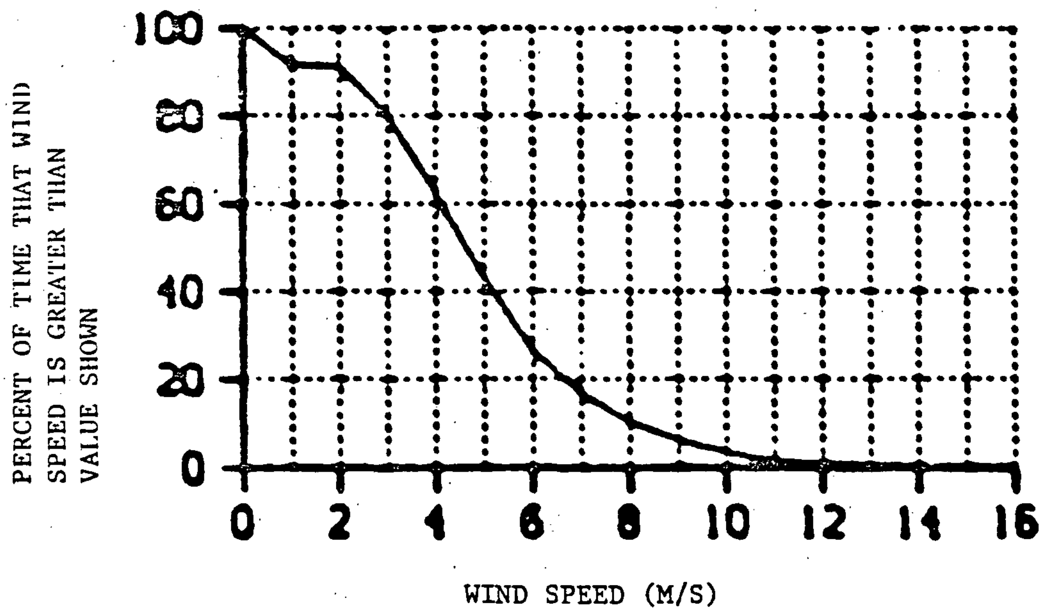


FIGURE 3-2. DIURNAL VARIATIONS FOR ELY WINDS
12/61 - 12/78

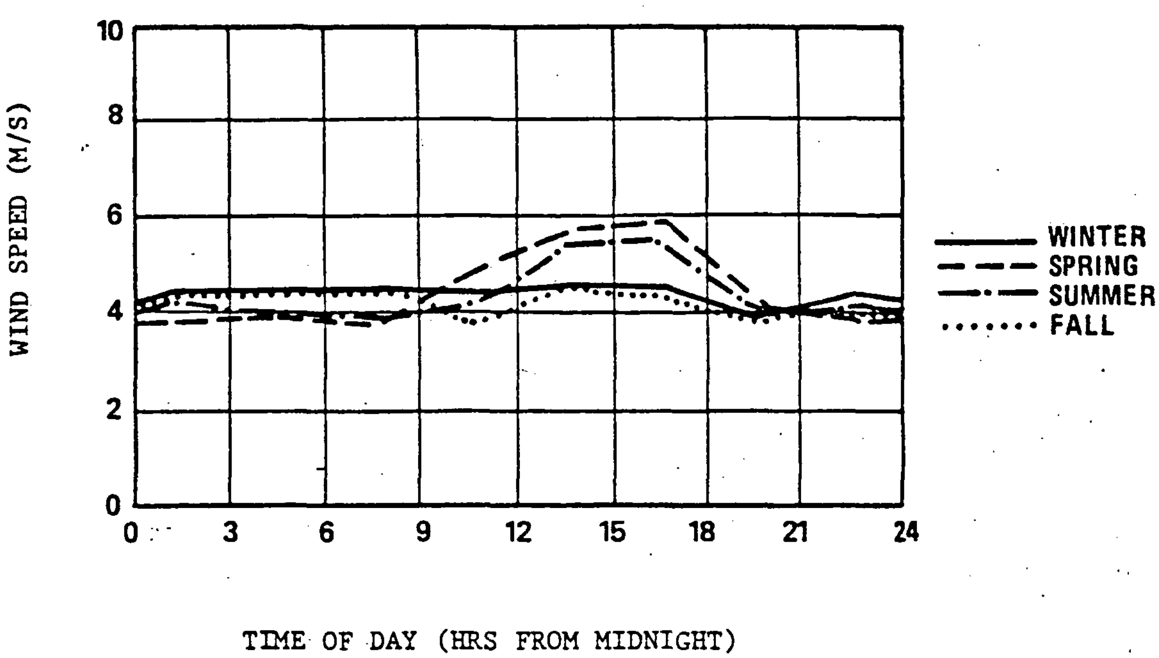


FIGURE 3-3. SEASONAL VARIATIONS FOR ELY WINDS
12/61 - 12/78

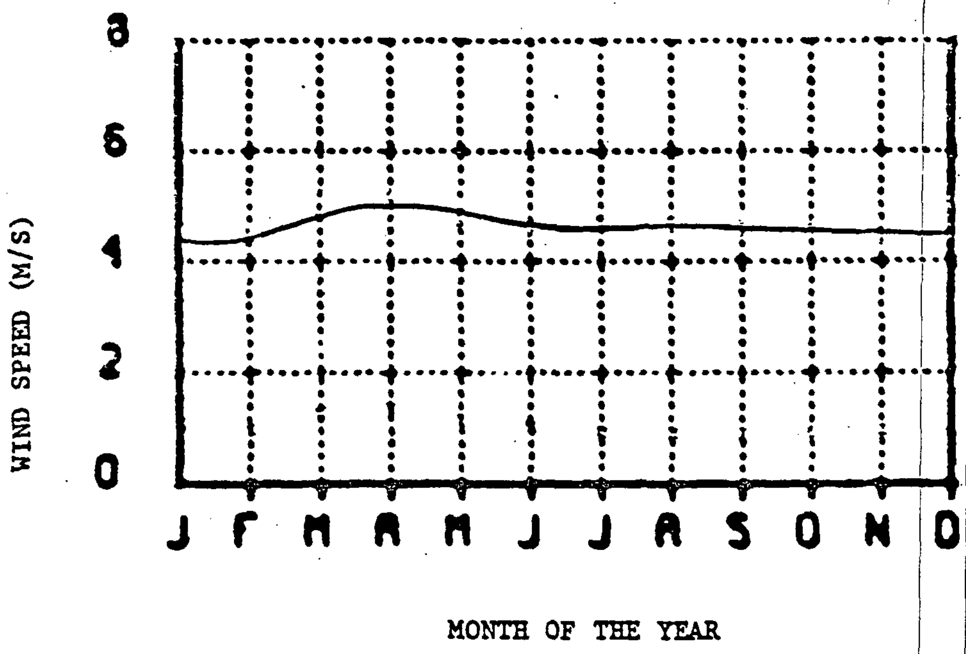


FIGURE 3-4. DISTRIBUTION OF WIND SPEED BELOW A GIVEN THRESHOLD
ELY, NV

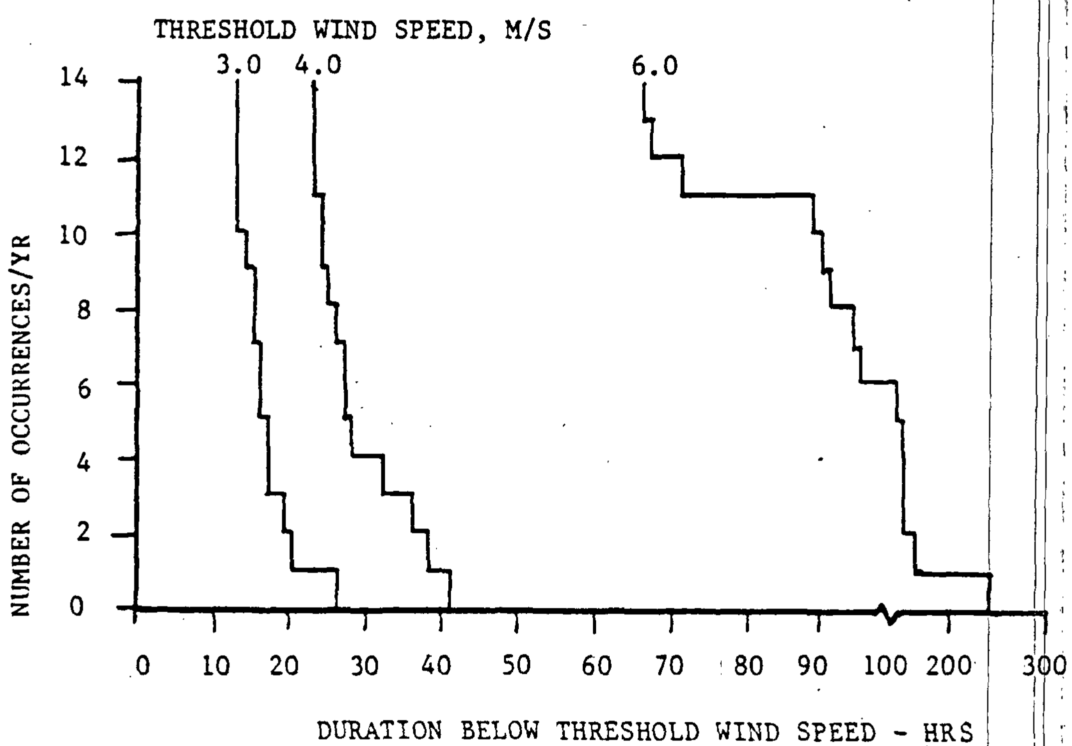


FIGURE 3-5. CUMULATIVE DISTRIBUTION FUNCTION FOR TONOPAH WINDS
07/59 - 12/78

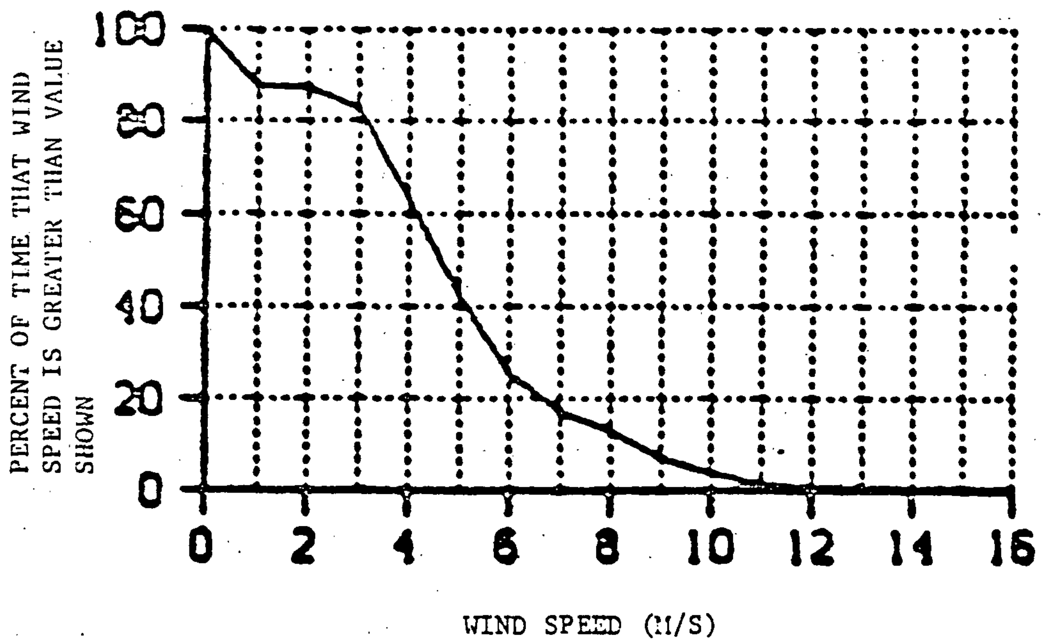


FIGURE 3-6. DIURNAL VARIATION FOR TONOPAH WINDS
07/59 - 12/78

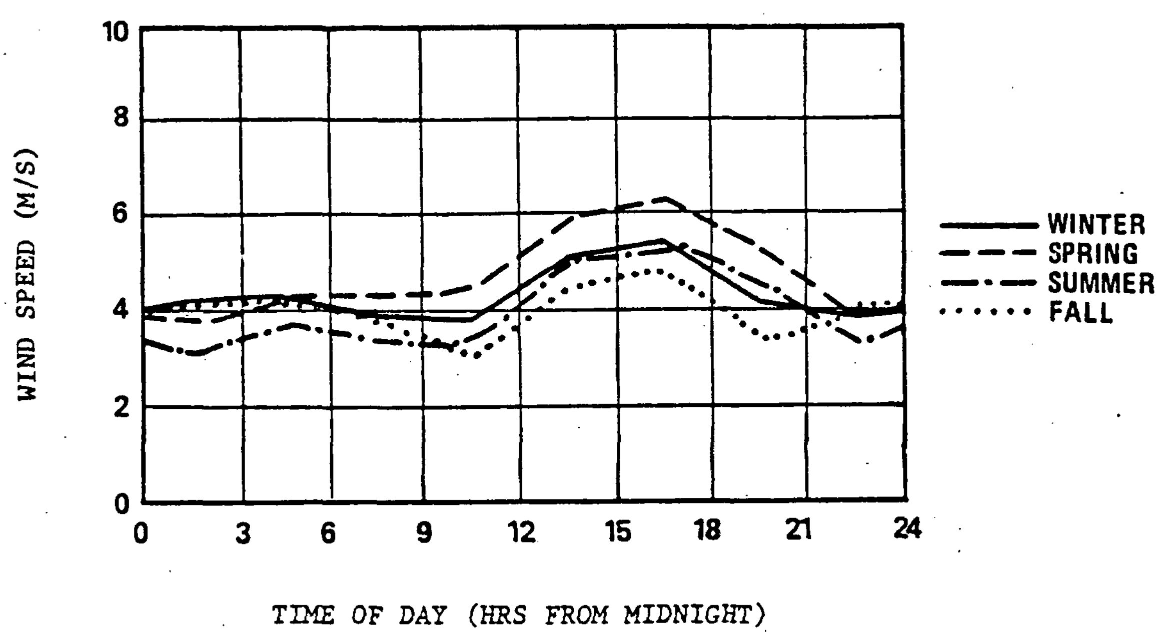


FIGURE 3-7. SEASONAL VARIATIONS FOR TONOPAH WINDS 07/59 - 12/78

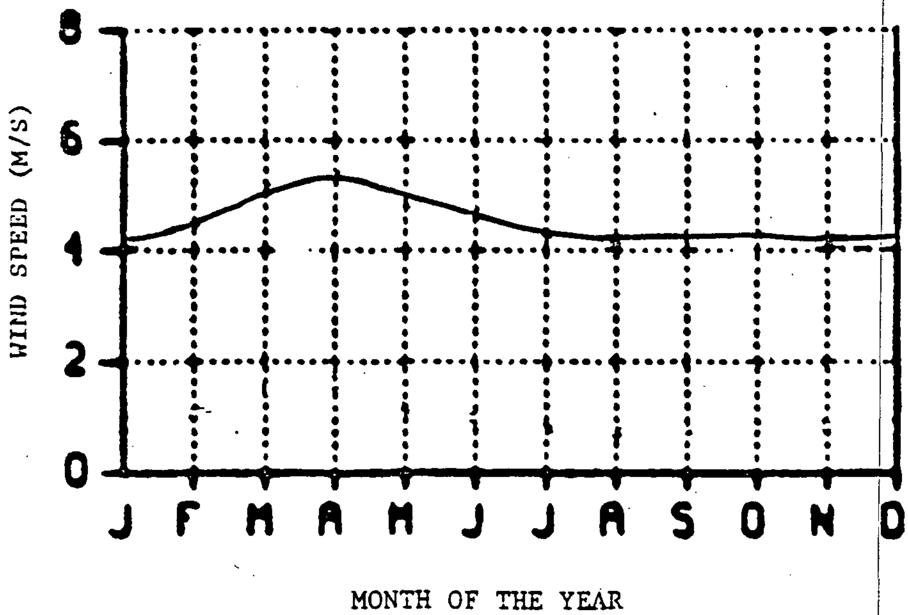


FIGURE 3-8. CUMULATIVE DISTRIBUTION FUNCTION FOR PEQUOP SUMMIT WINDS - 04/76 - 05/79

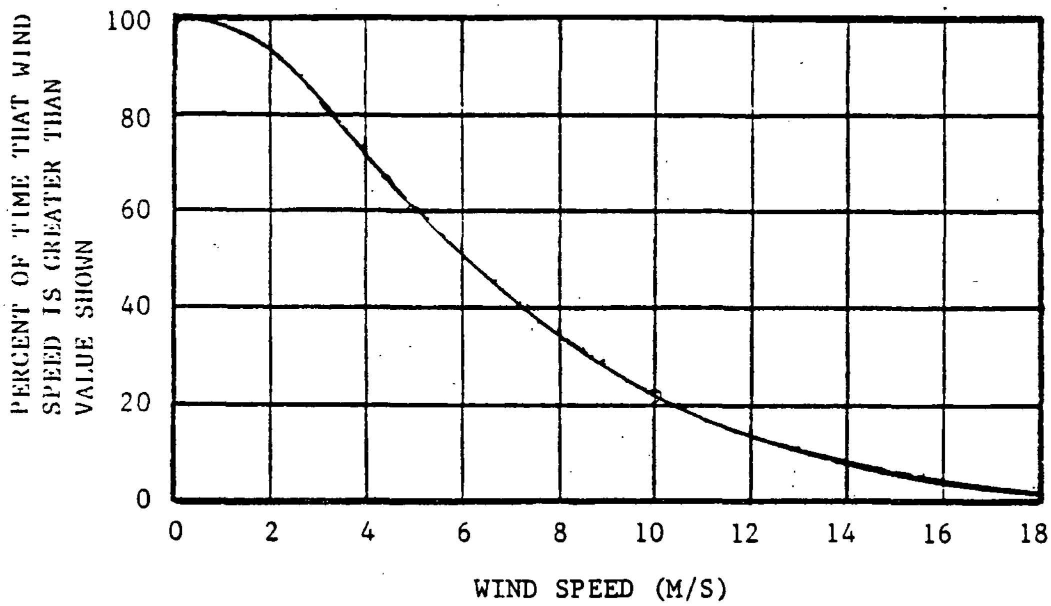
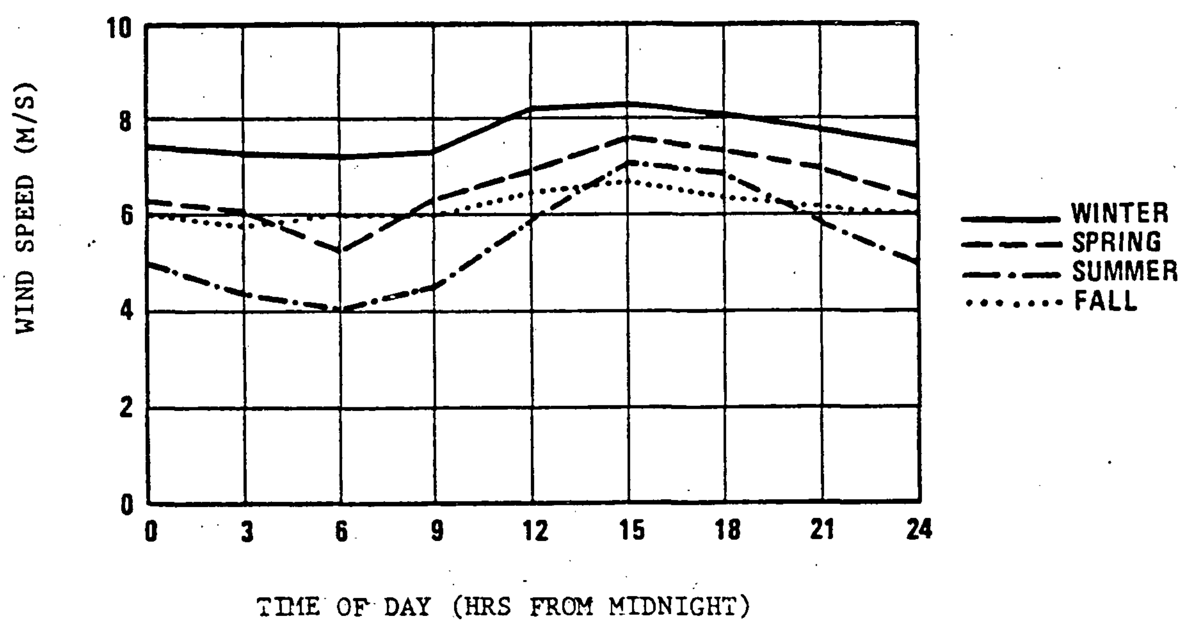


FIGURE 3-9. DIURNAL VARIATIONS FOR PEQUOP SUMMIT WINDS 04/76 - 05/79



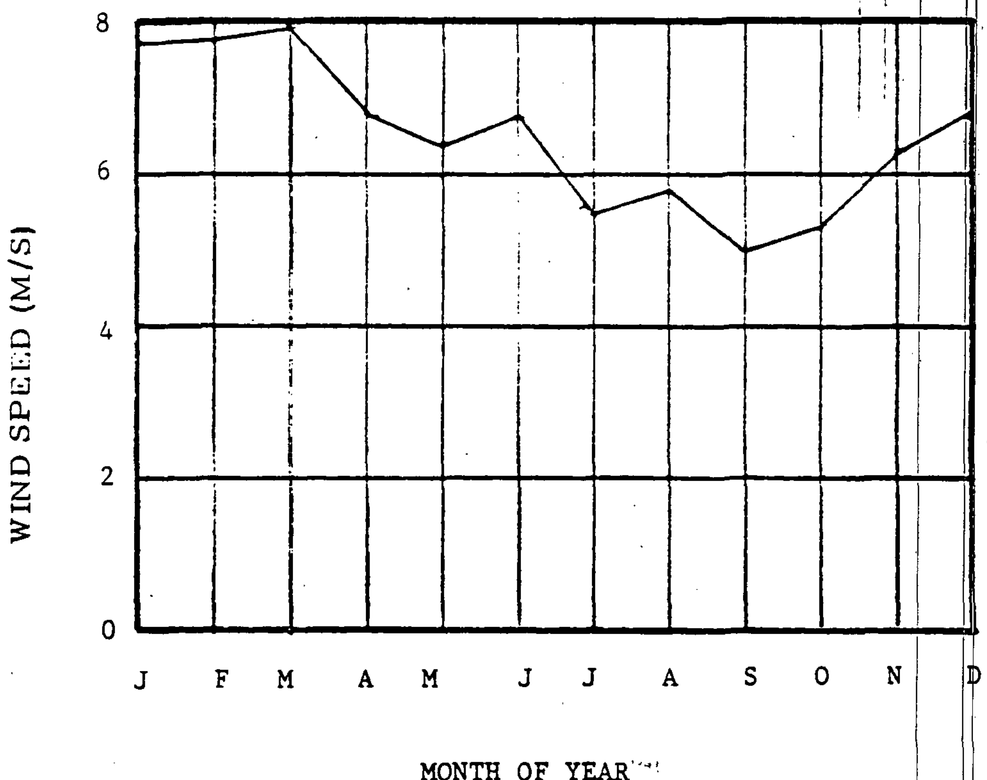


FIGURE 3-10. SEASONAL VARIATIONS FOR PEQUOP SUMMIT WINDS
04/76 - 05/79

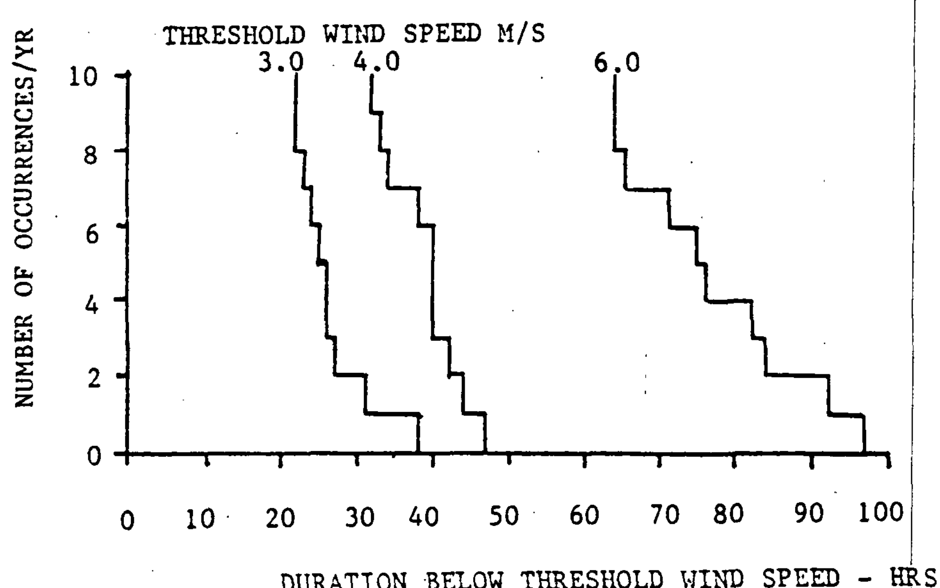


FIGURE 3-11. DISTRIBUTION OF WIND SPEED BELOW A GIVEN THRESHOLD
PEQUOP SUMMIT, NV

extrapolated to 10 meters to form the data base for wind power resource. The annual average wind speed was 8.0 m/s (~18 mph). Salient characteristics of the White Mountain wind resource are shown in Figures 3-12, 3-13, 3-14, and 3-15. All figures were constructed from data in Reference 6.18.

3.6 ADDITIONAL DATA

The following three additional sets of wind data are provided for use by Offerers. These data are extracts and summaries of results all originating from basic hourly wind data archived by the NCC in TD-1440 tape format (see Reference 6.19).

3.6.1 Successive Day Wind Probabilities

SOLMET formatted data, which were derived from TD-1440 data, were analyzed and provided as successive day wind probabilities for Ely in Reference 6.4. Tables 3-1 to 3-3 provide successive day wind probabilities for Ely as a guide to estimating the durations of wind power above threshold levels of 60, 100, 140, 180, and 220 watts per square meter (W/m^2). Probabilities are shown in percent pertaining to 1, 3, 5, and 7 successive days for each threshold level. These data were taken from Reference 6.4, and are based on 24 years of observations.

3.6.2 TMY Winds

The Typical Meteorological Year (TMY) described in Section 2.0 of this attachment was extracted from the 24 year Ely SOLMET data tape, and also contains wind data (see also Reference 6.3). However, the process for selecting typical months for the TMY emphasized insolation statistics and de-emphasized wind statistics. Offerers are accordingly cautioned when using the Ely TMY wind data for wind power work.

3.6.3 Preliminary Wind Assessment by PNL

Battelle PNL have reviewed the NCC TD-1440 wind data for Nevada and included a summary of wind deformed vegetation on ridgecrests in Central Nevada in Reference 6.20. Quantified data therein indicate that valley locations may yield annual average wind speeds of 4.3 to 5.6 m/s, while ridgetop speeds may range from 6.7 to 10.8 m/s. See Section 5.2.3 for more discussion of Reference 6.20 data.

Reference 6.20 provides an additional set of five references which are listed here for Offerer convenience as References 6.21 to 6.25. Reference 6.26 presents results of an aerial survey of Nevada performed by Global Weather Consultants under subcontract to PNL; it is indicated therein that there is a likelihood that mean annual wind speeds may exceed 14 mph on well-exposed ridgetops above approximately 8000 ft.

3.7 DATA VARIABILITY

The temporal and spatial variability of wind speed values across the MX deployment area may be inferred from the following information.

FIGURE 3-12. CUMULATIVE DISTRIBUTION FUNCTION FOR WHITE MOUNTAIN WINDS

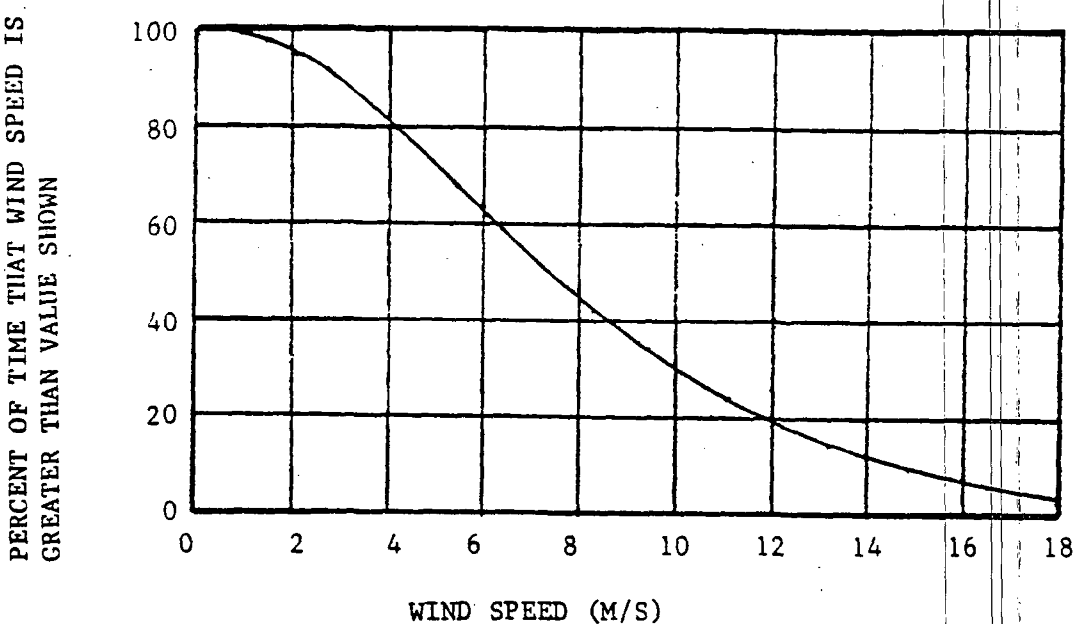


FIGURE 3-13. DIURNAL VARIATIONS FOR WHITE MOUNTAIN WINDS

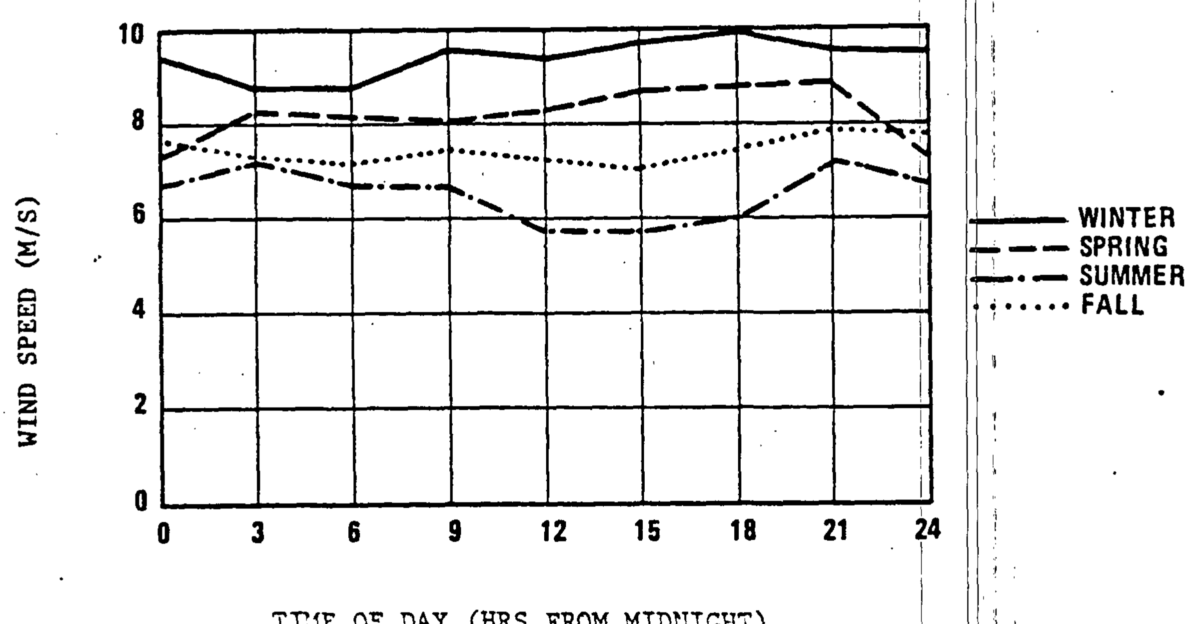


FIGURE 3-14. SEASONAL VARIATIONS FOR WHITE MOUNTAIN WINDS

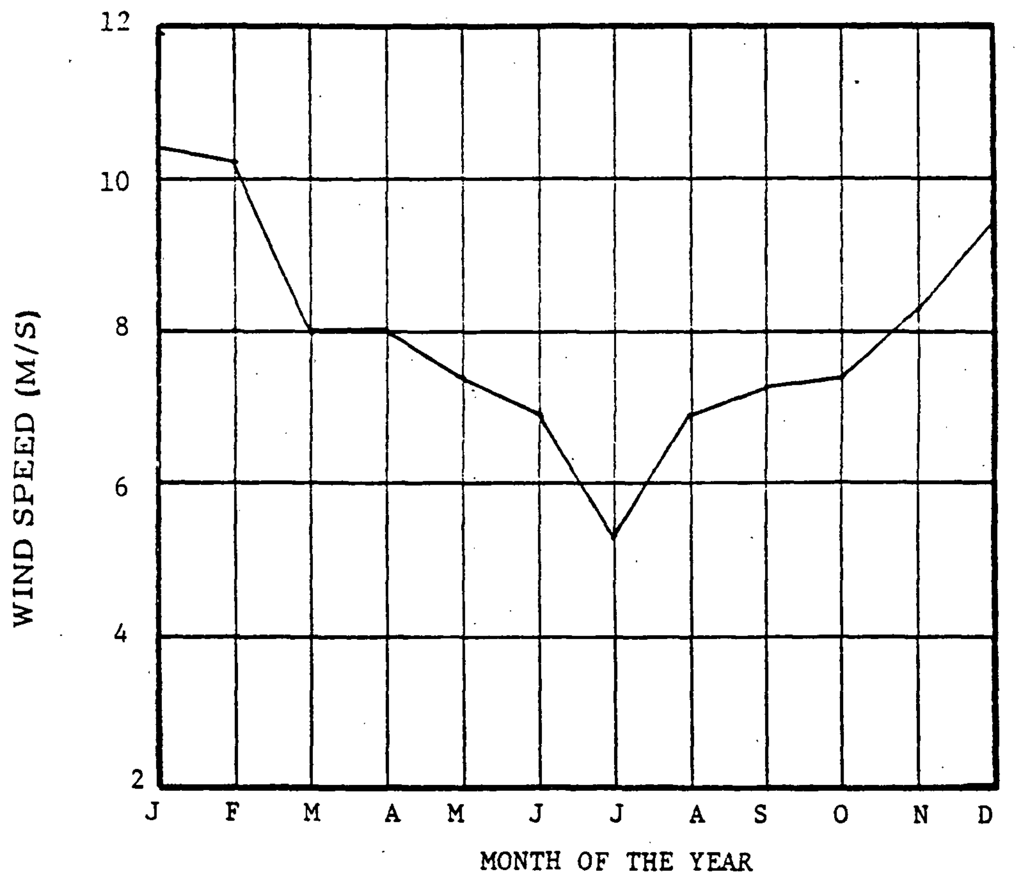


FIGURE 3-15. DISTRIBUTION OF WIND SPEED BELOW A GIVEN THRESHOLD - WHITE MT, NV/CA

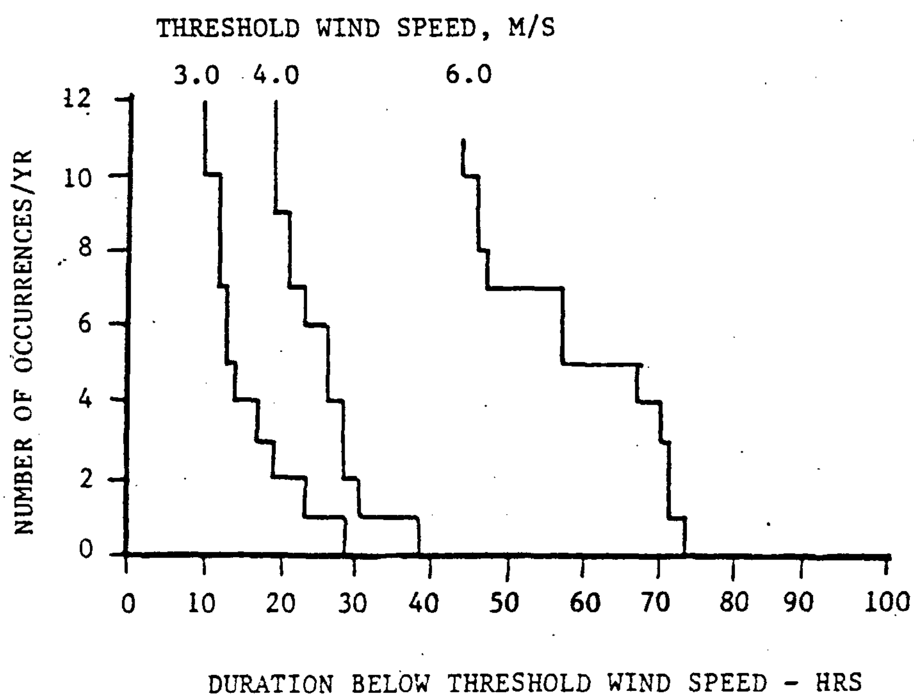


TABLE 3-1. PROBABILITY OF SUCCESSIVE DAYS - ELY, NEVADA

WIND (DAY)

WIND POWER (W/M^2), DAYTIME AVERAGE

	JAN				FEB				MAR				APR			
	DAYS				DAYS				DAYS				DAYS			
INT	1	3	5	7	1	3	5	7	1	3	5	7	1	3	5	7
60	14	1	0	0	20	1	0	0	34	4	0	0	42	10	2	0
100	8	0	0	0	10	1	0	0	22	2	0	0	25	3	0	0
140	5	0	0	0	6	0	0	0	14	0	0	0	16	0	0	0
180	3	0	0	0	3	0	0	0	9	0	0	0	10	0	0	0
220	2	0	0	0	2	0	0	0	5	0	0	0	8	0	0	0

	MAY				JUN				JUL				AUG			
	DAYS				DAYS				DAYS				DAYS			
INT	1	3	5	7	1	3	5	7	1	3	5	7	1	3	5	7
60	39	10	2	0	31	6	2	0	30	7	2	0	27	5	0	0
100	22	3	0	0	18	2	0	0	15	2	0	0	13	1	0	0
140	14	0	0	0	9	0	0	0	8	1	0	0	7	0	0	0
180	8	0	0	0	6	0	0	0	4	0	0	0	4	0	0	0
220	5	0	0	0	4	0	0	0	2	0	0	0	3	0	0	0

	SEP				OCT				NOV				DEC			
	DAYS				DAYS				DAYS				DAYS			
INT	1	3	5	7	1	3	5	7	1	3	5	7	1	3	5	7
60	26	4	0	0	19	2	0	0	17	2	0	0	13	0	0	0
100	13	0	0	0	10	1	0	0	10	0	0	0	7	0	0	0
140	8	0	0	0	6	0	0	0	5	0	0	0	4	0	0	0
180	5	0	0	0	3	0	0	0	3	0	0	0	2	0	0	0
220	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0

TABLE 3-2. PROBABILITY OF SUCCESSIVE DAYS - ELY, NEVADA

WIND (NIGHT)

WIND POWER (W/M^2), NIGHTIME AVERAGE

	JAN				FEB				MAR				APR			
	DAYS				DAYS				DAYS				DAYS			
INT	1	3	5	7	1	3	5	7	1	3	5	7	1	3	5	7
60	41	14	5	1	26	4	0	0	22	3	0	0	23	4	1	0
100	18	3	0	0	13	2	0	0	12	1	0	0	12	1	0	0
140	12	1	0	0	8	1	0	0	8	0	0	0	5	0	0	0
180	10	1	0	0	5	0	0	0	5	0	0	0	2	0	0	0
220	7	0	0	0	3	0	0	0	3	0	0	0	1	0	0	0

	MAY				JUN				JUL				AUG			
	DAYS				DAYS				DAYS				DAYS			
INT	1	3	5	7	1	3	5	7	1	3	5	7	1	3	5	7
60	11	0	0	0	6	0	0	0	9	0	0	0	7	0	0	0
100	4	0	0	0	1	0	0	0	1	0	0	0	2	0	0	0
140	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
180	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
220	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	SEP				OCT				NOV				DEC			
	DAYS				DAYS				DAYS				DAYS			
INT	1	3	5	7	1	3	5	7	1	3	5	7	1	3	5	7
60	9	0	0	0	22	4	0	0	24	7	2	1	43	16	6	1
100	3	0	0	0	9	1	0	0	10	1	0	0	19	3	0	0
140	1	0	0	0	5	0	0	0	5	0	0	0	10	1	0	0
180	0	0	0	0	3	0	0	0	3	0	0	0	8	1	0	0
220	0	0	0	0	2	0	0	0	2	0	0	0	6	1	0	0

TABLE 3-3. PROBABILITY OF SUCCESSIVE DAYS - ELY, NEVADA

WIND (TOTAL)

DAILY AVERAGE WIND POWER (W/M^2)

INT	JAN 1	JAN 3	JAN 5	JAN 7	FEB 1	FEB 3	FEB 5	FEB 7	MAR 1	MAR 3	MAR 5	MAR 7	APR 1	APR 3	APR 5	APR 7
60	55	24	12	5	46	15	5	2	53	19	8	3	60	25	12	6
100	32	8	2	0	27	3	0	0	37	8	1	0	40	9	1	0
140	19	3	0	0	19	2	0	0	26	4	0	0	27	4	0	0
180	14	2	0	0	14	1	0	0	19	1	0	0	21	2	0	0
220	11	1	0	0	10	1	0	0	15	0	0	0	17	1	0	0

INT	MAY 1	MAY 3	MAY 5	MAY 7	JUN 1	JUN 3	JUN 5	JUN 7	JUL 1	JUL 3	JUL 5	JUL 7	AUG 1	AUG 3	AUG 5	AUG 7
60	56	24	11	5	49	16	5	1	54	20	8	3	48	18	7	3
100	35	9	2	0	28	6	2	0	28	5	1	0	24	5	0	0
140	24	4	0	0	16	1	0	0	15	3	0	0	14	2	0	0
180	16	1	0	0	10	1	0	0	8	1	0	0	8	1	0	0
220	10	0	0	0	6	0	0	0	4	0	0	0	5	0	0	0

INT	SEP 1	SEP 3	SEP 5	SEP 7	OCT 1	OCT 3	OCT 5	OCT 7	NOV 1	NOV 3	NOV 5	NOV 7	DEC 1	DEC 3	DEC 5	DEC 7
60	46	15	3	0	45	15	5	1	47	17	7	4	54	24	12	6
100	23	4	0	0	22	4	0	0	24	5	1	0	29	5	1	0
140	14	1	0	0	16	2	0	0	14	2	0	0	18	2	0	0
180	9	0	0	0	11	1	0	0	11	1	0	0	13	2	0	0
220	6	0	0	0	9	1	0	0	8	1	0	0	10	1	0	0

3.7.1 Temporal Variations

Histories of the annual average wind speed available at Tonopah, and Ely, Nevada, have been processed to obtain coefficients of variability (i.e., ratio of standard deviation to mean) for each site. The coefficients are provided in Table 3-4.

Table 3-4

INTERANNUAL WIND SPEED VARIABILITY

Site	Number of Years (Sample Size)	Coefficient of Variability (σ/μ, %)
Tonopah, NV	26	5
Ely, NV	21	4

These data may be used as a guide to the interannual variability occurring at other sites for which there is no extensive history.

3.7.2 Spatial Variability

Indications of spatial variability may be inferred by considering the data previously presented in Sections 3.2 through 3.6 for the pertinent sites.

4.0 JOINT INSOLATION-WIND RELATIONS

The following two categories of data pertaining to Ely, Nevada are provided to assist Offerers in their interpretation of joint insolation-wind resource relationships. First is a set of joint probabilities extracted from the 24 year SOLMET data base. Second is a set of 12 typical days (one for each month) extracted from the TMY.

4.1 JOINT POWER PROBABILITIES

Figures 4-1 to 4-3 provide joint probabilities for occurrences of wind and insolation on successive days at Ely. These joint probabilities are for equivalent wind power resource levels greater than 60, 120, and 180 watts per square meter (W/m^2) occurring in combination with insolation power levels greater than 50, 150, and 250 W/m^2. Tables 4-1 and 4-2 show these same joint probabilities in tabular form plus the same probabilities for 3, 5, and 7 successive days. These data are taken from Reference 6.4.

4.2 ELY TMY SUMMARY

Tables 4-3 through 4-16 show joint data extracted from the Ely TMY tape described in Section 2.0 (see also Reference 6.3). The tables provide hourly values of insolation, wind, temperature, pressure, and sky covers for the 12 days designated as

FIGURE 4-1. JOINT PROBABILITY VS MONTH, COMBINED INSOLATION-WIND (TOTAL) (1 SUCCESSIVE DAY)

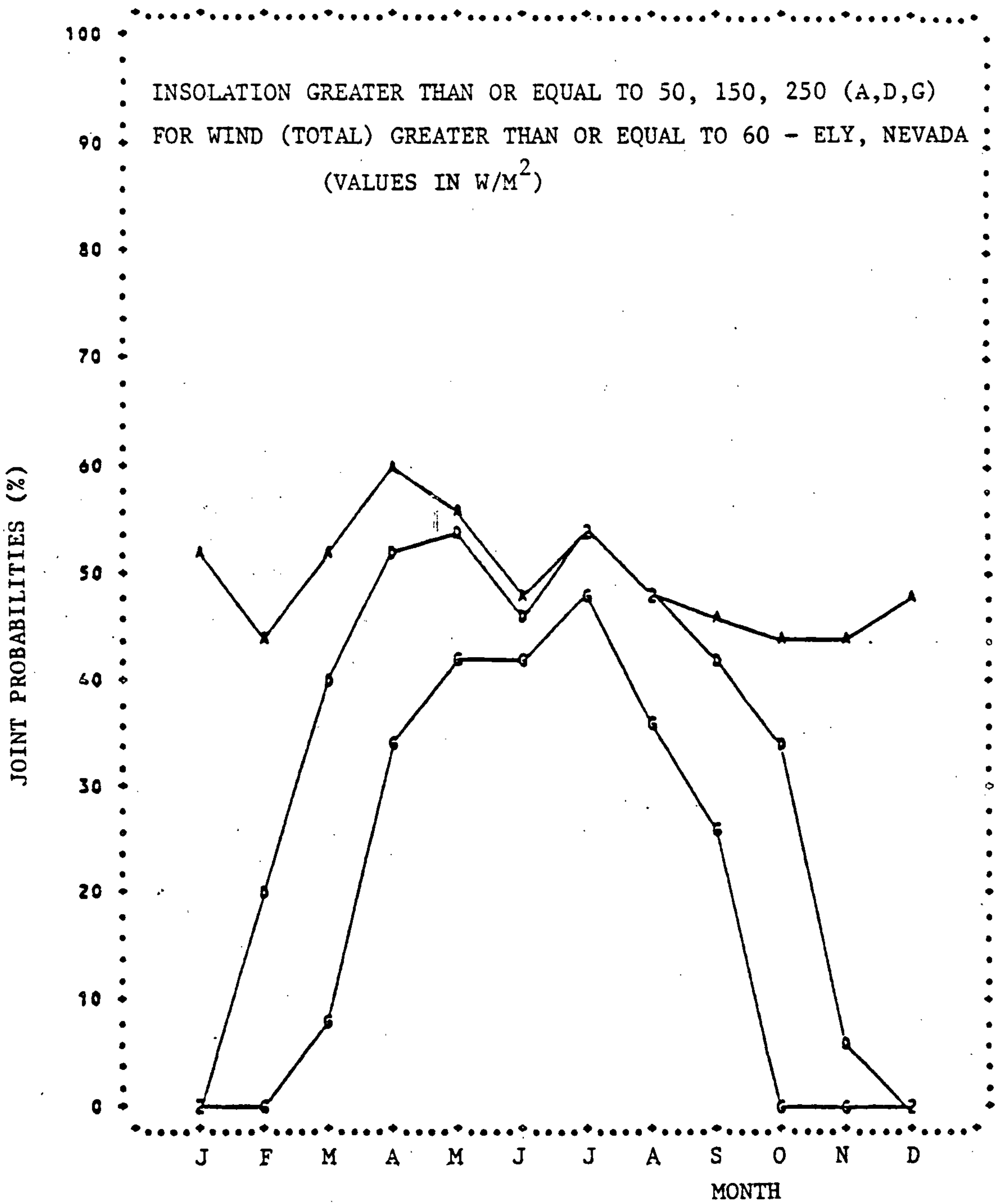


FIGURE 4-2. JOINT PROBABILITY VS MONTH, COMBINED INSOLATION-WIND (TOTAL) (1 SUCCESSIVE DAY)

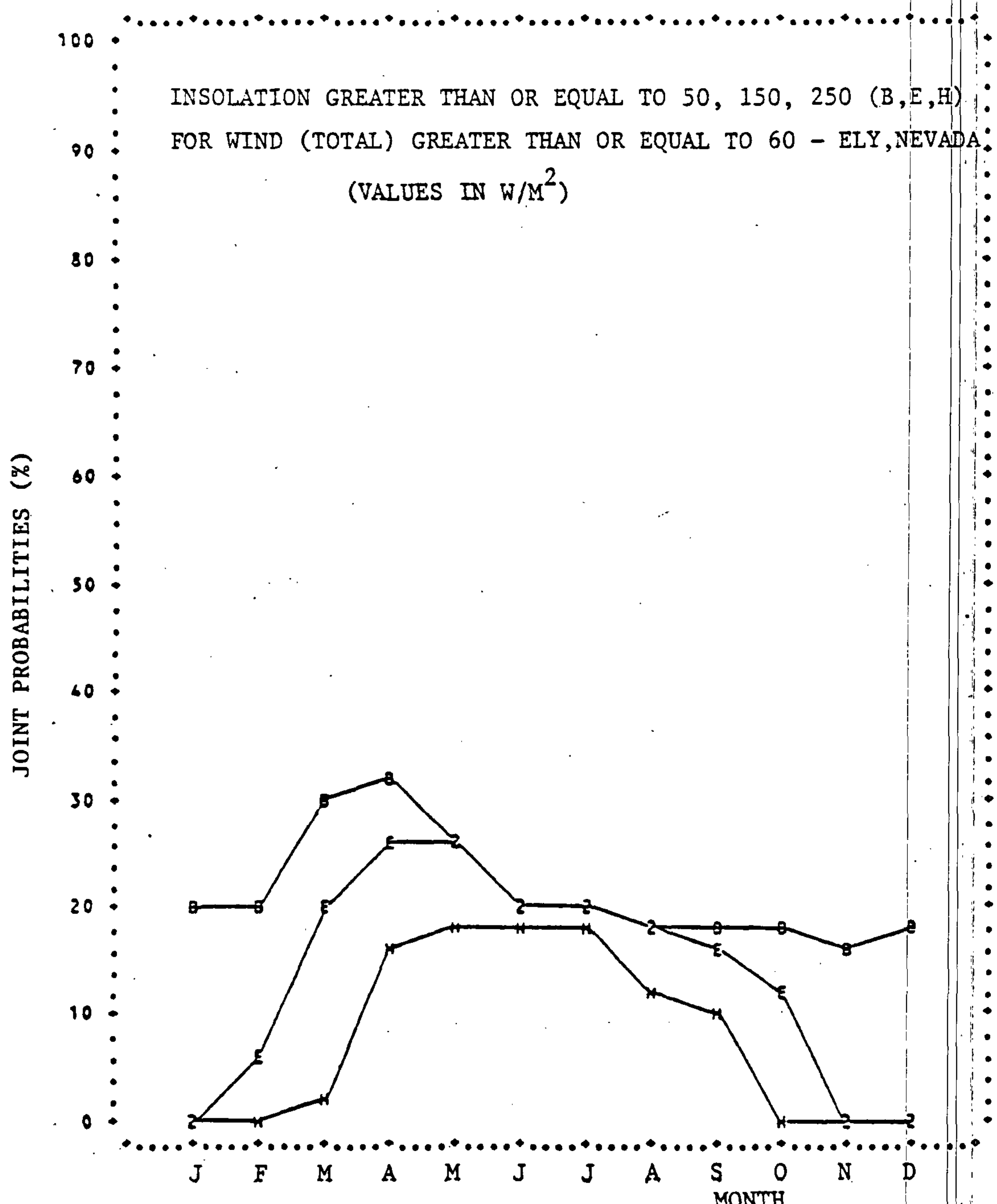


FIGURE 4-3. JOINT PROBABILITY VS MONTH, COMBINED INSOLATION-WIND (TOTAL) (1 SUCCESSIVE DAY)

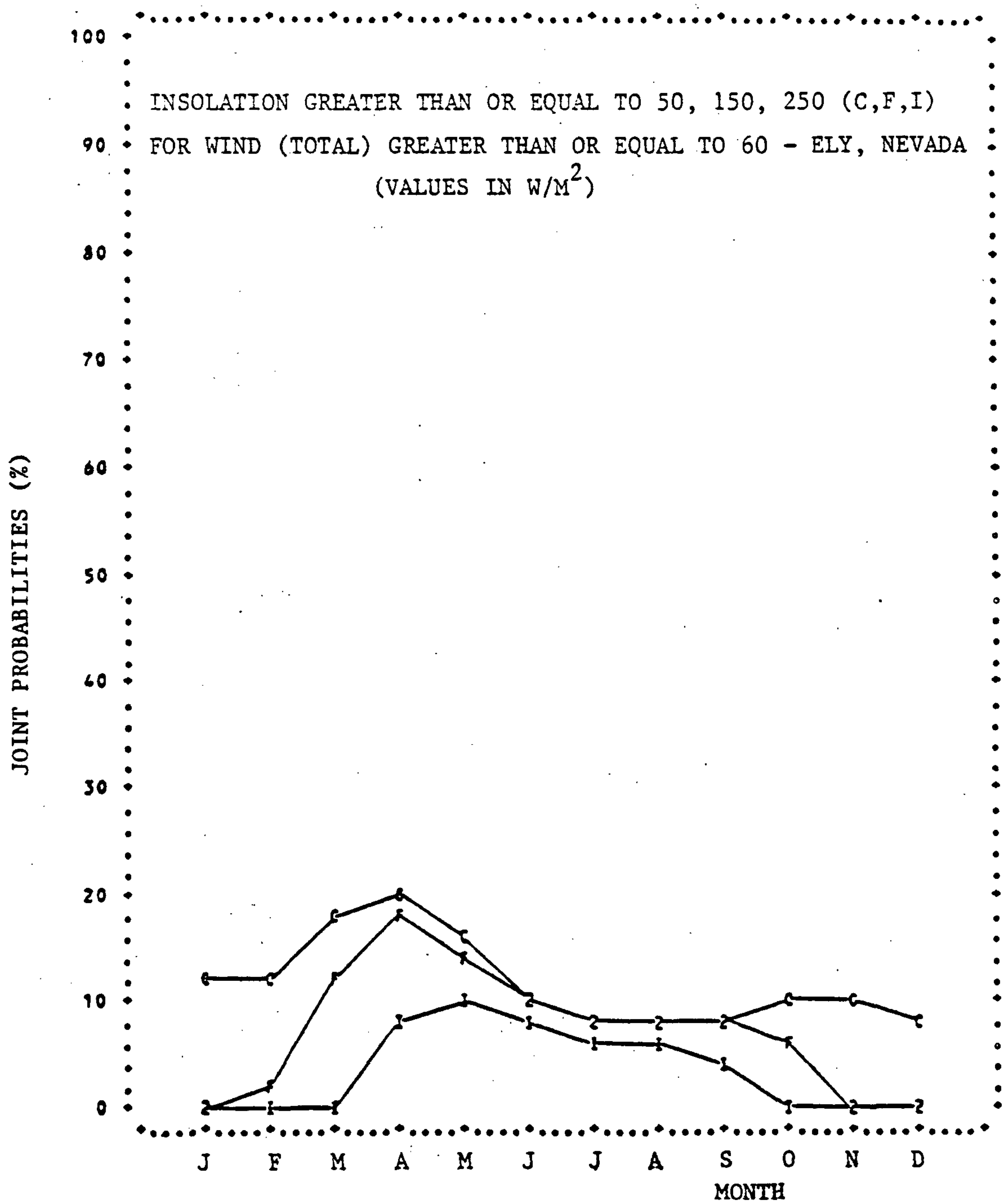


TABLE 4-1. PROBABILITY OF SUCCESSIVE DAYS - ELY, NEVADA

COMBINED INSOLATION - WIND (DAY)

COMBINATIONS OF POWER LEVELS, INSOLATION/WINDS (W/M^2), DAILY AVERAGES

	JAN				FEB				MAR				APR			
	DAYS				DAYS				DAYS				DAYS			
I N T	1	3	5	7	1	3	5	7	1	3	5	7	1	3	5	7
50/ 60	12	1	0	0	18	0	0	0	34	4	0	0	42	10	2	0
50/120	5	0	0	0	7	0	0	0	18	1	0	0	20	1	0	0
50/180	2	0	0	0	3	0	0	0	9	0	0	0	10	0	0	0
150/ 60	0	0	0	0	6	0	0	0	24	2	0	0	36	6	1	0
150/120	0	0	0	0	1	0	0	0	12	0	0	0	17	0	0	0
150/180	0	0	0	0	0	0	0	0	5	0	0	0	8	0	0	0
250/ 60	0	0	0	0	0	0	0	0	4	0	0	0	22	2	0	0
250/120	0	0	0	0	0	0	0	0	2	0	0	0	10	0	0	0
250/180	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0

	MAY				JUN				JUL				AUG			
	DAYS				DAYS				DAYS				DAYS			
I N T	1	3	5	7	1	3	5	7	1	3	5	7	1	3	5	7
50/ 60	39	10	2	0	31	6	2	0	30	7	2	0	27	5	0	0
50/120	17	1	0	0	12	1	0	0	11	1	0	0	9	0	0	0
50/180	8	0	0	0	6	0	0	0	4	0	0	0	4	0	0	0
150/ 60	38	10	2	0	30	6	2	0	30	7	2	0	27	4	0	0
150/120	17	1	0	0	12	1	0	0	11	1	0	0	9	0	0	0
150/180	8	0	0	0	6	0	0	0	4	0	0	0	4	0	0	0
250/ 60	28	5	1	0	26	5	2	0	27	6	1	0	20	3	0	0
250/120	12	1	0	0	10	1	0	0	10	1	0	0	7	0	0	0
250/180	5	0	0	0	6	0	0	0	3	0	0	0	4	0	0	0

	SEP				OCT				NOV				DEC			
	DAYS				DAYS				DAYS				DAYS			
I N T	1	3	5	7	1	3	5	7	1	3	5	7	1	3	5	7
50/ 60	26	4	0	0	19	2	0	0	16	1	0	0	11	0	0	0
50/120	10	0	0	0	8	0	0	0	6	0	0	0	3	0	0	0
50/180	5	0	0	0	3	0	0	0	2	0	0	0	1	0	0	0
150/ 60	24	3	0	0	13	0	0	0	1	0	0	0	0	0	0	0
150/120	10	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
150/180	4	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
250/ 60	14	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
250/120	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
250/180	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 4-2. PROBABILITY OF SUCCESSIVE DAYS - ELY, NEVADA

COMB. INSOL - WIND (TOTAL)

INT	JAN DAYS 1	3	5	7	FEB DAYS 1	3	5	7	MAR DAYS 1	3	5	7	APR DAYS 1	3	5	7
50/ 60	52	18	6	3	44	14	5	1	53	19	8	3	60	25	12	6
50/120	20	2	0	0	20	2	0	0	30	5	1	0	33	6	1	0
50/180	12	1	0	0	13	1	0	0	19	1	0	0	21	2	0	0
150/ 60	0	0	0	0	21	3	0	0	40	9	3	1	53	18	6	5
150/120	0	0	0	0	7	0	0	0	21	1	0	0	27	3	0	0
150/180	0	0	0	0	3	0	0	0	12	0	0	0	18	1	0	0
250/ 60	0	0	0	0	0	0	0	0	9	0	0	0	35	8	3	2
250/120	0	0	0	0	0	0	0	0	3	0	0	0	16	2	0	0
250/180	0	0	0	0	0	0	0	0	1	0	0	0	9	0	0	0

INT	MAY DAYS 1	3	5	7	JUN DAYS 1	3	5	7	JUL DAYS 1	3	5	7	AUG DAYS 1	3	5	7
50/ 60	56	24	11	5	49	16	5	1	54	20	8	3	48	18	7	3
50/120	27	5	1	0	20	2	1	0	20	4	0	0	18	2	0	0
50/180	16	1	0	0	10	1	0	0	8	1	0	0	8	1	0	0
150/ 60	54	23	9	5	47	16	5	1	54	19	7	2	48	17	6	2
150/120	26	5	1	0	20	2	1	0	20	4	0	0	18	2	0	0
150/180	15	1	0	0	10	1	0	0	8	1	0	0	8	1	0	0
250/ 60	42	15	5	2	42	13	4	1	48	16	5	2	36	9	3	0
250/120	19	3	0	0	18	2	1	0	19	3	0	0	13	1	0	0
250/180	11	0	0	0	9	1	0	0	7	1	0	0	6	0	0	0

INT	SEP DAYS 1	3	5	7	OCT DAYS 1	3	5	7	NOV DAYS 1	3	5	7	DEC DAYS 1	3	5	7
50/ 60	46	15	3	0	44	14	4	1	45	15	6	3	48	17	9	5
50/120	18	2	0	0	18	2	0	0	17	2	0	0	18	0	0	0
50/180	9	0	0	0	11	1	0	0	10	1	0	0	9	0	0	0
150/ 60	43	11	2	0	34	7	1	0	6	1	0	0	0	0	0	0
150/120	17	1	0	0	12	1	0	0	1	0	0	0	0	0	0	0
150/180	8	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0
250/ 60	27	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
250/120	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
250/180	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

COMBINATIONS OF POWER LEVELS, INSOLATION/WINDS (W/M^2), DAILY AVERAGES

TABLE 4-3.

SELECTED PARAMETERS FROM THE ELY TMY DATA TAPE

FOR 23 JANUARY 1974

SOLAR HOUR	INSOLATION (KJ/M2)* EXTRATERRESTRIAL ON HORIZONTAL SURFACE	DIRECT	GLOBAL	STATION PRESSURE (K PA)	TEMPERATURE (DEGREES C) DRY BULB	DEW POINT	WIND DIR (DEG)	SPEED (M/SEC)	SKY COVER (TENTHS) TOTAL	OPAQUE
1	0	0.0	0.0	81.52	-12.70	-14.20	203	4.60		
2	0	0.0	0.0	81.48	-13.90	-15.60	210	4.60	4	3
3	0	0.0	0.0	81.46	-13.60	-15.30	200	3.60		
4	0	0.0	0.0	81.43	-13.40	-15.10	190	2.50		
5	0	0.0	0.0	81.41	-13.30	-15.00	180	1.50	10	10
6	0	0.0	0.0	81.42	-12.10	-13.80	170	1.90		
7	0	0.0	0.0	81.43	-11.00	-12.70	160	2.20		
8	339	505.0	136.0	81.44	-10.00	-11.70	150	2.60	8	7
9	1174	2790.0	811.0	81.45	-7.90	-10.30	110	2.80		
10	1860	3336.0	1613.0	81.47	-5.80	-9.00	70	2.90		
11	2345	3568.0	2024.0	81.48	-3.90	-7.80	30	3.10	10	2
12	2596	3630.0	2090.0	81.46	-2.70	-6.60	20	4.00		
13	2596	3626.0	2055.0	81.43	-1.60	-5.40	10	4.80		
14	2345	3544.0	1898.0	81.41	-.60	-4.40	0	5.70	2	2
15	1860	3379.0	1473.0	81.42	-.70	-4.50	357	5.30		
16	1174	2548.0	793.0	81.43	-.80	-4.70	353	5.00		
17	339	50.0	79.0	81.44	-1.10	-5.00	350	4.60	3	1
18	0	0.0	0.0	81.46	-2.90	-5.80	357	4.60		
19	0	0.0	0.0	81.49	-4.70	-6.80	3	4.60		
20	0	0.0	0.0	81.51	-6.70	-7.80	10	4.60	3	3
21	0	0.0	0.0	81.53	-8.10	-9.40	313	3.90		
22	0	0.0	0.0	81.56	-9.50	-11.00	257	3.30		
23	0	0.0	0.0	81.58	-11.10	-12.80	200	2.60	0	0
24	0	0.0	0.0	81.58	-11.40	-13.10	197	3.10		

TOTAL FOR DAY	DIRECT	GLOBAL
KJ/M2	26976.00	12972.00
KWHR/M2	7.49	3.60

* CONVERSION FACTOR: $KJ/M^2 \times 2.777 \times 10^4 = KW\text{-}HR/M^2$

TABLE 4-4.

SELECTED PARAMETERS FROM THE ELY TMY DATA TAPE

FOR 24 FEBRUARY 1971

SOLAR HOUR	INSOLATION (KJ/M2)* EXTRATERRESTRIAL ON HORIZONTAL SURFACE	DIRECT	GLOBAL	STATION PRESSURE (K PA)	TEMPERATURE (DEGREES C) DRY BULB	DEW POINT	WIND DIR (DEG)	SPEED (M/SEC)	SKY COVER (TENTHS) TOTAL	OPAQUE
1	0	0.0	0.0	80.58	-6.20	-9.20	230	5.30		
2	0	0.0	0.0	80.60	-7.20	-10.00	200	6.20	0	0
3	0	0.0	0.0	80.61	-7.70	-10.50	200	5.30		
4	0	0.0	0.0	80.62	-8.20	-11.00	200	4.50		
5	0	0.0	0.0	80.63	-8.90	-11.70	200	3.60	0	0
6	0	0.0	0.0	80.65	-9.20	-11.80	197	4.50		
7	102	0.0	45.0	80.68	-9.50	-11.90	193	5.30		
8	927	2767.0	620.0	80.70	-10.00	-12.20	190	6.20	0	0
9	1798	3364.0	1348.0	80.70	-6.60	-11.00	190	5.20		
10	2508	3602.0	1978.0	80.70	-3.20	-9.90	190	4.10		
11	3010	3685.0	2427.0	80.70	0.00	-8.90	190	3.10	1	0
12	3270	3720.0	2628.0	80.64	2.20	-8.80	163	2.80		
13	3270	3718.0	2598.0	80.59	4.50	-8.80	137	2.40		
14	3010	3660.0	2346.0	80.53	6.70	-8.90	110	2.10	2	2
15	2508	3579.0	1933.0	80.48	6.70	-7.90	137	2.60		
16	1798	3268.0	1333.0	80.44	6.70	-6.90	163	3.10		
17	927	2691.0	626.0	80.39	6.70	-6.10	190	3.60	0	0
18	102	0.0	52.0	80.39	4.70	-5.40	193	4.30		
19	0	0.0	0.0	80.39	2.60	-4.90	197	5.00		
20	0	0.0	0.0	80.39	.60	-4.40	200	5.70	0	0
21	0	0.0	0.0	80.33	.80	-5.20	193	6.20		
22	0	0.0	0.0	80.28	.90	-6.20	187	6.70		
23	0	0.0	0.0	80.22	1.10	-7.20	180	7.20	0	0
24	0	0.0	0.0	80.12	1.70	-7.50	190	6.90		
TOTAL FOR DAY										
KJ/M2		34054.00	17934.00							
KWHR/M2		9.46	4.98							

* CONVERSION FACTOR: $KJ/M^2 \times 2.777 \times 10^4 = KW\text{-}HR/M^2$

TABLE 4-5.

SELECTED PARAMETERS FROM THE ELY TMY DATA TAPE

FOR 21 MARCH 1971

SOLAR HOUR	INSOLATION (KJ/M2)* EXTRATERRESTRIAL ON HORIZONTAL SURFACE	DIRECT	GLOBAL	STATION PRESSURE (K PA)	TEMPERATURE (DEGREES C) DRY BULB	DEW POINT	WIND DIR (DEG)	SPEED (M/SEC)	SKY COVER (TENTHS) TOTAL	OPAQUE
1	0	0.0	0.0	80.79	-2.10	-6.80	197	5.50		
2	0	0.0	0.0	80.80	-2.80	-6.70	190	5.70	0	0
3	0	0.0	0.0	80.81	-3.20	-7.00	187	5.50		
4	0	0.0	0.0	80.82	-3.80	-7.30	183	5.30		
5	0	0.0	0.0	80.83	-4.40	-7.80	180	5.10	0	0
6	0	0.0	0.0	80.85	-3.40	-7.30	187	5.10		
7	496	1272.0	305.0	80.88	-2.50	-7.00	193	5.10		
8	1468	2705.0	1089.0	80.90	-1.70	-6.70	200	5.10	3	0
9	2340	3246.0	1852.0	80.92	2.60	-7.50	233	5.50		
10	3052	3417.0	2479.0	80.95	6.80	-8.40	267	5.80		
11	3555	3492.0	2903.0	80.97	11.10	-9.40	300	6.20	7	1
12	3816	3510.0	3107.0	80.91	12.60	-10.10	307	6.00		
13	3816	3493.0	3086.0	80.86	14.10	-10.80	313	5.90		
14	3555	3438.0	2851.0	80.80	15.60	-11.70	320	5.70	8	2
15	3052	3325.0	2355.0	80.80	15.60	-9.70	300	5.50		
16	2340	2857.0	1701.0	80.80	15.60	-7.90	280	5.30		
17	1468	2125.0	967.0	80.80	15.60	-6.10	260	5.10	7	5
18	496	1174.0	276.0	80.82	12.60	-6.20	270	4.80		
19	0	0.0	0.0	80.85	9.70	-6.40	280	4.40		
20	0	0.0	0.0	80.87	6.70	-6.70	290	4.10	7	7
21	0	0.0	0.0	80.90	5.80	-6.80	293	3.80		
22	0	0.0	0.0	80.94	4.80	-6.90	297	3.40		
23	0	0.0	0.0	80.97	3.90	-7.20	300	3.10	0	0
24	0	0.0	0.0	80.99	2.40	-6.60	267	3.30		

TOTAL FOR DAY	DIRECT	GLOBAL
KJ/M2	34054.00	22971.00
KWHR/M2	9.46	6.38

* CONVERSION FACTOR: $KJ/M^2 \times 2.777 \times 10^4 = KW\text{-}HR/M^2$

TABLE 4-6.

SELECTED PARAMETERS FROM THE ELY TMY DATA TAPE

FOR 15 APRIL 1971

SOLAR HOUR	INSOLATION (KJ/M2)* EXTRATERRESTRIAL ON HORIZONTAL SURFACE	DIRECT	GLOBAL	STATION PRESSURE (K PA)	TEMPERATURE (DEGREES C) DRY BULB	DEW POINT	WIND DIR (DEG)	SPEED (M/SEC)	SKY COVER (TENTHS) TOTAL	OPAQUE
1	0	0.0	0.0	80.31	2.20	-5.70	143	2.80		
2	0	0.0	0.0	80.29	1.70	-5.60	180	2.60	1	0
3	0	0.0	0.0	80.27	.80	-5.90	183	3.40		
4	0	0.0	0.0	80.24	-.10	-6.20	187	4.30		
5	0	0.0	0.0	80.22	-1.10	-6.70	190	5.10	0	0
6	130	703.0	67.0	80.24	.90	-5.80	197	4.60		
7	1001	2474.0	704.0	80.27	3.00	-5.10	203	4.10		
8	1946	3292.0	1529.0	80.29	5.00	-4.40	210	3.60	0	0
9	2794	3541.0	2293.0	80.27	7.80	-3.90	243	4.10		
10	3486	3655.0	2899.0	80.24	10.50	-3.60	277	4.60		
11	3976	3695.0	3298.0	80.22	13.30	-3.30	310	5.10	1	1
12	4229	3701.0	3485.0	80.21	14.60	-5.80	307	5.50		
13	4229	3694.0	3474.0	80.20	15.90	-8.40	303	5.80		
14	3976	3667.0	3252.0	80.19	17.20	-11.10	300	6.20	2	2
15	3486	3615.0	2841.0	80.17	17.60	-9.90	293	7.10		
16	2794	3495.0	2233.0	80.14	17.90	-8.80	287	7.90		
17	1946	3255.0	1483.0	80.12	18.30	-7.80	280	8.80	2	2
18	1001	2409.0	691.0	80.14	15.50	-8.80	303	6.90		
19	130	728.0	74.0	80.17	12.80	-9.90	327	5.00		
20	0	0.0	0.0	80.19	10.00	-11.10	350	3.10	1	0
21	0	0.0	0.0	80.22	9.10	-10.10	337	3.80		
22	0	0.0	0.0	80.26	8.10	-9.10	323	4.40		
23	0	0.0	0.0	80.29	7.20	-8.30	310	5.10	0	0
24	0	0.0	0.0	80.29	5.00	-7.80	270	4.80		
TOTAL FOR DAY										
KJ/M2		41924.00	28323.00							
KWHR/M2		11.65	7.87							

* CONVERSION FACTOR: $KJ/M^2 \times 2.777 \times 10^4 = KW\text{-}HR/M^2$

TABLE 4-7.

SELECTED PARAMETERS FROM THE ELY TMY DATA TAPE

FOR 16 MAY 1956

SOLAR HOUR	INSOLATION (KJ/M2) * EXTRATERRESTRIAL ON HORIZONTAL SURFACE	DIRECT	GLOBAL	STATION PRESSURE (K PA)	TEMPERATURE (DEGREES C) DRY BULB	DEW POINT	WIND DIR (DEG)	SPEED (M/SEC)	SKY COVER (TENTHS) TOTAL	OPAQUE
1	0	0.0	0.0	81.97	3.30	-.70	180	5.70		
2	0	0.0	0.0	81.98	2.80	-.60	180	6.20	0	0
3	0	0.0	0.0	81.97	1.70	-1.20	180	5.50		
4	0	0.0	0.0	81.96	.50	-2.00	180	4.80		
5	0	0.0	8.0	81.95	-.60	-2.80	160	4.10	0	0
6	531	529.0	281.0	81.98	.60	-1.70	180	3.60	0	0
7	1455	1805.0	1019.0	82.02	5.00	0.00	180	2.60	0	0
8	2348	2805.0	1881.0	82.02	10.00	1.70	0	0.00	0	0
9	3149	3107.0	2657.0	82.00	12.20	.80	0	1.40		
10	3802	3242.0	3290.0	81.97	14.50	-.10	0	2.70		
11	4264	3268.0	3675.0	81.95	16.70	-1.10	0	4.10	0	0
12	4504	3268.0	3834.0	81.88	18.20	-2.90	300	3.80		
13	4504	3270.0	3836.0	81.82	19.60	-4.70	240	3.40		
14	4264	3269.0	3678.0	81.75	21.10	-6.70	180	3.10	0	0
15	3802	3234.0	3266.0	81.69	21.50	-5.80	165	2.90		
16	3149	3097.0	2652.0	81.64	21.80	-5.10	150	2.80		
17	2348	2810.0	1881.0	81.58	22.20	-4.40	135	2.60	0	0
18	1455	1920.0	1042.0	81.60	19.20	-2.30	143	2.90		
19	531	644.0	295.0	81.63	16.30	-.20	150	3.30		
20	0	0.0	4.0	81.65	13.30	1.70	158	3.60	1	1
21	0	0.0	0.0	81.67	11.50	.80	165	4.30		
22	0	0.0	0.0	81.69	9.60	-.10	173	5.00		
23	0	0.0	0.0	81.71	7.80	-1.10	180	5.70	3	1
24	0	0.0	0.0	81.70	6.10	-1.40	180	5.20		

TOTAL FOR DAY	DIRECT	GLOBAL
KJ/M2	36268.00	33299.00
KWHR/M2	10.07	9.25

* CONVERSION FACTOR: $KJ/M^2 \times 2.777 \times 10^4 = KW\text{-}HR/M^2$

TABLE 4-8.

SELECTED PARAMETERS FROM THE ELY TMY DATA TAPE

FOR 26 JUNE 1975

SOLAR HOUR	INSOLATION (KJ/M2)* EXTRATERRESTRIAL ON HORIZONTAL SURFACE	DIRECT	GLOBAL	STATION PRESSURE (K PA)	TEMPERATURE (DEGREES C) DRY BULB	DEW POINT	WIND DIR (DEG)	SPEED (M/SEC)	SKY COVER (TENTHS) TOTAL	OPAQUE
1	0	0.0	0.0	81.32	2.80	-5.10	173	4.90		
2	0	0.0	0.0	81.31	2.20	-6.10	180	5.10	0	0
3	0	0.0	0.0	81.30	.90	-6.00	197	4.30		
4	0	0.0	0.0	81.28	-.30	-6.00	213	3.40		
5	58	0.0	0.0	81.27	-1.70	-6.10	230	2.60	0	0
6	762	102.0	137.0	81.27	1.30	-5.10	263	2.20		
7	1649	1116.0	790.0	81.27	4.20	-4.10	297	1.90		
8	2505	3010.0	1987.0	81.27	7.20	-3.30	330	1.50	0	0
9	3273	3460.0	2707.0	81.21	11.70	-2.70	277	1.70		
10	3901	3567.0	3266.0	81.16	16.10	-2.10	223	1.90		
11	4344	3598.0	3635.0	81.10	20.60	-1.70	170	2.10	0	0
12	4573	3602.0	3813.0	81.06	21.30	-2.70	187	3.10		
13	4573	3620.0	3835.0	81.01	22.10	-3.80	203	4.10		
14	4344	3619.0	3654.0	80.97	22.80	-5.00	220	5.10	1	0
15	3901	3588.0	3284.0	80.92	23.50	-4.30	220	6.10		
16	3273	3480.0	2722.0	80.88	24.30	-3.80	220	7.20		
17	2505	3017.0	2001.0	80.83	25.00	-3.30	220	8.20	0	0
18	1649	1162.0	801.0	80.81	23.50	-3.40	207	6.80		
19	762	128.0	145.0	80.79	22.10	-3.60	193	5.50		
20	58	0.0	0.0	80.77	20.60	-3.90	180	4.10	8	5
21	0	0.0	0.0	80.77	19.30	-5.30	193	5.10		
22	0	0.0	0.0	80.77	18.00	-6.70	207	6.20		
23	0	0.0	0.0	80.77	16.70	-8.30	220	7.20	5	4
24	0	0.0	0.0	80.76	14.70	-6.90	217	6.50		
TOTAL FOR DAY										
KJ/M2		37069.00	32777.00							
KWHR/M2		10.30	9.10							

* CONVERSION FACTOR: $JK/M^2 \times 2.777 \times 10^4 = KW\text{-}HR/M^2$

TABLE 4-9.

SELECTED PARAMETERS FROM THE ELY TMY DATA TAPE

FOR 19 JULY 1958

SOLAR HOUR	INSOLATION (KJ/M2)* EXTRATERRESTRIAL ON HORIZONTAL SURFACE	DIRECT	GLOBAL	STATION PRESSURE (K PA)	TEMPERATURE (DEGREES C) DRY BULB	DEW POINT	WIND DIR (DEG)	SPEED (M/SEC)	SKY COVER (TENTHS) TOTAL	OPAQUE
1	0	0.0	0.0	81.14	8.90	-7.10	180	2.60		
2	0	0.0	0.0	81.17	6.70	-7.10	135	2.60		
3	0	0.0	0.0	81.17	5.60	-7.10	135	4.10		
4	0	0.0	0.0	81.17	5.00	-7.10	180	2.60		
5	18	0.0	4.0	81.17	5.00	-7.20	180	4.60	0	0
6	639	1665.0	301.0	81.21	6.10	-5.50	180	5.70		
7	1541	2702.0	1061.0	81.24	10.60	-3.90	180	3.60	0	0
8	2413	3039.0	1878.0	81.24	15.60	-4.40	203	2.60	0	0
9	3195	3271.0	2603.0	81.21	21.10	-2.20	180	3.10	0	0
10	3834	3385.0	3166.0	81.17	23.90	-2.20	180	3.10	0	0
11	4285	3419.0	3534.0	81.17	25.00	-2.80	160	2.10	0	0
12	4519	3436.0	3731.0	81.14	26.10	-3.90	225	5.70	0	0
13	4519	3453.0	3739.0	81.14	26.70	-2.80	225	4.10	1	1
14	4285	3478.0	3600.0	81.07	27.20	-3.30	203	7.70	2	2
15	3834	3421.0	3183.0	81.04	28.30	-5.00	203	5.10	2	2
16	3195	3266.0	2638.0	81.00	28.30	-5.00	203	4.10	2	2
17	2413	2682.0	1757.0	80.97	27.80	-6.10	203	3.60	2	2
18	1541	321.0	594.0	80.90	27.80	-4.80	225	7.70		
19	639	8.0	96.0	80.93	23.90	-3.60	203	5.10		
20	18	0.0	4.0	81.00	23.90	-2.40	315	5.10		
21	0	0.0	0.0	81.07	21.70	-1.20	360	4.10		
22	0	0.0	0.0	81.14	20.60	-0.00	360	5.10		
23	0	0.0	0.0	81.14	18.90	1.10	23	3.60	4	4
24	0	0.0	0.0	81.17	16.70	.60	360	3.10		

TOTAL FOR DAY	DIRECT	GLOBAL
KJ/M2	37546.00	31889.00
KWHR/M2	10.43	8.86

* CONVERSION FACTOR: $KJ/M^2 \times 2.777 \times 10^4 = KW\text{-}HR/M^2$

TABLE 4-10.

SELECTED PARAMETERS FROM THE ELY TMY DATA TAPE

FOR 18 AUGUST 1973

SOLAR HOUR	INSOLATION (KJ/M2)* EXTRATERRESTRIAL ON HORIZONTAL SURFACE	INSOLATION DIRECT	INSOLATION GLOBAL	STATION PRESSURE (K PA)	TEMPERATURE (DEGREES C) DRY BULB	TEMPERATURE (DEGREES C) DEW POINT	WIND DIR (DEG)	WIND SPEED (M/SEC)	SKY COVER (TENTHS) TOTAL	SKY COVER (TENTHS) OPAQUE
1	0	0.0	0.0	81.06	16.10	4.80	217	6.50		
2	0	0.0	0.0	81.07	15.00	4.40	230	6.20	5	5
3	0	0.0	0.0	81.08	15.40	4.80	227	6.40		
4	0	0.0	0.0	81.09	15.70	5.20	223	6.50		
5	0	0.0	0.0	81.10	16.10	5.60	220	6.70	1	1
6	263	8.0	54.0	81.15	17.40	6.00	213	6.70		
7	1185	1351.0	743.0	81.19	18.70	6.30	207	6.70		
8	2102	2716.0	1570.0	81.24	20.00	6.70	200	6.70	0	0
9	2924	3069.0	2338.0	81.25	22.20	5.20	213	6.50		
10	3595	3235.0	2950.0	81.26	24.50	3.70	227	6.40		
11	4069	3301.0	3359.0	81.27	26.70	2.20	240	6.20	0	0
12	4315	3316.0	3560.0	81.25	27.60	2.00	223	5.80		
13	4315	3310.0	3554.0	81.23	28.50	1.90	207	5.50		
14	4069	3286.0	3351.0	81.21	29.40	1.70	190	5.10	0	0
15	3595	3198.0	2923.0	81.17	30.00	.40	210	5.50		
16	2924	3020.0	2299.0	81.14	30.50	-.80	230	5.60		
17	2102	2555.0	1531.0	81.10	31.10	-2.20	250	6.20	1	1
18	1185	1266.0	722.0	81.11	28.50	0.00	240	5.50		
19	263	8.0	53.0	81.13	25.90	2.20	230	4.80		
20	0	0.0	0.0	81.14	23.30	4.40	220	4.10	0	0
21	0	0.0	0.0	81.20	22.20	4.00	213	4.40		
22	0	0.0	0.0	81.25	21.10	3.70	207	4.80		
23	0	0.0	0.0	81.31	20.00	3.30	200	5.10	0	0
24	0	0.0	0.0	81.33	19.10	1.80	200	5.10		

TOTAL FOR DAY	DIRECT	GLOBAL
KJ/M2	33639.00	29007.00
KWHR/M2	9.34	8.06

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*CONVERSION FACTOR: $KJ/M^2 \times 2.777 \times 10^4 = KW\text{-}HR/M^2$

TABLE 4-11.

SELECTED PARAMETERS FROM THE ELY TMY DATA TAPE

FOR 25 SEPTEMBER 1966

SOLAR HOUR	INSOLATION (KJ/M2)* EXTRATERRESTRIAL ON HORIZONTAL SURFACE	DIRECT	GLOBAL	STATION PRESSURE (K PA)	TEMPERATURE (DEGREES C) DRY BULB	DEW POINT	WIND DIR (DEG)	SPEED (M/SEC)	SKY COVER (TENTHS) TOTAL	OPAQUE
1	0	0.0	0.0	80.79	15.50	3.70	200	5.70		
2	0	0.0	0.0	80.80	14.40	3.30	200	6.20	0	0
3	0	0.0	0.0	80.80	13.50	3.50	200	5.00		
4	0	0.0	0.0	80.80	12.60	3.70	200	3.80		
5	0	0.0	0.0	80.80	11.70	3.90	200	2.60	1	1
6	0	0.0	0.0	80.82	12.10	4.10	197	2.60		
7	471	995.0	233.0	80.85	12.40	4.20	193	2.60		
8	1431	2554.0	1032.0	80.87	12.80	4.40	190	2.60	0	0
9	2293	3165.0	1813.0	80.86	16.10	2.90	187	3.80		
10	2996	3371.0	2452.0	80.84	19.50	1.50	183	5.00		
11	3493	3471.0	2901.0	80.83	22.80	0.00	180	6.20	0	0
12	3751	3496.0	3104.0	80.81	23.50	0.00	187	5.70		
13	3751	3477.0	3100.0	80.79	24.30	0.00	193	5.10		
14	3493	3403.0	2838.0	80.77	25.00	0.00	200	4.60	0	0
15	2996	3283.0	2358.0	80.73	24.80	-.50	207	5.00		
16	2293	3073.0	1748.0	80.70	24.60	-1.00	213	5.30		
17	1431	2170.0	949.0	80.66	24.40	-1.70	220	5.70	1	1
18	471	662.0	200.0	80.67	21.60	-1.20	210	5.30		
19	0	0.0	0.0	80.69	18.90	-.90	200	5.00		
20	0	0.0	0.0	80.70	16.10	-.60	190	4.60	0	0
21	0	0.0	0.0	80.74	14.80	-1.00	247	3.10		
22	0	0.0	0.0	80.79	13.50	-1.60	303	1.50		
23	0	0.0	0.0	80.83	12.20	-2.20	0	0.00	0	0
24	0	0.0	0.0	80.84	10.50	-1.90	303	1.70		

TOTAL FOR DAY	DIRECT	GLOBAL
KJ/M2	33120.00	22728.00
KWHR/M2	9.20	6.31

*CONVERSION FACTOR: $KJ/M^2 \times 2.777 \times 10^4 = KW\text{-}HR/M^2$

TABLE 4-12.

SELECTED PARAMETERS FROM THE ELY TMY DATA TAPE

FOR 23 OCTOBER 1966

SOLAR HOUR	INSOLATION (KJ/M2)* EXTRATERRESTRIAL ON HORIZONTAL SURFACE	DIRECT	GLOBAL	STATION PRESSURE (K PA)	TEMPERATURE (DEGREES C) DRY BULB	DEW POINT	WIND DIR (DEG)	SPEED (M/SEC)	SKY COVER (TENTHS) TOTAL	OPAQUE
1	0	0.0	0.0	81.53	.40	-2.70	253	1.70		
2	0	0.0	0.0	81.54	-1.10	-3.90	200	2.60	0	0
3	0	0.0	0.0	81.56	-1.70	-4.40	200	2.60		
4	0	0.0	0.0	81.59	-2.50	-4.90	200	2.60		
5	0	0.0	0.0	81.61	-3.30	-5.60	200	2.60	0	0
6	0	0.0	0.0	81.64	-2.50	-4.90	197	3.30		
7	70	0.0	34.0	81.68	-1.70	-4.40	193	3.90		
8	844	2552.0	626.0	81.71	-1.10	-3.90	190	4.60	10	3
9	1702	3161.0	1267.0	81.73	2.20	-2.50	247	3.10		
10	2404	3317.0	1944.0	81.76	5.60	-1.20	303	1.50		
11	2899	3440.0	2371.0	81.78	8.90	0.00	0	0.00	6	2
12	3156	3465.0	2555.0	81.75	10.60	-.50	3	2.10		
13	3156	3450.0	2500.0	81.71	12.20	-1.00	7	4.10		
14	2899	3406.0	2240.0	81.68	13.90	-1.70	10	6.20	1	0
15	2404	3222.0	1766.0	81.69	14.10	-2.70	10	5.80		
16	1702	2420.0	1118.0	81.70	14.20	-3.80	10	5.50		
17	844	1309.0	408.0	81.71	14.40	-5.00	10	5.10	0	0
18	70	0.0	9.0	81.76	12.60	-5.10	7	3.40		
19	0	0.0	0.0	81.80	10.70	-5.30	3	1.70		
20	0	0.0	0.0	81.85	8.90	-5.60	0	0.00	0	0
21	0	0.0	0.0	81.88	6.50	-6.00	307	1.70		
22	0	0.0	0.0	81.92	4.10	-6.60	253	3.40		
23	0	0.0	0.0	81.95	1.70	-7.20	200	5.10	0	0
24	0	0.0	0.0	81.97	.60	-7.50	200	4.80		

TOTAL FOR DAY	DIRECT	GLOBAL
KJ/M2	29742.00	16838.00
KWHR/M2	8.26	4.68

*CONVERSION FACTOR: $KJ/M^2 \times 2.777 \times 10^4 = KW\text{-}HR/M^2$

TABLE 4-13.

SELECTED PARAMETERS FROM THE ELY TMY DATA TAPE

FOR 18 NOVEMBER 1963

SOLAR HOUR	INSOLATION (KJ/M2)* EXTRATERRESTRIAL ON HORIZONTAL SURFACE	DIRECT	GLOBAL	STATION PRESSURE (K PA)	TEMPERATURE (DEGREES C) DRY BULB	DEW POINT	WIND DIR (DEG)	SPEED (M/SEC)	SKY COVER (TENTHS) TOTAL	OPAQUE
1	0	0.0	0.0	80.90	-11.10	-12.80	180	4.60	2	2
2	0	0.0	0.0	80.90	-12.20	-13.90	180	6.20	2	2
3	0	0.0	0.0	80.87	-13.90	-15.60	180	6.20	3	2
4	0	0.0	0.0	80.87	-13.90	-15.60	180	6.20	5	3
5	0	0.0	0.0	80.87	-13.90	-15.60	180	5.10	5	2
6	0	0.0	0.0	80.87	-13.90	-15.60	180	4.60	5	3
7	0	0.0	0.0	80.87	-15.60	-17.80	180	6.20	0	0
8	372	1564.0	197.0	80.90	-14.40	-16.70	203	5.10	0	0
9	1209	3010.0	866.0	80.97	-12.80	-15.60	180	4.10	1	0
10	1893	3404.0	1454.0	80.97	-7.20	-11.70	180	4.60	2	0
11	2376	3523.0	1859.0	81.00	-3.30	-10.60	180	2.60	7	1
12	2627	3567.0	2076.0	80.93	0.00	-6.70	0	0.00	8	3
13	2627	3555.0	2093.0	80.90	-.60	-8.90	0	0.00	8	3
14	2376	3521.0	1866.0	80.83	.60	-10.60	0	0.00	4	1
15	1893	3398.0	1459.0	80.80	3.90	-8.90	0	0.00	2	0
16	1209	2871.0	858.0	80.80	4.40	-7.20	0	0.00	0	0
17	372	1364.0	199.0	80.77	5.00	-6.10	0	0.00	1	1
18	0	0.0	0.0	80.80	-3.90	-7.80	180	2.60	3	2
19	0	0.0	0.0	80.83	-6.10	-8.90	180	3.60	3	1
20	0	0.0	0.0	80.83	-7.20	-10.00	180	4.60	3	1
21	0	0.0	0.0	80.83	-7.80	-10.00	180	3.60	2	1
22	0	0.0	0.0	80.83	-8.90	-11.10	180	4.10	2	1
23	0	0.0	0.0	80.80	-7.80	-10.60	180	4.60	4	2
24	0	0.0	0.0	80.77	-5.00	-8.90	203	6.70	6	3
TOTAL FOR DAY										
KJ/M2		29777.00	12927.00							
KWHR/M2		8.27	3.59							

*CONVERSION FACTOR: $KJ/M^2 \times 2.777 \times 10^4 = KW\text{-}HR/M^2$

TABLE 4-14.

SELECTED PARAMETERS FROM THE ELY TMY DATA TAPE

FOR 24 DECEMBER 1965

SOLAR HOUR	INSOLATION (KJ/M2) * EXTRATERRESTRIAL ON HORIZONTAL SURFACE	DIRECT	GLOBAL	STATION PRESSURE (K PA)	TEMPERATURE (DEGREES C) DRY BULB	DEW POINT	WIND DIR (DEG)	SPEED (M/SEC)	SKY COVER (TENTHS) TOTAL	OPAQUE
1	0	0.0	0.0	81.20	-16.80	-25.70	190	6.70		
2	0	0.0	0.0	81.21	-16.70	-25.60	190	7.20	0	0
3	0	0.0	0.0	81.20	-16.20	-25.30	190	6.90		
4	0	0.0	0.0	81.18	-15.90	-25.10	190	6.50		
5	0	0.0	0.0	81.17	-15.60	-25.00	190	6.20	0	0
6	0	0.0	0.0	81.16	-14.90	-24.20	183	5.50		
7	0	0.0	0.0	81.15	-14.40	-23.40	177	4.80		
8	162	870.0	112.0	81.14	-13.90	-22.80	170	4.10	4	4
9	919	2647.0	676.0	81.14	-10.10	-20.30	180	5.80		
10	1588	3247.0	1199.0	81.14	-6.40	-17.90	190	7.60		
11	2062	3419.0	1542.0	81.14	-2.80	-15.60	200	9.30	0	0
12	2307	3504.0	1733.0	81.04	-.50	-13.40	197	9.10		
13	2307	3496.0	1738.0	80.93	1.70	-11.40	193	9.00		
14	2062	3377.0	1542.0	80.83	3.90	-9.40	190	8.80	0	0
15	1588	2944.0	1136.0	80.79	2.80	-10.60	187	10.30		
16	919	2118.0	590.0	80.74	1.70	-11.90	183	11.90		
17	162	269.0	68.0	80.70	.60	-13.30	180	13.40	0	0
18	0	0.0	0.0	80.69	-.80	-11.70	187	12.00		
19	0	0.0	0.0	80.67	-2.30	-10.30	193	10.70		
20	0	0.0	0.0	80.66	-3.90	-8.90	200	9.30	0	0
21	0	0.0	0.0	80.62	-3.40	-9.70	193	9.30		
22	0	0.0	0.0	80.57	-3.10	-10.70	187	9.30		
23	0	0.0	0.0	80.53	-2.80	-11.70	180	9.30	0	0
24	0	0.0	0.0	80.48	-2.70	-11.20	177	9.10		
TOTAL FOR DAY										
KJ/M2		25891.00	10336.00							
KWHR/M2		7.19	2.87							

*CONVERSION FACTOR: $KJ/M^2 \times 2.777 \times 10^4 = KW\text{-}HR/M^2$

TABLE 4-15.

SELECTED PARAMETERS FROM THE ELY TMY DATA TAPE

FOR 19 APRIL 1971

SOLAR	INSOLATION (KJ/M2)*			STATION	TEMPERATURE		WIND		SKY COVER	
HOUR	EXTRATERRESTRIAL ON HORIZONTAL SURFACE	DIRECT	GLOBAL	PRESSURE (K PA)	(DEGREES C) DRY BULB	DEW POINT	DIR (DEG)	SPEED (M/SEC)	(TENTHS) TOTAL	OPAQUE
1	0	0.0	0.0	80.07	-4.90	-6.40	37	5.10		
2	0	0.0	0.0	80.09	-5.60	-7.20	40	5.10	6	6
3	0	0.0	0.0	80.08	-5.50	-7.30	17	3.90		
4	0	0.0	0.0	80.06	-5.50	-7.50	353	2.70		
5	0	0.0	0.0	80.05	-5.60	-7.80	330	1.50	7	7
6	173	75.0	53.0	80.05	-4.70	-7.10	340	1.00		
7	1072	796.0	447.0	80.05	-4.00	-6.60	350	.50		
8	2011	1266.0	933.0	80.05	-3.30	-6.10	0	0.00	10	9
9	2853	817.0	1117.0	80.05	-2.30	-5.10	7	1.40		
10	3541	16.0	1068.0	80.05	-1.40	-4.10	13	2.70		
11	4027	9.0	827.0	80.05	-.60	-3.30	20	4.10	10	10
12	4279	9.0	877.0	80.03	.50	-2.30	27	3.90		
13	4279	10.0	879.0	80.01	1.70	-1.40	33	3.80		
14	4027	10.0	829.0	79.99	2.80	-.60	40	3.60	10	10
15	3541	9.0	727.0	80.01	2.60	-.10	33	3.80		
16	2853	8.0	575.0	80.03	2.40	.20	27	3.90		
17	2011	5.0	387.0	80.05	2.20	.60	20	4.10	10	10
18	1072	1.0	187.0	80.07	2.00	.20	320	3.40		
19	173	4.0	25.0	80.10	1.90	-.10	260	2.80		
20	0	0.0	0.0	80.12	1.70	-.60	200	2.10	3	3
21	0	0.0	0.0	80.12	1.10	-.90	197	2.80		
22	0	0.0	0.0	80.12	.60	-1.20	193	3.40		
23	0	0.0	0.0	80.12	0.00	-1.70	190	4.10	5	2
24	0	0.0	0.0	80.10	-.50	-1.60	187	4.30		

TOTAL FOR DAY	DIRECT	GLOBAL
KJ/M2	3055.00	8931.00
KWHR/M2	.85	2.48

*CONVERSION FACTOR: $KJ/M^2 \times 2.777 \times 10^4 = KW\text{-}HR/M^2$

TABLE 4-16.

SELECTED PARAMETERS FROM THE ELY TMY DATA TAPE

FOR 23 MAY 1956

SOLAR HOUR	INSOLATION (KJ/M2)* EXTRATERRESTRIAL ON HORIZONTAL SURFACE	DIRECT	GLOBAL	STATION PRESSURE (K PA)	TEMPERATURE (DEGREES C) DRY BULB	DEW POINT	WIND DIR (DEG)	SPEED (M/SEC)	SKY COVER (TENTHS) TOTAL	OPAQUE
1	0	0.0	0.0	81.33	7.00	5.60	180	4.60		
2	0	0.0	0.0	81.31	6.10	5.00	180	4.10	5	2
3	0	0.0	0.0	81.30	5.90	4.80	180	4.40		
4	0	0.0	0.0	81.28	5.80	4.60	180	4.80		
5	11	0.0	8.0	81.27	5.60	4.40	180	5.10	5	2
6	610	1059.0	340.0	81.27	6.70	4.40	180	4.10	7	3
7	1523	2196.0	1044.0	81.27	10.60	6.70	203	5.10	7	3
8	2405	3183.0	1867.0	81.24	14.40	7.20	158	3.10	7	3
9	3196	3335.0	2663.0	81.19	17.00	6.50	105	2.10		
10	3841	3394.0	3234.0	81.15	19.60	5.70	53	1.00		
11	4298	3031.0	3680.0	81.10	22.20	5.00	0	0.00	4	3
12	4534	289.0	1704.0	81.07	22.00	4.40	300	1.00		
13	4534	315.0	1308.0	81.03	21.90	3.90	240	2.10		
14	4298	3303.0	3480.0	81.00	21.70	3.30	180	3.10	8	6
15	3841	74.0	966.0	81.01	19.30	5.30	210	3.30		
16	3196	4.0	453.0	81.03	16.80	7.40	240	3.40		
17	2405	0.0	228.0	81.04	14.40	9.40	270	3.60	10	9
18	1523	3.0	166.0	80.98	13.50	9.40	300	2.40		
19	610	15.0	182.0	80.93	12.60	9.40	330	1.20		
20	11	0.0	8.0	80.87	11.70	9.40	0	0.00	8	6
21	0	0.0	0.0	80.86	10.60	8.70	53	1.20		
22	0	0.0	0.0	80.84	9.40	7.90	105	2.40		
23	0	0.0	0.0	80.83	8.30	7.20	158	3.60	4	3
24	0	0.0	0.0	80.82	7.90	6.80	128	3.10		
TOTAL FOR DAY KJ/M2		20201.00	21331.00							
KWHR/M2		5.61	5.93							

*CONVERSION FACTOR: $KJ/M^2 \times 2.777 \times 10^4 = KW\text{-}HR/M^2$

typical clear days in Section 2.0, i.e., clear days near the 21st of each month. Offerers are again admonished regarding use of the TMY wind data for establishing wind power estimates. The TMY months were selected by a process that de-emphasized wind power statistics.

5.0 DATA INTERPRETATION

The following discussions are provided to aid Offerers in further interpretations and implementations of the data in Sections 2.0 to 4.0. Included are definitions, clarifications, and expectations for insolation, wind, and joint data and their applications.

5.1 INSOLATION

Supporting information for insolation data interpretation is as follows.

5.1.1 Definitions

The two standard measurements of interest to this RFP pertain to direct and global insolation.

a. Direct (also known as direct-normal and normal-incidence) Insolation: This is the flux on a surface normal to the sun's rays and is usually measured with a pyrheliometer having a 5.7° field of view. For most purposes, the difference between the 5.7° field of view and the sun's angular diameter of 0.5° may be ignored. However, for highly concentrating systems with acceptance angles approaching the sun's angular diameter, the larger field of view of the pyrheliometer will overestimate the flux available to the energy system by up to 10 percent or more due to the circumsolar radiation caused by forward scattering from large aerosols in the atmosphere. Measurements of this solar aureole have been made by the Lawrence Berkeley Laboratories (e.g., Reference 6.10) and the entire topic is summarized in a recent report by A.D. Watt (Reference 6.11).

b. Global (also known as total, and total-hemispheric) Insolation: This is the flux on a horizontal surface having a hemispheric (180°) field of view and a response that is constant with angle from the vertical. The observed global insolation, Q, is related to the direct insolation, D, by the relationship shown previously in Equation 2-2.

5.1.2 TMY/SOLMET Clarification

The following is pertinent to usage of the TMY and SOLMET data bases.

a. SOLMET: The potential SOLMET tape user should be aware that numerical values may not always be present in every formatted field defined. The user should also be aware that many of the meteorological parameters will be available only every third hour. These hourly data are available from the National Climatic Center (Reference 6.3).

b. TMY: The TMY contains a more manageable number of data points than the SOLMET, so it is recommended for use as the standard insolation data set for MX-RES system applications. The format for the TMY tape is provided in Figures 2-1. The TMY tape was derived from the SOLMET tapes so that most of the limitations of the SOLMET tapes also apply to the TMY tapes. In preparing the TMY data sets missing values of barometric pressure, temperature, wind velocity and direction were obtained by interpolation. A single tape containing the TMY for 26 SOLMET stations (i.e., including Ely) is available from the NCC (Reference 6.3).

5.1.3 Data Status and Plans

a. Currently Available Data: Insolation data of high accuracy are currently unavailable for the broad MX deployment area. The TMY used herein is the most representative data set available at this time. The TMY and the summary data comprise a standardized set of data for all bidders to use.

b. Subsequent Resource Data: The data contained in this RFP will be refined and supplemented by additional data for incorporation into the MX-RES Data Base Book. Refinements will include incorporation of the latest set of monthly observations and ersatz estimates. Supplements will include: (1) hourly insolation values for each day of monthly observations; (2) monthly ersatz estimates of daily temperature and normal heating/cooling degree-days; and (3) any new sources of valid data uncovered in the interim.

c. Insolation Measurement Program: A measurement program dedicated to MX-RES applications is being planned to obtain both global and direct insolation. Measurements are anticipated at selected sites (e.g., Dry Lake Valley) which are considered likely for MX deployment. Appropriately processed versions of these measurements will be incorporated into the MX-RES Data Base Book.

5.2 WIND

Supporting information for wind data interpretation is as follows.

5.2.1 Data Basis

The wind resource data presented herein are primarily in terms of speed. This is considered to be the most pertinent parameter for generic site concept design; i.e., sizing and storage (if any). When site-specific hardware is designed, measured wind direction data will be provided for the appropriate sites. The Offerer is again cautioned against using wind direction data from the TMY for wind energy system design.

Note that air density data are also missing herein for wind power calculations. The Offerer may assume that the atmospheric density can be obtained from the 1976 Standard Atmosphere (see Reference 6.27) at the altitude of the proposed site.

Wind power data used in Sections 3.6 and 4.1 were extracted from Reference 6.5, which used the following definition of power in conjunction with SOLMET tape readings. The amount of power contained in the wind was calculated by one-half the air density times the cube of instantaneous "useful" windspeed. Air density was calculated using atmospheric pressure and dry bulb temperature data taken from the SOLMET tapes. "Useful" windspeeds were defined such that values from SOLMET below 1.6 m/s (~3.5 mph) were set to zero, while values above 14.2 m/s (~32 mph) were set to 14.2 m/s. Wind power was computed for each observation in W/m^2, summed for the day, and divided by the total number of observations in the day to obtain a daily average of wind power.

5.2.2 Data Availability

The data contained herein are the best set known to be available for standardized MX-RES Offerer usage. Pertinent data were prepared in the consistent formats of Sections 3.2 to 3.5. A paucity of actual measurement data currently exists which precluded the preparation of a detailed set of wind resource characterization data for the RFP.

The data generated specifically for this RFP was extracted from computer tapes recently obtained or created from measurements at the indicated sites. The TMY and SOLMET tapes are considered appropriate for the Offerers, but Offerers are again reminded of the de-emphasized wind statistics on the TMY tape; i.e., insolation was given half the weight in making the selection of months while the other half of the weight was distributed equally among wind speed, ambient temperature, and humidity.

5.2.3 Preliminary Assessment Summary

The following discussion of MX-RES wind resources is extracted directly from Reference 6.20.

> "A preliminary assessment of the wind resource in the MX-RES project study area was made using National Climatic Center (NCC) TD-1440 tape data for Nevada and an aerial survey of wind-deformed vegetation on ridgecrests in central Nevada. The NCC data are mostly from stations in valley locations in which the annual average wind resource at 50m above ground level (AGL) ranges from 100 to 200 watts/m^2 or 9.8 to 12.5 mph. Analysis of the deformed vegetation gives estimates of ridgetop mean winds in the 15 to 24 mph range at 50m AGL with corresponding wind power densities of 350 to 1400 watts/m^2. A ridgetop site near Wells, Nevada with a mean 50m AGL speed of 18.6 mph, appears to support this analysis.
>
> "A spring (March to May) seasonal maximum (winter minimum) and early afternoon daily maximum (late night minimum) in the mean wind speed are indicative of valley

locations affected by nocturnal temperature inversions. Although Pequop Summit, a ridge to site near Wells, Nevada follows the valley pattern, some ridgecrests may depart significantly from the valley pattern.

"The paucity of quantitative data at ridgecrest sites within the study area precludes making a geographically more refined estimate of the wind resource at this time. However, it can be said with high confidence that the wind resource lies within the bounds stated above."

5.2.4 Data Plans

a. Subsequent Resource Data Book: Upgraded wind resource data will be included in the MX-RES Data Base Book discussed in Section 5.1.3. The book will combine the data of this RFP with subsequently determined data into consistent formats and standardized extrapolations of measurement heights. Interim results will be included from the current DOE Wind Measurement Program which covers Nevada and Utah. Temporal and spatial variability will be given a high priority.

b. MX-RES Wind Resources Assessment Program: A program is near initiation which will lead to both near term and long term wind resource characterizations. The program calls for locations, characterization, and verification of wind resources appropriate to MX-RES. Data processed from the measurements of this program will be made available via the MX-RES Data Base Book to those awarded contracts.

5.3 JOINT INSOLATION/WIND

Supporting information for joint insolation and wind data interpretation is as follows.

5.3.1 Ely Data Base

The Ely SOLMET data base is the best known set of joint insolation and wind data currently available that is applicable to the MX deployment area. SOLMET data were used in Reference 6.5 to construct the joint probabilities in Section 4.1. The hourly values from the TMY in Section 4.2 also derive from SOLMET. Offerers should note that the joint data on the SOLMET tape were not available at each hour since wind speed was observed every third hour after 1965. Therefore, in preparing the TMY data sets, any missing values of wind velocity and direction were obtained by interpolation.

5.3.2 Data Plans

a. Resource Data: Upgraded joint insolation/wind data will be included in the MX-RES Data Base Book, due for release with awarded contracts. Searches for other valid data sources are in progress.

b. Measurement Program: Measurement programs for insolation and winds will be augmented as appropriate to obtain joint measurements. Data processed from these measurements will be made available to those awarded contracts (as the data become available) for use in their preliminary design efforts.

6.0 REFERENCES

6.1 C.M. Randall, "Evaluation of Insolation Data Bases Available in 1980," Aerospace Corporation Technical Memorandum ATM-80(5820-02)-4, 21 March 1980.

6.2 I.J. Hall, R.R. Prairie, H.E. Anderson, and E.C. Boes, "Generation of Typical Meteorological Years for 26 SOLMET Stations," Sandia Laboratories Report SAND 78-1601, August 1978.

6.3 SOLMET and TMY computer tapes are available at the nominal cost of about $60 from the National Climatic Center, Federal Building, Asheville, North Carolina, 28801. Information about ordering may be obtained by contacting the Digital Products Branch at (704) 258-2850, extension 203.

6.4 "SOLMET Volume 2 - Final Report, TD-9724," F.T. Quinlan, editor, National Oceanic and Atmospheric Administration, Environmental Data and Information Service, National Climatic Center, Asheville North Carolina, February 1979.

6.5 "Solar-Climatic Statistical Study," Vol. 2, Northrop Services, Inc., Report HCP/T4016-01/2, Huntsville, Alabama, February 1979.

6.6 "Month Summary, Solar Radiation Data," published monthly by the Environmental Data and Information Service of the National Oceanic and Atmospheric Administration, National Climatic Center, Asheville, North Carolina.

6.7 V. Cinquemani, J.R. Owenby, Jr., and R.G. Baldwin, "Input Data for Solar Systems," National Climatic Center, Asheville, North Carolina, November 1978.

6.8 K. Ya. Kondratyev, "Radiation Processes in the Atmosphere," World Meterological Organization Publication WMO-No. 309, 1972.

6.9 E.C. Boes, H.E. Anderson, I.J. Hall, R.R. Prairie, and R.T. Stromberg, "Availability of Direct, Total, and Diffuse Solar Radiation to Fixed and Tracking Collectors in the USA," Sandia Laboratories Report SAND 77-0885, August 1977.

6.10 T.M. Klucher, "Evaluation of Models to Predict Insolation on Tilted Surfaces," Solar Energy 23, 111-114 (1979).

6.11 D.F. Grether, D. Evans, A. Hunt, and M. Wahlig, "Application of Circumsolar Measurements to Concentrating Collectors," Report 9412, Lawrence Berkeley Laboratories, 1979.

6.12 A.D. Watt, "Circumsolar Radiation," Watt Engineering Ltd., Sandia Laboratories Report SAND 80-7009, April 1980.

6.13 E.C. Boes, "Insolation Modeling Overview," Energy 4, 523-529 (1979).

6.14 C.M. Randall and M.E. Whitson, "Hourly Insolation and Meteorological Data Bases Including Improved Direct Insolation Estimates," Aerospace Corporation Report ATR-78(7592)-2, 1 December 1977.

6.15 R.J. Yinger, "Solar Energy Measurements at Selected Sites Throughout the Southwest During 1978," WEST Associates, Southern California Edison Company Project Manager, September 1979.

6-16 Letter from W.R. Batchet of Battelle Pacific Northwest Laboratories, Richland, Washington, to F.E. Augustine of The Aerospace Corporation, dated 3 June 1980, enclosing tabular wind power characteristics for several Nevada locations.

6.17 Letter from R.W. Baker of Oregon State University, Corvallis, Oregon, to F.E. Augustine of The Aerospace Corporation, dated 12 June 1980, enclosing a magnetic tape containing measured wind data from Pequop Summit, NV.

6.18 C.A. Lindley, "Transcription of White Mountain Wind Data for MX-RES Use," Aerospace Technical Memorandum (in preparation), June 1980.

6-19 "TDF-14 Surface Observations, Tape Deck 1440 Airways Surface Observations," National Climatic Center, Natinal Oceanic and Atmospheric Administration, Asheville, North Carolina, October 1975.

6-20 W.R. Barchet, R.L. Simon, "MX-RES Project Wind Resource," Paper prepared for MX-RES Project Office, February 1980.

6.21 M.J. Changery, W.T. Hodge, and J.V. Ramsdell, "Index-Summarized Wind Data," BNWL-2220 Wind 11, NOAA/Pacific Northwest Laboratory, National Climatic Center, Asheville, North Carolina, 1977.

6.21 M.J. Changery, "National Wind Data Index," HCO/T1041-01, DOE/NOAA, E(49-26)-1041, National Climatic Center, Asheville, North Carolina, 1978.

6.23 E.W. Hewson, and R.W. Baker, "Network Wind Power Over the Pacific Northwest," Report No. BPA 77-2, Department of Atmospheric Sciences, Oregon State University, Corvalis, Oregon, 1978.

6.24 J.W. Reed, "Wind Power Climatology of the United States - Supplement," SAND78-1620, Sandia Laboratories, Albuquerque, New Mexico, 2979.

6.25 J.E. Wade, and E.W. Hewson, 1979, "Trees as a Local Climatic Wind Indicator," J. Appl. Meteor., 18, 1182-1187.

6.26 R. Simon, "Summary of Wind - Deformed Vegetation Observed in Nevada," Report by Global Weather Consultants of Work Performed under PNL Subcontract No. B-87920-A.

6.27 "U.S. Standard Atmosphere, 1976," National Oceanic and Atmospheric Administration, National Aeronautics and Space Administration, U.S. Air Force, Washington, D.C., 1976. (Available from the Government Printing Office.)