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BARSTOW INSULATION
AND METEOROLOGICAL
DATA BASE

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FOREWORD

This report is written as a partial account of work performed for the Department of Energy, on the 10 MW Solar Thermal Pilot Plant Project, under Contract Number E(04-3)-1101, Project Agreement No. 2.

ABSTRACT AND SUMMARY

A data base containing insolation and meteorological parameters at 15 minute intervals for the entire year of 1976 at Barstow, California has been prepared on computer compatible magnetic tape. The observed insolation values obtained by the Southern California Edison Company and meteorological values obtained by the Federal Aviation Agency which form the data base have been carefully checked for internal consistency. The data tape is written in a modified form of the SOLMET format and is available from The Aerospace Corporation. This report describes in detail the data included on the tape, the sources of the data, and any editing performed on the data itself.

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1. INTRODUCTION

Insolation and meteorological data for the year 1976 at 15 minute intervals of Local Standard Time (LST) have been placed on a data tape for use in simulation of the operation of the solar thermal electric pilot plant to be built near Barstow, California. The insolation values were measured in the town of Barstow by the Southern California Edison Company (SCE) acting as part of the West Associates Solar Resource Assessment project (Ref. 1). The hourly meteorological observations were made by the Federal Aviation Agency (FAA) at a San Bernardino County airport site at Daggett. The relation of the two observation locations and the proposed plant site are shown on the map of Fig. 1. Quantitative location information is provided in Table 1.

The data are presented on the data tape in the SOLMET format modified to include four additional solar related quantities. The contents supplied are summarized in Table 2. The SOLMET format is described in Appendix A. Daily insolation values obtained from the tape and monthly mean daily insolation values are provided in Tables 3 and 4. These values differ slightly from those provided elsewhere (Refs. 1 and 2) for reasons discussed herein.

All of the insolation and meteorological values have been carefully reviewed by a series of tests described in following sections of this report. The primary problems detected with the meteorological data were missing data and errors in transcription of the data from the FAA observation manuscripts to computer compatible punched cards. The primary problems with the insolation data were several previously unflagged missing data periods in the SCE data, and anomalously low diffuse insolation values during some time periods. Missing insolation data values have been estimated, and all direct and global insolation values were made consistent. The data tape now provides reasonable values of the parameters listed in Table 2 for every 15 minute interval of 1976. The following sections provide a detailed description of the data sources and tests applied.

2. INSOLATION DATA

Observations

The insolation observations were made by SCE using an Eppley normal incidence pyroheliometer (NIP) and an Eppley Black and White pyronometer. Both instruments are calibrated on the IPS scale. On this data base they were converted to the absolute scale by multiplying by 1.08 (Ref 3). The energy observed by each of these instruments during every 15 minute interval of local standard time (LST) is recorded along with the mean dry bulb temperature (Ref 1). The data base prepared here has retained this structure in equal increments of LST to avoid problems of interpolating into equal increments of solar time. The integration process used resulted in small nonzero values even if there was no insolation. Therefore, insolation values less than 0.75 W hr/m^2 were set to zero. Observed insolation values are indicated by "0" in the appropriate data code indicator. Unmodified global insolation observations appear in SOLMET Field 106. Complete global values, including estimated values of missing data, are presented in Field 107, and all direct insolation values in Field 102.

Computed Values

The azimuth and elevation of the sun, as well as extraterrestrial direct and global insolation can be computed by well known formulas from the position of the sun in the celestial sphere (Ref 4). The position of the sun in the celestial sphere is determined once per day at noon local time. The declination is provided in SOLMET Field 104. The right observation provides the time dependent part of the "equation of time" relating local standard time (Field 4) to the true solar time, TST (Field 3). Values of the solar elevation and azimuth at the midpoint of any interval for which the sun is above the horizon are provided in Fields 109 and 110, respectively. Values of the extraterrestrial global insolation, Q_0 , and direct insolation, D_0 , for each 15 minute interval, based on a solar constant of 1.377 kW/m^2 are provided in Fields 101 and 105, respectively. In all

these calculations the position of the solar observing station at Barstow was employed.

Insolation Tests

All the tests applied to insolation are based on ratios of observed to computed extraterrestrial insolation values:

$$t = D/D_0$$

$$p = Q/Q_0$$

$$u = p - t,$$

where D is the observed direct insolation (NIP reading), Q is the observed global insolation (pyronometer reading), and t, p and u are referred to as the percent-of-possible direct, global, and diffuse insolation, respectively.

Bounding values of t and u were derived for the recently completed insolation estimation project (Ref 4). The limiting values from that study are shown in Figs 2 and 3. A maximum limiting value of p of 95% was adopted.

The four tests applied are shown in Table 5 along with the action taken when the test fails. In addition to the action listed in the table, a message was printed by the generation computer program for each failure. A summary of days when numerous problems occurred is provided in Table 6. When insolation values are modified as a consequence of a test, the data indicator of the appropriate field is changed to "5".

The initial limiting values for the diffuse tests were taken directly from Ref 4, even though that study involves hourly values and the present study involves 15 minute intervals. The first runs of the program revealed that Tests 1, 3, and 4 were frequently failing. A closer examination of conditions associated with Test 1 failures showed that they almost always occurred at the beginning and ending time periods of the daylight portion of the day. Since it is during these time periods that global observations are the most imprecise these failures did not reflect real problems in the data.

The failures of the excess diffuse test were traced to two sources. On partly cloudy days, clouds can reflect significant additional quantities of energy onto a pyronometer for periods of a few minutes. The program was modified to indicate if clouds were present in the meteorological data and, if so, the observed diffuse was accepted as reasonable. The second source of high diffuse values was missing direct insolation values, which were not flagged as missing in the source SCE tape. The intervals for which direct insolation was estimated are listed in Table 7. Those not flagged as missing by SCE in the source tape are marked with asterisks.

The minimum diffuse failures occurred for two reasons. There was one interval of undetected missing global insolation, indicated by asterisks in Table 8. This was corrected by estimation using adjacent day values for the same time intervals. The majority of the failure cases involved values of diffuse insolation between 2 and 5% of Q_0 which occurred during the middle of the day under nominally clear conditions. This problem was reviewed with SCE/West Associates, but no clear mechanism for this effect was identified. It is believed diffuse insolation values of 2 to 5% are not physically realistic, and thus the numbers result either from instrumental operation problems or calibration problems. Application of the same test to the 1976 West Associates data for Ridgecrest, California (another desert California site about 70 miles from Barstow) did not reveal these low values, further indicating that this observation was peculiar to the Barstow data and not a characteristic of desert insolation. In the absence of auxiliary information to indicate whether the direct insolation was too low or the global too high no corrections could be made, and so the minimum diffuse limit was lowered to 2%, as shown by the dotted line in Fig 3, and values of u greater than this amount were accepted.

Insolation Estimation

1. Global Insolation Estimation

Global insolation estimates were required for at least part of four days listed in Table 8. Meteorological observations reported the time

periods involved to be clear (0 tenths cloud cover) for all these days except 11 May. Therefore values for the same time intervals from adjacent clear days were substituted. February 13 data were used for February 12 and May 14 values were used for May 12, 17. The meteorological data indicated the cloud cover was approximately the same during the first few missing intervals on May 11 as it was during the last available data intervals from the same day, and that later it became clear. Values of p were obtained from the last available data interval on May 11 and used to modify the May 14 clear sky observations for the cloudy hours on May 11. For clear intervals the May 14 observations were used. All estimated values were required to pass the tests described above. Estimated values are indicated by "2" as the data indicator in Field 107. Values that are adjusted to satisfy the tests are indicated by "5" in this position.

2. Direct Insolation Estimation

The direct insolation values required for the intervals shown on Table 7 were estimated from the available global insolation value by means of the diffuse insolation model shown by a solid line in Fig 4. The values of this curve were derived from Ref 5. Values obtained subsequently from Barstow data while preparing the data tape are shown by dashed lines. For the limited number of days involved in the estimation it was not judged worthwhile to rework the data tape with a Barstow specific model. All estimated direct values are indicated by a flag of "7" in the first character of Field 102. All estimated values were required to pass the tests described previously. Values changed as a result of one of these tests are indicated by a flag of "5" in the first character.

3. Diffuse Insolation

The diffuse insolation, d , has been computed from the values of direct and global insolation finally adopted and appearing in Fields 107 and 102:

$$d = Q_0 u = Q_0(p - t)$$

The result is placed in Field 103 with a data indicator of "6".

Daily Insolation Sums

The solar energy for each day, as integrated from the values on the tape, is provided in Tables 3 and 4. These values may differ from those in the West Associates Report (Ref 1) because of the application of limiting procedures, conversion to absolute scale, and estimating procedures which were applied for some days. These values will differ from those provided in Ref 2 for the months of August through December since the Ref 2 values were for 1975, while the values present in Tables 3 and 4 are from 1976.

3. METEOROLOGICAL DATA

Meteorological observations are made by the FAA at the Daggett site a few minutes before every hour, LST. These hourly observations are then recorded on special forms (Fig 5). The National Climatic Center (NCC) transcribes into computer compatible format only every third hour from this and most other U.S. weather stations. To obtain the highest possible time resolution copies of the Daggett manuscript records for 1976 were obtained from the NCC. At Aerospace the quantities listed in Table 9 were punched for every hour and for a few special times between the hourly observations when all values wanted were present.

A value of the meteorological variables listed in Table 2 was determined from the hourly observations by considering the midpoint of each 15 minute interval as the time for which the observation was desired. For all parameters except wind the desired value was obtained by linear interpolation between observed values using the actual observation time as the interpolation parameter. To preserve frequency distributions the wind data were not interpolated but the value from the observation time closest to the interval was adopted.

All meteorological data were subjected to tests. For a few parameters several days of data had to be estimated because of missing values. The tests applied and estimating procedures used are discussed below.

Time

Each observation was required to follow the preceding one and to occur not more than 1.68 hrs later. This assured that the data were in order and none were missing. With one exception an observation was available for every hour during 1976.

Temperature

1. Dry Bulb

The temperature was required to fall between the limits specified in Table 10. The values in Table 10 were obtained by taking the extreme values by months from Yuma, Arizona and Las Vegas, Nevada, since the

required analysis of Daggett data for extreme temperature value was not available. All cases of temperature change rates greater than 10°C per hour were listed. They were very infrequent.

The FAA Daggett temperatures were used for the data base, to be consistent with the dew point temperature values and pilot plant location. The SCE and FAA temperature values were compared and frequently were more than 6°C different.

2. Dew Point

The dew point temperature was required to correspond to a relative humidity between 5 and 100%. This necessitated calculating only the dew point temperature corresponding to 5% relative humidity and required the dew point temperature to fall between this minimum value and the corresponding dry bulb temperature. All cases of dew point temperature change rates greater than 10°C per hour were listed. They were found to be infrequent.

Dew point temperature data were missing for the period 13:45 on 6 September through 13:48 on 8 September, and from 7:50 on 10 September through 23:50 on 11 September. Values were estimated by comparison with similar nearby days.

Visibility

Visibility was required to be between 0 and 98 km. This test was never failed.

Wind

1. Wind Direction

Wind direction was required to have a value between 0 and 360° . This test was always satisfied.

2. Wind Speed

Wind speed was listed if it was less than 0 or greater than 20 m/sec. This test resulted in listing data for 19 February, on which high winds were observed. The entire meteorological observation manuscript for this day is shown in Fig 6, since the winds were gusting on this date up to 25 m/sec.

Wind data were missing for the period 12:54 on 23 October to 15:50 on 25 October. Values having the frequency distribution in direction and speed as that found in an analysis of ten years of Daggett data (Ref 7) were used.

Barometric Pressure

The barometric pressure was required to be between 915 and 980 mbars. The standard barometric pressure at the 588 m elevation of the Daggett airport is 943 mbars. The limits correspond approximately to $\pm 4\%$ limits. This test was never failed.

Cloud Cover

Both total and opaque sky cover were required to have values between 0 and 10 tenths. This test was never failed.

4. DISCUSSION

The careful testing has revealed several problems. These have been mentioned in the previous sections and are summarized below. For each problem, appropriate estimated values are provided in the data base. However, if the entire year is not required for an analysis then time periods during which the parameters of interest for the analysis have not been estimated should be used.

Insolation Data

See Tables 6, 7, and 8 for detailed summaries. Direct and global insolation values are estimated for 11, 12, and 13 May. Direct insolation values are estimated in early September, late November, and early December. The diffuse values appear somewhat low during June and August, but no changes have been made in the data.

Meteorological Data

Wind data are estimated for 23 to 25 October. Dew Point temperatures are estimated for September 6-8, 10, 11.

5. TAPE AVAILABILITY

The data tape is available from The Aerospace Corporation for the cost of reproduction. The tape may be ordered by writing to

Mr. Don Herman
The Aerospace Corporation
P.O. Box 92957
Los Angeles, California 90009
Telephone: (213) 648-5757

and identifying the tape as the "1976 Barstow Data in Modified SOLMET format".

Table 1. Locations Related to Barstow Insolation - Meteorology Data Base

	Reference	Latitude (Deg N)	Longitude (Deg W)	Altitude (m)
Pilot Plant Site	8	34.873	116.832	591
FAA-Daggett San Bernardino County Airport	9	34.867	116.783	588
SCE Barstow Insolation Measuring Site	1	34.889	117.006	664

Table 2. Quantities Included in Data Base for Barstow Solar Thermal Electric Power Plant.

	SOLMET Field	Units	Observations Interval (minutes)
Tape Deck Number	1	9724	
Station Number	2	23161	
Time			
Year	3		
Month	3		
Day	3		
Solar Time	3		
Local Standard Time	4		
Hour of Meteorological Observation	201		
Computed Solar Quantities			
Extraterrestrial Insolation on Horizontal Surface	101	kJ/m^2	
Solar Declination	*104	Degrees	
Extraterrestrial Solar Irradiance (Direct Insolation)	*105	kJ/m^2	
Solar Elevation	*109	Degrees	
Solar Azimuth	*110	Degrees from South	
Observation Based Solar Data			
Direct Normal Insolation ^a	102	kJ/m^2	15
Observed Global Insolation ^b	106	kJ/m^2	15
Complete Global Insolation ^c	107	kJ/m^2	
Diffuse Insolation ^d	103	kJ/m^2	
Meteorological Data			
Visibility	204	km	
Station Pressure	206	k Pascals	60
Dry Bulb Temperature	207	Degrees C	60
Dew Point Temperature	207	Degrees C	60
Surface Wind Direction	208	Tens of Degrees from North	60
Surface Wind Speed	208	m/sec	60
Opaque Cloud Cover	209	Tenths	60
Total Cloud Cover	209	Tenths	60

Table 2. (Continued)

Notes:

*Non-standard SOLMET field usage.

^aDirect Insolation values as reported by West Associates, estimated if missing, and modified if needed to satisfy limits described in the text.

Data Code Indicator	
0	Observed, unmodified
5	Adjusted to satisfy a limit test
7	Values estimated from global insolation in Field 107
9	Missing

^bGlobal insolation values as reported by West Associates. No modifications or limits applied.

Data Code Indicator	
0	Observed
9	Missing

^cGlobal insolation values as reported by West Associates, estimated if missing, and modified if required to satisfy the limits described in the text.

Data Code Indicator	
0	Observed
2	Estimated (see text for method)
5	Adjusted to satisfy limits

^dDiffuse global insolation computed from Fields 102 and 107, all data code indicators set to 6.

TABLE 3. DAILY GLOBAL-HEMISPHERIC INSOLATION

BARSTOW CALIFORNIA, 1976

(KW-HR/M**2)

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	3.42	4.17	3.44	7.07	8.08	8.51	8.76	8.13	7.16	5.33	4.43	3.57
2	3.43	4.29	4.80	7.02	7.76	8.03	8.66	8.09	6.67	5.65	4.35	3.51
3	3.20	3.57	4.30	6.22	6.26	8.58	8.55	8.03	3.70	5.81	4.40	3.55
4	3.37	4.02	5.42	5.52	7.73	8.50	8.50	8.07	6.38	5.66	4.39	3.41
5	3.10	2.90	5.52	6.29	7.01	8.67	8.59	8.07	5.62	5.65	4.34	3.49
6	2.76	3.25	5.54	7.09	6.71	8.61	8.41	8.09	4.29	5.62	4.31	3.43
7	3.35	1.28	5.81	7.07	4.67	8.51	8.27	8.09	6.67	5.55	4.20	3.51
8	3.45	.97	4.16	5.58	8.00	7.88	8.27	7.93	6.18	5.62	4.18	3.48
9	3.31	3.92	4.54	7.26	7.85	7.65	8.29	8.03	2.03	5.57	3.77	3.26
10	3.46	3.27	4.58	6.61	7.97	7.53	7.75	8.08	.76	5.48	4.08	3.45
11	3.54	4.56	5.74	6.58	7.98	8.55	8.12	8.04	3.01	5.37	2.82	3.45
12	3.55	4.55	6.23	5.46	8.21	8.45	8.16	7.99	6.40	5.23	1.68	3.41
13	3.55	4.59	5.15	4.41	8.41	8.48	8.13	7.77	6.32	5.29	3.62	3.37
14	3.58	4.64	5.96	5.84	8.21	8.74	7.39	5.94	5.50	5.29	3.34	3.20
15	3.63	3.17	6.20	4.40	8.24	8.86	6.11	7.52	6.27	5.22	3.86	3.36
16	3.61	4.08	4.49	7.05	8.16	8.53	6.00	7.67	6.30	4.29	3.78	3.38
17	3.60	4.24	5.09	7.57	8.49	8.46	8.06	7.55	6.37	4.74	3.83	3.33
18	3.47	5.02	5.06	7.51	8.12	8.65	8.23	7.44	6.34	4.83	3.76	3.02
19	3.71	4.32	5.50	7.57	7.79	8.55	8.28	7.47	5.95	4.60	3.71	2.84
20	3.79	5.12	6.45	7.56	6.63	8.70	8.19	7.49	2.84	3.49	3.70	3.28
21	3.83	5.19	6.51	7.41	7.77	8.69	8.15	7.21	6.14	2.76	3.59	3.37
22	3.49	4.83	5.91	7.37	8.29	8.74	3.98	7.40	5.33	2.72	3.65	3.37
23	3.80	4.60	6.46	7.51	8.36	8.83	4.61	7.46	5.02	4.45	3.66	2.71
24	3.70	5.14	5.48	7.48	8.34	8.93	7.87	7.24	3.58	4.55	3.65	3.39
25	3.89	5.20	6.35	7.72	8.27	8.66	6.11	7.21	4.84	4.45	3.65	3.39
26	3.81	4.82	6.73	7.96	8.35	8.75	5.69	7.22	5.69	4.45	3.38	2.74
27	3.98	5.10	6.64	7.96	8.34	8.66	6.12	7.17	5.63	4.67	3.77	3.32
28	4.03	5.16	6.66	7.56	8.38	8.41	6.26	7.04	4.41	4.69	3.67	3.43
29	4.02	4.78	6.84	7.96	8.28	8.40	6.93	7.03	2.90	4.53	3.63	2.44
30	3.65		6.97	8.01	8.47	8.53	5.35	7.00	5.84	4.46	3.61	.96
31	4.22		6.69		8.52		7.87	7.16		4.46		1.34
MEAN	3.59	4.16	5.72	5.89	7.86	8.50	7.41	7.57	5.14	4.85	3.76	3.15
STD DEV	.30	1.07	.93	1.00	.82	.33	1.30	.50	1.58	.79	.54	.60
ANNUAL MEAN =		5.72										

TABLE 4. DAILY DIRECT-NORMAL INSOLATION
BARSTOW CALIFORNIA, 1976
(KW-HR/M**2)

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	7.58	6.25	3.69	9.79	10.37	10.86	11.57	11.10	9.86	7.29	8.54	7.25
2	7.88	8.69	6.48	9.43	9.28	8.08	11.32	10.95	7.77	8.93	7.88	7.68
3	5.90	4.34	4.25	6.42	4.06	11.00	10.84	10.49	2.43	8.84	8.49	8.20
4	7.37	5.62	7.75	4.57	9.02	10.21	10.87	11.04	8.37	9.40	8.79	7.22
5	6.31	3.40	7.57	7.15	5.65	10.48	11.15	10.86	6.46	9.62	8.79	7.98
6	3.80	4.06	8.26	9.50	6.22	10.15	10.82	11.09	4.41	9.60	8.71	7.52
7	6.18	.02	9.26	9.70	2.52	9.94	10.09	11.11	8.50	8.84	8.39	7.84
8	7.72	0.00	2.77	6.37	10.52	8.37	10.09	10.65	7.04	9.62	8.32	7.77
9	6.58	5.17	3.85	9.50	9.28	8.49	10.16	11.17	.04	9.71	5.30	6.16
10	7.48	3.70	4.14	7.16	9.43	7.72	8.49	11.17	0.00	9.47	7.67	7.70
11	7.83	8.64	7.72	6.81	9.55	11.08	9.22	11.09	.03	8.95	1.83	7.69
12	7.21	8.51	10.27	3.72	10.31	10.64	9.87	10.79	8.21	8.38	.48	7.58
13	7.56	8.50	9.46	2.43	11.23	10.50	10.01	10.44	8.35	9.08	5.81	7.02
14	7.08	7.90	8.22	5.09	10.46	11.58	7.75	3.90	5.57	9.12	5.08	6.39
15	7.95	3.90	9.38	2.90	9.59	12.05	4.60	10.09	8.26	8.81	7.79	7.77
16	7.92	4.87	2.99	6.78	9.60	10.50	4.83	10.60	8.23	4.23	8.02	7.80
17	6.94	5.00	4.64	10.14	10.83	10.28	9.14	9.99	9.16	6.21	8.23	7.67
18	5.13	8.68	5.42	9.87	9.21	11.55	10.44	9.25	9.38	7.27	8.03	5.28
19	7.38	5.71	5.06	9.67	8.07	11.06	10.80	9.95	7.01	6.24	7.44	4.72
20	8.06	9.09	9.05	9.97	3.75	11.57	10.33	10.58	.64	1.62	7.56	7.26
21	7.58	9.28	9.92	8.52	8.34	11.58	10.12	9.29	8.91	.02	7.24	7.76
22	6.57	6.31	6.71	7.93	9.77	11.60	1.97	10.37	5.44	1.61	7.63	6.88
23	7.80	5.58	8.99	8.98	9.57	11.92	1.89	10.73	4.23	6.40	7.69	2.78
24	6.19	8.67	9.26	8.57	9.98	12.17	9.46	10.34	2.78	7.36	7.69	7.78
25	7.21	8.45	5.62	7.93	9.97	10.75	4.29	10.30	5.12	6.57	7.91	7.96
26	7.45	6.77	9.55	10.16	10.49	11.46	4.29	10.31	7.67	7.03	6.21	3.02
27	7.81	7.72	8.87	10.42	9.96	11.12	5.23	9.78	7.19	8.38	7.83	7.50
28	8.35	7.77	9.03	8.88	9.15	9.55	6.76	9.32	3.18	8.84	7.49	8.05
29	8.26	5.76	9.68	10.65	9.72	10.05	5.62	9.19	0.00	7.76	7.36	1.55
30	4.46		10.48	10.85	10.41	10.53	3.37	8.85	9.30	7.92	7.37	.06
31	8.46		8.84		11.01		9.72	9.31		8.34		.69
MEAN	7.10	6.15	7.33	8.00	8.95	10.56	8.23	10.13	5.78	7.47	7.19	6.40
STD DEV	1.11	2.50	2.39	2.35	2.19	1.16	2.99	1.34	3.25	2.49	1.89	2.31
ANNUAL MEAN =	7.78											

Table 5. Limiting Tests Applied to Barstow Insolation Observations

Test	Limiting Value	Action Taken for Values Not Passing Test
(1) $p \leq p_{\max}$	$p_{\max} = 95\%$	Field 106 unmodified, Field 107 set to 95% level.
(2) $t \leq t_{\max}$	$t_{\max}$ from Fig. 2	Field 102 set to $t_{\max}$.
(3) $u \geq u_{\min}$	$u_{\min}$ from Fig. 3	Field 107 Q modified to provide $u = u_{\min}$.
(4) $u \leq u_{\max}$	$u_{\max}$ from Fig. 3	No modification, but message printed out.

TABLE 6.
1976 BARSTON INSOLATION DATA PROBLEM SUMMARY
(EACH SYMBOL REPRESENTS ONE DAY)

MONTH	PROBLEM
JANUARY	-----
FEBRUARY	-----G-----
MARCH	-----AA-----A-
APRIL	-----
MAY	-----FFF-----A
JUNE	--A-----A---ACCA-AAAAACA---C
JULY	A-----
AUGUST	AA-AAAAA-AAAA-AAAACA-AAAAA---CC
SEPTEMBER	C-----CGGHCC-----A
OCTOBER	----AA-A-----C-----
NOVEMBER	-----C-----CCCC
DECEMBER	CGC-----B---BB---BB-----

PROBLEM CODE KEY

I	NO PROBLEMS CORRECTED, LESS THAN 4 WERE FLAGGED FOR THE DAY
A	DIFFUSE LESS THAN 4 PERCENT OF EXTRATERRESTRIAL GLOBAL
B	MISSING DIRECT-FLAGGED BY SCE - ESTIMATED FROM GLOBAL
C	MISSING DIRECT-TOC LARGE DIFFUSE-ESTIMATED FROM GLOBAL
D	MISSING GLOBAL-FLAGGED BY SCE-ESTIMATED FROM ADJACENT DAY
E	MISSING GLOBAL-NEGATIVE DIFFUSE-ESTIMATED FROM ADJ. DAY
F	COMBINATION OF B AND D
G	COMBINATION OF C AND E
H	MISSING DIRECT SUSPICION BUT CLOUDY SO USED REPORTED VALUES

Table 7. 1976 Estimated Barstow Direct Insolation Intervals

Date	Estimated Intervals
February 12	47
May 11	50-96
12	1-96
13	1-32
June 16	66-96*
17	1-60*
25	41-59*
30	32-62*
August 18	1-96*
19	1-57*
30	60-96*
31	1-96*
September 1	1-56*
7	44-96*
8	1-96*
12	1-96*
13	1-61*
October 19	1-96*
November 19	38-42*
27	1-96*
28	1-96*
29	1-96*
30	1-96*
December 1	1-96*
2	1-44*
9	1-96
13	1-96
14	1-96
18	1-96
19	1-96

*Not flagged as missing in Ref. 1.

Table 8. 1976 Barstow Global Insolation Intervals
Estimated from Cloud Cover and Adjacent Days

Date	Intervals Estimated
12 February	39-44*
11 May	50-96
12 May	1-96
13 May	1-32
2 December	43*

*Not flagged as missing in Ref. 1.

Table 9. Meteorological Observations Punched from FAA
Manuscript Weather Records

1. Observation Time
2. Visibility
3. Dry Bulb Temperature
4. Dew Point Temperature
5. Wind Direction
6. Wind Speed
7. Station Pressure
8. Opaque Sky Cover
9. Total Sky Cover

Table 10. Extreme Dry Bulb Temperature Limits
 Adopted for Barstow Data.
 Composite of Yuma, Arizona and Las Vegas, Nevada.

Month	Temperature (°C)	
	Maximum	Minimum
January	31.1	-13.3
February	31.7	- 7.2
March	36.7	- 5.0
April	38.9	- 0.6
May	42.8	4.4
June	46.8	10.6
July	46.8	16.6
August	46.8	13.3
September	45.6	7.8
October	40.0	- 3.3
November	34.4	- 3.3
December	28.3	- 9.4

Figure 2. Scatter plot of 1961 direct insolation values for Albuquerque as a function of zenith angle, z . The function shown is the limiting value of direct insolation used for 1961, an exceptionally clear year (Ref. 4). The values used to limit D in the present study are about $0.96 \times$ the above limiting function.

Figure 3. Diffuse Insolation Limits. The scatter diagram shows values of hourly mean diffuse insolation computed from observed hourly mean direct and global insolation at Raleigh N. Carolina (Ref. 4). The solid curve is the diffuse insolation limit used in Ref. 4. and initially in the present work. The dashed curve shows the final limits employed for the reasons discussed in the text.

Figure 4. Diffuse insolation model used to estimate direct insolation. The solid line is the model employed and derived from Reference 5. $\square$ The mean monthly diffuse insolation for December at Barstow. $\circ$ The mean monthly diffuse insolation for June at Barstow.

U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION NATIONAL WEATHER SERVICE										STATION: DAGGETT CALIF. - FAA DATE: JUN 24 1976									
SURFACE WEATHER OBSERVATIONS (Adapted for use at designated Cord Stations)																			
To number LIST to GAT ADD 8 SUBTRACT																			
TYPE	TIME (L.S.T.)	SEA AND CEILING (Number of feet)	VISIBILITY (stat mi)		WEATHER AND OBSTRUCTIONS TO VISION	SEA LEVEL PRESS. (mb.)	TEMP. (°F)	DEW PT. (°F)	WIND			ALT. SETTING (in.)	REMARKS AND SUPPLEMENTAL CODED DATA	STATION PRESS. PS (in.)	DPT DWS (°F)	DPT DWS (°F)	TOL TOL (in.)	TOTAL WIND VELOCITY (in.)	TOTAL WIND DIRECTION (in.)
			SURFACE	TOPO					DIREC- TION (00-360)	SPEED (kts)	CHAR- ACTER								
R	0053	CLR	15			113	78.3	32	108		995	208		27.925			00	00	00
R	0154	CLR	15			120	75.38	26	07		996			27.935			00	00	00
R	0251	CLR	15			120	72.39	25	08		996			27.935			00	00	00
R	0352	CLR	35			120	73.39	32	09		996	103	72	27.935			00	00	00
R	0450	CLR	35			129	73.37	00	00		999			27.965			00	00	00
R	0550	CLR	35			134	75.36	27	08		001			27.980			00	00	00
R	0658	CLR	35			139	82.35	00	00		003	322		28.000			00	00	00
R	0749	CLR	35			144	88.29	03	07		004			28.010			00	00	00
R	0852	CLR	35			144	91.30	08	07		004			28.010			00	00	00
R	0953	CLR	35			145	92.30	08	07		004	BOBN NE	103 72	28.010			00	00	00
R	1052	CLR	35			136	94.32	04	14		002	BOBN NE		27.990			00	00	00
R	1151	CLR	35			131	91.33	35	05		000			27.975			00	00	00
R	1249	CLR	35			124	98.34	01	08		998	719		27.955			00	00	00
R	1350	CLR	35			118	98.34	10	09		996			27.935			00	00	00
R	1448	CLR	35			112	100.35	34	07		994			27.915			00	00	00
R	1552	CLR	35			102	100.35	04	07		991	822 00		27.890			00	00	00
R	1650	CLR	35			096	100.35	07	05		989			27.870			00	00	00
R	1740	CLR	35			091	99.34	36	06		984			27.860			00	00	00
R	1850	CLR	35			089	99.33	09	05		983	610		27.860			00	00	00
R	1955	CLR	15			083	98.25	16	04		989			27.870			00	00	00
R	2055	CLR	15			077	96.25	20	07		990			27.890			00	00	00
R	2150	CLR	15			101	92.22	26	05		991	210 00		27.890			00	00	00
R	2255	CLR	15			101	81.22	27	10		991			27.890			00	00	00
R	2354	CLR	15			102	80.21	31	07		990			27.880			00	00	00

TIME (L.S.T.)	NO.	PRECIP. (in.)	SNOW FALL (in.)	SNOW DEPTH (in.)	MAX. TEMP. (°F)	MIN. TEMP. (°F)	STATION PRESSURE COMPUTATIONS				SUMMARY OF DAY (Midnight to Midnight)								
							TIME (L.S.T.) (00)	0358	0955	1535	2155	24-HR. MAX. TEMP. (°F)	24-HR. MIN. TEMP. (°F)	24-HR. PRECIP. PAATH EQUIV. (in.)	24-HR. SNOW FALL UNMLTD. (in.)	1800 GMT SNOW (in.)			
0352	1	0	0	0	80	72													
0451	1	0	0	0	92	73													
1545	1	0	0	0	100	92													
2142	1	0	0	0	100	92													
0000	1	0	0	0	82	80													

Figure 5. Typical meteorological data manuscript form from which hourly Daggitt surface weather observations during 1976 were obtained.

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3. C. Frohlich, J. Geist, J. Kendall, R. M. Marchgraber, "The Third International Comparisons of Pyrheliometers and a Comparison of Radiometric Scales," Solar Energy 14, 157-166 (1973).
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7. "Seasonal and Annual Wind Distribution by Pasquill Stability Classes (6) Star Program, Station 23161, Daggett, California," National Climatic Center, Asheville, North Carolina, 9 February 1972.
8. "10 Megawatt Solar Power Pilot Plant. Environmental Impact Assessment/Environmental Impact Report," Environmental Improvement Agency of San Bernardino County, California, November 1977.
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APPENDIX A

SOLMET FORMAT FOR BARSTOW DATA TAPE

APPENDIX A

SOLMET FORMAT FOR BARSTOW DATA TAPE

The standard SOLMET format has been modified in three ways for use with the Barstow data.

1. The tape is organized in 15 minute intervals rather than hourly.
2. The tape is organized in increments of local standard time.
3. Additional computed solar position related quantities have been included.

The first and second changes require no further comment. The four additional computed quantities are listed in Table A.1. These four quantities all have a data code indicator of 6.

The standard SOLMET format is specified in Table A.2. The data codes for the Barstow tape are provided in Table 2 of the text and are not those listed in Table A.2. The night time computed insolation values are zero, not 9999.

The tape is nine-track EBCDIC coded, blocked with the 96 fifteen minute intervals of a day in each block on the tape.

Table A-1. Non-SOLMET - Standard Solar Position Quantities Included
in the Barstow Data Tape

Quantity	SOLMET Field	Units
Solar Declination	104	Degrees to Tenths
Extraterrestrial Solar Irradiance (Direct Insolation)	105	kJ/m^2
Solar Elevation	109	Degrees to Hundredths
Solar Azimuth	110	Integral Degrees

Table A-2.

TAPE DECK		SOLMET										PAGE NO.																																																																			
9724												1																																																																			
<table border="1"> <thead> <tr> <th colspan="6">IDENTIFICATION</th> <th colspan="10">SOLAR RADIATION OBSERVATION</th> <th rowspan="4">S U N S H I N E M I N</th> </tr> <tr> <th rowspan="3">TAPE DECK #</th> <th rowspan="3">WBAN STN #</th> <th colspan="4">SOLAR TIME</th> <th rowspan="3">LST TIME</th> <th rowspan="3">ETR KJ/m²</th> <th colspan="8">RADIATION VALUES KJ/m²</th> </tr> <tr> <th rowspan="2">YR</th> <th rowspan="2">MO</th> <th rowspan="2">DY</th> <th rowspan="2">HRMN</th> <th rowspan="2">D I R E C T</th> <th rowspan="2">D I F F U S E</th> <th rowspan="2">N E T</th> <th rowspan="2">T I L T E D</th> <th colspan="3">GLOBAL</th> <th rowspan="2">A</th> <th rowspan="2">B</th> </tr> <tr> <th>OBS</th> <th>ENG COR</th> <th>STD YR COR</th> </tr> </thead> </table>												IDENTIFICATION						SOLAR RADIATION OBSERVATION										S U N S H I N E M I N	TAPE DECK #	WBAN STN #	SOLAR TIME				LST TIME	ETR KJ/m ²	RADIATION VALUES KJ/m ²								YR	MO	DY	HRMN	D I R E C T	D I F F U S E	N E T	T I L T E D	GLOBAL			A	B	OBS	ENG COR	STD YR COR	9724	XXXX	XX	XX	XX	XXXX	XXXX	XXXX	1XXXX	1XXXX	1XXXX	1XXXX	1XXXX	1XXXX	1XXXX	1XXXX	1XXXX	1XXXX	XX
IDENTIFICATION						SOLAR RADIATION OBSERVATION										S U N S H I N E M I N																																																															
TAPE DECK #	WBAN STN #	SOLAR TIME				LST TIME	ETR KJ/m ²	RADIATION VALUES KJ/m ²																																																																							
		YR	MO	DY	HRMN			D I R E C T	D I F F U S E	N E T	T I L T E D	GLOBAL			A		B																																																														
												OBS	ENG COR	STD YR COR																																																																	
FIELD NUMBER	001	002	003			004	101	102	103	104	105	106	107	108	109	110	111																																																														

SURFACE METEOROLOGICAL OBSERVATION																				S N O W C O V E R														
O B S E R V E R L S T	C E I L I N G d a m	SKY COND	VSBY hm	WEATHER	PRESSURE kPa		TEMP °C		WIND		CLOUDS																							
					SEA LEVEL	STA- TION	DRY BULB	DEW- PT.	D I R	S P E E D	T O T A L	LOWEST				SECOND					THIRD				FOURTH									
												A M O U N T	T I M E	H E I G H T	T I M E	A M O U N T	T I M E	H E I G H T	T I M E		A M O U N T	T I M E	H E I G H T	T I M E	A M O U N T	T I M E	H E I G H T							
XX	XXXX	1XXXX	XXXX	XXXXXXXXXX	XXXXX	XXXXX	XXXX	XXXX	XXX	XXXX	XX	XX	XX	XXXX	XX	XX	XXXX	XX	XX	XXXX	XX	XX	XX	XXXX	XX	XX	XX	XXXX	XX	XX	XX	XXXX	XX	X
201	202	203	204	205	206	207	208	209																									210	

TAPE FIELD NUMBER	TAPE POSITIONS	ELEMENT
001	001 - 004	TAPE DECK NUMBER
002	005 - 009	WBAN STATION NUMBER
003	010 - 019	SOLAR TIME
004	020 - 023	LOCAL STANDARD TIME
101	024 - 027	EXTRATERRESTRIAL RADIATION
102	028 - 032	DIRECT RADIATION
103	033 - 037	DIFFUSE RADIATION
104	038 - 042	NET RADIATION
105	043 - 047	GLOBAL RADIATION ON A TILTED SURFACE
106	048 - 052	GLOBAL RADIATION ON A HORIZONTAL SURFACE - OBSERVED DATA
107	053 - 057	GLOBAL RADIATION ON A HORIZONTAL SURFACE - ENGINEERING CORRECTED DATA
108	058 - 062	GLOBAL RADIATION ON A HORIZONTAL SURFACE - STANDARD YEAR CORRECTED DATA
109, 110	063 - 072	ADDITIONAL RADIATION MEASUREMENTS
111	073 - 074	MINUTES OF SUNSHINE
201	075 - 076	TIME OF TD 1440 OBSERVATION
202	077 - 080	CEILING HEIGHT
203	081 - 085	SKY CONDITION
204	086 - 089	VISIBILITY
205	090 - 097	WEATHER
206	098 - 107	PRESSURE
207	108 - 115	TEMPERATURE
208	116 - 122	WIND
209	123 - 162	CLOUDS
210	163	SNOW COVER INDICATOR

TAPE DECK	SOLMET	PAGE NO.
9724		2

NOTE: Except for tape positions 001-027 in fields 001-101, elements with a tape configuration of 9's indicate missing or unknown data.

TAPE FIELD NUMBER	TAPE POSITIONS	ELEMENT	TAPE CONFIGURATION	CODE DEFINITIONS AND REMARKS
001	001 - 004	TAPE DECK NUMBER	9724	
002	005 - 009	WBAN STATION NUMBER	01001 - 98999	Unique number used to identify each station.
003	010 - 019	SOLAR TIME		
	010 - 011	YEAR	00 - 99	Year of observation, 00 - 99 = 1900 - 1999
	012 - 013	MONTH	01 - 12	Month of observation, 01 - 12 = Jan. - Dec.
	014 - 015	DAY	01 - 31	Day of month
	016 - 019	HOUR	0001 - 2400	End of the hour of observation in solar time (hours and minutes)
004	020 - 023	LOCAL STANDARD TIME	0000 - 2359	Local Standard Time in hours and minutes corresponding to end of solar hour indicated in field 003.
101	024 - 027	EXTRATERRESTRIAL RADIATION	0000 - 4957	Amount of solar energy in kJ/m^2 received at top of atmosphere during solar hour ending at time indicated in field 003, based on solar constant = $1377\text{J}/(\text{m}^2.\text{s})$ 9999 = nighttime values defined as zero kJ/m^2 .
102	028 - 032	DIRECT RADIATION		
	028	DATA CODE INDICATOR	0 - 8	Portion of radiant energy in kJ/m^2 received at the pyrheliometer directly from the sun during solar hour ending at time indicated in field 003.
	029 - 032	DATA	0000 - 4957	
103	033 - 037	DIFFUSE RADIATION		
	033	DATA CODE INDICATOR	0 - 8	Amount of radiant energy in kJ/m^2 received at the instrument indirectly from reflection, scattering, etc., during the solar hour ending at the time indicated in field 003.
	034 - 037	DATA	0000 - 4957	
104	038 - 042	NET RADIATION		
	038	DATA CODE INDICATOR	0 - 8	Difference between the incoming and outgoing radiant energy in kJ/m^2 during the solar hour ending at the time indicated in field 003. A constant of 5000 has been added to all net radiation data.
	039 - 042	DATA	2000 - 8000	
105	043 - 047	GLOBAL RADIATION ON A TILTED SURFACE		
	043	DATA CODE INDICATOR	0 - 8	Total of direct and diffuse radiant energy in kJ/m^2 received on a tilted surface (tilt angle indicated in station - period of record list) during solar hour ending at the time indicated in field 003.
	044 - 047	DATA	0000 - 4957	
	048 - 062	GLOBAL RADIATION ON A HORIZONTAL SURFACE		
				Total of direct and diffuse radiant energy in kJ/m^2 received on a horizontal surface by a pyranometer during the solar hour ending at the time indicated in field 003.
106	048 - 052	OBSERVED DATA		
	048	DATA CODE INDICATOR	0 - 8	Observed value.
	049 - 052	DATA	0000 - 4957	
107	053 - 057	ENGINEERING CORRECTED DATA		
	053	DATA CODE INDICATOR	0 - 8	Observed value corrected for known scale changes, station moves, recorder and sensor calibration changes, etc.
	054-057	DATA	0000 - 4957	

TAPE DECK		SOLMET		PAGE NO.
9724				3
TAPE FIELD NUMBER	TAPE POSITIONS	ELEMENT	TAPE CONFIGURATION	CODE DEFINITIONS AND REMARKS
108	058 - 062	STANDARD YEAR CORRECTED DATA		
	058	DATA CODE INDICATOR	0 - 8	
	059 - 062	DATA	0000 - 4957	Observed value adjusted to Standard Year Model. This model yields expected clear sky irradiance received on a horizontal surface at the elevation of the station.
109, 110	063 - 072	ADDITIONAL RADIATION MEASUREMENTS		Supplemental Fields A and B for additional radiation measurements; type of measurement specified in station-period of record list.
	063, 068	DATA CODE INDICATORS	0 - 8	
	064-067	DATA		
	069-072	DATA		
NOTE FOR FIELDS 102-110: Data code indicators are:				
		0	Observed data	
		1	Estimated from model using sunshine and cloud data	
		2	Estimated from model using cloud data	
		3	Estimated from model using sunshine data	
		4	Estimated from model using sky condition data	
		5	Estimated from linear interpolation	
		6	Reserved for future use	
		7	Estimated from other model (see individual station notes at end of manual)	
		8	Estimated without use of a model	
(See model description in Volume 2.)				
111	073 - 074	MINUTES OF SUNSHINE	00 - 60	For Local Standard Hour most closely matching solar hour.
201	075 - 076	TIME OF TD 1440 OBSERVATION	00 - 23	Local Standard Hour of TD 1440 Meteorological Observation that comes closest to mid-point of the solar hour for which solar data are recorded.
202	077 - 080	CEILING HEIGHT	0000 - 3000	Ceiling height in dekameters (dam = m x 10 ¹); ceiling is defined as sky cover of .6 or greater.
			7777	7777 = unlimited; clear
			8888	8888 = unknown height of cirroform ceiling
203	081 - 085	SKY CONDITION		
	081	INDICATOR	0	Identifies observations after 1 June 51. Coded by layer in ascending order; four layers are described; if less than 4 layers are present the remaining positions are coded 0. The code for each layer is:
	082 - 085	SKY CONDITION	0000 - 8888	0 = Clear or less than .1 cover 1 = Thin scattered (.1 - .5 cover) 2 = Opaque scattered (.1 - .5 cover) 3 = Thin broken (.6 - .9 cover) 4 = Opaque broken (.6 - .9 cover) 5 = Thin overcast (1.0 cover) 6 = Opaque overcast (1.0 cover) 7 = Obscuration 8 = Partial obscuration
204	086 - 089	VISIBILITY	0000 - 1600	Prevailing horizontal visibility in hectometers (hm = m x 10 ²).
			8888	0000 - 1600 = 0 to 160 kilometers 8888 = unlimited

7/77

TAPE DECK		SOLMET		PAGE NO.
9724				4
TAPE FIELD NUMBER	TAPE POSITIONS	ELEMENT	TAPE CONFIGURATION	CODE DEFINITIONS AND REMARKS
205	090 - 097	WEATHER		
	090	OCCURRENCE OF THUNDERSTORM, TORNADO OR SQUALL	0 - 4	0 = None 1 = Thunderstorm - lightning and thunder. Wind gusts less than 50 knots, and hail, if any, less than 3/4 inch diameter. 2 = Heavy or severe thunderstorm - frequent intense lightning and thunder. Wind gusts 50 knots or greater and hail, if any, 3/4 inch or greater diameter. 3 = Report of tornado or waterspout. 4 = Squall (sudden increase of wind speed by at least 16 knots, reaching 22 knots or more and lasting for at least one minute).
	091	OCCURRENCE OF RAIN, RAIN SHOWERS OR FREEZING RAIN	0 - 8	0 = None 1 = Light rain 2 = Moderate rain 3 = Heavy rain 4 = Light rain showers 5 = Moderate rain showers 6 = Heavy rain showers 7 = Light freezing rain 8 = Moderate or heavy freezing rain
	092	OCCURRENCE OF DRIZZLE, FREEZING DRIZZLE	0 - 6	0 = None 1 = Light Drizzle 2 = Moderate drizzle 3 = Heavy drizzle 4 = Light freezing drizzle 5 = Moderate freezing drizzle 6 = Heavy freezing drizzle
	093	OCCURRENCE OF SNOW, SNOW PELLETS OR ICE CRYSTALS	0 - 8	0 = None 1 = Light snow 2 = Moderate snow 3 = Heavy snow 4 = Light snow pellets 5 = Moderate snow pellets 6 = Heavy snow pellets 7 = Light ice crystals 8 = Moderate ice crystals Beginning April 1963 intensities of ice crystals were discontinued. All occurrences since this date are recorded as an 8.
	094	OCCURRENCE OF SNOW SHOWERS AND SNOW GRAINS	0 - 6	0 = None 1 = Light snow showers 2 = Moderate snow showers 3 = Heavy snow showers 4 = Light snow grains 5 = Moderate snow grains 6 = Heavy snow grains Beginning April 1963 intensities of snow grains were discontinued. All occurrences since this date are recorded as a 5.

TAPE DECK		SOLMET		PAGE NO.
9724				5
TAPE FIELD NUMBER	TAPE POSITIONS	ELEMENT	TAPE CONFIGURATION	CODE DEFINITIONS AND REMARKS
	095	OCCURRENCE OF SLEET (ICE PELLETS), SLEET SHOWERS OR HAIL	0 - 8	0 = None 1 = Light sleet or sleet showers (ice pellets) 2 = Moderate sleet or sleet showers (ice pellets) 3 = Heavy sleet or sleet showers (ice pellets) 4 = Light hail 5 = Moderate hail 6 = Heavy hail 7 = Light small hail 8 = Moderate or heavy small hail Prior to April 1970 ice pellets were coded as sleet. Beginning April 1970 sleet and small hail were redefined as ice pellets and are coded as a 1, 2 or 3 in this position. Beginning September 1956 intensities of hail were no longer reported and all occurrences were recorded as a 5.
	096	OCCURRENCE OF FOG, BLOWING DUST OR BLOWING SAND	0 - 5	0 = None 1 = Fog 2 = Ice fog 3 = Ground fog 4 = Blowing dust 5 = Blowing sand These values recorded only when visibility less than 7 miles.
	097	OCCURRENCE OF SMOKE, HAZE, DUST, BLOWING SNOW, BLOWING SPRAY	0 - 6	0 = None 1 = Smoke 2 = Haze 3 = Smoke and haze 4 = Dust 5 = Blowing snow 6 = Blowing spray These values recorded only when visibility less than 7 miles.
206	098 - 107 098 - 102 103 - 107	PRESSURE SEA LEVEL PRESSURE STATION PRESSURE	08000 - 10999 08000 - 10999	Pressure, reduced to sea level, in kilopascals (kPa) and hundredths. Pressure at station level in kilopascals (kPa) and hundredths. 08000 - 10999 = 80 to 109.99 kPa
207	108 - 115 108 - 111 112 - 115	TEMPERATURE DRY BULB DEW POINT	-700 to 0600 -700 to 0600	°C and tenths °C and tenths -700 to 0600 = -70.0 to +60.0°C
208	116 - 122 116 - 118 119 - 122	WIND WIND DIRECTION WIND SPEED	000 - 360 0000 - 1500	Degrees m/s and tenths; 0000 with 000 direction indicates calm. 0000 - 1500 = 0 to 150.0 m/s

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TAPE FIELD NUMBER	TAPE POSITIONS	ELEMENT	TAPE CONFIGURATION	CODE DEFINITIONS AND REMARKS
209	123 - 162	CLOUDS		See following explanatory "NOTES."
	123 - 124	TOTAL SKY COVER		
	125 - 126	LOWEST CLOUD LAYER AMOUNT		
	127 - 128	TYPE OF LOWEST CLOUD OR OBSCURING PHENOMENA		
	129 - 132	HEIGHT OF BASE OF LOW- EST CLOUD LAYER OR OBSCURING PHENOMENA		
	133 - 134	SECOND LAYER AMOUNT		
	135 - 136	TYPE OF SECOND CLOUD LAYER		
	137 - 140	HEIGHT OF BASE OF SECOND CLOUD LAYER		
	141 - 142	SUMMATION OF FIRST 2 LAYERS		
	143 - 144	THIRD LAYER AMOUNT		
	145 - 146	TYPE OF THIRD CLOUD LAYER		
	147 - 150	HEIGHT OF BASE OF THIRD CLOUD LAYER		
	151 - 152	SUMMATION OF FIRST 3 LAYERS		
	153 - 154	FOURTH LAYER AMOUNT		
	155 - 156	TYPE OF FOURTH CLOUD LAYER		
	157 - 160	HEIGHT OF BASE OF FOURTH CLOUD LAYER		
	161 - 162	TOTAL OPAQUE SKY COVER		
NOTES: (1) Tape Configuration and Remarks for Total Sky Cover, Cloud Layer Amount, Summation of Cloud Layers and Total Opaque Sky Cover				
		<u>Configuration</u>	<u>Remarks</u>	
		00 - 10	Amount of celestial dome in tenths covered by clouds or obscuring phenomena. Opaque means clouds or obscuration through which the sky or higher cloud layers cannot be seen.	
(2) Tape Configuration and Remarks for Type of Cloud or Obscuring Phenomena.				
		<u>Configuration</u>	<u>Remarks</u>	
		00 - 16	Generic cloud type or obscuring phenomena. 0 = None 1 = Fog 2 = Stratus 3 = Stratocumulus 4 = Cumulus 5 = Cumulonimbus 6 = Altostratus 7 = Altocumulus 8 = Cirrus 9 = Cirrostratus 10 = Stratus Fractus 11 = Cumulus Fractus 12 = Cumulonimbus Mamma 13 = Nimbostratus 14 = Altocumulus Castellanus 15 = Cirrocumulus 16 = Obscuring phenomena other than fog	

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(3) Tape Configuration and Remarks for Height of Base of Cloud Layer or Obscuring Phenomena.

	<u>Configuration</u>	<u>Remarks</u>
	0000 - 3000	Dekameters
	7777	7777 = Unlimited, clear
	8888	8888 = Unknown height or cirroform layer
210	163 SNOW COVER INDICATOR	0 - 1 0 indicates no snow or trace of snow on ground; 1 indicates more than trace of snow on ground.