Appendix G

Typical Meteorological Year (TMY) Weather Data Format Description

For convenience we have reprinted the following discussion from the documentation for DOE2.1A *Reference Manual*, (p. VIII-31), and tables (Table 1-23) from "Typical Meteorological Year" (National Climatic Center 1981). The reprint of tables from "Typical Meteorological Year" also includes some additional notes from our experience with TMY data. If this summary is insufficient for your weather processing needs, the complete documentation on TMY weather data can be obtained from the National Climatic Center (NCC) in Asheville, North Carolina. Their address is Federal Bldg., Asheville, NC 28801-2733, telephone 704-271-4800.

Solar radiation and surface meteorological data recorded on an hourly[1] basis are maintained at the NCC. These data cover recording periods from January 1953 through December 1975 for 26 data rehabilitation stations, although the recording periods for some stations may differ. The data are available in blocked (compressed) form on magnetic tape (SOLMET) for the entire recording period for the station of interest.

Contractors desiring to use a data base for simulation or system studies for a particular geographic area require a data base that is more tractable than these, and also one that is representative of the area. Sandia National Laboratory has used statistical techniques to develop a method for producing a typical meteorological year (TMY) for each of the 26 rehabilitation stations. This section describes the use of these magnetic tapes.

The TMY tapes comprise specific calendar months selected from the entire recorded span for a given station as the most representative, or typical, for that station and month. For example, a single January is chosen from the 23 Januarys for which data are recorded from 1953 through 1975 on the basis of its being most nearly like the composite of all 23 Januarys. Thus, for a given station, January of 1967 might be selected as the typical meteorological month (TMM) after a statistical comparison with all of the other 22 Januarys. This process is pursued for each of the other calendar months, and the twelve months chosen then constitute the TMY.

Although the data have been rehabilitated by NCC, some recording gaps do occur in the SOLMET tapes. Moreover, there are data gaps because of the change from one-hour to three-hour meteorological data recording in 1965. Consequently, as TMY tapes were being constituted from the SOLMET data, the variables data for barometric pressure, temperature, and wind velocity and direction were scanned on a month-by-month basis, and missing data were replaced by linear interpolation. Missing data in the leading and trailing positions of each monthly segment are replaced with the earliest/latest legitimate observation.

Also, since the TMMs were selected from different calendar years, discontinuities occurred at the month interfaces for the above continuous variables. Hence, after the monthly segments were rearranged in calendar order, the discontinuities at the month interfaces were ameliorated by cubic spline smoothing covering the six-hourly points on either side of the interface.

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[1]Hourly readings for meteorological data are available through 1964; subsequent readings are on a three-hour basis.

TAPE DECK	Table 1-23. Typical Meteorological Year Data Format
9734	

Tape Field Number[a]	Tape Positions[a]	Element	Tape Configuration	Code Definitions and Remarks
002	001-005	WBAN Station number	01001–98999	Unique number used to identify each station
003	006–015 006–007 008–009 010–011 012–015	Solar time Year Month Day Hour	 00–99 01–12 01–31 0001–2400	 Year of observation, 00–99 = 1900–1999 Month of observation, 01–12 = Jan.–Dec. Day of month End of the hour of observation in solar time (hours and *minutes*)
004	016–019	Local Standard Time	0000–2359	Local Standard Time in hours and minutes corresponding to end of solar hour indicated in field 003.
101	020–023	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 $J/(m^2 \cdot s)$. **0000 = nighttime values for extraterrestrial radiation, and 80000 = corresponding nighttime value in field 108. 99999 = nighttime values defined as zero kJ/m^2, for stations noted as "rehabilitated" in the station list.[b]**
102 Use for direct normal solar radiation	024–028 024 025–028	Direct radiation Data code indicator[c] Data[d]	 0–9 0000–4957	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. **99999 = nighttime values defined as zero kJ/m^2.**
103	 029 030–033	Diffuse radiation Data code indicator[c] Data[d]	 0–9 0000–4957	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. Note: *Diffuse data not available.*
104	034–038 034 035–038	Net radiation Data code indicator[c] Data[d]	 0–9 2000–8000	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. Note: *Net radiation data not available.*
105	039–043 039 040–043	Global radiation on a tilted surface Data code indicator[c] Data[d]	 0–9 0000–4957	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. Note: *Data not available.*
	044–058	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 solar hour ending at the time indicated in field 003.

TAPE DECK	Table 1-23. Typical Meteorological Year Data Format (Continued)			
9734				
Tape Field Number[a]	Tape Positions[a]	Element	Tape Configuration	Code Definitions and Remarks
106	044–048 044 045–048	Observed data Data code indicator[c] Data[d]	 0–9 0000–4957	 Observed value. Note: *These data are not corrected. Recommend use of data in field 108.*
107	049–053 049 050–053	Engineering corrected data Data code indicator[c] Data[d]	 0–9 0000–4957	*Note: Recommend use of data in field 108.* Observed value corrected for known scale changes, station moves, recorder and sensor calibration changes, etc.
108 Use for total horizontal solar radiation	054–058 054 055–058	Standard year Corrected data Data code indicator[c] Data[d]	 0–9 000–4957	 Observed value adjusted to Standard Year Model. This model yields expected sky irradiance received on a horizontal surface at the elevation of the station. The value includes the effects of clouds. Note: *All nighttime values coded as 80000 except stations noted as rehabilitated in the station list; for those stations, nighttime values are coded 99999.*[b]
109, 110	059–068 059–064 060–063 065–068	Additional radiation measurements Data code indicators[c] Data[d] Data[d]	 0–9	Supplemental fields A and B for additional radiation measurements: type of measurement specified in station-period of record list.
111	069–070	Minutes of sunshine	00–60	For Local Standard Hour most closely matching solar hour. Note: *Data available only for when observations were made.*
201	071–072	Time of TD 1440 Observations	00–23	Local Standard Hour of TD 1440 Meteorological Observation that comes closest to midpoint of the solar hour for which solar data are recorded.
202	073–076	Ceiling height	0000–3000 7777 8888	Ceiling height in dekameters (dam = m × 10^1); ceiling is defined as opaque sky cover of 0.6 or greater. 0000–3000 = 0 to 30,000 meters 7777 = unlimited; clear 8888 = unknown height of cirroform ceiling

TAPE DECK	Table 1-23. Typical Meteorological Year Data Format (Continued)
9734	

Tape Field Number[a]	Tape Positions[b]	Element	Tape Configuration	Code Definitions and Remarks
203	077–081 077 078–081	Sky condition Indicator Sky condition	0 0000–8888	Identifies observation after June 1, 1951. Coded by layer in ascending order; four layers are described; if fewer than four layers are present the remaining positions are coded 0. The code for each layer is: 0 = Clear or less than 0.1 cover 1 = Thin scattered (0.1–0.5 cover) 2 = Opaque scattered (0.1–0.5 cover) 3 = Thin broken (0.6–0.9 cover) 4 = Opaque broken (0.6–0.9 cover) 5 = Thin overcast (1.0 cover) 6 = Opaque overcast (1.0 cover) 7 = Obscuration 8 = Partial obscuration
204	082–085	Visibility	0000–1600 8888	Prevailing horizontal visibility in hectometers (hm = m × 10^2). 0000–1600 = 0 to 160 kilometers 8888 = unlimited
205	086–093 086	Weather 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).
	087	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

TAPE DECK	Table 1-23. Typical Meteorological Year Data Format (Continued)			
9734				
Tape Field Number[a]	Tape Positions[a]	Element	Tape Configuration	Code Definitions and Remarks
205 (cont'd)	088	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
	089	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.
	090	Occurrence of snow showers or 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	Table 1-23. Typical Meteorological Year Data Format (Continued)
9734	

Tape Field Number[a]	Tape Positions[a]	Element	Tape Configuration	Code Definitions and Remarks
205 (Cont'd)	091	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.
	092	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.
	093	Occurrence of smoke, haze, dust, blowing snow, or 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	094–103 094–098 099–103	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	104–111 104–107 108–111	Temperature Dry bulb Dew point	 -700 to 0600 -700 to 0600	 °C and tenths -700 to 0600 = -70.0 to +60.0°C

TAPE DECK	Table 1-23. Typical Meteorological Year Data Format (Concluded)			
9734				
Tape Field Number[a]	Tape Positions[a]	Element	Tape Configuration	Code Definitions and Remarks
	112–118 112–114 115–118	Wind Wind direction Wind speed	 000–360 0000–1500	 Degrees m/s and tenths; 0000 with 000 direction indicates calm. 000–1500 = 0 to 150.0 m/s
209	119–122 119–120 121–122	Clouds Total sky cover Total opaque sky cover	 00–10 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.
210	123	Snow cover Indicator	0–1	0 indicates no snow or trace of snow. 1 indicates more than a trace of snow on the ground.
211	124–132	Blank		

[a]Tape positions are the precise column locations of data. Tape Field Numbers are ranges representing topical groups of tape positions.
[b]DRYCOLD.TMY is not defined as a "rehabilitated" station.
[c]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 in SOLMET: Volume 1), 8=Estimated without use of a model, 9=Missing data follows (See model description in SOLMET: Volume 2).
[d]"9s" may represent zeros or missing data or the quantity nine depending on the positions in which they occur. Except for tape positions 001-023 in fields 002-101, elements with a tape configuration of 9's indicate missing or unknown data.