EnergyPlus Weather File (EPW) Data Dictionary

The “data dictionary” for EnergyPlus Weather Data is shown below. Note that semi-colons do NOT terminate lines in the EnergyPlus Weather Data. It helps if you have familiarity with the IDD conventions please view them in the Input Output Reference document. Briefly, we have similar “\” conventions that are important for reading the following tables:

\minimum, \minimum> - values for this field must be either >= or > than the following number

\maximum, \maximum< - values for this field must be either <= or < than the following number

\missing – if values in this field are >= the following number, it is considered “missing” and missing data rules will apply

\default – blank fields will receive the following as “default” values

\units – expected units for the field. Standard EnergyPlus units are shown in the Input Output Reference Document.

Note that in the header records where “date” is used, the interpretation is shown in the following table.

Table 1. Weather File Date Field Interpretation

Field Contents	Interpretation	Header Applicability
<number>	Julian Day of Year	All date fields
<number> / <number>	Month / Day	All date fields
<number> / <number> / <number>	Month / Day / Year	DataPeriod only – special multiple year file – ref: RunPeriod:CustomRange object in IDF / Input Output Reference document
<number> Month	Day and Month	All date fields
Month <number>	Day and Month	All date fields
<number> Weekday in Month	Numbered weekday of month	Holiday, DaylightSavingPeriod
Last Weekday In Month	Last weekday of month	Holiday, DaylightSavingPeriod

In the table, Month can be one of (January, February, March, April, May, June, July, August, September, October, November, December). Abbreviations of the first three characters are also valid.

In the table, Weekday can be one of (Sunday, Monday, Tuesday, Wednesday, Thursday, Friday, Saturday). Abbreviations of the first three characters are also valid.

```
!ESP(r)/EnergyPlus Weather Format
!April 2002
\memo  Dates in the EPW file can be several formats:
\memo  <number>/<number>  (month/day)
\memo  <number> Month
\memo  Month <number>
\memo <number>  (taken to be Julian day of year)
\memo Months are January, February, March, April, May,
\memo            June, July, August, September, October, November, December
\memo Months can be the first 3 letters of the month
```

```
LOCATION,
   A1, \field city
   \type alpha
   A2, \field State Province Region
   \type alpha
   A3, \field Country
   \type alpha
   A4, \field Source
   \type alpha
   N1, \field WMO
    \note usually a 6 digit field. Used as alpha in EnergyPlus
    \type alpha
   N2 , \field Latitude
       \units deg
       \minimum -90.0
       \maximum +90.0
       \default 0.0
       \note + is North, - is South, degree minutes represented in decimal (i.e. 30 minutes is .5)
       \type real
   N3 , \field Longitude
       \units deg
       \minimum -180.0
       \maximum +180.0
       \default 0.0
       \note - is West, + is East, degree minutes represented in decimal (i.e. 30 minutes is .5)
       \type real
   N4 , \field TimeZone
       \units hr - not on standard units list???
       \minimum -12.0
       \maximum +12.0
       \default 0.0
       \note  Time relative to GMT.
       \type real
   N5 ; \field Elevation
       \units m
       \minimum -1000.0
       \maximum< +9999.9
       \default 0.0
       \type real
```

The Location header record duplicates the information required for the Location Object. When only a Run Period object is used (i.e. a weather file), then the Location Object Is not needed. When a Run Period and Design Day objects are entered, then the Location on the weather file (as described previously) is used and overrides any Location Object entry.

```
DESIGN CONDITIONS,
     N1, \field Number of Design Conditions
     A1, \field Design Condition Source
         \note current sources are ASHRAE HOF 2009 US Design Conditions, Canadian Design Conditions
         \note and World Design Conditions
     A2, \field Design Condition Type (HEATING)
       \note fields here will be dependent on the source, they are shown in a header/data format
       \note in both the .rpt and .csv files that are produced by the WeatherConverter program
     ...
     An, \field Design Condition Type (COOLING)
       \note same as note on Heating Design Conditions
```

The Design Conditions header record encapsulates matching (using WMO# -- World Meteorological Organization Station Number) design conditions for a weather file location. Currently only those design conditions contained in the ASHRAE Handbook of Fundamentals 2009 are contained in the weather files. These conditions can be used as desired. In addition, Design Day definition files have been created of all World, Canada, and United States Design Conditions. These files are available in the DataSet folder of the EnergyPlus installation.

```
TYPICAL/EXTREME PERIODS,
     N1, \field Number of Typical/Extreme Periods
     A1, \field Typical/Extreme Period 1 Name
     A2, \field Typical/Extreme Period 1 Type
     A3, \field Period 1 Start Day
     A4, \field Period 1 End Day
     \note repeat (A1-A3) until number of typical periods
 -- etc to # of periods entered
```

Using a heuristic method, the weather converter can determine typical and extreme weather periods for full year weather files. These will then be shown on the Typical/Extreme Periods header record. These are also reported in the statistical report output from the Weather Converter.

```
GROUND TEMPERATURES,
       N1, Number of Ground Temperature Depths
       N2, \field Ground Temperature Depth 1
         \units m
       N3, \field Depth 1 Soil Conductivity
         \units W/m-K,
       N4, \field Depth 1 Soil Density
         \units kg/m3
       N5, \field Depth 1 Soil Specific Heat
         \units J/kg-K,
       N6, \field Depth 1 January Average Ground Temperature
        \units C
       N7, \field Depth 1 February Average Ground Temperature
        \units C
       N8, \field Depth 1 March Average Ground Temperature
        \units C
       N9, \field Depth 1 April Average Ground Temperature
        \units C
       N10, \field Depth 1 May Average Ground Temperature
        \units C
       N11, \field Depth 1 June Average Ground Temperature
        \units C
       N12, \field Depth 1 July Average Ground Temperature
        \units C
       N13, \field Depth 1 August Average Ground Temperature
        \units C
       N14, \field Depth 1 September Average Ground Temperature
        \units C
       N15, \field Depth 1 October Average Ground Temperature
        \units C
       N16, \field Depth 1 November Average Ground Temperature
        \units C
       N17, \field Depth 1 December Average Ground Temperature
        \units C
      \note repeat above (N2-N17) to number of ground temp depths indicated
-- etc to # of depths entered
```

The weather converter program can use a full year weather data file to calculate “undisturbed” ground temperatures based on temperatures. Since an important part of soil heat transfer includes soil properties such as conductivity, density and specific heat AND these cannot be calculated from simple weather observations, this header record is provided primarilyfor user information. However, with the FC construction option, these are automatically selected (.5 depth) for use if the user does not include values in the Site:GroundTemperature:FcfactorMethod object.

As noted in the statistics report, the “undisturbed” ground temperatures calculated by the weather converter should not be used in building losses but are appropriate to be used in the GroundTemperatures:Surface and GroundTemperatures:Deep objects. The reasoning (for building losses) is that these values are too extreme for the soil under a conditioned building. For best results, use the Slab or Basement program described in this document to calculate custom monthly average ground temperatures (see the Ground Heat Transfer section). This is especially important for residential applications and very small buildings. If one of these ground

temperature preprocessors is not used, for typical commercial buildings in the USA, a reasonable default value is 2C less than the average indoor space temperature.

```
HOLIDAYS/DAYLIGHT SAVING,
     A1, \field LeapYear Observed
      \type choice
      \key Yes
      \key No
      \note Yes if Leap Year will be observed for this file
      \note No if Leap Year days (29 Feb) should be ignored in this file
     A2, \field Daylight Saving Start Day
     A3, \field Daylight Saving End Day
     N1, \field Number of Holidays (essentially unlimited)
     A4, \field Holiday 1 Name
     A5, \field Holiday 1 Day
     \note repeat above two fields until Number of Holidays is reached
-- etc to # of Holidays entered
```

The Holidays / Daylight Saving header record details the start and end dates of Daylight Saving Time and other special days such as might be recorded for the weather file. These can be used by keying “Yes” for appropriate fields in the Run Period Object.

Note: Processed weather files available on the EnergyPlus web site: https://energyplus.net/weather have neither special days specified nor daylight saving period.

For example, using a RunPeriod:

```
RunPeriod,    ! Example of RunPeriod object before 9.0 EnergyPlus Release
    Weather Data,            !- Name
    1,                       !- Begin Month
    1,                       !- Begin Day Of Month
    12,                      !- End Month
    31,                      !- End Day Of Month
    Wednesday,               !- Day Of Week For Start Day
    Yes,                     !- Use WeatherFile Holidays/Special Days
    No,                      !- Use WeatherFile DaylightSavingPeriod
    Yes,                     !- Apply Weekend Holiday Rule
    Yes,                     !- Use WeatherFile Rain Indicators
    Yes;                     !- Use WeatherFile Snow Indicators
```

```
RunPeriod,    ! Example of RunPeriod object after 9.0 EnergyPlus Release
    Weather Data,            !- Name
    1,                       !- Begin Month
    1,                       !- Begin Day Of Month
     ,                       !- Begin Year
    12,                      !- End Month
    31,                      !- End Day Of Month
     ,                       !- End Year
    Wednesday,               !- Day Of Week For Start Day
    Yes,                     !- Use WeatherFile Holidays/Special Days
    No,                      !- Use WeatherFile DaylightSavingPeriod
    Yes,                     !- Apply Weekend Holiday Rule
    Yes,                     !- Use WeatherFile Rain Indicators
    Yes,                     !- Use WeatherFile Snow Indicators
    ;                        !- Treat Weather as Actual
```

Will use any holidays specified in the Holidays / Daylight Saving header record of the weather file but will not use the Daylight Saving Period that is specified there (if any). In addition, the user can specify Special Day Periods via the Special Day Period object and/or Daylight Saving Period via the Daylight Saving Period object to additionally specify these items.

```
COMMENTS 1, A1 \field Comments_1
COMMENTS 2, A1 \field Comments_2
```

The Comment header records may provide additional information about the weather data source or other information which may not fit in other header record formats.

```
DATA PERIODS,
     N1, \field Number of Data Periods
     N2, \field Number of Records per hour
     A1, \field Data Period 1 Name/Description
     A2, \field Data Period 1 Start Day of Week
       \type choice
       \key  Sunday
       \key  Monday
       \key  Tuesday
       \key  Wednesday
       \key  Thursday
       \key  Friday
       \key  Saturday
     A3, \field Data Period 1 Start Day
     A4, \field Data Period 1 End Day
     \note repeat above to number of data periods
-- etc to # of periods entered
```

A weather file may contain several “data periods” though this is not required (and, in fact, may be detrimental). In addition, a weather file may contain multiple records per hour BUT these must match the Number of Time Steps In Hour for the simulation. Multiple interval data files can be valued when you want to be sure of the weather values for each time step (rather than relying on “interpolated” weather data). A weather file may also contain several consecutive years of weather data. EnergyPlus will automatically process the extra years when the Number of Years field is used in the RunPeriod object. Sorry – there is no way to jump into a year in the middle of the EPW file.

Note that a Run Period object may not cross Data Period boundary lines.

For those interested in creating their own weather data in the CSV or EPW formats or reading the .csv and .epw files that are produced by the Weather Converter program, the fields are shown in the following “IDD” description. Items shown in bold are used directly in the EnergyPlus program.

```
! Actual data does not have a descriptor
     N1, \field Year
     N2, \field Month
     N3, \field Day
     N4, \field Hour
     N5, \field Minute
     A1, \field Data Source and Uncertainty Flags
     \note Initial day of weather file is checked by EnergyPlus for validity (as shown below)
     \note Each field is checked for "missing" as shown below. Reasonable values, calculated
     \note values or the last "good" value is substituted.
```

```
    N6, \field Dry Bulb Temperature
       \units C
       \minimum> -70
       \maximum< 70
       \missing 99.9
    N7, \field Dew Point Temperature
       \units C
       \minimum> -70
       \maximum< 70
       \missing 99.9
    N8, \field Relative Humidity
        \missing 999.
        \minimum 0
        \maximum 110
    N9, \field Atmospheric Station Pressure
       \units Pa
       \missing 999999.
       \minimum> 31000
       \maximum< 120000
    N10, \field Extraterrestrial Horizontal Radiation
       \units Wh/m2
       \missing 9999.
       \minimum 0
    N11, \field Extraterrestrial Direct Normal Radiation
       \units Wh/m2
       \missing 9999.
       \minimum 0
    N12, \field Horizontal Infrared Radiation Intensity
       \units Wh/m2
       \missing 9999.
       \minimum 0
    N13, \field Global Horizontal Radiation
       \units Wh/m2
       \missing 9999.
       \minimum 0
    N14, \field Direct Normal Radiation
       \units Wh/m2
       \missing 9999.
       \minimum 0
    N15, \field Diffuse Horizontal Radiation
       \units Wh/m2
       \missing 9999.
       \minimum 0
    N16, \field Global Horizontal Illuminance
       \units lux
       \missing 999999.
       \note will be missing if >= 999900
       \minimum 0
    N17, \field Direct Normal Illuminance
       \units lux
       \missing 999999.
       \note will be missing if >= 999900
       \minimum 0
    N18, \field Diffuse Horizontal Illuminance
       \units lux
       \missing 999999.
       \note will be missing if >= 999900
       \minimum 0
    N19, \field Zenith Luminance
       \units Cd/m2
       \missing 9999.
       \note will be missing if >= 9999
       \minimum 0
    N20, \field Wind Direction
       \units degrees
       \missing 999.
       \minimum 0
       \maximum 360
```

```
    N21, \field Wind Speed
       \units m/s
       \missing 999.
       \minimum 0
       \maximum 40
    N22, \field Total Sky Cover
       \missing 99
       \minimum 0
       \maximum 10
    N23, \field Opaque Sky Cover (used if Horizontal IR Intensity missing)
       \missing 99
       \minimum 0
       \maximum 10
    N24, \field Visibility
       \units km
       \missing 9999
    N25, \field Ceiling Height
       \units m
       \missing 99999
    N26, \field Present Weather Observation
    N27, \field Present Weather Codes
    N28, \field Precipitable Water
       \units mm
       \missing 999
    N29, \field Aerosol Optical Depth
       \units thousandths
       \missing .999
    N30, \field Snow Depth
       \units cm
       \missing 999
    N31, \field Days Since Last Snowfall
       \missing 99
    N32, \field Albedo
       \missing 999
    N33, \field Liquid Precipitation Depth
         \units mm
       \missing 999
    N34; \field Liquid Precipitation Quantity
         \units hr
       \missing 99
```

Data Field Descriptions

Descriptions of the fields are taken from the IWEC manual – as descriptive of what should be contained in the data fields.

Field: Year

This is the Year of the data. Not really used in EnergyPlus. Used in the Weather Converter program for display in audit file.

Field: Month

This is the month (1-12) for the data. Cannot be missing.

Field: Day

This is the day (dependent on month) for the data. Cannot be missing.

Field: Hour

This is the hour of the data. (1 – 24). Hour 1 is 00:01 to 01:00. Cannot be missing.

Field: Minute

This is the minute field. (0..60) Again, not used directly by the simulation.

Field: Data Source and Uncertainty Flags

The data source and uncertainty flags from various formats (usually shown with each field) are consolidated in the E/E+ EPW format. More is shown about Data Source and Uncertainty in Data Sources/Uncertainty section later in this document.

Field: Dry Bulb Temperature

This is the dry bulb temperature in C at the time indicated. Note that this is a full numeric field (i.e. 23.6) and not an integer representation with tenths. Valid values range from –70 °C to 70 °C. Missing value for this field is 99.9.

Field: Dew Point Temperature

This is the dew point temperature in C at the time indicated. Note that this is a full numeric field (i.e. 23.6) and not an integer representation with tenths. Valid values range from –70 °C to 70 °C. Missing value for this field is 99.9.

Field: Relative Humidity

This is the Relative Humidity in percent at the time indicated. Valid values range from 0% to 110%. Missing value for this field is 999.

Field: Atmospheric Station Pressure

This is the station pressure in Pa at the time indicated. Valid values range from 31,000 to 120,000. (These values were chosen from the "standard barometric pressure" for all elevations of the World). Missing value for this field is 999999.

Field: Extraterrestrial Horizontal Radiation

This is the Extraterrestrial Horizontal Radiation in Wh/m2. It is not currently used in EnergyPlus calculations. It should have a minimum value of 0; missing value for this field is 9999.

Field: Extraterrestrial Direct Normal Radiation

This is the Extraterrestrial Direct Normal Radiation in Wh/m2. (Amount of solar radiation in Wh/m2 received on a surface normal to the rays of the sun at the top of the atmosphere during the number of minutes preceding the time indicated). It is not currently used in EnergyPlus calculations. It should have a minimum value of 0; missing value for this field is 9999.

Field: Horizontal Infrared Radiation Intensity

This is the Horizontal Infrared Radiation Intensity in Wh/m2. If it is missing, it is calculated from the Opaque Sky Cover field as shown in the following explanation. It should have a minimum value of 0; missing value for this field is 9999.

$$Horizontal\_IR = Sky_{emissivity} \bullet Sigma \bullet Temperature_{drybulb}^{4}$$

where

Horizontal_IR = horizontal IR intensity {W/m^2}

$Sky_{emissivity}$ = sky emissivity

Sigma = Stefan-Boltzmann constant = 5.6697e-8 {$W/m^2\text{-}K^4$}

$Temperature_{drybulb}$ = drybulb temperature {K}

The sky emissivity is given by

$$Sky_{emissivity} = \left(.787 + .764 \bullet \ln\left(\frac{Temperature_{dewpoint}}{273.} \right) \right) \bullet \left(1. + .0224N - .0035N^2 + .00028N^3 \right)$$

where

$Temperature_{dewpoint}$ = dewpoint temperature {K}

N = opaque sky cover {tenths}

Example: Clear sky (N=0), $Temperature_{drybulb}$ = 273+20=293 K, $Temperature_{dewpoint}$ = 273+10=283 K:

$Sky_{emissivity}$ = 0.787 + 0.764*0.036 = 0.815

Horizontal_IR = 0.815*5.6697e-8*(293**4) = 340.6 W/m^2

References (Walton, 1983) (Clark, Allen, 1978) for these calculations are contained in the references section at the end of this list of fields.

Field: Global Horizontal Radiation

This is the Global Horizontal Radiation in Wh/m2. (Total amount of direct and diffuse solar radiation in Wh/m2 received on a horizontal surface during the number of minutes preceding the time indicated.) It is not currently used in EnergyPlus calculations. It should have a minimum value of 0; missing value for this field is 9999.

Field: Direct Normal Radiation

This is the Direct Normal Radiation in Wh/m2. (Amount of solar radiation in Wh/m2 received directly from the solar disk on a surface perpendicular to the sun's rays, during the number of minutes preceding the time indicated.) If the field is "missing (≥ 9999)" or invalid (<0), it is set to 0. Counts of such missing values are totaled and presented at the end of the runperiod.

Field: Diffuse Horizontal Radiation

This is the Diffuse Horizontal Radiation in Wh/m2. (Amount of solar radiation in Wh/m2 received from the sky (excluding the solar disk) on a horizontal surface during the number of minutes preceding the time indicated.) If the field is "missing (≥ 9999)" or invalid (<0), it is set to 0. Counts of such missing values are totaled and presented at the end of the runperiod.

Field: Global Horizontal Illuminance

This is the Global Horizontal Illuminance in lux. (Average total amount of direct and diffuse illuminance in hundreds of lux received on a horizontal surface during the number of minutes preceding the time indicated.) It is not currently used in EnergyPlus calculations. It should have a minimum value of 0; missing value for this field is 999999 and will be considered missing of >= 999900.

Field: Direct Normal Illuminance

This is the Direct Normal Illuminance in lux. (Average amount of illuminance in hundreds of lux received directly from the solar disk on a surface perpendicular to the sun's rays, during the number of minutes preceding the time indicated.) It is not currently used in EnergyPlus calculations. It should have a minimum value of 0; missing value for this field is 999999 and will be considered missing of >= 999900.

Field: Diffuse Horizontal Illuminance

This is the Diffuse Horizontal Illuminance in lux. (Average amount of illuminance in hundreds of lux received from the sky (excluding the solar disk) on a horizontal surface during the number of minutes preceding the time indicated.) It is not currently used in EnergyPlus calculations. It should have a minimum value of 0; missing value for this field is 999999 and will be considered missing of >= 999900.

Field: Zenith Luminance

This is the Zenith Illuminance in Cd/m2. (Average amount of luminance at the sky's zenith in tens of Cd/m2 during the number of minutes preceding the time indicated.) It is not currently used in EnergyPlus calculations. It should have a minimum value of 0; missing value for this field is 9999.

Field: Wind Direction

This is the Wind Direction in degrees where the convention is that North=0.0, East=90.0, South=180.0, West=270.0. (Wind direction in degrees at the time indicated. If calm, direction equals zero.) Values can range from 0 to 360. Missing value is 999.

Wind direction is reported by the direction from which it originates. For example, a *northerly* wind blows from the north to the south. Wind direction is usually reported in cardinal directions (E, SE, W) or in azimuth degrees. Wind direction is measured in degrees clockwise from due north and so a wind coming from the north has a wind direction of 0 degrees; one from the east is 90 degrees; one from the south has a wind direction of 180 degrees. One from the west is 270 degrees or -90 degrees. (Negative degrees are translated to positive for EPW files.

Field: Wind Speed

This is the wind speed in m/sec. (Wind speed at time indicated.) Values can range from 0 to 40. Missing value is 999.

Field: Total Sky Cover

This is the value for total sky cover (tenths of coverage). (i.e. 1 is 1/10 covered. 10 is total coverage). (Amount of sky dome in tenths covered by clouds or obscuring phenomena at the hour indicated at the time indicated.) Minimum value is 0; maximum value is 10; missing value is 99.

Field: Opaque Sky Cover

This is the value for opaque sky cover (tenths of coverage). (i.e. 1 is 1/10 covered. 10 is total coverage). (Amount of sky dome in tenths covered by clouds or obscuring phenomena that prevent observing the sky or higher cloud layers at the time indicated.) This is not used unless the field for Horizontal Infrared Radiation Intensity is missing and then it is used to calculate Horizontal Infrared Radiation Intensity. Minimum value is 0; maximum value is 10; missing value is 99.

Field: Visibility

This is the value for visibility in km. (Horizontal visibility at the time indicated.) It is not currently used in EnergyPlus calculations. Missing value is 9999.

Field: Ceiling Height

This is the value for ceiling height in m. (77777 is unlimited ceiling height. 88888 is cirroform ceiling.) It is not currently used in EnergyPlus calculations. Missing value is 99999.

Field: Present Weather Observation

If the value of the field is 0, then the observed weather codes are taken from the following field. If the value of the field is 9, then “missing” weather is assumed. Since the primary use of these fields (Present Weather Observation and Present Weather Codes) is for rain/wet surfaces, a missing observation field or a missing weather code implies “no rain”.

Table 2. Present Weather Observation Values

Element	Values	Definition
Observation Indicator	0 or 9	0 = Weather observation made; 9 = Weather observation not made, or missing

Field: Present Weather Codes

The present weather codes field is assumed to follow the TMY2 conventions for this field. Note that though this field may be represented as numeric (e.g. in the CSV format), it is really a text field of 9 single digits. This convention along with values for each "column" (left to right) is presented in Table 16. Note that some formats (e.g. TMY) does not follow this convention – as much as possible, the present weather codes are converted to this convention during WeatherConverter processing. Also note that the most important fields are those representing liquid precipitation – where the surfaces of the building would be wet. EnergyPlus uses "Snow Depth" to determine if snow is on the ground.

Table 3. Weather Codes Field Interpretation

Column -- Position in Field	Element Description	Possible Values	Definition
1	Occurrence of Thunderstorm, Tornado, or Squall	0 - 2, 4, 6 - 9	0 = Thunderstorm—lightning and thunder. Wind gusts less than 25.7 m/s, and hail, if any, less than 1.9 cm diameter 1 = Heavy or severe thunderstorm—frequent intense lightning and thunder. Wind gusts greater than 25.7 m/s and hail, if any, 1.9 cm or greater diameter 2 = Report of tornado or waterspout 4 = Moderate squall—sudden increase of wind speed by at least 8.2 m/s, reaching 11.3 m/s or more and lasting for at least 1 minute 6 = Water spout (beginning January 1984) 7 = Funnel cloud (beginning January 1984) 8 = Tornado (beginning January 1984) 9 = None if Observation Indicator element equals 0, or else unknown or missing if Observation Indicator element equals 9

Column -- Position in Field	Element Description	Possible Values	Definition
2	Occurrence of Rain, Rain Showers, or Freezing Rain	0 - 9	0 = Light rain 1 = Moderate rain 2 = Heavy rain 3 = Light rain showers 4 = Moderate rain showers 5 = Heavy rain showers 6 = Light freezing rain 7 = Moderate freezing rain 8 = Heavy freezing rain 9 = None if Observation Indicator element equals 0, or else unknown or missing if Observation Indicator element equals 9 Notes: Light = up to 0.25 cm per hour Moderate = 0.28 to 0.76 cm per hour Heavy = greater than 0.76 cm per hour
3	Occurrence of Rain Squalls, Drizzle, or Freezing Drizzle	0, 1, 3 - 9	0 = Light rain squalls 1 = Moderate rain squalls 3 = Light drizzle 4 = Moderate drizzle 5 = Heavy drizzle 6 = Light freezing drizzle 7 = Moderate freezing drizzle 8 = Heavy freezing drizzle 9 = None if Observation Indicator element equals 0, or else unknown or missing if Observation Indicator element equals 9 Notes: When drizzle or freezing drizzle occurs with other weather phenomena: Light = up to 0.025 cm per hour Moderate = 0.025 to 0.051 cm per hour Heavy = greater than 0.051 cm per hour When drizzle or freezing drizzle occurs alone: Light = visibility 1 km or greater Moderate = visibility between 0.5 and 1 km Heavy = visibility 0.5 km or less
4	Occurrence of Snow, Snow Pellets, or Ice Crystals	0 - 9	0 = Light snow 1 = Moderate snow 2 = Heavy snow 3 = Light snow pellets 4 = Moderate snow pellets 5 = Heavy snow pellets 6 = Light ice crystals 7 = Moderate ice crystals 8 = Heavy ice crystals 9 = None if Observation Indicator element equals 0, or else unknown or missing if Observation Indicator element equals 9 Notes: Beginning in April 1963, any occurrence of ice crystals is recorded as a 7.

Column -- Position in Field	Element Description	Possible Values	Definition
5	Occurrence of Snow Showers, Snow Squalls, or Snow Grains	0 - 7, 9	0 = Light snow 1 = Moderate snow showers 2 = Heavy snow showers 3 = Light snow squall 4 = Moderate snow squall 5 = Heavy snow squall 6 = Light snow grains 7 = Moderate snow grains 9 = None if Observation Indicator element equals 0, or else unknown or missing if Observation Indicator element equals 9
6	Occurrence of Sleet, Sleet Showers, or Hail	0 - 2, 4, 9	0 = Light ice pellet showers 1 = Moderate ice pellet showers 2 = Heavy ice pellet showers 4 = Hail 9 = None if Observation Indicator element equals 0, or else unknown or missing if Observation Indicator element equals 9 Notes: Prior to April 1970, ice pellets were coded as sleet. Beginning in April 1970, sleet and small hail were redefined as ice pellets and are coded as 0, 1, or 2.
7	Occurrence of Fog, Blowing Dust, or Blowing Sand	0 - 9	0 = Fog 1 = Ice fog 2 = Ground fog 3 = Blowing dust 4 = Blowing sand 5 = Heavy fog 6 = Glaze (beginning 1984) 7 = Heavy ice fog (beginning 1984) 8 = Heavy ground fog (beginning 1984) 9 = None if Observation Indicator element equals 0, or else unknown or missing if Observation Indicator element equals 9 Notes: These values recorded only when visibility is less than 11 km.
8	Occurrence of Smoke, Haze, Smoke and Haze, Blowing Snow, Blowing Spray, or Dust	0 - 7, 9	0 = Smoke 1 = Haze 2 = Smoke and haze 3 = Dust 4 = Blowing snow 5 = Blowing spray 6 = Dust storm (beginning 1984) 7 = Volcanic ash 9 = None if Observation Indicator element equals 0, or else unknown or missing if Observation Indicator element equals 9 Notes: These values recorded only when visibility is less than 11 km.

Column -- Position in Field	Element Description	Possible Values	Definition
9	Occurrence of Ice Pellets	0 - 2, 9	0 = Light ice pellets 1 = Moderate ice pellets 2 = Heavy ice pellets 9 = None if Observation Indicator element equals 0, or else unknown or missing if Observation Indicator element equals 9

For example, a Present Weather Observation (previous field) of 0 and a Present Weather Codes field of 929999999 notes that there is heavy rain for this data period (usually hourly but depends on the number of intervals per hour field in the "Data Periods" record).

Field: Precipitable Water

This is the value for Precipitable Water in mm. (This is not "rain" – rain is inferred from the PresWeathObs field but a better result is from the Liquid Precipitation Depth field)). It is not currently used in EnergyPlus calculations (primarily due to the unreliability of the reporting of this value). Missing value is 999.

Field: Aerosol Optical Depth

This is the value for Aerosol Optical Depth in thousandths. It is not currently used in EnergyPlus calculations. Missing value is .999.

Field: Snow Depth

This is the value for Snow Depth in cm. This field is used to tell when snow is on the ground and, thus, the ground reflectance may change. Missing value is 999.

Field: Days Since Last Snowfall

This is the value for Days Since Last Snowfall. It is not currently used in EnergyPlus calculations. Missing value is 99.

Field: Albedo

The ratio (unitless) of reflected solar irradiance to global horizontal irradiance. It is not currently used in EnergyPlus.

Field: Liquid Precipitation Depth

The amount of liquid precipitation (mm) observed at the indicated time for the period indicated in the liquid precipitation quantity field. If this value is not missing, then it is used and overrides the "precipitation" flag as rainfall. Conversely, if the precipitation flag shows rain and this field is missing or zero, it is set to 1.5 (mm).

Field: Liquid Precipitation Quantity

The period of accumulation (hr) for the liquid precipitation depth field. It is not currently used in EnergyPlus.

Data Sources/Uncertainty

More recent weather data source files have introduced the concept of data sources and uncertainty flags for many of the fields. The EnergyPlus weather format faithfully reproduces these fields as appropriate for the input source data types. By and large, most of the data sources and uncertainties have used the TMY2 established fields and values (See following table). As noted earlier, to enhance readability and reduce obfuscation, the EnergyPlus

format for the data source and uncertainty flags collates them into one large field. Each data element still has its data source and uncertainty: it is positionally embodied depending on its place in the EPW data record.

Table 4. Key to Data Source and Uncertainty Flags

Data Flag	Flag Values
Dry Bulb Temperature Data Source	A-F
Dry Bulb Temperature Data Uncertainty	0-9
Dew Point Temperature Data Source	A-F
Dew Point Temperature Data Uncertainty	0-9
Relative Humidity Data Source	A-F
Relative Humidity Data Uncertainty	0-9
Atmospheric Station Pressure Data Source	A-F
Atmospheric Station Pressure Data Uncertainty	0-9
Horizontal Infrared Radiation Data Source	A-H, ?
Horizontal Infrared Radiation Data Uncertainty	0-9
Global Horizontal Radiation Data Source	A-H, ?
Global Horizontal Radiation Data Uncertainty	0-9
Direct Normal Radiation Data Source	A-H, ?
Direct Normal Radiation Data Uncertainty	0-9
Diffuse Horizontal Radiation Data Source	A-H, ?
Diffuse Horizontal Radiation Data Uncertainty	0-9
Global Horizontal Illuminance Data Source	I, ?
Global Horizontal Illuminance Data Uncertainty	0-9
Direct Normal Illuminance Data Source	I, ?
Direct Normal Illuminance Data Uncertainty	0-9
Diffuse Horizontal Illuminance Data Source	I, ?
Diffuse Horizontal Illuminance Data Uncertainty	0-9
Zenith Luminance Data Source	I, ?
Zenith Luminance Data Uncertainty	0-9
Wind Direction Data Source	A-F
Wind Direction Data Uncertainty	0-9
Wind Speed Data Source	A-F
Wind Speed Data Uncertainty	0-9
Total Sky Cover Data Source	A-F
Total Sky Cover Data Uncertainty	0-9
Opaque Sky Cover Data Source	A-F
Opaque Sky Cover Data Uncertainty	0-9
Visibility Data Source	A-F, ?
Visibility Data Uncertainty	0-9
Ceiling Height Data Source	A-F, ?
Ceiling Height Data Uncertainty	0-9
Precipitable Water Data Source	A-F

Precipitable Water Data Uncertainty	0-9
Broadband Aerosol Optical Depth Data Source	A-F
Broadband Aerosol Optical Depth Data Uncertainty	0-9
Snow Depth Data Source	A-F, ?
Snow Cover Data Uncertainty	0-9
Days Since Last Snowfall Data Source	A-F, ?
Days Since Last Snowfall Data Uncertainty	0-9

The definition of the solar radiation source flags and solar radiation uncertainty flags are shown in the following two tables:

Table 5. Solar Radiation and Illuminance Data Source Flag Codes

Flag Code	Definition
A	Post-1976 measured solar radiation data as received from NCDC or other sources
B	Same as "A" except the global horizontal data underwent a calibration correction
C	Pre-1976 measured global horizontal data (direct and diffuse were not measured before 1976), adjusted from solar to local time, usually with a calibration correction
D	Data derived from the other two elements of solar radiation using the relationship, global = diffuse + direct ´ cosine (zenith)
E	Modeled solar radiation data using inputs of observed sky cover (cloud amount) and aerosol optical depths derived from direct normal data collected at the same location
F	Modeled solar radiation data using interpolated sky cover and aerosol optical depths derived from direct normal data collected at the same location
G	Modeled solar radiation data using observed sky cover and aerosol optical depths estimated from geographical relationships
H	Modeled solar radiation data using interpolated sky cover and estimated aerosol optical depths
I	Modeled illuminance or luminance data derived from measured or modeled solar radiation data
?	Source does not fit any of the above categories. Used for nighttime values and missing data

Table 6. Solar Radiation and Illuminance Data Uncertainty Flag Codes

Flag	Uncertainty Range (%)
1	Not used
2	2 - 4
3	4 - 6
4	6 - 9
5	9 - 13
6	13 - 18
7	18 - 25
8	25 - 35
9	35 - 50
0	Not applicable

Finally, the Meteorological data source and uncertainty flag/codes are shown in the following two tables:

Table 7. Meteorological Data Source Flag Codes

Flag	Definition
A	Data as received from NCDC, converted to SI units
B	Linearly interpolated
C	Non-linearly interpolated to fill data gaps from 6 to 47 hours in length
D	Not used
E	Modeled or estimated, except: precipitable water, calculated from radiosonde data; dew point temperature calculated from dry bulb temperature and relative humidity; and relative humidity calculated from dry bulb temperature and dew point temperature
F	Precipitable water, calculated from surface vapor pressure; aerosol optical depth, estimated from geographic correlation
?	Source does not fit any of the above. Used mostly for missing data

Table 8. Meteorological Uncertainty Flag Codes

Flag	Definition
1- 6	Not used
7	Uncertainty consistent with NWS practices and the instrument or observation used to obtain the data
8	Greater uncertainty than 7 because values were interpolated or estimated
9	Greater uncertainty than 8 or unknown.
0	Not definable.

References

Walton, G. N. 1983. Thermal Analysis Research Program Reference Manual. NBSSIR 83-2655. National Bureau of Standards, p. 21.

Clark, G. and C. Allen, "The Estimation of Atmospheric Radiation for Clear and Cloudy Skies," Proceedings 2nd National Passive Solar Conference (AS/ISES), 1978, pp. 675-678.