**ME404 Climate-related parameters**

Energy simulation is often used to test alternative design possibilities against relatively short period data that characterise typical or extreme weather conditions for the location in question. In this way undesirable options may be disregarded before the near final scheme is subjected to long term simulations, annual or greater, to determine energy consumption trends. The selection of an annual weather collection requires some care. Of particular importance is the applicability of the data in relation to the design problem in hand. Generally, two conditions require to be met:

1. portions of the collection should correspond to the different levels of severity under which the building will operate (e.g. extreme and typical conditions in the winter, summer and transition seasons); and
2. the collection overall should support an assessment of cost-in-use.

Typically, the former condition is the easier to satisfy since it is usually possible to locate apposite data sequences within collections that do not necessarily correspond to the location in question and therefore will have an unacceptable overall severity. The latter condition will usually require the existence of site-specific data and a technique to rate severity.

**1. Availability of weather data**

Table 1 summarises the main weather parameters required for simulation. While many weather observation centres exist throughout the world, most will only collect a subset of these data, with solar radiation often excluded. Table 2 lists the data that has historically been measured at some UK locations.

Table 2.1: Required weather parameters.

| | |
|---|---|
| Dry bulb temperature (°C) | Wind speed (m/s) |
| Wet bulb temperature (°C) | Wind direction (° from north) |
| Global horizontal (or direct normal) solar radiation ($W/m^2$) | Precipitation (mm) |
| Diffuse horizontal solar radiation ($W/m^2$) | Atmospheric pressure (bar) |
| Net longwave radiation ($W/m^2$) | |
| and, where solar radiation data is not available: | |
| Cloud cover and type (%, -) | Sunshine hours (hr) |

Table 2.2: UK solar radiation stations and parameters measured.

| Station | Latitude | Longitude | Elevation (m) | Element measured |
|---|---|---|---|---|
| Lerwick | 60° 08' N | 01° 11' W | 82 | G, D, L, B, SS |
| Eskdalemuir | 55° 19' N | 03° 12' W | 242 | G, D, L, B, SS |
| Aldergrove | 54° 39' N | 06° 13' W | 68 | G, D, L, B, SS |
| Aberporth | 52° 08' N | 04° 34' W | 133 | G, D, SS |
| Cardington | 52° 06' N | 00° 25' W | 29 | G, D, SS |
| London | 51° 31' N | 00° 07' W | 77 | G, D, L, SS |
| Kew | 51° 28' N | 00° 19' W | 5 | G, D, L, B, SS, I, F |
| Bracknell | 51° 23' N | 00° 47' W | 73 | G, D, L, SS, I, F, N, S, E, W |
| Jersey | 49° 13' N | 02° 12' W | 83 | G, D, L, B, SS |
| Aberdeen | 57° 10' N | 02° 05' W | 35 | G |
| Dunstaffnage | 56° 28' N | 05° 26' W | 3 | G |
| Dundee | 56° 27' N | 03° 04' W | 30 | G, B |
| Hurley | 51° 32' N | 00° 49' W | 43 | G |
| G is global horizontal solar radiation, D diffuse horizontal solar radiation, I direct normal solar radiation, N/S/E/W are total solar radiation on vertical surfaces facing the cardinal points, SS sunshine hours, B radiation balance, L total horizontal illumination and F diffuse horizontal illumination. | | | | |

In the US, the National Climatic Data Center (NCDC) has published weather collections for locations throughout the world, while the American Society of Heating, Refrigeration and Air Conditioning (ASHRAE) and the National Renewable Energy Laboratory (NREL) have released weather data for use in building simulation. Typical Meteorological Years have been produced by NREL for 239 locations in the US and the IWEC (International Weather for Energy Calculations) collection, comprising hourly weather data for 227 non-US locations, has been published by ASHRAE.

In Europe, the Meteonorm system is a comprehensive source of weather data covering some 2400 meteorological stations worldwide. In addition to measured data, the system offers models for the calculation of inclined surface irradiance and supports data exporting in a variety of program-ready formats.

The European Solar Radiation Atlas, published by the European Commission, contains monthly means of global, diffuse and beam solar radiation as well as sunshine hours for representative sites throughout Europe. Work is underway to extend this resource by adding information on the spectral components (UVA, UVB, illuminance etc.) of surface irradiation under clear, overcast and intermediate skies. National data-sets have also been produced along with technical information on their use.

Often a simulation exercise will require local weather data that takes account of micro climate effects. The International Association for Urban Climate is an organisation concerned with all aspects of urban climatology and air quality. Through its members it is possible to source urban climate data for particular locations.

**2. Weather collection classification**

Irrespective of the source of weather data, a collection (usually annual) must be classified in terms of its severity. A Test Reference Year (TRY) is a weather collection which, when judged against some relevant criteria, is deemed to be representative. While many organisations/countries have produced TRYs, the procedures used are markedly different and a standard has yet to be established. Typical Meteorological Years (TMY) and Weather Years for Energy Calculations (WYEC) have been produced in an attempt to overcome the two main deficiencies of a TRY: the paucity of solar data and the method's tendency to exclude extreme conditions.

TRY-like weather years should be avoided because they do not represent typical long-term weather patterns, while synthesised weather years, such as TMY and WYEC, will usually give a better match between predicted and actual consumption over the long term.

**3. Climate severity assessment**

Most weather classification methods suffer from the fact that only simple synoptic data is used to discriminate between different collections and no attempt is made to include the characteristics of the building in the selection procedure.

To address these issues, the techniques have been developed to assess the severity of a given weather collection in terms of simple indices such as temperature only degree-days or compound indices that indicate the thermal stress placed on a building by all weather parameters.

Most modelling systems will provide a range of pre-constructed weather files and support the importing/exporting of data in alternative formats. In addition, it is usually possible to graph the weather data and extract relevant statistics such as period degree days, max/min

conditions, irradiance totals and the frequency of occurrence of specified conditions.

**4. Climate change**

Currently there is much concern about climate change and debate about its cause: is it a natural cycle, the result of human activity or a mix of both. While there is a political consensus in many countries that the cause is mostly related to human activities resulting in the release of greenhouse gasses, the scientific evidence is equivocal. This stems from the complexity of the climate system and the difficulty of separating out anthropogenic factors from the natural variability.