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Hygrothermal performance of buildings — Calculation and presentation of climatic data —

Part 4: Hourly data for assessing the annual energy use for heating and cooling

Performance hygrothermique des bâtiments — Calcul et présentation des données climatiques —

Partie 4: Données horaires pour l'évaluation du besoin énergétique annuel de chauffage et de refroidissement

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Contents

Page

Foreword iv
Introduction v
1 Scope 1
2 Normative references 1
3 Terms, definitions and symbols 1
4 Sources of meteorological data 2
5 Construction of reference year 2
6 Presentation of the reference years 4
Bibliography 5

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 15927-4 was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 89, *Thermal performance of buildings and building components,* in collaboration with Technical Committee ISO/TC 163, *Thermal performance and energy use in the built environment*, Subcommittee SC 2, *Calculation methods* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

ISO 15927 consists of the following parts, under the general title *Hygrothermal performance of buildings — Calculation and presentation of climatic data*:

— *Part 1: Monthly means of single meteorological elements*

— *Part 4: Hourly data for assessing the annual energy for heating and cooling*

— *Part 5: Data for design heat load for space heating*

— *Part 6: Accumulated temperature differences (degree days)*

Future parts are planned on the following subjects:

— *Hourly data for design cooling load*

— *Calculation of a driving rain index for vertical surfaces from hourly wind and rain data*

Introduction

This standard covers the selection of appropriate meteorological data for the assessment of the long-term mean energy use for heating and cooling of buildings. Means of selecting data to assess the maximum heating demand are specified in ISO 15927-5.

Correct simulation of building performance depends not only on the appropriate mean values of the meteorological parameters, but also on the frequency distributions of individual parameters and the cross correlations between them. As these can be difficult to retain in the type of artificially constructed reference year discussed in this part of ISO 15927, the use of long periods (at least ten years but preferably more) of hourly meteorological data is preferred where possible. This also takes into account long spells of unusually warm or cold weather, lasting several months, which is eliminated in the construction of a reference year. In practice, however, long runs of hourly data containing all the necessary parameters are very expensive and can be difficult to obtain for many areas. There is, therefore, still a need for annual sets of data that can be used to represent the long-term mean performance of buildings. These can be generated once from long runs of expensive data and then distributed more cheaply.

This part of ISO 15927 specifies a method for the construction of a reference year from a longer meteorological record. Other methods are possible for constructing reference years for specific purposes, including those methods that are based on an analysis of general weather situations.

Hygrothermal performance of buildings — Calculation and presentation of climatic data —

Part 4: Hourly data for assessing the annual energy use for heating and cooling

1 Scope

This part of ISO 15927 specifies a method for constructing a reference year of hourly values of appropriate meteorological data suitable for assessing the average annual energy for heating and cooling. Other reference years representing average conditions can be constructed for special purposes. The procedures in this part of ISO 15927 are not suitable for constructing extreme or semi-extreme years for simulation of, for example, moisture damage or energy demand in cold years.

Meteorological instrumentation and methods of observation are not covered; these are specified by the World Meteorological Organization.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

World Meteorological Organization (WMO): *Guide to meteorological instruments and methods of observation.* No. 8, 6th Edition, 1996

3 Terms, definitions and symbols

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1.1
cumulative distribution function
normalized rank order of the values of a parameter, when drawn up in increasing order, within a specified period

3.1.2
reference year
year of hourly values of appropriate meteorological parameters representative of the long term climate

3.2 Symbols

$F(p)$ cumulative distribution function of p within each individual month

F_S Finkelstein-Schafer statistic

J rank order of daily means within a calendar month in one year

K rank order of daily means within that calendar month in the whole data set

N number of days in any calendar month in the whole data set

m month of the year

n number of days in an individual month

p climate parameter (temperature, solar radiation or humidity)

$\overline{p}$ daily mean of any climate parameter

y year

$\Phi(p)$ cumulative distribution function of p within each calendar month in all the years in a sample

4 Sources of meteorological data

Data used for calculations in accordance with this standard shall have been measured by the methods specified in *WMO Guide No. 8, 1996*.

Because the data used in the selection procedure [see 5.3.1, items a) to g)] are processed in a way different from that normally used by the weather services, much care has to be exercised in the quality control of the raw data. Missing values shall be generated by linear interpolation or by estimate, and sudden, unnatural jumps or singular values shall be examined and corrected. If the raw data are available only as three-hourly data (sometimes referred to as synoptic data), then the missing values shall be calculated by linear interpolation.

5 Construction of reference year

5.1 Necessary parameters

The reference year shall contain hourly values of at least the following meteorological parameters, taken from a location or locations representative of the climate concerned:

— dry-bulb air temperature;

— direct normal solar irradiance and diffuse solar irradiance on a horizontal surface;

— relative humidity, absolute humidity, water vapour pressure or dewpoint temperature;

— wind speed at a height of 10 m above ground.

As temperature, radiation and humidity are the key parameters for cooling and heating calculations, these are used to construct the reference year.

NOTE Other parameters can be used to develop reference years for special applications.

5.2 Principle of construction

In principle, if a year existed within the long-term data in which each month was representative of the long-term conditions, this year could be used as a reference year. However, that is unlikely and in practice the most appropriate months are selected from a number of different years and joined together, with smoothing at the joins, to construct a complete year.

The procedure specified below is designed to construct a year of hourly values in which

— the mean value of individual variables,

— their frequency distribution, and

— correlations between the different variables within each month

are as close as possible to the corresponding calendar month of the long term data set.

The procedure therefore has two stages:

a) selection of the best month, as defined in 5.3, from the multi-year record for each calendar month;

b) adjustment of the hourly values in the selected month so as to provide a smooth transition when the different months are joined to form a year.

The procedures in a) and b) are such that the correlations between variables are retained.

5.3 Procedure

5.3.1 Selection of months to form the reference year

In the procedure described below, dry-bulb temperature, solar radiation and humidity are taken as the primary parameters for selecting the “best” months to form the reference year, with wind speed as a secondary parameter. Other combinations of primary and secondary parameters can be used to develop reference years for special purposes; the variables chosen as the basis of the reference year shall always be stated in the accompanying documentation.

For each climatic parameter, p, where p is dry-bulb temperature, solar radiation or humidity, carry out the following operations.

a) From at least 10 years (but preferably more) of hourly values of p, calculate the daily means, $\overline{p}$.

b) For each calendar month, calculate the cumulative distribution function of the daily means over all years in the data set, $\Phi(p,m,i)$, by sorting all the values in increasing order and then using Equation (1):

$$\Phi(p,m,i) = \frac{K(i)}{N+1} \tag{1}$$

where $K(i)$ is the rank order of the ith value of the daily means within that calendar month in the whole data set.

c) For each year of the data set, calculate the cumulative distribution function of the daily means within each calendar month, $F(p,y,m,i)$, by sorting all the values for that month and that year in increasing order and then using Equation (2):

$$F(p,y,m,i) = \frac{J(i)}{n+1} \tag{2}$$

where $J(i)$ is the rank order of the ith value of the daily means within that month and that year.

d) For each calendar month, calculate the Finkelstein-Schafer statistic, $F_S(p,y,m)$, for each year of the data set using Equation (3):

$$F_S(p,y,m) = \sum_{i=1}^{n} \left| F(p,y,m,i) - \Phi(p,m,i) \right| \quad (3)$$

e) For each calendar month, rank the individual months from the multiyear record in order of increasing size of $F_S(p,y,m)$.

f) For each calendar month and each year, add the separate ranks for the three climate parameters.

g) For each calendar month, for the three months with the lowest total ranking, calculate the deviation of the monthly mean wind speed from the corresponding multi-year calendar-month mean. The month with the lowest deviation in wind speed is selected as the “best” month to be included in the reference year.

Further parameters can be investigated if necessary.

5.3.2 Adjustment of the hourly values

Adjust the parameters in the last eight hours of each month and the first eight hours of the next month by interpolation to ensure a smooth transition when the “best” months are joined to form the reference year. This adjustment shall include the last eight hours of December and the first eight hours of January so that the reference year can be used repeatedly in simulations.

6 Presentation of the reference years

The reference years shall be sequences of 8 760 hourly values of dry-bulb temperature, water vapour pressure (or other humidity parameter), solar irradiation and wind speed and any other available climate parameters.

The details (location and altitude) of the station, the climate parameters used, the period of the original data set and the years from which the individual months were taken shall be reported. If reference years are produced for several places in a country, the geographical area of validity or preference should be specified for each of them.

Bibliography

[1] SKARTVEIT, A.; LUND, H. AND OLSETH, J. DNMI: *The Design Reference Year*. Klima report 11/94.

[2] ISO 15927-5, *Hygrothermal performance of buildings — Calculation and presentation of climatic data — Part 5: Data for design heat load for space heating*

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