INTERNATIONAL STANDARD

ISO 15927-5

First edition
2004-11-15

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

Part 5: Data for design heat load for space heating

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

Partie 5: Données pour la charge calorifique de conception pour le chauffage des locaux

Reference number
ISO 15927-5:2004(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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 was prepared by the European Committee for Standardization (CEN) 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 5: Data for design heat load for space heating*

The following parts are under preparation:

— *Part 4: Data for assessing the annual energy for cooling and heating systems*

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

Introduction

The choice of design heat load for space heating is a matter of balancing user needs against cost. On the one hand, users expect a heating system to maintain the internal temperatures needed for health and comfort; on the other hand, very high heating demand arises from time to time, when a meteorological extreme occurs. It may be uneconomic to design heating systems for rare extremes, as this can lead to high capital (initial) cost and to lower operational efficiency of the system.

The practical solution is to choose an infrequent, but not extreme, climatological value as the basis for the design load. This means that from time to time heat demand will exceed the system capacity, with the result that internal temperatures will be lower than desired, or that supplementary heating will be needed (e.g. from local heaters). The methods of calculation in this part of ISO 15927 include a standard return period or frequency, which is judged to give an acceptable balance between risk of inadequate performance and cost.

The definition of winter external design temperatures also needs to reflect the interaction between buildings and their external environment. Buildings possess thermal inertia and do not respond instantly to changes in weather conditions. The time delay (or lag) before internal conditions are significantly affected varies among different types of construction and heating methods. To allow for this, winter external design temperatures, calculated according to this part of ISO 15927, can be defined over a range of periods from as short as 1 h to as long as 4 days.

The influence of wind is important, as infiltration can cause a large proportion of heat loss from buildings that are not airtight; this is especially true in climates where infrequent, low temperatures are associated with high wind speeds. This part of ISO 15927 specifies that average coincident wind speed and range of directions are determined for the conditions of the winter external design temperature.

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

Part 5: Data for design heat load for space heating

1 Scope

This part of ISO 15927 specifies the definition, method of calculation and method of presentation of the climatic data to be used in determining the design heat load for space heating in buildings. These include

— the winter external design air temperatures;

— the relevant wind speed and direction, where appropriate.

Heat loss through the ground, which also contributes to the heat load for buildings, depends on longer-term temperature changes; methods for calculating ground heat loss are given in ISO 13370[1)].

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.

ISO 6243, *Climatic data for building design — Proposed system of symbols*

World Meteorological Organization: *Guide to Meteorological Instruments and Methods of Observation, 6th Edition, WMO — No. 8, 1996*

3 Terms, definitions, symbols and units

3.1 Terms and definitions

For the purposes of this standard, the terms and definitions given in ISO 6243 and the following apply.

3.1.1
design heat load
maximum heat output required from the heating system of a building, in order to maintain required internal temperatures without supplementary heating

3.1.2
winter external design temperature
low external air temperature with a defined return period, used to determine the design heat load of a building

1) ISO 13370, *Thermal performance of buildings — Heat transfer via the ground — Calculation methods*.

3.1.3
coincident wind speed
average wind speed during a period over which temperature is averaged

3.1.4
hourly temperature
average of continuously recorded air temperatures during 1 h, or in the absence of continuous measurements, the average of the air temperatures observed at regular intervals

3.1.5
daily maximum temperature
maximum dry-bulb air temperature during a day (00:00 to 24:00), taken as either the highest hourly mean temperature or the recorded extreme on a maximum thermometer

3.1.6
daily minimum temperatures
minimum dry-bulb air temperature during a day (00:00 to 24:00), taken as either the lowest hourly mean temperature or the recorded extreme on a minimum thermometer

3.1.7
***n*-day mean temperature**
average of dry-bulb air temperature on n consecutive days, where n is one, two, three or four

3.2 Symbols and units

θ_{dx} daily maximum temperature, expressed in degrees Celsius

θ_{dn} daily minimum temperature, expressed in degrees Celsius

θ_{hm} hourly mean temperature, expressed in degrees Celsius

$\theta_{n\mathrm{dm}}$ n-day mean temperature, expressed in degrees Celsius

θ_{h}^{*} hourly mean design temperature, expressed in degrees Celsius

$\theta_{n\mathrm{d}}^{*}$ n-day mean design temperature, expressed in degrees Celsius

NOTE The letter symbols used differ in some cases from those given in ISO 6243, mainly to comply with the developing practice in other International Standards from ISO/TC 163. However, the principles of ISO 6243 have been followed where possible.

4 Methods of calculation

4.1 Sources of data

The temperatures and wind speeds used to calculate the winter external design temperature shall be measured by the methods specified by the *WMO Guide No.8 1996*.

4.2 Types of winter external design temperature required

Two main types of winter external design temperature can be calculated:

— an n-day mean air temperature, $\theta_{n\mathrm{d}}^{*}$, where n is one, two, three or four;

— an hourly mean air temperature, θ_{h}^{*}.

4.3 n-day mean design temperature

The n-day mean design temperature, $\theta^{*}_{n\mathrm{d}}$, is calculated as the n-day mean air temperature, where n is one, two, three or four, having an average return period of 1 year (e.g. occurring on average 20 times in 20 years). The n-day mean air temperature on which it is based may be calculated, for every combination of n successive days, in one of several ways, depending on the data available.

a) Where hourly data are available, $\theta_{n\mathrm{dm}}$ shall be calculated as the mean of 24n hourly values between 00:00 on the first day and 23:00 on the final day.

b) Where three-hourly data are available, $\theta_{n\mathrm{dm}}$ shall be calculated as the mean of 8n three-hourly values between 00:00 on the first day and 21:00 on the final day.

c) Where temperatures observed at 07:30 ($\theta_{7:30}$), 14:30 ($\theta_{14:30}$) and 21:30 ($\theta_{21:30}$), or at other similar times, are available, $\theta_{n\mathrm{dm}}$ shall be calculated using Equation (1) or the equivalent equation for the appropriate times:

$$\theta_{n\mathrm{dm}} = \frac{\sum_{i=1}^{n} \left(\theta_{7:30} + \theta_{14:30} + 2\,\theta_{21:30}\right)_i}{4n} \qquad (1)$$

where the summation is over one, two, three or four days.

d) Where only daily maximum and daily minimum temperatures are available, a less accurate estimate [relative to those derived from 4.3 a), 4.3 b) or 4.3 c)] shall be obtained using Equation (2):

$$\theta_{n\mathrm{dm}} = \frac{\sum_{i=1}^{n} \left(\theta_{\mathrm{dx}} + \theta_{\mathrm{dn}}\right)_i}{2n} \qquad (2)$$

where the summation is over one, two, three or four days.

The choice of calculation method has a relatively small influence on the value of $\theta^{*}_{n\mathrm{d}}$, which shall be derived from the most finely resolved data available for a location in order of priority from 4.3 a) to 4.3 d).

4.4 Hourly mean design temperature

Calculate θ^{*}_{h} as the hourly mean air temperature exceeded on average in 99 % of the hours during the coldest month of the year. It may be either

a) calculated from hourly temperature data, sorted into a frequency distribution, or

b) estimated from three-hourly data, where hourly data are not available, using quadratic interpolation to estimate the temperatures in intermediate hours and then treating the estimated hourly data as in 4.3 a).

The coldest month is the month with the lowest 20-year average monthly mean temperature. It shall be used as the month from which hourly data are drawn, even in those years (if any) when the lowest monthly mean temperature occurs in a different month.

4.5 Period of records of source data

All values of winter external design temperature shall, if possible, be based on measurements recorded over a continuous period of at least 20 years, the period being stated with the data. If any data are missing from this period, meteorological advice shall be sought to ensure that the results will be representative of the distribution of infrequent low temperatures during the period.

5 Coincident wind speed

5.1 Determination of mean wind speed

Where continuously recorded wind speeds are available, continuous average wind speeds shall be calculated as averages over the period defined in 5.2 and 5.3. Where non-continuous data, such as mean wind speeds averaged over 10 min, are available, continuous average wind speeds shall be estimated. All wind speeds shall be determined at, or corrected to, a height of 10 m above ground level.

Correction factors for local shelter or exposure or for the height of buildings may be specified in national standards.

5.2 Wind speed related to *n*-day mean design temperature

The coincident wind speed shall be taken as the 95-percentile wind speed from all the *n*-day periods with mean temperature equal to or colder than the *n*-day mean design temperature.

5.3 Wind speed related to hourly mean design temperature

The coincident wind speed shall be taken as the 95-percentile wind speed from all the hours with a mean temperature equal to or colder than the hourly mean design temperature.

6 Dominant wind direction

6.1 Determination of dominant wind direction

Wind directions shall be analysed by non-overlapping 30° segments. Any segment from which the wind blows for 40 %, or more, of the time shall be declared a dominant wind direction. If more than one segment is dominant, the main and secondary segments shall be reported. Dominant wind directions shall be described by the limits of their segment, e.g. 30° to 60°.

6.2 Dominant wind direction related to *n*-day mean design temperature

The dominant wind direction or directions shall be determined for the *n*-day period nearest in mean temperature to the *n*-day mean design temperature, $\theta^*_{n\mathrm{d}}$, and all the colder *n*-day periods in the period of records.

6.3 Dominant wind direction related to hourly mean design temperature

The dominant wind direction or directions shall be determined for the hour selected as the hourly mean design temperature, θ^*_{h}, and all the colder hours in the period of the records.

7 Reference altitude

All winter external design temperature data shall relate to a reference altitude; this may be either

a) the altitude of the location e.g. a meteorological station, at which the air temperature data were recorded,

b) a general altitude for temperature data applying to an area, region or zone; this may be mean sea level,

c) the actual altitudes over an area of land, in the case of design temperature isopleths on maps.

Use a correction factor to estimate design temperatures at altitudes other than that at which the original air temperature data were recorded. This factor, the “lapse rate” for $\theta^*_{n\mathrm{d}}$ and θ^*_{h}, shall be determined from local meteorological records. The correction factor is used to compute design temperature data for cases 7 b) and 7 c), and to enable the user to convert design temperature data from their reference altitude to an actual altitude, where different.

Lapse rates and other causes of local variation in low temperatures can be strongly influenced by air drainage, radiation losses and "heat island" effects. Specialist meteorological advice shall be obtained where possible.

8 Presentation of data

8.1 Data requirements

Winter external design temperature data shall be given together with coincident wind speed. Dominant wind direction shall be included when applicable.

Air temperature shall be given in degrees Celsius, wind speed in metres per second, and direction in degrees.

8.2 Qualifying information to be given with all data

The following information shall be given:

a) reference to this part of ISO 15927, i.e., ISO 15927-5:2004;

b) the return period or frequency of the value, as specified for θ_{nd}^{*} in 4.3 or for θ_{h}^{*} in 4.4;

c) the period of records (number of years of measurements) from which the data were calculated;

d) except for isopleths on maps, the reference altitude in metres above mean sea level.

8.3 Coincident wind speed

The average wind speed over the calculation period shall be stated with the air temperature. Average wind speeds shall be rounded to the nearest 0,5 m/s. Where the value is below 1 m/s, the coincident wind speed shall be described as "calm" (C).

8.4 Dominant wind direction

Where the average wind speed is 2,5 m/s or more and the criteria for the dominant wind direction in Clause 6 are satisfied, the dominant wind direction(s) shall be stated with the corresponding air temperature and wind speed data.

8.5 Winter external design temperature data in tables

Winter external design temperature data for specific sites (e.g. meteorological stations) shall be presented in tabular form, rounded to the nearest multiple of 0,1 °C, and stating coincident wind conditions (see 8.3).

8.6 Winter external design temperature data in maps

Winter external design temperature data for an area, region or country may be presented on maps either as zones or isopleths (contours);

a) data applying to zones shall be rounded to the nearest multiple of 1 °C and stated together with average coincident wind conditions applicable to the zone;

b) data given as isopleths on maps shall be rounded to the nearest multiple of 2 °C. It will usually not be possible to show coincident wind speeds on the isopleths; these should be stated separately.