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

Part 2: Hourly data for design cooling load

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

Partie 2: Données horaires pour la charge de refroidissement de conception

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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.

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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 2: Hourly data for design cooling load*

— *Part 3: Calculation of a driving rain index for vertical surfaces from hourly wind and rain data*

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

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

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

Introduction

The choice of design load for space cooling is a matter of balancing user needs against cost. On the one hand, users expect a cooling system to maintain the internal temperatures needed for health and comfort; on the other hand, very high cooling loads can arise from extreme meteorological conditions. It is usually uneconomic to design cooling systems for rare extremes, as this leads to high capital cost and, usually, to lower operational efficiency of the system. The highest cooling loads occur with a combination of high daily mean dry-bulb temperature and dewpoint temperature, high daily total irradiation, low daily swing in temperature and low wind speed. Data are therefore needed on the values of these parameters when they occur in combination at specific return periods.

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

Part 2: Hourly data for design cooling load

1 Scope

This part of ISO 15927 gives the definition and specifies methods of calculation and presentation of the monthly external design climate to be used in determining the design cooling load of buildings and the design of air conditioning systems.

Depending on the building type, a range of parameters can be used to define the individual days of hourly or three-hourly data in each calendar month that impose a cooling load likely to be exceeded on 5 %, 2 % and 1 % of days.

The parameters that are always used in the selection are dry-bulb temperature and total global solar irradiation (or sunshine hours). The daily swing in dry-bulb temperature, dewpoint temperature and wind speed and any other parameters relevant to particular buildings may also be included.

Hourly peak values of dry-bulb temperature and dewpoint temperature are needed for the design of air conditioning systems.

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 15927-1, *Hygrothermal performance of buildings — Calculation and presentation of climatic data — Part 1: Monthly means of single meteorological elements*

World Meteorological Organization (WMO), *Guide to Meteorological Instruments and Methods of Observation*, No. 8, 6th Edition, 1996[1)]

1) World Meteorological Organization: http://www.wmo.ch/pages/catalogue/New%20HTML/frame/engfil/8.html.

3 Terms, definitions, symbols and units

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 15927-1 and the following apply.

3.1.1
hourly value
average of instantaneous values of a parameter measured during an hour or value observed at a particular moment (e.g. on the hour)

NOTE Hourly values can be estimated by interpolation from data measured at three-hour intervals.

3.1.2
daily mean value
average of 24 hourly values or eight 3-hourly values of a parameter during a day from 00:00 to 23:00 or 01:00 to 24:00

3.1.3
dry-bulb temperature
air temperature measured in a thermometer screen or with similar shielding from solar radiation

3.1.4
daily swing in dry-bulb temperature
difference between the maximum and minimum dry-bulb temperatures in one day

3.1.5
dewpoint temperature
temperature to which air is cooled to become saturated with the same water vapour content

3.1.6
global solar irradiation on a horizontal surface
total solar energy falling on a horizontal surface in a given period

NOTE Global solar irradiation is the sum of the direct and diffuse solar irradiation received by the surface in the period.

3.1.7
summer external design day
day from any calendar month with a specified return period for extreme values of the significant meteorological parameters, for example: temperature, temperature swing, dewpoint temperature, solar irradiation and wind speed

3.2 Symbols and units

Symbol	Quantity	Unit
$\hat{I}_s$	daily total global solar irradiation	kWh/(m^2·d)
$\hat{h}_s$	daily total sunshine hours	h
v	wind speed	m/s
$\overline{v}$	daily mean wind speed	m/s
θ	dry-bulb temperature	°C
$\overline{\theta}$	daily mean dry-bulb temperature	°C
θ_d	dewpoint temperature	°C
$\overline{\theta}_d$	daily mean dewpoint temperature	°C
θ_{sw}	daily swing in dry-bulb temperature	K

Subscript x%, as in $p_{x\%}$, represents the value of a parameter that is exceeded on 100 - x % of days.

4 Method of determination

4.1 Sources of data

Hourly files of meteorological data, containing at least the dry-bulb temperature and global solar irradiation or sunshine hours for at least 10 years, shall be analysed. Other parameters, such as dewpoint temperature or daily swing in temperature and wind speed, may be included if design days are needed for specific purposes. The parameters used shall be fully reported.

NOTE Global solar irradiation is preferred to sunshine hours as it gives a better index of the performance of the building; however, solar radiation data are available from very few stations compared to sunshine hours.

Methods for calculating meteorological parameters are given in ISO 15927-1.

The meteorological data shall have been measured in accordance with WMO Guide No. 8, 1996.

4.2 Identification of the design days

4.2.1 The procedure in 4.2.2 to 4.2.5 describes the use of dry-bulb temperature, global solar irradiation or sunshine hours, dewpoint temperature, daily temperature swing and wind speed to construct design days. The same principles may be applied to the use of any other parameters appropriate to specific buildings.

4.2.2 Identify the parameters that are to be used to construct the design days. Daily mean dry-bulb temperature and daily total global solar radiation or daily total sunshine hours, shall be included in all cases; daily mean dewpoint temperature, daily temperature swing and daily mean wind speed may also be included.

For each day in the data set, calculate:

a) the daily mean dry-bulb temperature, $\overline{\theta}$;

b) the daily total global solar irradiation, $\hat{I}_{\mathrm{s}}$, or daily total sunshine hours, $\hat{h}_{\mathrm{s}}$;

c) if relevant, the daily mean dewpoint temperature, $\overline{\theta}_{\mathrm{d}}$, the daily mean wind speed, $\overline{v}$, and the daily swing in dry-bulb temperature, θ_{sw} .

4.2.3 For each calendar month in the data set (i.e. all the January data taken together, all the February data taken together, etc.) find the values of daily mean temperature and daily total solar irradiation or daily total sunshine hours exceeded on 1 %, 2 % and 5 % of days. If relevant, find the values of the daily mean dewpoint temperature that are reached or exceeded on 1 %, 2 % and 5 % of days and the values of the daily temperature swing and daily mean wind speed that are exceeded on 99 %, 98 % and 95 % of days. These are:

a) daily mean dry-bulb temperature, $\overline{\theta}_{99\%}$, $\overline{\theta}_{98\%}$ and $\overline{\theta}_{95\%}$;

b) daily total global solar irradiation, $\hat{I}_{\mathrm{s},99\%}$, $\hat{I}_{\mathrm{s},98\%}$ and $\hat{I}_{\mathrm{s},95\%}$;

c) daily total sunshine hours, $\hat{h}_{\mathrm{s},99\%}$, $\hat{h}_{\mathrm{s},98\%}$ and $\hat{h}_{\mathrm{s},95\%}$;

d) daily mean dewpoint temperature, $\overline{\theta}_{\mathrm{d},99\%}$, $\overline{\theta}_{\mathrm{d},98\%}$ and $\overline{\theta}_{\mathrm{d},95\%}$;

e) daily swing in dry-bulb temperature, $\theta_{\mathrm{sw},1\%}$, $\theta_{\mathrm{sw},2\%}$, and $\theta_{\mathrm{sw},5\%}$;

f) daily mean wind speed, $\overline{v}_{1\%}$, $\overline{v}_{2\%}$ and $\overline{v}_{5\%}$.

4.2.4 Define the initial intervals for each of the parameters to be the following:

a) daily mean dry-bulb temperature, $\overline{\theta}_{x\%} \pm 0{,}5$ °C;

b) daily total global solar irradiation, $\hat{I}_{\mathrm{s},x\%}$ ± 0,05 kWh/(m²·d);

c) daily total sunshine hours, $\hat{h}_{\mathrm{s},x\%} \pm 0{,}5$ h;

d) if used, daily mean dewpoint temperature, $\overline{\theta}_{\mathrm{d},x\%} \pm 0{,}5$ °C;

e) if used, daily swing in dry-bulb temperature, $\theta_{\mathrm{sw},x\%} \pm 0{,}5$ K;

f) if used, daily mean wind speed, $\overline{v}_{x\%} \pm 0{,}5$ m/s.

where x% is the risk factor in percent.

4.2.5 For each calendar month and for each of the three risk levels, identify days on which the daily means of all the parameters used fall within the error bands. There are three possibilities.

a) If for any month, M, and risk level, x%, only one day is identified, this is the design day for that month and risk level.

b) If for any month, M, and risk level, x%, more than one day is identified, progressively reduce the intervals defined above, one at a time and in the following order

   1) the dry-bulb temperature in steps of 0,1 °C,

   2) the global solar irradiation in steps of 0,01 kWh/(m^2·d), or the daily total sunshine hours in steps of 0,1 h,

   3) if used, the dewpoint temperature in steps of 0,1 °C,

   4) if used, the daily swing in dry-bulb temperature in steps of 0,1 K,

   5) if used, the wind speed in steps of 0,1 m/s,

until only one day is identified. This is the design day for that month and risk level.

c) If for any month, M, and risk level, x%, no days are identified, progressively increase the intervals defined above, one at a time and in the following order

   1) the dry-bulb temperature in steps of 0,1 °C,

   2) the global solar irradiation in steps of 0,01 kWh/(m^2·d), or the daily total sunshine hours in steps of 0,1 h,

   3) if used, the dewpoint temperature in steps of 0,1 °C,

   4) if used, the daily swing in dry-bulb temperature in steps of 0,1 K,

   5) if used, the wind speed in steps of 0,1 m/s,

until only one day is identified. This is the design day for that month and risk level.

NOTE An example of this procedure for one month is given in Annex A.

5 Data for the design of air conditioning systems

For all the hourly data in the data set, calculate the dry-bulb temperature exceeded on 1 %, 2 % and 5 % of occasions. These are $\theta_{99\%}$, $\theta_{98\%}$ and $\theta_{95\%}$.

For all the hours when the dry-bulb temperature is within the range $\theta_{99\%} \pm 0{,}1$ °C, calculate the dewpoint temperature exceeded on 1 % of occasions. This is $\theta_{d,99,99}$.

For all the hours when the dry-bulb temperature is within the range $\theta_{98\%} \pm 0{,}1$ °C, calculate the dewpoint temperature exceeded on 2 % of occasions. This is $\theta_{d,98,98}$.

For all the hours when the dry-bulb temperature is within the range $\theta_{95\%} \pm 0{,}1$ °C, calculate the dewpoint temperature exceeded on 5 % of occasions. This is $\theta_{d,95,95}$.

6 Presentation of the design days

The following information shall be reported:

— the location of the meteorological station recording the original data;

— the dates of the start and finish of the original data set;

— for each calendar month and risk level:

1) the date of the design day;

2) the hourly or three-hourly values of the parameters used on that day.

7 Presentation of the data for the design of air conditioning systems

The following information shall be reported:

— the location of the meteorological station recording the original data;

— the dates of the start and finish of the original data set;

— The values of:

1) $\theta_{99\%}$ and $\theta_{d,99,99}$;

2) $\theta_{98\%}$ and $\theta_{d,98,98}$;

3) $\theta_{95\%}$ and $\theta_{d,95,95}$.

Annex A
(informative)

Example of the procedure for identifying a design day

A.1 Introduction

This annex gives an example of the procedure for identifying the design day for July from 20 years (1976 to 1995) of hourly data. The procedure for the other months is identical.

A.2 Identification procedure

Firstly, the mean daily values are obtained for the dry-bulb temperature and the total global solar irradiation, and, if used, the dewpoint temperature, wind speed and the daily swing in dry-bulb temperature, for each day in the data set (total of $20 \times 31 = 620$ days). This set of daily values is then examined to ascertain the values exceeded for different risk levels. For example, the 99 % value for dry-bulb temperature is the mean temperature exceeded on 6 days (1 % of 620 days). The results are shown in Table A.1.

Table A.1 — Values exceeded for 1 %, 2 % and 5 % risks

Parameter	Risk level					
	1 %	2 %	5 %	99 %	98 %	95 %
Daily mean dry-bulb temperature, °C				25,5	24,4	23,2
Daily mean dewpoint temperature, °C				17,5	17,3	16,7
Daily total global solar irradiation, kWh/(m^2·d)				15,0	14,7	13,9
Daily dry-bulb temperature swing, K	2,7	3,2	4,1			
Daily mean wind speed, m/s	1,2	1,4	1,6			

The initial searches for the 1 %, 2 % and 5 % days are therefore based on the criteria in Table A.2 (see 4.2.4).

Table A.2 — Initial limit values for 1 %, 2 % and 5 % risks

Parameter	Risk level					
	1 %		2 %		5 %	
	Lower limit	Upper limit	Lower limit	Upper limit	Lower limit	Upper limit
Daily mean dry-bulb temperature, °C	25,0	26,0	23,9	24,9	22,7	23,7
Daily mean dewpoint temperature, °C	17,0	18,0	16,8	17,8	16,2	17,2
Daily total global solar irradiation, kWh/(m^2·d)	14,5	15,5	14,2	15,2	13,4	14,4
Daily dry-bulb temperature swing, K	2,2	3,2	2,7	3,7	3,6	4,6
Daily mean wind speed, m/s	0,7	1,7	0,9	1,9	1,1	2,1

An examination of all 620 days did not identify any day in which each of the parameters were between the upper and lower limits in Table A.2 in any of the three risk categories. Progressively expanding the limits to the values shown in Table A.3 produced one day in each category, as given in Table A.4.

Table A.3 — Final limit values for 1 %, 2 % and 5 % risks

Parameter	Risk level					
	1 %		2 %		5 %	
	Lower limit	Upper limit	Lower limit	Upper limit	Lower limit	Upper limit
Daily mean dry-bulb temperature, °C	24,5	26,5	23,4	25,4	22,2	24,2
Daily mean dewpoint temperature, °C	16,5	18,5	16,3	18,3	16,0	17,6
Daily total global solar irradiation, kWh/(m^2·d)	14,2	15,8	14,0	15,4	13,1	14,7
Daily dry-bulb temperature swing, K	1,7	3,7	2,4	4,0	3,3	4,9
Daily mean wind speed, m/s	0,2	2,2	0,4	2,4	0,7	2,7

Table A.4 — Parameters for design day

Parameter	Risk level		
	1 %	2 %	5 %
Daily mean dry-bulb temperature, °C	26,5	25,4	24,2
Daily mean dewpoint temperature, °C	18,5	18,3	17,6
Daily total global solar irradiation, kWh/(m^2·d)	15,8	15,4	14,7
Daily dry-bulb temperature swing, K	1,7	2,4	3,3
Daily mean wind speed, m/s	0,2	0,4	0,7

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