Extract from:

Meteorological Data for Design of Building and Installation: A Reference Year

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STATENS BYGGEFORSKNINGSINSTITUT
~~SBI-RAPPORT 89 · KØBENHAVN 1974~~
I KOMMISSION HOS TEKNISK FORLAG

THERMAL INSULATION LABORATORY
Report no 66, 2. ed. September 1977.

SUMMARY

To meet the lack of correlated weather data to be used with design of buildings e.g. calculations of indoor climate a "Reference Year" has been selected.

The Reference Year is based on Danish meteorological observations through eleven years and is built up by typical months from the eleven years period. Each month contains all observations made at one location in accordance with international codes for meteorological observations and is supplemented with data for solar radiation.

The selection is based on the mean dry bulb temperature, daily maximum dry bulb temperature and the daily total of solar radiation.

The selection of each typical month is carried out using the following criteria:

A: Exclusion of months where the mean value of one or more of 20 observed parameters deviate more than the standard deviation of the same mean value for 30 years of observations.

B: Determining months having the best mean value for daily mean dry bulb temperature, daily maximum dry bulb temperature and daily sum of solar radiation.

C: Determining months having the most typical variations from day to day in the above mentioned three parameters.

For each day and parameter in a month the difference between the actual observation and the mean value for the eleven years observation period for the same day is found. The monthly mean value of these differences divided by the standard deviation of the eleven months differences gives one figure for each of the three parameters which classifies the month according to criterion B.

Doing the same procedure with the deviation for the differences, another figure for each parameter comes out, which classifies the month according to criterion C.

The highest of these six figures (two figures for each of three parameters) describing one month is used as classification number to put each January, February etc. in a row where the one having the lowest classification number is the best.

The data which amounts to approx. 80.000 covering 34 parameters, most of them given for each hour, are available on magnetic tape suited for EDP treatment.

Some of those data of greatest interest are also given in tables in the appendix 4 in the report.

The data are recommended as usable for Denmark as a whole except for Copenhagen City and areas app. 200 m from the coast-line.

INTRODUCTION

The reference year consists of outdoor climatic data for a whole year built up of typical whole months. Each month comprises for every hour throughout the month recorded outdoor climatic data observed at the same locality. The reference year thus provides simultaneous values of 34 weather parameters (fig. 1) and moreover illustrates the natural variation of the weather parameters throughout the year. In this it differs from the ordinarily available data and is thus useful for calculations in which more than one parameter or the variations of the parameters with time are of importance. The values of the reference year have been selected with a view on particular to calculations of heating and ventilating installations.

The reference year has been built up month by month from recorded weather parameters selected among observations made at the air base at Værløse and at Højbakkegård at Tåstrup throughout a period of eleven years (1959-1969). The manner in which the individual months of the reference year have been selected ensures that they are typical as regards monthly mean values and variations throughout the month of daily mean temperature, daily maximum temperature and daily total of solar radiation. In addition the selection is based on a comprehensive evaluation of a large number of weather parameters compared with the parameters of the 30-years normal period for Denmark. On the basis of these criteria the most suitable month of January, month of February, etc. were chosen.

The reference year resulting from this selection consists of recorded weather parameters for every hour of the following months:

January	1961	May	1967	September	1965
February	1964	June	1961	October	1962
March	1960	July	1963	November	1964
April	1960	August	1960	December	1961

Because of the way in which the reference year has been built up and its months selected it reflects the natural correlation between the weather parameters as well as their variation throughout the year. The reference year is therefore particularly suitable for calculations in connection, for instance, with snow-melting equipment, weather resistance of building materials, vapour diffusion through walls and roofs, and planning of outdoor areas.

Another important field of application is calculation of indoor temperatures according to the so-called heat-balance methods. For this purpose the outdoor climatic data of the reference year will ensure results which are more accurate and more widely applicable than those available hitherto. Clients, architects, and engineers are thus enabled really to judge the indoor climatic and economic consequences of different disigns of buildings and ventilating equipment.

The reference year or the total material of outdoor climatic data from which it has been selected may also be used as basis for the selection of simpler types of weather data suitable for special purposes, as for instance frequency analyses of heat and moisture contents of the atmosphere or weather data for the hottest or coldest periods throughout the year.

Copies of the weather data of the reference year on punched cards or magnetic tape are available on application to SBI (Danish Building Research Institute), P.O.Box 119, 2970 Hørsholm.

WEATHER OBSERVATIONS

Selection of months for the reference year is based on weather observations made at the air base at Værløse during the years 1959-1969, both years included, supplemented with observations of solar radiation made at Højbakkegård near Tåstrup, and numbers of hours of sunshine observed at the meteorological station at the Copenhagen port. The material has been placed at our disposal by the Meteorological Institute and the Veterinary and Agricultural University.

The Air Force Base at Værløse (20 km NW of Copenhagen) is a main synoptic weather station in Denmark where observations and recording of the individual weather parameters are made every hour according to international rules as mentioned in (1) and in Appendix 1: "Measurement of Weather Parameters". The weather parameters of the reference year are thus directly comparable with weather parameters observed at other synoptic stations in Denmark and abroad.

Since solar intensity and solar radiation are not observed at Værløse, we have used for these parameters data obtained at the experimental farm, Højbakkegård, near Tåstrup (20 km W of Copenhagen), which belongs to the Agricultural and Veterinary University. For the majority of the months selected for the reference year the only data available for total radiation derive from measurements made on a horizontal surface (global radiation). During the period 1966-1969 separate measurements of diffuse radiation have been made in addition to the measurements of global radiation. However, from this period only one month has been selected, and for the sake of uniformity we have for all months of the reference year considered the global radiation solely. For calculations concerned with indoor climates it is of importance, however, also to know the normal radiation, i.e. the direct solar radiation impinging on a surface at normal to the direction to the sun.

For this reason the hourly global radiation has been divided up. Based on cloud observations at Værløse, direct as well as diffuse radiation on a horizontal surface have been calculated, whereupon the hourly global radiation actually measured at Højbakkegård has been divided into diffuse radiation and normal radiation. In this connection both Værløse and Højbakkegård may be considered to be representative of the country as a whole with the exception of narrow areas along the coasts and central city areas, and the errors introduced by combining observations from two stations at a distance of 15 km are considered to be insignificant for the purpose.

In order to be able to describe the climate at points of observation in Denmark it is necessary to have observations from a thirty-year period. From Værløse useful observations were available from an eleven-year period only, and there are no other synoptic stations with longer periods of observation. Also for this reason a thorough comparison has been carried out between the individual months of the observation period and the corresponding months of the Danish normal period 1931 through 1960.

The reference year contains all the weather parameters recorded, fig. 1. The most important parameters are given by their numerical value, while the remaining are given in the same codes as in synoptic weather reports, (1). The units stated in connection with the reference year are the same as those used in synoptic weather reports. When values have been calculated by the working group, SI units have been used.

Errors might occur in all measurements, and the material has therefore been studied with a view to the detection of errors in the most important weather parameters. Appendix 3:"Errors and Missings in Weather Data" describes the technique applied and the corrections made.

Observation		Interval or observation time
Dry bulb temperature	°C	h
Dew point temperature	°C	h
Relative humidity	%	h
Entalphi, calc.	kJ/kg	h
Minimum temperature Maximum temperature	°C	7 and 19 CET
Snowcover and-thickness, State of ground surface		13 CET
Hours with clear sun	h	24 CET
Global radiation (on horizontal)	W/m^2	h
Diffuse radiation, calc.	W/m^2	h
Normal radiation, calc.	W/m^2	h
Precipitation	mm	1,7,13 and 19 CET
Cloud cover		h
Wind direction		h
Wind speed	knots	h
Visibility		h
Weather		h
Weather since last major observation		h
Cloud cover in low or medium altitude		3h
Cloud types, low altitude		3h
Altitude of lowest clouds		3h
Cloud types, medium altitude		3h
Cloud types, high altitude		3h
Cloud cover, lowest clouds ≥ 5/8 of sky		h
Cloud type herein		h
Altitude hereof or vertical visibility		h
Cloud cover, lowest clouds ≤ 4/8 of sky		h
Cloud type herein		h
Altitude		h
Barometrie pressure	mbar	3h
Character of change in pressure		3h
Weather symbols (not always present)		h
Month, day, hour		h

Fig. 1. Weather parameters in the "Reference Year". "h" indicates hourly presence, "3h" every third hour (the "synoptic" hours 1, 4, 7, 10 --- CET). CET means Central European Time ~ GMT + 1. All temperatures are given with 0.1°C, pressure with 0.1 mbar, precipitation 0.1 mm, and radiation with 1 W/m^2 and wind speed with 1 knot as least significant digit

SELECTION OF MONTHS

The months of the reference year were selected according to three criteria:

A Months with abnormal weather conditions were excluded. Comparison between about twenty different weather parameters of each of the months of the observation period and the corresponding normal values from the period 1931-1960.

B Selection of months with typical mean values of the most important weather parameters.
As regards daily mean temperature, daily maximum temperature, and daily total of solar radiation: a comparison between monthly mean values for every month of the observation period and the average values of the eleven corresponding months of the observation period.

C Selection of months with typical variations, i.e. with both hot and cold days.
As regards daily mean temperature, daily maximum temperature, and daily total of solar radiation: a comparison between deviations from the mean values shown by the data for each day of a month during the observation period and the mean deviations during the eleven corresponding months of the observation period.

Applying criteria B and C, the months of the eleven years are arranged according to suitability as far as the three most important weather parameters are concerned. The most suitable month is selected, if it is not to be rejected according to criterion A.

With a view to the object of the reference year - and the selection criteria - we have determined to build up the reference year of individual months. Shorter periods would result in too small deviations from mean values and too many abrupt changes in values on going from one period the the next.

Criterion A

To enable complete evaluation of the climatic conditions at a point of observation in Denmark it is necessary to make observations of the weather throughout a period of thirty years. For the purpose of excluding months with abnormal weather conditions a comprehensive meteorological evaluation has been made of every month of the period 1959-1969 by comparing with mean values from the whole of the country for the same month during the thirty-year normal period for Denmark, i.e. 1931-1960, both years included.

This evaluation has been made by an experienced meteorologist on the basis of monthly mean values of about twenty different weather parameters, see fig. 2.

Monthly mean temperature	x
Mean of daily maximum temperatures	x
Mean of daily minimum temperatures	x
Absolute value of monthly maximum temperature	
Absolute value of monthly minimum temperature	
Frequencies of wind velocities	x
Frequencies of wind directions	x
Monthly mean atmospheric pressure	x
Hours of sunshine	x
Number of days with precipitation	
Monthly amount of precipitation	x
Monthly mean humidity	x
Number of days with fog	
Number of cloudless days	
Number of overcast days	

Fig. 2. Weather parameters included in the comprehensive meteorological evaluation according to criterion A. In addition to the above parameters the number of days during winter with frost, ice, and snow and depth of snow fall have also been considered. With regard to the summer months it has been considered whether the number of days with maximum temperatures above 25°C and the number of days with thunder are normal. Weather parameters which are considered to be particularly important to the evaluation are marked with an x.

As basis for the comparisons between weather conditions of the individual months we have used monthly means at the air base at Værløse and monthly means and standard deviations of the means in Denmark during the normal period 1931-1960. A month is described as "not qualified" if the mean value of one of the parameters described as particularly important differs by more than the standard deviation from the mean value of the same parameter and month during the normal period. Correspondingly, a month is described as "not qualified" if several of the other weather parameters differ by more than the standard deviation from the mean of the normal period. As regards certain weather parameters the difference has been further narrowed when the standard deviations of the monthly means are large on account of abnormal distribution of weather conditions during the normal period. This applies in particular to the winter months in the case of which the difference as regards outdoor temperatures has been halved. The results of the evaluation are given in fig. 3 in which limiting cases are in addition marked by brackets.

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1959	(k)	i	i	i	i	i	i	i	i	(k)	(k)	i
1960	(k)	(i)	(k)	(k)	i	(k)	i	(i)	i	i	(k)	i
1961	(k)	i	i	i	(k)	(k)	i	(i)	i	i	i	(i)
1962	i	i	i	k	i	i	i	i	i	(k)	(i)	i
1963	i	i	i	i	i	(k)	(k)	i	(k)	(k)	i	i
1964	i	(k)	i	(k)	i	i	i	(i)	(k)	i	k	(k)
1965	i	k	k	i	i	(k)	i	i	(k)	i	i	i
1966	i	i	(i)	i	k	i	(k)	i	i	i	(i)	i
1967	(k)	i	i	(k)	(k)	i	(k)	(i)	(i)	i	(k)	(i)
1968	(i)	k	i	i	i	i	i	i	i	i	i	i
1969	i	i	i	(k)	(i)	(k)	(i)	i	i	i	i	i

Fig.3. Comprehensive meteorological evaluation of the suitability of the months as reference months according to comparison, based on a great number of weather parameters, with the months of the normal period 1931-1960. None of the months of August occurring during the period 1959-1969 ware typical judged according to criterion A. The months of the eleven years are classified according to criterion A using the following scale: k: qualified, (k): qualified, but not completely in agreement with the weather during the normal period, (i): not qualified, but may be used in the absence of better qualified months, i: not qualified.

Criteria B and C

As regards the most important weather parameters the reference year must reflect the typical annual variations, but at the same time it must show typical deviations from the annual variation. This is of particular importance in connection with heat-balance calculations. For the purpose of finding the months which in the best possible way fulfil these requirements the daily mean temperatures, daily maximum temperatures and daily solar radiation have been treated statistically. Other weather parameters might have been included, for instance absolute humidity and cloudiness, but it was considered that the correlation to these parameters was positive.

The deviation of a month from the typical annual variation (criterion B) was found for each parameter by calculating for each day of the month the deviation from the average value of the means of the day in question during the eleven year period, and then to obtain the monthly mean values from these deviations.

To enable comparisons to be made between the deviations found for the three parameters the ratio of the average deviation of the month to the standard deviation of the average deviations of the eleven months was set up.

In addition the standard deviation was found for the deviations from the typical annual variations calculated for each month. The deviation of this standard deviation from the standard deviation for the same month of the eleven years is a measure of the typical variations from the mean value, i.e. the smaller the deviation the more typical the variations (criterion C).

In order to enable comparisons also between these values with regard to the three parameters, and also with criterion B, division by the standard deviation of the standard deviations was also carried out in this case.

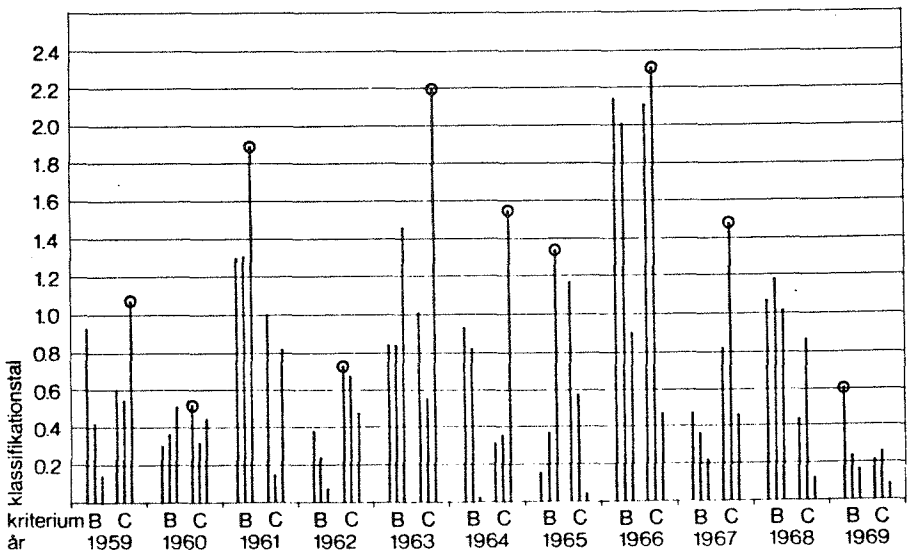

Fig. 4. Graphical representation of the figures used for the selection of the month of April for the reference year according to criteria B and C. For each of the months of April of the eleven years and for each criterion the height of the lines represents the characteristic figures of the three parameters, the characteristic figures being a measure of their deviations from the typical course. The order in which the parameters is given is daily mean temperature, daily maximum temperature, and total of solar radiation. 0 denotes the decisive classification figure of the months which are to be compared. The year with the lowest decisive classification figure is preferred. In the case of April it is thus 1960.

Classification According to Criteria B and C

In this way we have for each month of the eleven years two figures for each parameter, altogether 2 x 3 figures, which characterize the month. Of these six figures the greatest is used for classification of the month. The most suitable month is the month which has the smallest classification figure, i.e. the month which differs least from the typical course.

Fig. 4 shows for each of the eleven years the six figures for the month of April which represent the deviation from the typical course, refer criteria B and C. It appears for instance from fig. 4 that the classification figure for April 1960 is 0.56, the smallest of all during these years, for April 1969 it is 0.65, and for April 1962 it is 0.99.

Consequently the most suitable month is April of 1960, the second best April of 1969 and the third best April of 1962.

The mathematical description of the selection according to criteria B and C will appear from Appendix 2.

Fig. 5 gives the classification figures for the three best years which are used for the selection of the months of the reference year.

Month	1.selection		2.selection		3.selection	
	year	class.	year	class.	year	class.
Jan.	61	0.56	59	0.92	67	1.19
Feb.	(69	0.92)	64	0.99	(62	1.11)
Mar.	(62	1.13)	60	1.21	(64	1.22)
Apr.	60	0.56	69	0.65	62	0.99
May	67	0.69	61	0.77	(60	1.08)
June	61	1.00	(64	1.16)	(66	1.26)
July	(60	0.63)	63	0.97	(61	1.10)
Aug.	60	0.50	61	1.06	(68	1.20)
Sept.	65	1.00	66	1.13)	(60	1.21)
Oct.	62	1.00	(69	1.09)	63	1.12
Nov.	64	0.75	60	0.83	66	0.90
Dec.	61	0.75	(63	0.91)	(68	1.18)

Fig. 5. The three best months and their classification figures according to criteria B and C. Brackets denote that the months in question must be excluded according to criterion A. The months selected for the reference year are underlined.

REFERENCE YEAR

The Reference Year chosen holds a number of weather data so large that in full it is too unmanageable for manual calculations, and so the total number of data does only exist on punched cards and magnetic tapes. However, a selection of the most important weather data are stated in tabular form in the appendix 4: Selected weather data from the Reference Year.

At the selection of the individual months for the Reference Year it has been tried to find months typical for the most important weather parameters, as regards both monthly mean values and variations throughout the month, and in addition to this, not atypical for a considerable number of other weather parameters. Fig. 4 and 5 show, however, that it is not possible to have the three selection criteria fulfilled to perfection. This is due to the fact that the observation period of eleven years is not quite sufficient as a basis for the selection - for which normally a period of 3o years would be used. Still, the Reference Year is the most suitable one, which can be built up now and within the next few years.

The meteorological observations forming the basis of the Reference Year have been made at Værløse, and of the solar radiation, at Tåstrup. These locations are representative of the surroundings of Copenhagen, whereas there will be smaller differences from the weather conditions at other locations. These differences will be examined by members of the working group.

For rough calculations and for use at particularly complicated EDP calculations it will be advantageous with more simple weather data for special purposes, corresponding to the ones already known, as for instance the warmest and the coldest days of the year, or frequencies of certain weather conditions. Results of calculation achieved on this basis will be comparable with equivalent results achieved by means of the weather data of the Reference Year. A selection of more simple weather data is being considered by the working group.

FIELDS OF APPLICATION

Design of buildings and of ventilating equipment for buildings demands heat balance calculations to find the type which is most favourable as regards quality of indoor climate and initial and working costs. The weather data of the reference year are particularly useful for heat balance calculations, and members of the working group are preparing the necessary computer programs.

Also in connection with many other technical problems in heating and ventilating engineering the weather data of the reference year will provide improved basis for evaluations. As examples we may mention the dimensioning of snow melting equipment, control of and working costs of ventilating systems, planning of outdoor areas in which thermal comfort must be provided, choice of the type of energy and control devices to be used in heating systems, and moisture diffusion through walls and roofs.

On the other hand the data of the reference year are not suitable for the solution of problems in which infrequent extremes are decisive, as for instance in judging the risk of storm damage. For this purpose it is necessary to use statistical information based on observations throughout long periods, possibly the eleven-year period, or better, the thirty-year normal period.

The reference year will also be useful for the solution of problems outside the field of heating and ventilating. This applies for instance to weather resistance of building materials, storage of materials and possibly planning of building activities.

The members of the working group will be glad to receive communications from persons or organisations who intend to utilize the reference year or corresponding weather data within fields other than those mentioned.

APPENDIX 2

Description of Mathematical Selection Criteria

We have for every day of eleven years observations of three meteorological characteristics which at the day t are denoted x_{1t}, x_{2t} and x_{3t} or x_{it}. The observations may be assumed to be results of a stochastic process which is periodic, the length of the period being one year. It is necessary therefore first and foremost to eleminate seasonal variations from x_{it} so as to arrive at a residual element which may reasonably be assumed to be the result of a stationary process. This should actually be done by considering the deviations of the observations from the true mean. Since this value is not known, we use instead as an estimated value the average throughout the eleven years at the time t, $x_{(11)t}$.*) This means that instead of the observations of the individual characteristics x_{it} we may consider the difference

$$y_{it} = x_{it} - \bar{x}_{(11)t}$$

Since the distribution of y_{it} is not known, it is assumed to be a normal distribution. This assumption together with the fact that possible correlation between the individual characteristics as well as possible autoregression in the process have been neglected is a considerable simplification of the actual conditions. But since the object is solely to select typical months and neither to judge estimated values nor to test hypotheses, this simplification is considered to be permissible.

If the individual year is denoted j and the individual month k, the meaning of t will be the individual day of a month, and for the month k of the year j it is then possible to calculate mean and standard deviation of the residual term y_{ijkt}.

*) Using of "smoothed" mean value would have been more correct.

$$\bar{y}_{ijk} = \frac{\sum_{t=1}^{n} y_{ijkt}}{n}$$

$$s_{ijk} = \sqrt{\frac{\sum_{t=1}^{n} (y_{ijkt} - \bar{y}_{ijk})^2}{n-1}}$$

If the value of n is large, both $\bar{y}_{ijk}$ and s_{ijk} may be considered to have a normal distribution, and the average value for eleven years of both mean and standard deviation (for the month k) is found from:

$$\bar{y}_{i\cdot k} = \frac{1}{11} \sum_{j=1}^{11} \bar{y}_{ijk}$$

In this case the quantity $\bar{y}_{i\cdot k}$ will equal nil, but it is retained in the following expression for the sake of the systematics:

$$\bar{s}_{i\cdot k} = \frac{1}{11} \sum_{j=1}^{11} \bar{s}_{ijk}$$

$$s_{(\bar{y}ijk)} = \sqrt{\frac{\sum_{j=1}^{11} (\bar{y}_{ijk} - \bar{y}_{i\cdot k})^2}{10}}$$

$$s_{(\bar{s}ijk)} = \sqrt{\frac{\sum_{j=1}^{11} (\bar{s}_{ijk} - \bar{s}_{i\cdot k})^2}{10}}$$

For every month k there are 33 values of the monthly mean M_{ijk} since there are three characteristics and 11 years. These 33 values are now standardized so as to make them comparable and we have:

$$fm_{ijk} = \left| \frac{\bar{y}_{ijk} - \bar{y}_{i\cdot k}}{s_{(\bar{y}ijk)}} \right|$$

The smaller fm_{ijk} the smaller the deviation of $\bar{y}_{ijk}$ from the total mean. The standard deviation values, s_{ijk}, may be standardized in the same way. We have then:

$$fs_{ijk} = \left| \frac{\bar{s}_{ijk} - \bar{s}_{i\cdot k}}{\bar{s}_{(\bar{s}ijk)}} \right|$$

For a specified month and a specified year we now have six standardized values which show how much the mean and the standard deviation deviates from the average value of the eleven means and eleven standard deviations of the three characteristics. The smaller the deviation, the more suitable the month will be as month of a reference year.

Criteria B and C indicate that for a certain month k, the year j to be selected is one for which the values of fm_{ijk} and fs_{ijk} are small.

The selection method is now as follows: For specified values of k and j the largest of the six values of fm and fs is selected. This value is denoted $f_{ijk}(max)$. If we select maximum values out of all the values for j for a given k, we obtain eleven maximum values which may be arranged according to increasing magnitude:

$$f_{i(1)k}(max),\ f_{i(2)k}(max)\ \text{----------},\ f_{i(11)k}(max)$$

The brackets around the figures of the subscript indicate that the expressions are arranged according to magnitude. The year which should be selected to supply the month k is the one which is represented by $F_{i(1)k}(max)$, because this is the year in which maximum standardized deviation of mean or standard deviation is smaller than maximum deviation in the case of any other of the years in question. The next best year is the one represented by the next term in the series, etc. etc. Fig. 5 of the report indicates the three most suitable years for each month.

APPENDIX 4

Tables Giving Weather Data of the Reference Year

Monthly mean values of 21 weather parameters from the reference year, from the period 1959-1969 and from the normal period 1931-1960 .....

Daily values of air temperature, maximum temperature, total radiation, and dew point temperature during the months of the reference year and corresponding mean values from the period 1959-1969 .....

Calculated probable total radiation on clear days ..

Frequency of the conditions of the air within specified temperature and humidity intervals represented in h-x diagrams. Given as number of hours during the entire reference year, during each month and during the four quarters of the year .....

Cumulated values of air temperature, relative humidity, enthalpy, and absolute humidity. Given in hours during the entire reference year, during individual months and during the quarters of the year ..

		PERIODE	JAN	FEB	MAR	APR	MAJ	JUN	JUL	AUG	SEP	OKT	NOV	DEC	I ALT GEN. ELL. SUM
UDELUFTTEMPERATUR.	°C	REFERENCEAR 1959-69	0.2	-0.4	2.0	5.7	11.4	16.0	16.4	16.1	13.7	9.2	5.0	-0.4	G 8.0
		1931-60	-1.0	-0.7	1.9	6.1	10.8	15.2	15.8	15.8	13.3	9.3	4.6	0.1	G 7.6
			-0.1	-0.4	1.7	6.2	11.1	14.5	16.6	16.3	13.1	8.7	4.9	2.2	G 7.9
DØGNMAKSIMUMTEMP..	°C	REFERENCEAR 1959-69	1.9	2.1	5.5	9.8	16.2	20.9	21.2	20.2	17.7	12.6	7.3	1.5	
		1931-60	1.3	1.7	5.1	10.4	15.2	20.1	20.2	20.3	17.4	12.5	6.8	2.1	
			2.0	2.2	5.0	10.2	15.7	19.0	21.1	20.6	17.2	12.0	7.2	4.1	
ABSOLUT MAKSIMUMTEMP..	°C	REFERENCEAR 1959-69	6.7	7.5	12.0	18.8	23.4	28.0	28.1	27.8	21.9	19.2	10.6	11.4	28.1
HØJESTE ENKELTVÆRDI I		1931-60	6.7	14.4	20.0	23.6	25.5	29.3	29.1	30.9	26.1	21.0	16.7	11.4	30.9
PERIODEN			11.8	15.5	21.2	28.2	32.8	35.5	35.3	35.8	32.3	24.6	18.5	14.5	35.8
DØGNMINIMUMTEMP..	°C	REFERENCEAR 1959-69	-1.8	-3.4	-0.9	1.9	7.1	11.5	11.9	12.0	10.5	5.5	2.4	-3.1	
		1931-60	-3.5	-3.5	-1.2	2.3	6.5	10.4	11.8	11.6	9.2	5.9	2.2	-2.3	
			-2.4	-3.0	-1.3	2.4	6.3	9.7	12.2	12.2	9.7	5.9	2.6	0.1	
ABSOLUT MINIMUMTEMP..	°C	REFERENCEAR 1959-69	-5.8	-14.5	-5.4	-3.0	0.1	7.4	7.4	6.9	6.4	-2.7	-4.5	-16.0	-16.0
LAVESTE ENKELTVÆRDI I		1931-60	-22.2	-22.7	-12.0	-8.7	-2.7	0.8	4.8	5.1	-0.6	-4.3	-10.6	-22.3	-22.7
PERIODEN			-31.0	-29.0	-27.0	-19.0	-8.0	-3.5	-0.9	-2.0	-5.6	-11.9	-21.2	-24.4	-31.0
DUGPUNKTTEMPERATUR.	°C	REFERENCEAR 1959-69	-1.4	-2.6	-0.2	2.0	7.2	11.7	11.5	13.2	11.1	7.0	3.6	-2.0	
		1931-60 *)	-2.0	-2.1	-0.2	2.9	6.7	10.7	12.4	12.5	10.5	7.6	3.4	-0.7	
ABSOLUT FUGTINDHOLD.	G/KG	REFERENCEAR 1959-69	3.5	3.2	3.8	4.5	6.5	8.7	8.6	9.6	8.3	6.4	5.0	3.4	G 6.0
		1931-60 *)	3.4	3.3	3.8	4.8	6.3	8.2	9.1	9.2	8.1	6.7	5.0	3.7	G 6.0
RELATIV LUFTFUGTIGHED.	%	REFERENCEAR 1959-69	89	85	86	78	78	77	74	84	85	87	91	89	G 84
		1931-60	93	90	86	82	78	76	81	82	85	90	92	94	G 86
			89	87	85	78	72	73	76	79	83	86	89	91	G 82
ENTALPI.	KJ/KG	REFERENCEAR 1959-69	8.9	7.6	11.4	16.9	27.8	38.2	38.3	40.5	34.8	25.3	17.6	8.1	G 23.0
		1931-60 *)	7.6	7.7	11.5	18.3	26.6	35.9	39.0	39.1	33.8	26.1	17.2	9.4	G 22.8
GLOBALSTRALING.	WH/M²DAG	REFERENCEAR 1959-69	616	1305	2682	4076	4794	5667	5192	3952	2773	1415	639	475	G 2900
DØGNSUM		1931-60 *)	548	1176	2328	3789	4906	5999	4963	4146	3036	1467	566	368	G 2756
DIFFUS STRALING.	WH/M²DAG	REFERENCEAR 1966-69	268	563	996	1621	2126	2593	2562	2123	1476	780	386	248	G 1316
FINDES KUN FOR REF.AR OG		1931-60 *)	257	594	1053	1639	2194	2524	2463	1800	1303	706	309	191	G 1253
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*) The values do not exist.

Monthly mean values from the reference year, from the period 1959-1969 from which the months of the reference year have been selected, and mean values for the entire of Denmark from the normal period 1931-1960.

	PERIODE	JAN	FEB	MAR	APR	MAJ	JUN	JUL	AUG	SEP	OKT	NOV	DEC		IALT GEN. SUM
SOLSKINSTIMER, H/DAG	REFERENCEAR	2.3	2.4	4.8	6.6	6.0	7.3	7.3	5.0	4.8	2.8	1.0	1.5	G	4.3
MALT VED TULDBODEN, KBH.	1959-69	1.2	2.0	3.6	5.4	6.9	8.5	6.6	6.5	5.4	3.0	1.2	0.8	G	4.3
30-ARS PER.: HELE LANDET	1931-60	1.3	2.3	4.1	6.0	8.3	8.6	8.0	7.1	5.5	3.2	1.4	0.9	G	4.7
SKYDÆKKE, %	REFERENCEAR	63	61	55	53	59	60	61	64	53	66	70	65	G	61
GENNEMSNIT KL 8. 14 OG 21	1959-69	76	74	63	62	59	54	62	58	54	66	75	76	G	65
	1931-60	74	72	62	58	53	55	58	57	56	67	77	78	G	64
VINDHASTIGHED, M/S	REFERENCEAR	5.1	5.8	5.9	6.7	6.0	5.0	3.3	4.4	5.2	3.5	5.0	5.1	G	5.1
GENNEMSNIT KL 8. 14 OG 21	1959-69	5.4	5.6	6.1	5.6	5.1	4.8	4.5	4.6	5.0	5.0	5.6	4.9	G	5.2
	1931-60 **)	4.5	4.5	4.2	4.2	3.9	3.8	3.7	3.6	3.7	4.0	4.1	4.2	G	4.0
BLÆSTDØGN, ANTAL DØGN MED	REFERENCEAR	2.0	4.0	7.0	7.0	4.0	2.0	0.0	0.0	1.0	0.0	3.0	0.0	S	30.0
6 BEAUFORT ELL. DEROVER =	1959-69	2.7	3.5	5.1	3.5	1.9	1.7	0.7	0.6	2.5	2.1	2.7	3.2	S	30.6
10.7M/S KL 8. 14 ELLER 21	1931-60	5.0	3.9	4.6	4.0	3.0	2.6	2.2	2.5	2.8	3.4	4.2	4.4	S	43.0
LUFTTRYK, MB	REFERENCEAR	1015	1015	1021	1017	1013	1013	1017	1009	1010	1019	1012	1001	G	1014
	1959-69	1013	1015	1014	1013	1015	1015	1013	1012	1014	1014	1011	1009	G	1013
	1931-60	1013	1014	1016	1014	1016	1014	1013	1013	1015	1014	1014	1012	G	1014
NEDBØR, MM/MANED	REFERENCEAR	23	19	19	27	42	38	79	91	59	19	35	40	S	491
	1959-69	34	26	21	36	37	40	70	70	48	44	49	44	S	520
	1931-60	55	39	34	39	38	48	74	81	72	70	60	55	S	644
NEDBØR, ANTAL DØGN PR.	REFERENCEAR	10	8	4	10	9	18	13	14	11	11	14	22	S	144
MANED MED MINDST 0.1MM	1959-69	14	12	11	13	13	11	13	14	10	12	16	15	S	155
	1931-60	15	13	10	12	10	11	13	14	14	15	16	16	S	159
FROSTDØGN, ANTAL DØGN MED	REFERENCEAR	19.0	24.0	21.0	5.0	0.0	0.0	0.0	0.0	0.0	2.0	6.0	19.0	S	96.0
MINIMUMTEMPERATUR < 0 °C	1959-69	21.6	20.6	17.9	6.2	0.1	0.0	0.0	0.0	0.5	1.7	7.1	19.1	S	94.8
FRA KL 7 TIL KL 7	1931-60	21.0	19.0	19.0	6.0	1.0	0.0	0.0	0.0	0.1	2.0	6.1	14.0	S	88.0
ISDØGN, ANTAL DØGN MED	REFERENCEAR	4.0	6.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.0	S	20.0
MAKSIMUMTEMPERATUR <= 0 °C	1959-69	10.0	9.3	2.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.7	7.4	S	30.1
FRA KL 7 TIL KL 7	1931-60	8.9	8.5	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	2.8	S	23.0
SOMMERDAGE, ANTAL DØGN	REFERENCEAR	0.0	0.0	0.0	0.0	0.0	5.0	4.0	3.0	0.0	0.0	0.0	0.0	S	12.0
MED MAKSIMUMTEMPERATUR	1959-69	0.0	0.0	0.0	0.0	0.1	2.7	2.7	2.5	0.4	0.0	0.0	0.0	S	8.5
OVER 25 °C	1931-60	0.0	0.0	0.0	0.0	0.6	2.1	3.8	3.4	0.3	0.0	0.0	0.0	S	10.0

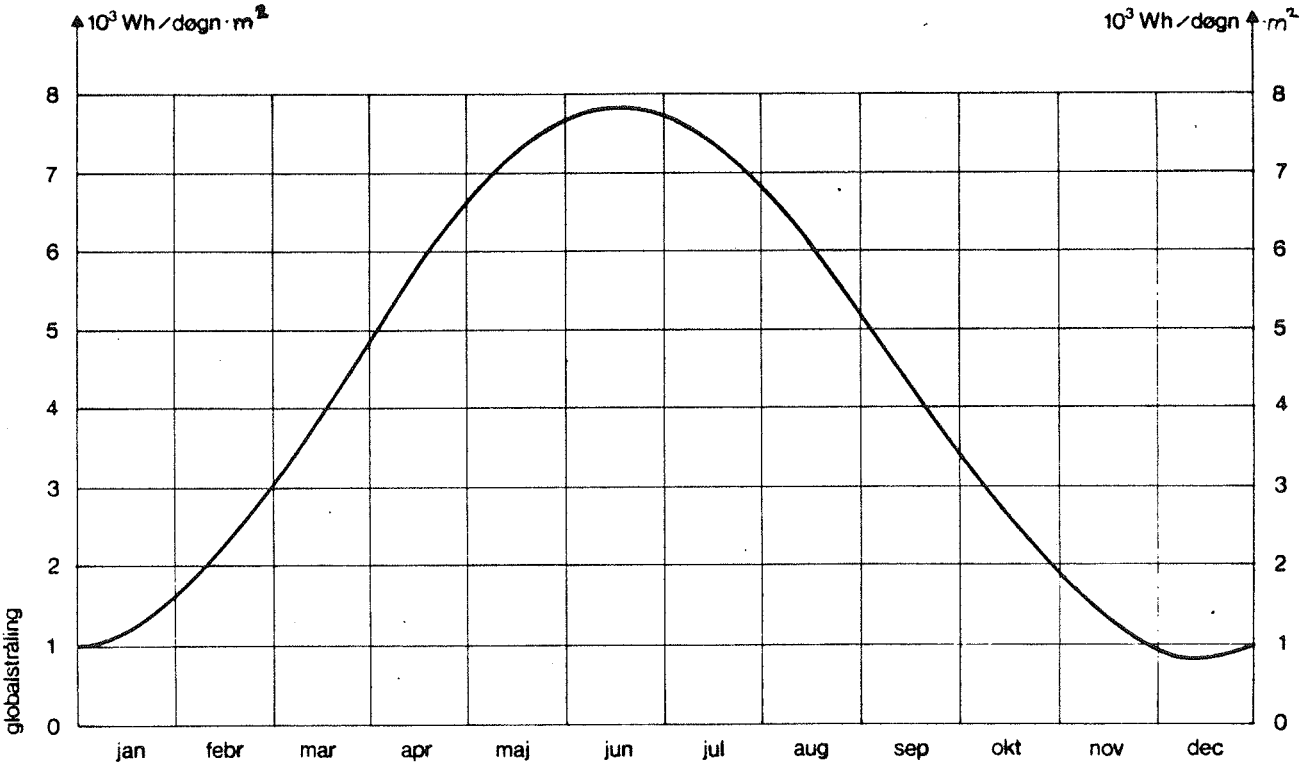
**) LANDSGENNEMSNIT FOR LANDSTATIONER

Monthly mean values from the reference year, from the period 1959-1969 from which the months of the reference year have been selected, and mean values for the entire of Denmark from the normal period 1931-1960.

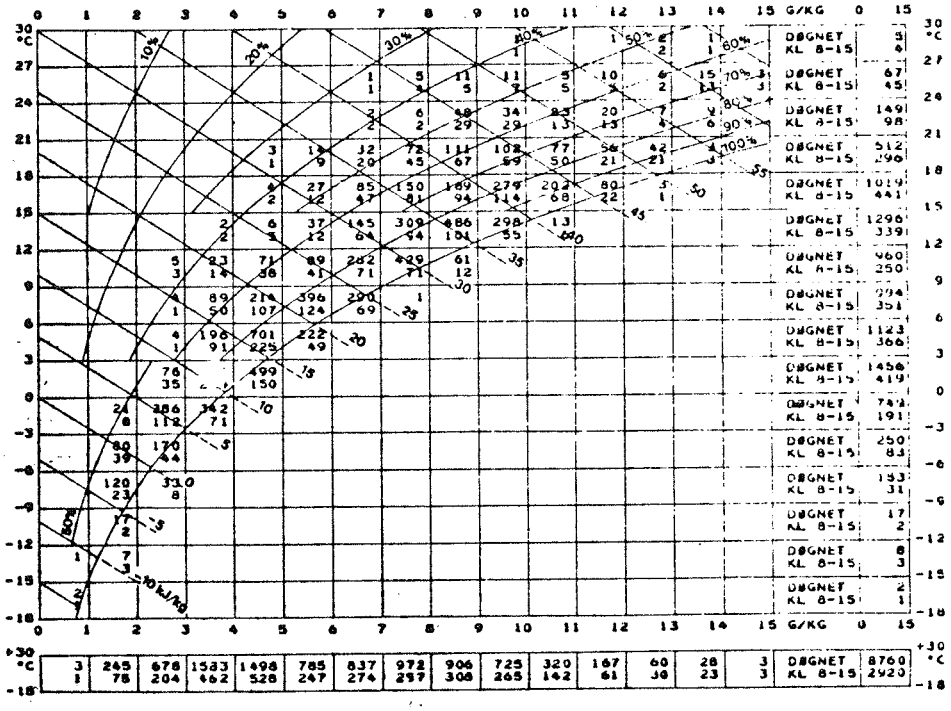
JAN /	UDELUFTTEMPERATUR °C			/ MAKSIMUMTEMPERATUR °C			/ GLOBALSTRALING WH/M² DAG			/ DUGPUNKTTEMPERATUR °C		
DAG /	Cronolo-gical	Ranked	Mean ranked	Cronolo-gical	Ranked	Mean ranked	Cronolo-gical	Ranked	Mean ranked	Cronolo-gical	Ranked	Mean ranked
1	1.2	-6.5	-9.2	1.8	-3.0	-4.9	74	45	92	0.5	-8.8	-10.5
2	2.3	-5.6	-7.4	3.0	-2.3	-3.5	240	74	124	1.4	-8.7	-8.9
3	2.4	-5.1	-6.1	5.0	-2.0	-2.7	45	103	142	1.4	-7.5	-7.8
4	2.4	-3.7	-5.1	3.3	-1.0	-2.2	343	111	157	1.5	-6.1	-6.7
5	1.3	-1.7	-4.5	3.2	0.0	-1.6	149	149	183	1.0	-5.3	-6.2
6	1.5	-1.6	-3.7	2.8	0.2	-1.1	353	167	201	0.6	-4.9	-5.2
7	1.3	-1.5	-3.3	1.9	0.3	-0.8	176	176	241	0.5	-4.5	-4.6
8	0.3	-1.3	-3.1	1.2	0.4	-0.7	305	213	261	-0.6	-3.4	-4.1
9	2.5	-1.2	-2.8	3.3	0.5	-0.3	167	240	281	1.5	-3.2	-3.8
10	1.6	-1.1	-2.6	3.2	0.8	-0.1	111	249	298	0.7	-3.1	-3.6
11	-0.6	-0.6	-2.1	1.0	1.0	0.2	213	305	317	-3.2	-2.9	-3.2
12	-1.6	-0.6	-1.7	0.3	1.0	0.5	1336	325	339	-3.1	-2.6	-2.9
13	2.2	0.0	-1.4	3.6	1.2	0.7	103	343	369	1.9	-2.0	-2.6
14	1.5	0.2	-1.0	3.6	1.3	0.9	993	353	392	1.0	-0.6	-2.0
15	2.3	0.3	-0.6	3.5	1.8	1.1	419	371	411	1.8	-0.6	-1.7
16	0.8	0.8	-0.3	3.5	1.8	1.4	1039	419	451	-0.6	-0.4	-1.1
17	0.2	1.2	-0.1	1.3	1.9	1.7	566	566	490	-2.0	0.5	-0.9
18	-1.7	1.3	0.1	0.0	2.8	1.8	1179	669	526	-5.3	0.5	-0.6
19	-1.5	1.3	0.5	0.5	3.0	2.0	1133	686	564	-4.9	0.6	-0.4
20	-1.1	1.5	0.6	1.0	3.2	2.3	954	734	586	-4.5	0.7	-0.2
21	-0.6	1.5	0.7	1.8	3.2	2.5	937	937	628	-2.9	1.0	-0.0
22	-1.3	1.6	0.8	0.2	3.3	2.8	669	954	650	-2.6	1.0	0.1
23	-1.2	2.2	1.1	0.4	3.3	3.0	371	993	681	-3.4	1.4	0.4
24	-3.7	2.3	1.5	-1.0	3.5	3.4	1077	1039	732	-6.1	1.4	0.6
25	-5.6	2.3	1.7	-3.0	3.5	3.6	1255	1077	800	-8.7	1.5	0.9
26	-6.5	2.4	1.9	-2.3	3.6	3.8	1540	1133	663	-8.8	1.5	1.0
27	-5.1	2.4	2.2	-2.0	3.6	4.2	1347	1179	969	-7.5	1.8	1.5
28	0.0	2.5	2.6	0.8	4.3	4.5	249	1255	1110	-0.4	1.9	1.9
29	3.2	3.2	3.2	5.0	5.0	5.1	325	1336	1224	2.4	2.2	2.3
30	5.2	3.3	3.5	6.7	5.0	5.5	734	1347	1367	3.6	2.4	2.8
31	3.3	5.2	4.3	4.3	6.7	6.6	686	1540	1534	2.2	3.6	3.6
Mean	0.2	0.2	-1.0	1.9	1.9	1.3	616	616	548	-1.4	-1.4	-2.0
Std.dev. for 11 years			2.2			1.7			153			2.4
Mean for 30 years			-0.1			2.0			MGL			MGL
Std.dev. for 30 years			2.4			2.4			MGL			MGL

Cronological
Ranked: Ranked in ascending order
Mean ranked: Mean of ranked values for 11 months during 1959-1969
Std.dev.: Standard deviation of monthly mean values

January: Daily values of mean temperature, maximum temperature, global radiation and dew point temperature. Mean values and standard deviations.



Calculated, probable global radiation on clear days. The diagram may be used for the evaluation of global radiation on the individual days of the reference year in relation to the probable global radiation occurring on clear days. Days with greater global radiation than the calculated value may occur (as regards the calculation see (6) in the bibliography of the present report).



Reference Year: Number of hours during which the condition of the air is within specified temperature and humidity intervals plotted in a h-x diagram. The table gives number of hours during the 24 hours and during the period 8 a.m. to 3 p.m. (i.e. until 4 p.m.). Similar tables are given for each month.

REFERENCEÅRET	GEN	MAX	MIN	*																
TEMPERATUR, °C				*	-18	-15	-12	-9	-6	-3	0	3	6	9	12	15	18	21	24	27
DØGNET	8.0	27.4	-15.9	*	8760	8757	8750	8730	8570	8304	7513	6031	4940	3956	2996	1692	695	215	65	4
KL 8-15, INCL	9.4	27.4	-15.9	*	2920	2919	2916	2913	2882	2795	2587	2155	1804	1458	1210	867	421	142	46	3
KL 16-23, INCL	8.3	27.1	-10.6	*	2920	2920	2920	2913	2844	2781	2535	2063	1659	1345	1076	637	255	73	19	1
REL. FUGT., %				*	0	10	20	30	40	50	60	70	80	90	100					
DØGNET	83.7	100.0	30.0	*	8760	8760	8760	8758	8732	8553	8099	7273	5910	3466	0					
KL 8-15, INCL	79.1	100.0	31.0	*	2920	2920	2920	2920	2903	2805	2547	2090	1521	836	0					
KL 16-23, INCL	81.7	100.0	30.0	*	2920	2920	2920	2918	2911	2831	2644	2329	1785	952	0					
ENTHALPI, KJ/KG				*	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	55	60
DØGNET	23.0	64.5	-13.9	*	8760	8754	8721	8508	8060	7079	5652	4626	3687	3129	2061	1055	402	113	41	11
KL 8-15, INCL	25.0	64.5	-13.9	*	2920	2917	2912	2855	2726	2456	2011	1649	1385	1203	881	526	217	74	31	11
KL 16-23, INCL	23.3	58.9	-7.5	*	2920	2920	2911	2830	2699	2393	1917	1542	1315	1070	738	354	128	36	10	0
ABS. FUGT., G/KG				*	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
DØGNET	6.0	14.7	0.8	*	8760	8757	8512	7834	6301	4803	4018	3181	2209	1303	578	258	91	31	3	0
KL 8-15, INCL	6.2	14.7	0.8	*	2920	2919	2844	2640	2178	1650	1403	1129	832	524	259	117	56	26	3	0
KL 16-23, INCL	5.9	13.5	1.1	*	2920	2920	2823	2631	2115	1616	1306	1042	729	423	184	82	27	5	0	0

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Reference year: Number of hours during which the condition of the air shows higher values than the values of temperature, relative humidity, enthalpy, and absolute humidity given. The number of hours are given a) for 24 hours, b) for the period 8 a.m. through 3 p.m., and c) for the period 4 p.m. through 11 p.m. Similar tables are given for each month.

App. 3 to
Meteorological Data for Design of Building and Installation: A Reference Year. Danish Building Research Institute, report 89. Translation by: Thermal Insulation Laboratory.

APPENDIX 3. ERRORS AND MISSINGS IN WEATHER DATA

At the preparation of the Reference Year, that part of the data material being of special interest for HVAC calculations were critically examined, i.e. the data material concerning temperature of outdoor air, humidity, radiation, and wind.

Subsequently additions and corrections were made according to principles as described below. As a principal rule, added or corrected data are marked, so that it appears that they are not authentic, measured values.

In the original material a number of data are missing, either because all measurements at certain hours are missing, or because for certain hours some of the measurements are missing. Moreover it has been necess y to reject some values of measurement for being beyond reasonable limits. Finally, in some cases during the calculation of diverted values (humidity, diffuse radiation, normal radiation) discrepancies between the different data of measurement appeared. In order to avoid such discrepancies, it has been necessary to make a selection of the contradictory data, as well as an adjustment of some of them.

Measuring at night

In the years before 1963, at Værløse no measurements were taken at 11 p.m., 12 p.m., 2 a.m., nor at 3 a.m. Central European Time. Consequently, for those months of the Reference Year dating from these years all data for these hours are "synthetic", i.e. calculated on the basis of data from before and after the missing hours. This applies to the months of January, March, April, June, August, October, and December in the Reference Year. For the remaining months of the Reference Year there are observations of cloud cover as well as measurements of direction and velocity of the wind, made at the hours in

question, whereas the temperatures are still "synthetic".

The temperatures at 11 p.m. and 12 p.m. were found by linear interpolation between 10 p.m. and 1 a.m. The temperatures at 2 a.m. and 3 a.m. for the months September - April were also found by linear interpolation between 1 a.m. and 4 a.m. This can be accepted, because the nightly minimum of the temperature of the air during these months mainly falls after 5 a.m. As regards the months May - August, however, a linear interpolation could cause a systematic error. This is why the temperature at 2 a.m. has been defined as the mean value of the value interpolated between 1 a.m. and 4 a.m., and the value found by extrapolation of the temperatures at 10 p.m. and 1 a.m. Analogously the temperature at 3 a.m. has been defined as the mean value of the value interpolated between 1 a.m. and 4 a.m., and the value found by extrapolation of the temperatures at 5 a.m. and 4 a.m. In case the temperature has decreased from 4 a.m. to 5 a.m., still for the months May - August, too, the temperatures at 2 a.m. and 3 a.m. have been defined by linear interpolation only.

Temperature of outdoor air

Gaps in the sequence of outdoor air temperatures due to rejection or missing records, others than the ones at night already mentioned, were filled in by means of linear interpolation. Most of these gaps are of only one or two hours. There are found 7 gaps of three hours and upwards, out of which the largest one of 9 hours, and all 7 in connection with missing temperatures at 10 p.m., 1 a.m., or 4 a.m.

Criteria for acceptance: Increases of temperature $\leq$ 3°C/h
Decreases of temperature $\leq$ 4°C/h.

There are found three sudden increases of temperature, exceeding 3,0°C/h, immediately succeeded by a similar fall of temperature. All three are considered errors of measurement and have been altered into mean values of the temperatures preceding and succeeding the increases.

There are found three sudden falls of temperature exceeding 4°C/h. Evidently they are due to showers, and are considered correct.

Maximum and minimum temperatures

For the months of January, March, April, June, August, and December, in the original material maximum temperatures are only stated at 7 p.m. for the previous 24 hours, and analogously minimum temperatures only at 7 a.m.

In the Reference Year maximum and minimum temperatures are stated at both 7 a.m. and 7 p.m. as 12 hour values.

Criteria and correction of errors: Maximum temperatures below the highest not rejected hourly values in the preceding period are raised. Maximum values exceeding the highest registered hourly values by 2° C are rejected and replaced by the highest hourly values. Likewise, the minimum temperatures are worked up. At night, however, extreme temperatures exceeding the hourly values by max. 4°C are accepted, because of the long intervals where no measuring takes place.

3 temperatures have been rejected for being too extreme, and about 85 for not being sufficiently extreme.

Humidity of the air

As regards some of the months, in the original material the relative humidity (RH, Danish: RF) is stated for every hour, and "wet bulb temperature" (WBT) for certain hours. For other months WBT is stated for every hour, and RH for certain hours.

In some cases, in the original material discrepancies between the two statements of humidity have been found. In those cases as a principal rule the value stated every hour has been chosen. The only exception is November, where the statements of WBT every three hours are considered to be the most correct. The remaining hourly values were found by interpolation. Therefore the calculations for the individual months were made on the following basis:

January 61	WBT	July 63	RH
February 64	RH	August 6o	WBT
March 6o	WBT	September 65	RH
April 6o	WBT	October 62	RH
May 67	RH	November 64	WBT
June 61	WBT	December 61	WBT

Criteria: Wet bulb temperatures above temperature of the air are not accepted. Changes in the calculated dew point temperatures (DPT) not exceeding 2° C/h are accepted. Greater changes per hour are accepted if, together with preceding and succeeding values or in connection with the other data - changes in temperature, showers, changing directions of the wind - they seem to be reasonable. Dew point temperatures above air temperature are not accepted.

In about 4o cases it was judged necessary to make corrections. Out of these, 3 were that the WBTs were stated as being o,1° C above the air temperatures, and in 12 cases the DPTs had exceeded the air temperatures during an interpolation.

Presumably a part of the other errors are due to "over-swing" in hair hygrometers.

In every single case of incorrect dew point temperatures, these have been replaced by values found by interpolation between the preceding and succeeding values, or, in cases where

this would raise the DPT till or over the temperature of the air, by a value o,1° C below the air temperature.

In addition to this, there were registered a large number of cases, where the wet bulb temperature or the dew point temperature had changed more than 2°C/h, but where the measurement was judged to be acceptable.

Radiation data

The hourly values for the total radiation at Tåstrup have been read off from multipoint recorder charts, except for the month of May. The registration appears in the form of points, and in a lightly clouded weather it can be difficult to estimate a reasonable hourly mean value from about 24 points extended over a long interval, dependently on the actual sun and shade. The daily sums of these hourly values have been compared with the ones found from the same multipoint recorder charts by the Hydrotechnical Laboratory at the Royal Veterinary and Agricultural High School.

Deviations not exceeding 5 per cent or 5o W/m^2 of the 24 hour sums, are accepted. For 34 days with considerable deviations, the reading off from the recorder charts has been repeated and checked.

In excess of this there have been 4 periods of different lenghts, 3 - 48 hours, for which the registration is missing. Those are days with cloudy weather, and here values of the total radiation calculated on the basis of cloud observations at Værløse have been inserted.

For the month of May, for every lo minutes the registration can be found on a code tape. The hourly mean values are calculated on the basis of the measurements with the minute indications of 4o, 5o, oo, lo, 2o, and 3o.

Discrepancies between the hourly values for the measured global radiation at Tåstrup and the observed cloud cover at Værløse have necessitated in a number of cases the use of a modified cloud cover for the calculation of diffuse radiation and normal radiation (reference 6).

Wind

Missing data on wind velocities have been linearly interpolated.

Missing data on wind directions are more specially treated. For missing hourly values a linear interpolation via the smallest angle has been made. At intervals of two hours, the nearest adjacent values have been inserted. For three missing hours, the outer values have been put equal to the adjacent values, after which the central value has been found by interpolation. For longer intervals, however, and in some cases where the wind has turned 180°, it has been necessary to manually insert reasonable data. Here comparisons with data measured at Kastrup (Daily Weather Report) have been made. Different criteria for sorting out incorrect data, which could show as unreasonable jumps of wind direction or wind velocity, have not discarded any values.

Indication of corrected and added data

For each hour of the Reference Year an indicator A, which is 0 if all data are authentic measured data, is stated. The presence of corrected or added ("synthetic") data is indicated by A being given values diverging from 0.

Indicator A = 1oo Minimum temperature
2oo Maximum temperature
1o Direction of wind
2o Velocity of wind

1 Temperature of the air
2 Relative humidity, or wet bulb temperature according to the value used
4 Global radiation, if it has been calculated on the basis of cloud observations at Værløse, or distribution on diffuse radiation or normal radiation, if it has been necessary to include a modified cloud cover in the calculations.

The indicator values are summed up, if several data are "synthetic".

APPENDIX 1

Short translation of app. 1 in: Meteorological data for Design of Building and Installation, Reference Year.

Weather parameters in the Danish Reference Year

All data are given per hour unless otherwise specified.

Dry bulb temperature. Measured in a meteorological hut, 2 m above ground.

Tenths of degree C

Dew point temperature, tenths of degree C.

Relative humidity, percent.

Enthalpi of air. kJ/kg. Calculated from the expressions:

$$i = 1.005 \cdot t + 1.84 \cdot x \cdot t + 2500 \cdot x$$

where t is temperature, and $x = 0.622 \cdot p_d / (1013 - p_d)$

$$p_d = 6.106 + 0.460 \cdot t_d + 0.01093 \cdot t_d^2 + 0.000467 \cdot t_d^3$$

for $0^0C \leq t_d \leq 30^0C$

$$p_d = 6.106 \cdot (1.0852 - 0.0004 \cdot t_d)^{t_d}$$

for $-20^0C \leq t_d < 0^0C$

and i is enthalpi of air, kJ/kg

x is moisture content of the air, kg/kg

p_d is partial pressure of water vapor, mbar

t_d is dew point temperature, degree C

Maximum and minimum of air temperature

Given at 7 a.m. and 7 p.m., for the preceding 12 hours. Tenth of degree C.

Snowdepth Given once a day 1 p.m. cm.

Sunshine, hours. Given once a day, 11 p.m. total for the day. Tenths of an hour. Measured at Copenhagen Harbour, (Office of Customs).

Sunradiation. Global radiation on a horizontal surface, intensity W/m^2. Every hour. Measured in Taastrup.

Direct normal radiation (beam radiation)

Diffuse sky radiation on horizontal surface. Direct and diffuse are values computed from global radiation and cloud cover observations. A modified Kimura-Stephenson method is used.

Precipitation mm Given 7 a.m. and 7 p.m., for the preceeding 12 hours. Tenths of mm. -1.o indicate precipitation less than o.1 mm.

Cloud Cover Observations. Okta's. Total cloud cover is given every hour, the others at 1 a.m., 4 a.m., 7 a.m. etc.

Clear sky	N=0
Part of the sky covered:	
1/8 or less	1
2/8	2
-	
-	
7/8 or more	7
8/8, overcast	8
Amount of cloud cannot be observed	9

The other cloud data follow the WMO observation practice.

Wind direction and wind speed.

Measured 10 m above ground, mean value for 10 minutes.

Direction is given as tens of degrees from north. 09 is east, 18 south, 27 west, 36 north, 00 is calm and 99 is unsteady, low speed.

Wind speed, knots (1 knot = 0,514 m/s)

Barometric pressure. "Reduced pressure" to sea surface, and corrected for temperature. Given in tenth of mbar minus 900 mbar.

Example: 1045.6 mbar is given as 1456.

Content:

References:

1) Danish Meteorological Institute et al: Meteorological Codes (in Danish), Copenhagen 1967.

2) Danish Meteorological Institute: Håndbog vedrørende meteorologisk observations-tjeneste (in Danish), 1971.

3) World Meteorological Organisation: Guide to meteorological instruments and observation practices. WMO-No.8. TP 3. Geneva 1971.

4) H.C. Aslyng and Sv. E. Jensen: Radiation and Energy Balances at Copenhagen 1955-64. The Royal Danish Veterinary and Agricultural High School, 1966.

5) K. Kimura and D.G. Stephenson: Solar Radiation on Cloudy Days. ASHRAE transactions no. 2106, 1969/II.

6) Hans Lund: Diffuse and direct radiation in cloudy weather. (In Danish, unpublished). Internal report, Sept. 1973, Thermal Insulation Laboratory, Technical University of Denmark.