The CIBS Example Weather Year for Kew (1964/65) has been established[1], and some reduced data published[2,3]. The thinking behind the concept of an example weather year was presented by Holmes and Hitchin in 1974[4], since that time the process of selection has been formalised by a CIBS task group under the auspices of the Computer Applications Panel. Two more example years have been selected for areas represented by the Aldergrove and Eskdalemuir Meteorological stations. This paper presents these 'new years' describing how they were selected, how the data is to be interpreted and gives some general advice on obtaining suitable data from the meteorological office.

The 'Example Weather Years' selected to date are:

Kew	Oct. 1964—Sept. 1965
Aldergrove	Oct. 1977—Sept. 1978
Eskdalemuir	Oct. 1970—Sept. 1971

A

The CIBS example weather year

CIBS Example Weather Year Task Group:

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1 Introduction

Weather data is an essential ingredient of both building thermal load and energy consumption calculations. The increased application of computers in the building services industry has resulted in a demand for more detailed weather data. Basic information is readily available, at a price, from the Meteorological Office, airports, agricultural research stations and similar institutions.

These data (when processed) will, in general, be used to predict energy consumption and to compare the performance of different design options. These options may be generated by a single design team or could be the result of a number of submissions from different sources. The Institution considers it desirable that the weather data used to generate these predictions should be identical, so that comparisons are meaningful.

The use of selected meteorological parameters for design purposes is well documented in the CIBS Guide, Section A2. However, these external design parameters are, in essence, only the agreed values of the climatic variables used for defining the size of any space conditioning systems required to maintain comfort conditions and are therefore of little value in either the prediction of energy consumption or typical performance.

It is not possible to predict weather far in advance due to its complex origins and so, it is reasonable to use historical data to test the potential energy performance of buildings and systems. The ideal timespan would be equal to the life of the building/system under investigation, but such an approach is likely to be too costly and so, in practice, shorter timespans have to be considered. The most convenient period of time is a year, as weather conditions follow an annual cycle. However, it has to be recognised that no single year can include all variations. It may be possible in some cases to ignore part of the year as, for example, the summer months are usually unimportant when considering heating demands.

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The year chosen to represent the weather could be an actual year or one synthesised from selected days, weeks or months. In theory, a synthesised year should be able to produce a better statistical representation of the past, but in practice, this is very difficult to realise[5]. For an historical year, selection becomes a matter of choosing the least abnormal year from those for which data are available.

In order that this subject might be given serious consideration, the Example Weather Year Task Group was established by the Computer Applications Panel of the CIBS. The Task Group was unanimous that a real year should be used and many methods of selection with varying degrees of complexity can be envisaged. It was, however, recognised that a year chosen as suitable for representing weather in S.E. England may not be satisfactory for other sites in the UK. Thus, a number of these samples or 'Examples' of the UK climate would be required. The selection method should therefore be relatively simple and not require the purchase and analysis of, say, 20-year hourly weather tapes.

The simplest manual method is probably that described by Stamper[6]. It is an ASHRAE method based on monthly mean dry bulb temperature and the discrimination technique used is one of rejecting extremes. First the year with the warmest January is rejected, then the one with the coldest August and so on, using the other months until only one year remains. This method is reasonable when only a single parameter is involved. A more comprehensive method is that described by Holmes and Hitchin[4]. This method basically involved the rejection of years with months that differed significantly from the long term mean. The method permitted the inclusion of any parameters thought to be significant.

The Task Group decided that:—

(1) The 'CIBS Example Year' should be a real year.

(2) The selection method should be that proposed by Holmes and Hitchin.

(3) The year should start on 1 October as this was considered to be the beginning of the heating season. Thus:

(a) Continuous data are available for both air-conditioning and heating during periods of high load.
(b) Simultations can commence in a period of low load, thus minimising 'start-up' errors.

These proposals were fully discussed at a CIBS discussion meeting held in February 1979.

Full details of the selection method are given in Section 3 and it is the intention of the Task Group to select an Example Year for each of the Degree Day Regions in the UK for which suitable data are available. These years will be given the title 'CIBS Example Weather Year'.

The CIBS Example Weather Year should be used unchanged throughout each degree day region. This is to ensure that comparison between different system and building configurations can be made from a common basis for weather. It is intended that the use of real weather data should ensure that no system will be 'favoured' due to unusual combinations of weather.

2 Selection procedure

The object of the procedure is to select a year for which the monthly mean values of a number of pertinent parameters do not differ by more than a specified number of standard deviations from their long term mean. No weighting is given to any single parameter because this would involve some form of constraint on the generality of application of the selected year (and could bias design to a particular building type). One combination is used; that between wind speed and temperature which takes the form of Jackmans Infiltration Number[7] and, whilst directly related to ventilation, it covers all cases where wind speed and temperature appear as multiples. For example, convective heat loss from the outside of the building or solar collectors.

The parameters covered are:
Global radiation on a horizontal surface,
Diffuse radiation on a horizontal surface,
Daily mean wind speed,
Mean maximum dry bulb,
Mean minimum dry bulb,
Mean dry bulb, and
Infiltration number (windspeed × (18.0 — dry bulb)).

Hitchin and Holmes[4] proposed that the number of standard deviations used as the filter should be two. That is, if the weather parameters were normally distributed about the mean, 95 per cent of the values would pass through the filter. Experience has shown that a small increase in this band width (about 0.2) allows a very large number of years to pass the test whilst a similar decrease means that all years are likely to fail. There is always the possibility that more than one year will pass the test, so the final selection, from the years that pass, will be the one with the lowest total deviation of all parameters from the long term mean values.

The original Kew year was selected using a hand-held calculator. However, the amount of data to be handled really necessitates the use of a computer and a suitable program has been prepared, using an improved final rejection technique. This program was used by the Task Group to select both the Aldergrove and Eskdalemuir years. The selection for Kew was not repeated using the program, as the Kew Year will be reconsidered as part of the rotational re-examination of chosen years every ten years. Further data will be included in the reconsideration.

The method used by the Task Group is as follows:—

(1) Obtain monthly mean values for the past 25 years (if available) using the 'Monthly Weather Summary' published by the Meteorological Office. Some of the data may be missing. These can be ignored if the year is rejected on another parameter, but can be obtained at a later date on request from the Meteorological Office if not.

The following algorithm is now followed:

(2) Read in data—set any missing values to 999.

(3) Using data for each January, calculate the following for each weather parameter (i.e. direct solar, dry bulb, etc.), (where the value is 999, move to next January).

Infiltration number—this then is treated as a weather parameter

TVAL : parameter
TOT : sum of values (ΣTVAL)
TOT2 : sum of squares of TVAL
SUMT: total number of values of the parameter for January

At the end of all data for January:

Mean
TBAR = TOT/SUMT

Standard deviation

$$SDEV = \sqrt{\left(\frac{TOT2 - TBAR * TOT}{SUMT - 1}\right)}$$

(4) Repeat (3) for all months.

(5) Elimination Process: starting at the 1 October. Calculate for this and each of the next 11 months, for each parameter.

(a) Difference from long term mean. (Note that any missing data should assume the long term mean value.)
DELTA = (TBAR — TVAL)/SDEV.

If the absolute value of DELTA is no greater than 2, carry on, if not move to next October and start again as the year can be rejected.

(b) Calculate: SUMDEV : Sum of deviation of all parameters for the year.

(c) If all months of the year pass this test, the year is a 'potential example weather year.'

(6) If more than a single potential example year is selected, the year with the lowest total deviation (minimum SUMDEV) becomes the CIBS Example Weather Year. Should this year contain missing data, these items must be obtained and the procedure repeated before selection can be confirmed.

The above procedure is the minimum necessary to select an Example Weather Year, simple modifications can be introduced to give some form of data vetting and to show why a particular month was rejected. In addition, long term means, average deviation and other statistical information can be obtained. An example of the analysis of rejections is given in Fig. 1 for the Aldergrove and Eskdalemuir data, where the frequency of rejection of a particular parameter is given.

3 Weather data

This can be obtained on an hourly basis from the Meteorological Office at Bracknell. Department Met 01C supplies solar data and Department Met 03 supplies temperature data.

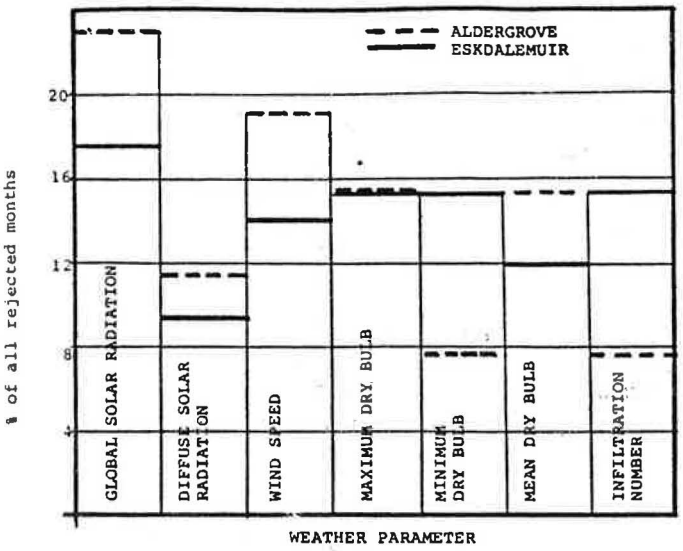

Fig. 1. Distribution of rejections.

The address is: Meteorological Office, Met 01C/Met 03, Eastern Road, Bracknell, Berkshire, RG12 2UR. Telephone: 0344-20242 extn. 2587 (1C), extn. 2278 (3).

The information requested can be supplied as computer print-out or as a magnetic tape formatted to the user's requirements. It is charged at a price per record (single reading) and its use is controlled by a very restrictive copyright agreement, which precludes CIBS (or a nominated organisation) from holding a ready formatted CIBS Example Weather Year tape.

Care must be taken to ensure that the data is read at the hour or averaged over the hour centred on the hour.

4 Concluding comments

In response to the need for agreed weather data for energy consumption calculations and evaluations of the relative performance of various building and system design strategies, the Example Weather Year Task Group of the Computer Application Panel have proposed a method of selection of the 'CIBS Example Weather Year'. The Example Weather Year consists of 24 × 365 hourly values of meteorological variables, starting on the 1 October.

So far, CIBS Example Weather Years have been selected for three Degree Day Regions. Work on the selection of Example Years for further regions is in progress.

In the meantime, for relative performance studies in regions so far not covered, the CIBS Example Weather Year of the nearest available region should be used.

The selection will be reviewed every ten years, wherever possible, based on the previous 25 years' weather data.

It needs to be stressed that, if the methodology proposed in this paper is used for the identification of example years for any other purposes, it cannot be considered as a CIBS Example Weather Year.

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1 CIBS Guide, Section A2.
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3 Letherman, K. M., Wai, F. M., Condensed statistics on the CIBS Example Weather Year, 1. External dry bulb temperature BSER&T, 1, (3), 157-159 (1980).
4 Holmes, M. J. and Hitchin, E. R., An 'Example Year' for the calculation of energy demand in buildings, Build. Serv. Eng., 45 (9), 186 (January 1978).
5 Isfault, E. and Taesler, R., Choice of climatic data to compute the energy requirements of buildings: a problem analysis, Swedish Council for Building Research, Stockholm (1975).
6 Stamper, F., Weather Data, ASHRAE Journal (February 1977).
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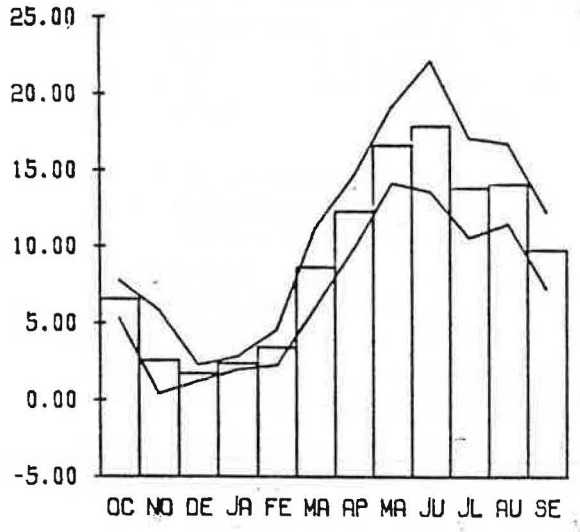
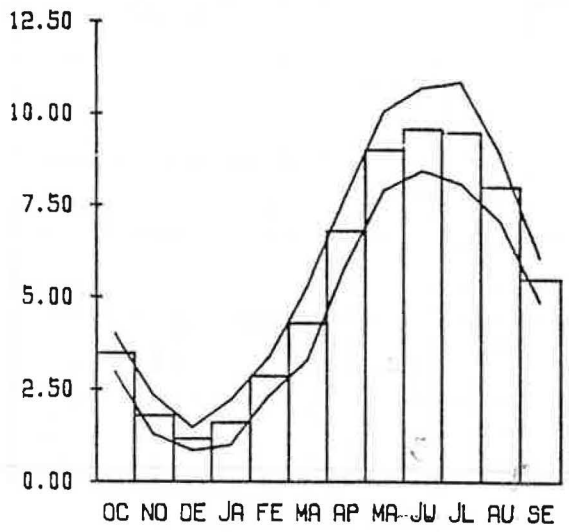
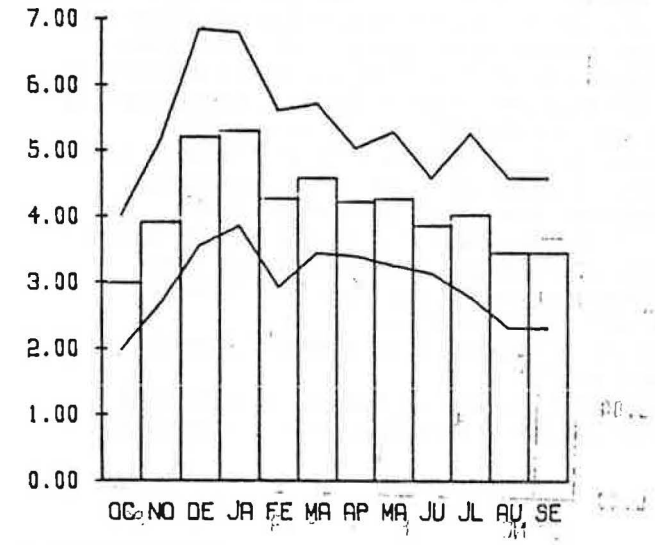
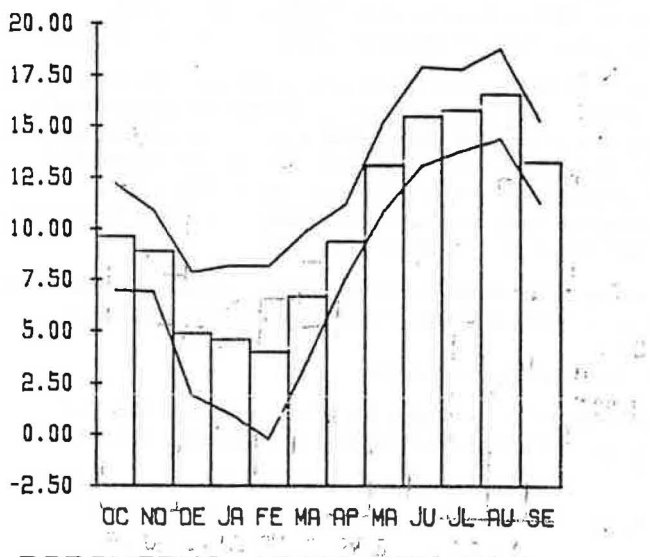
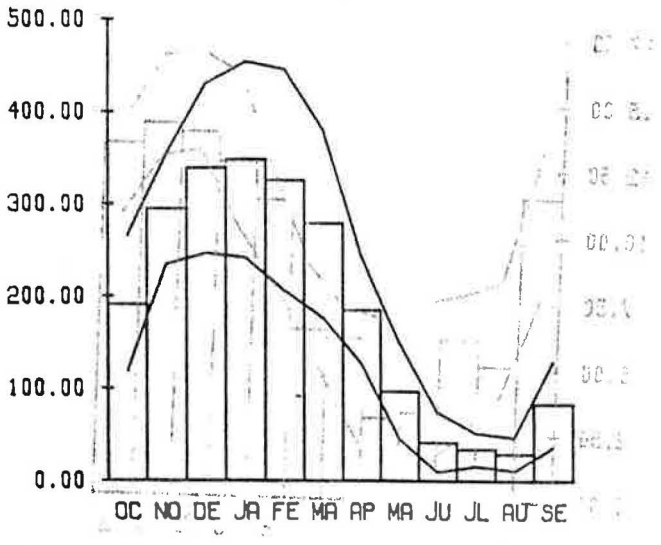










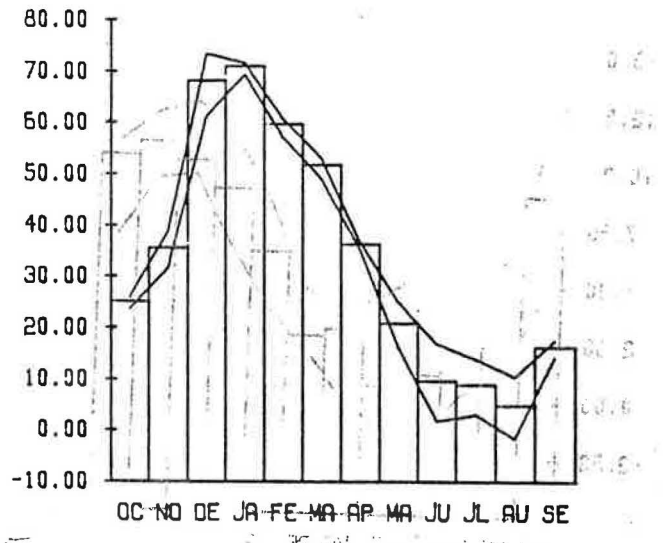
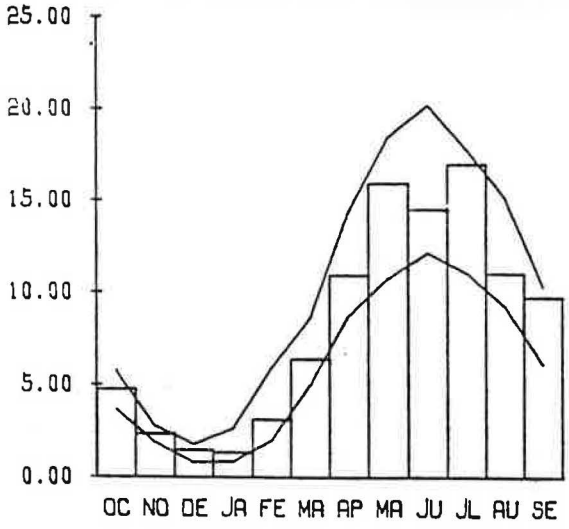


Fig. 2. CIBS Example Weather Year—Kew. Begins October 1964. Lines are ± 2 standard deviations about mean.



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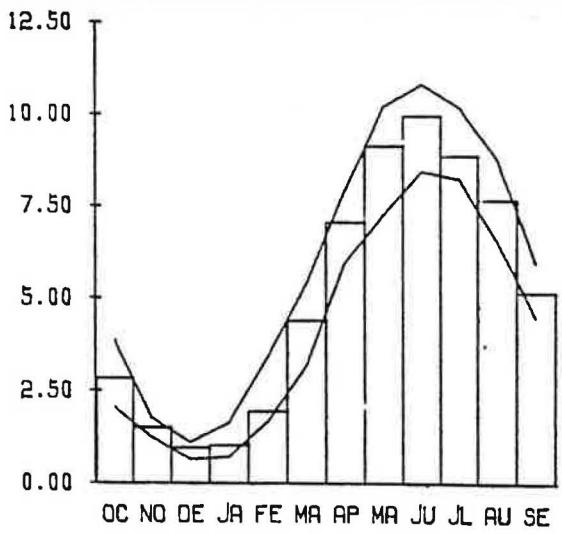

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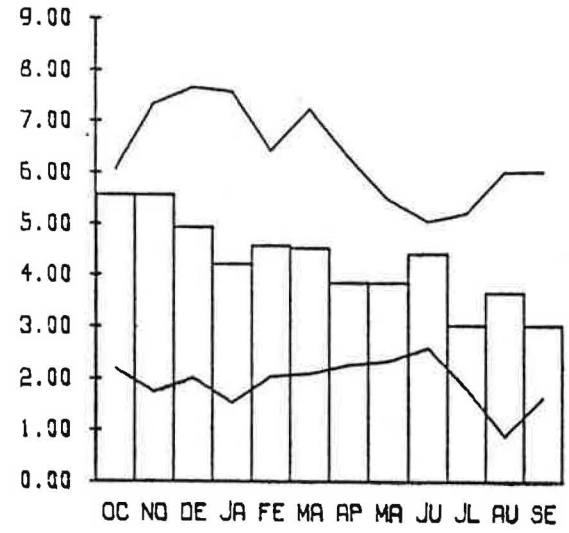

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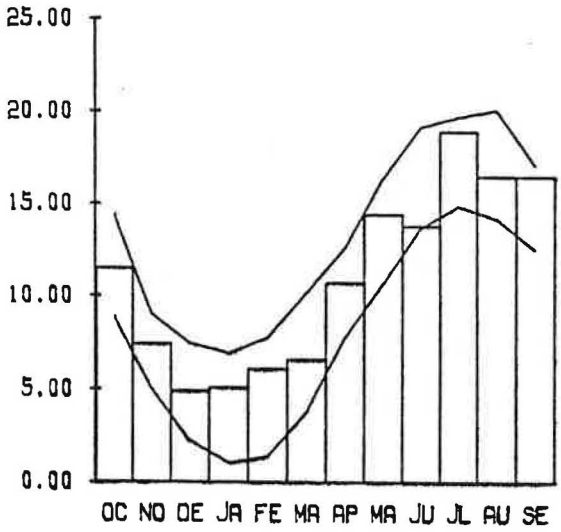
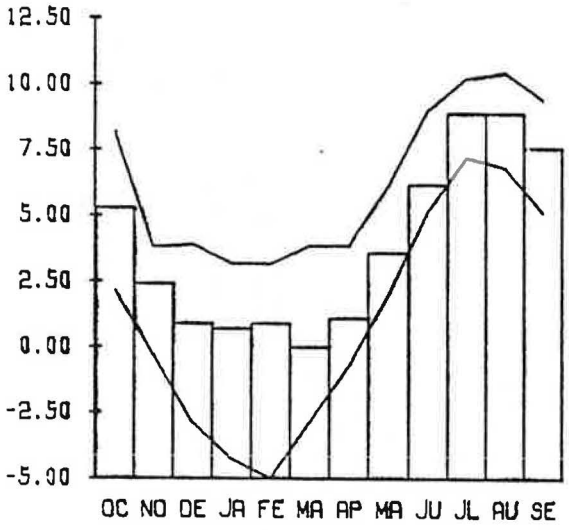


PARAMETER MAX DRY BULB



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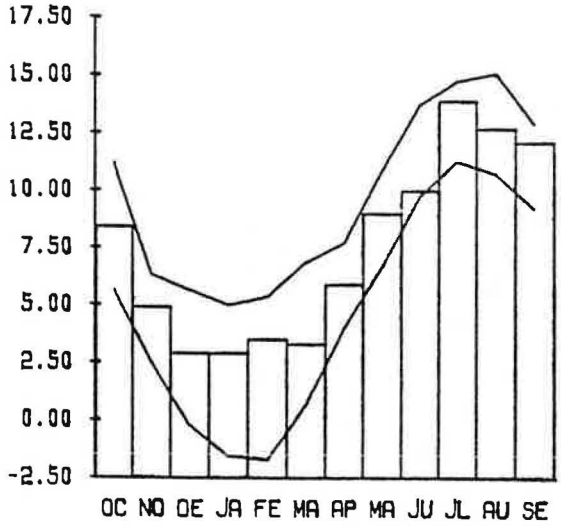
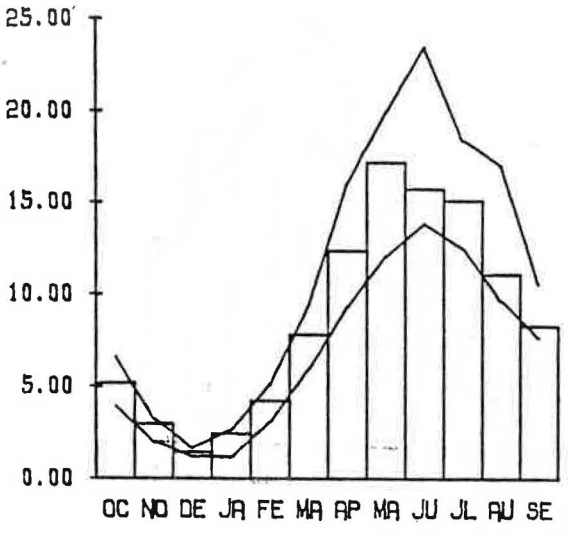


PARAMETER MEAN DRY BLB

Fig. 3. CIBS Example Weather Year—Eskdalemuir. Begins October 1970.



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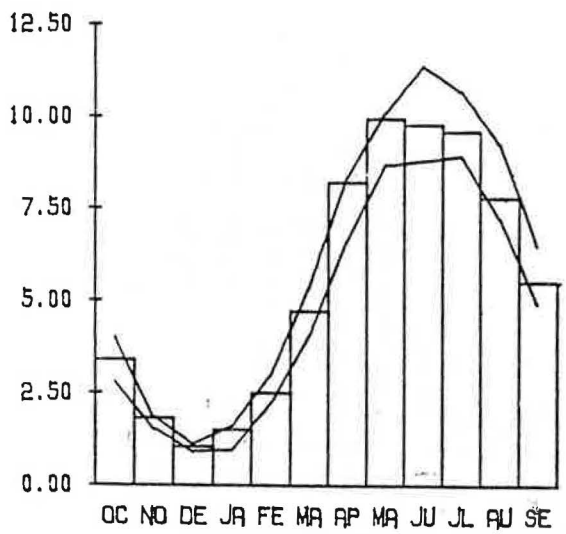

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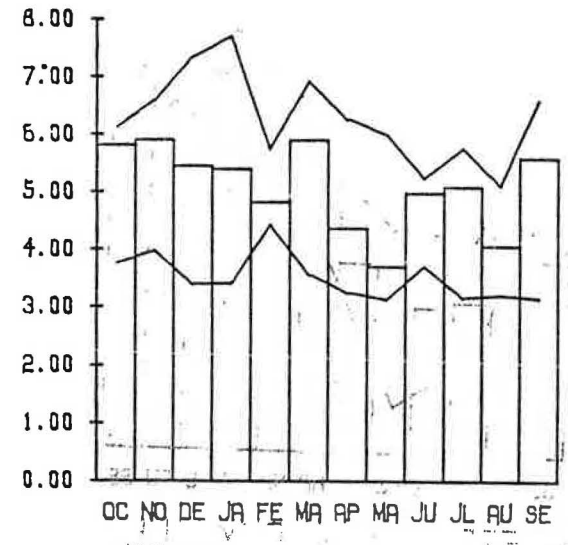

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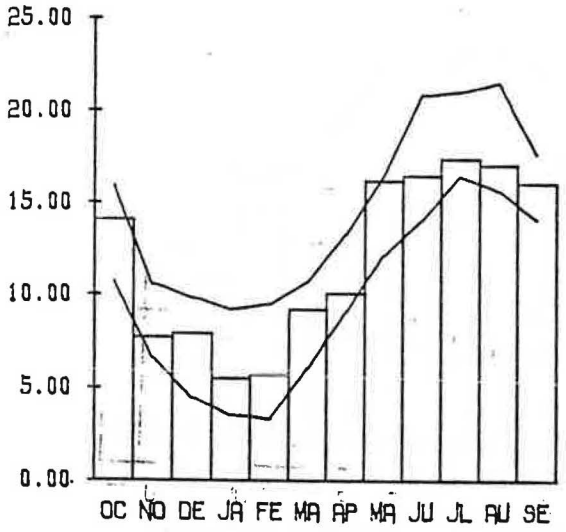

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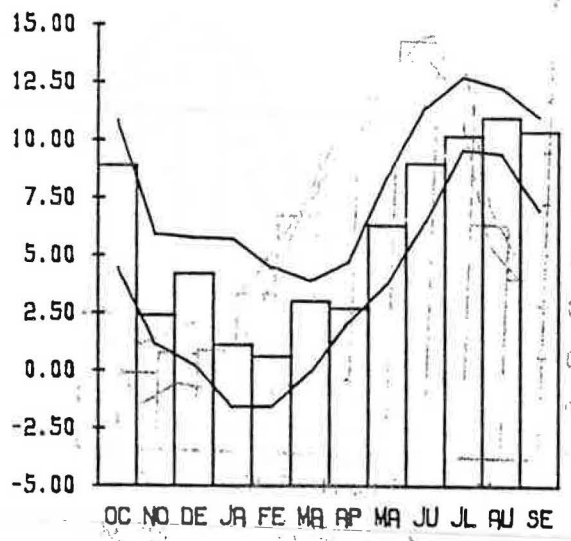

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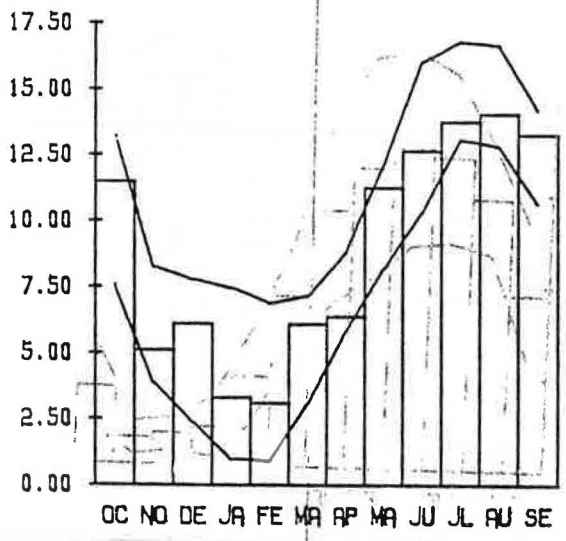

PARAMETER MEAN DRY BLB

Fig. 4. CIBS Example Weather Year—Aldergrove. Begins October 1977.